WP3 – RFID Standardisation

Working Draft 3, Final Report

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Table 1 Document history

Executive Summary

Work package 3 of project CE RFID deals with the topic of RFID standardisation. The main objectives of this work package are collection and analysis of all kinds of RFID concerning standards. This especially includes:

- RFID frequencies and radio regulations,
- RFID communication standards,
- RFID data standards,
- RFID network standards,
- RFID safety standards and
- RFID application standards.

The analysis of these standards shall take place with respect to overlaps, inconsistencies, sector specific standards and gaps within standards. After the analysis of different standards recommendations for European RFID, standardisation activities will be developed.

The aim of this document is to illustrate the working method of work package 3 and to reveal the results that were achieved.

During the project phase three workshops have taken place in order to collect different standards, to settle up a standards database and to analyse collected standards. Topics of these workshops were:

- Analysis and evaluation of available standards in the fields of radio regulations, air interface standards and safety standards
- Analysis and evaluation of available standards and regulations in the fields of RFID Data and Network Standards
- Analysis and evaluation of the available standards and regulations in the fields of RFID applications.

During the analysis of the standards, following basic recommendations were developed:

For the development of the European RFID market it seems necessary to support standardisation processes in the fields of radio regulations, air interfaces and tag data. Only a unification of pan-European regulations will be able to strengthen co-operations between different standardisation bodies and the position of European technology providers.

Another general recommendation is that fewer and broader accepted standards should be developed, while it should be easier to understand and work with them at the same time.

According to standardisation processes, the co-operation between international and national standard development organisations (SDO) should be supported. Also, the co-operation between ISO and EPCglobal has to be supported and improved. In general, the involvement of European standardisation organisations in international standardisation processes should be supported. The aim must be to take a leading role in the international standardisation of RFID. Therefore, the involvement of SMEs should be supported. Further, it will be important to develop licence free standards and to ensure an easy access to standards. Standards that already are developed must be improved continuously and should be applied internationally.

In the field of radio regulations the implementation of ERC/REC 70-03 annex 11B and the implementation of EC decision 2006/804/EC (11/2006) should be mandatory in all European countries. This decision regards to the UHF frequency band. In order to harmonise the existing frequency landscape, it seems to be helpful to work towards a single frequency authority in Europe. Moreover, it would be very helpful for Europe if more frequency resources would be available, especially for the UHF band. Currently, the United States provide a band with 26MHz bandwidth for UHF applications, while in Europe only 3MHz are available. For the HF band annex 9F11 is decisive. The implementation of this part should also be mandatory in all European countries. It would be helpful to develop international accepted high performance standards.

For standards concerning air interface protocols the main recommendation is to establish a uniform global standard for all industry sectors such as the compatible standards ISO 18000-6c and EPC Gen2.

In the field of data and communication standards the interoperability of barcode and RFID should be ensured. Therefore, it should be ensured that a migration path from the existing barcode data flow to a corresponding RFID data flow is set up and used.

Further suitable security methodologies should be developed, because different application areas need a different level of security.

Additionally, the development of standards for RFID combined with sensors should be intensified.

Generally speaking, it would seem very useful if the development of application guidelines as well as tools or methods for RFID applications would be initiated.

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1 Approach

This section describes the objectives of this report and the topics of this work package. Methodology and structure of the work package are described. Furthermore, this chapter gives several definitions and reveals why standards are an essential part in technology processes.

The members of work package 3 are:

- FEIG ELECTRONIC GmbH, Germany
- EADS Deutschland GmbH, Germany
- RF-iT Solutions GmbH, Austria

FEIG ELECTRONIC GmbH

For more than 35 years FEIG ELECTRONIC GmbH has specialized in contactless identification (RFID), door controllers and traffic sensor technology. FEIG ELECTRONIC was established in 1970 and employs about 170 staff members. The company is located in Weilburg, Germany. FEIG ELECTRONIC has many years of experience in development within all business fields and focuses on High Tech products in all divisions. Beyond it, FEIG ELECTRONIC is involved in research and standards development in co-operation with universities, industry organisations as well as industrial partners.

Within this work package, FEIG ELECTRONIC is responsible for standards according to frequencies, air interfaces and safety.

Internet: www.feig.de

EADS Deutschland GmbH

European Aeronautic Defence and Space Company (EADS) is Europe's prime aerospace and Defence Company and the second biggest worldwide. In 2005 EADS revenues amounted 34.2 billion EUR. EADS employs more than 113,000 people at over 70 sites in France, Germany, Great Britain and Spain. EADS Corporate Research Centre (CRC), with sites in Germany and France, provides world-class research capabilities, which correspond to cross-business-units interests. The research activities of EADS CRC Germany are: materials, structures and manufacturing, systems engineering, electronics, microsystems and sensors, optronics, lasers and image processing, mechatronics and adaptronics, structural dynamics and acoustics, passenger comfort and crew assistance.

Within the work package, EADS Deutschland GmbH is responsible for specific standards for applications.

Internet: www.eads.net

RF-iT Solutions GmbH

RF-iT Solutions GmbH was established as an Infineon management buy-out in 2005; its activities cover RFID software and services. It produces RFID platforms for system integrators. RF-iT Solutions GmbH implements reference projects in strategic market segments. With technical services, such as studies, technology assessments, benchmarking, technology consulting and pre-sales support, RF-iT Solutions forms the technical backbone for system integrators.

Within this work package, RF-iT Solutions GmbH is responsible for data and networking standards.

Internet: www.rf-it-solutions.com

1.1 Definition of this work package's topic

Definition:

In the context of technologies and industries, standardisation means a process of establishing a technical standard among competing entities in a market, where this will bring benefits without hurting competition. A standard is a rule or method that describes framework requirements.

During the past years RFID (Radio Frequency Identification) technology has become a key ICT technology. Especially within the asset tracking segment, which is pushed forward by logistics applications, a boom is expected. In this fast growing technological environment there is a special need for harmonised frequencies and a standardisation of communication protocols and data formats.

Despite Europe’s strong position in RFID applications and technologies there is still a lack in formulating and enforcing standards. Through the deficiencies in European unified standardisation, the USA is to be considered as decisive for RFID developments and the definition of the basic infrastructure. Users and vendors have agreed to work together in the proposed co-ordination action CE RFID to improve the conditions of competition for RFID technology and its further development in Europe. The activities of the project are aiming to strengthen the RFID value chain in Europe and to rein-force the position of European RFID vendors and RFID users as first-rate players in the most promising RFID market. work package 3 cares about the topic of “European RFID standardisation” within the project CE RFID.

Nevertheless, the project is not trying to establish new RFID standards. On the contrary, the working group will promote the harmonisation of European RFID frequency regulations, data formats and will foster the European participation within international standardisation processes.

The strategic objectives of CE RFID are:

- to set up a sustainable network of RFID technology providers, vendors and users,
- to coordinate the various activities of European industry and research institutions in the field of RFID,
- to elaborate suggestions for an effective harmonisation of RFID related frequencies and data standards,
- to provide recommendations for a European RTD policy on RFID, and
- to support the European Commission to increase political awareness and intensify activities for the enhancement of new technologies.

The standardisation of technologies and processes is quite necessary. Usually, such actions are taken by governments, industries and consumers. Standards generate a lot of benefits for stakeholders in industry and society. The most important advance is the establishment of interoperability and compatibility. Standards provide a level of assurance on compatibility of products, devices and services with other existing or future developments. Benefits of standardisation processes are the removal of trade barriers as well as improvements of safety and healthcare. Standards are clearly defining which attributes products shall have and which requests have to be carried out to serve a market. This fact encourages companies to enter new markets and contributes to enhance competition. Economies of scale are facilitated by standards, too. This has a very important impact on suppliers. Another advantage for both suppliers and users is the increasing of variety in products as well as the possibility to control its growth at the same time.

Standards are crucial when goods are transported between companies. If a certain company wants to exchange data to another company, even in case the latter is located in another country, a secure and clear transmission by the used transponder has to be guaranteed. Therefore, especially storage and processing of data of passports cannot be possible without bilateral agreements and standards.

The existence of radio regulations to rule the use of frequency bands and to secure the coexistence with other radio devices and services also seems to be very important.

In Europe the RFID industry has to deal with several problems caused by discrepancies in standardisation. Still there is a large number of national and sector specific data standards and frequency regulations. RFID applications transmit by various frequency bands. The UHF frequency band (865–868MHz) is not sufficient for ensuring failure-free readouts. The results are frequency overlaps and data collisions. The RFID sector lacks the total harmonisation that has been performed for radio frequencies for mobile phones. Various member states still operate legacy systems (applications based on older technologies) in frequencies that are seminal for RFID technology. This is exacerbated by poor assertions of the European RFID Norm 302208 in individual EU Member States. Due to the scarcity of frequencies current EU regulations require a "listen-before-talk" hardware. This leads to higher costs in the process of manufacturing and to more expensive systems. Indeed, technology standards have been widely adopted, but not data standards. This can be a great danger and serious obstacle for the ongoing development and interoperability of RFID technology. Because of missing mandatory rules and regulations there is a large number of differing voluntary standards in the specific industry sectors. Interoperability problems between the various industries are becoming apparent more and more because cross-industry requirements usually play a minor role within a given industry. However, to fully exploit the technology's potential, cross-industry and inter-European standards have to ensure interoperability. The slow diffusion of RFID technology also is a result of incompatible European data standards.

By participating in a standardisation process, the members of Work package 3 are trying to pay attention to these problems. The main objectives of this work package are the collection and analysis of all important RFID standards that can be found in Europe. This includes international standards as well as local regulations of all different categories. The found standards can be systematised as follows:

- RFID frequency and radio regulations,
- RFID communication standards,
- RFID data standards,
- RFID network standards,
- RFID safety standards and
- RFID application standards.

The collected standards from different application fields were subdivided into different types and categories. These categories are:

- general standards,
- EC legislation,
- mandatory standards,
- air interface standards,
- reader interface standards,
- data management interface standards,
- data standards,
- sensor standards,
- application interface standards,

- application standards,
- information network service and interface standards and
- guidelines.

Furthermore, collected information about current requirements and needs from different application sectors such as retail, fast moving consumer goods, logistics, pharmaceutical industry and healthcare, textile and garment industry, libraries, automotive and defence industry was collected. The results of this broad investigation are given in form of recommendations that should promote the European RFID value chain and be further passed to the European Commission.

1.2 Structure of work package topic

The results of this work package are presented in different steps. This will provide a wide and well-structured overview over results and state of the art.

One part of this report shows different standard development organisations. These organisations act on an international, a European or just national level, whereas within this report these organisations will be revealed as either governmental or industrial.

A short description of the described organisation, their members and standardisation activities shall be given as well.

Another chapter will divide collected standards into different categories, depending on the specific character of each standard. That is to say, that in some cases a standard might be mandatory for everybody and implemented by law, but it might be voluntary in form of guidelines or technical reports as well. Further criteria for classification are the particular organisation that developed the standard and the concerned issue.

A third chapter elaborates prevailing standards independent of application. In this chapter the most relevant standards for frequency bands, air interfaces, health and safety, environment are described. Furthermore, this chapter shows the most important EC directives concerning RFID.

In addition to this chapter there also is a section dealing with standards related to applications. This chapter uses the CE RFID reference model to provide an overview over different application fields and most important standards.

Very important topics for the rising RFID market are privacy and data protection. In a short section of chapter 3 (3.7) work package 3 also reveals the most important standards for protecting data and privacy related to RFID. A more detailed description of this issue can be found in the report of work package 5.

A further chapter deals with intellectual property rights (IPR). IPR Models of different organisations are given and the points of view of users, technology companies and SMEs described. Further on, the influence of IPR on standardisation is presented and recommendations for improving the current situation were developed.

Last, but not least, there is a chapter describing and justifying recommendations to be passed on to the European Commission.

1.3 Relevant stakeholders

The following subsection will describe the most relevant stakeholders for this work package. Corresponding to the DoW, mainly the following standardisation bodies and industry organisations will be considered and will only be addressed explicitly within this report if necessary. Some of these organisations have participated in this work package as additional contributors to take the project to a successful conclusion. The most important stakeholders for work package 3 are standard development organisations (SDOs). These are independent if they are acting on an international, European or a national level.

- International level
  - ISO/IEC
  - ITU-T
  - EPCglobal
- European Level

- CEN
- ETSI
- CENELEC
- GS1 Europe

- National Level
  - DIN, BSI and other national organisations
  - National representations of GS1 and EPCglobal

A description of these different standard development organisations can be found in chapter 3.1.

Further relevant stakeholders for work package 3, contacted either for participation as additional contributors or reviewers of the report are listed in the stakeholder list of WP3. This list divides stakeholders into different groups:

- RFID technology providers,
- RFID users,
- business associations,
- research and development,
- governments and governmental organisations,
- quasi-autonomous and non-governmental organisation and
- standardisation organisations.

Within work package 3, most of these groups are presented as additional contributors and have taken an active part in research.

2 Methodology

This chapter describes the methodology of work package 3. In the first part it shows the way the research was performed, which sources for information were used and how results were achieved. The second part of this chapter describes the criteria for the assessment of current standards.

2.1 Work performed

At the beginning of this project, the findings of the projects COPRAS and NO-REST have been reviewed and analysed. Both projects deal with processes of standardisation. However, RFID standards have not been the central topic of these investigated projects Nevertheless, the received results are of interest for standardisation in general. This analysis provided a well-founded knowledge about characteristic working methods.

In the ensuing project stage three workshops have taken place. The project partners met with additional contributors who are experts in different fields of standardisation. The topics of the three workshops were:

- Workshop 1, September 20, 2006 in Weilburg / Germany
  - Analysis and evaluation of available standards in the fields of radio regulations, air interface standards and safety standards.
- Workshop 2, November 17, 2006 in Munich / Germany
  - Analysis and evaluation of available standards and regulations in the fields of RFID Data and Network Standards.
- Workshop 3, January 19, 2007 in Graz / Austria
  - Analysis and evaluation of available standards and regulations in the field of RFID applications.

Every workshop was organised as a presentation of its topic, a collection of material, discussions and analyses.

The invited additional contributors were asked to deliver additional knowledge concerning standards development organisations and different types and categories of standards. Work package 3 tried to include organisations and companies with more widespread knowledge as well as organisations and companies with more specified knowledge. The aim was to achieve detailed and objective results and to cover all aspects of relevant standardisation issues. The additional contributors were able to support the project not only during workshops. During the complete time of the project different contributors were contacted and asked to provide their information. This method was very successful because thus the members of work package 3 were able to deliver a wide span of opinions on various topics.

Project partners, additional contributors and their knowledge:

Partner / add. contributor	**Knowledge / category of standards**
FEIG ELECTRONIC GmbH	General, air interface, spectrum, safety and reader interface standards
EADS Deutschland GmbH	Application and application interface standards
RF-iT Solutions GmbH	Data, data management and network standards

Table 2 Project partners and their knowledge

Additional Contributor	**Knowledge / Category of Standard**
GS1 / EPCglobal	All categories of standards, EPC global standards
IATA	Application and application interface standards
AIM European RFID Expert Group	Broad knowledge through a wide membership base
ETSI TG34	radio regulations
BITKOM	Broad knowledge through a wide membership base
7id	Software standards
Pepperl + Fuchs	Radio, frequency, application, production and Monitoring Standards
CISC Semiconductor GmbH	ISO and EPC global standards, sensor standards

Additional Contributor	Knowledge / Category of Standard
EURO I.D. Identifikationssys-teme	Application and application interface standards
Eurodata Council Stichting	Application and application interface standards, bar-code standards
Identec Solutions	Application and application interface standards
Airbus	Application standards
Infineon	Data standards and RFID transponders
University of Dortmund	General knowledge

Table 3 Additional partners and their knowledge

GS1 / EPCglobal

GS1 business is engaged in designing and implementing global standards and solutions. The objective is to improve the efficiency and visibility of supply and demand chains globally and across sectors. The GS1 system of standards is one of the most widely used supply chain standards system in the world.

Internet: www.gs1.org

IATA – International Air Transport Association

The International Air Transport Association (IATA) is a global trade organisation. IATA has developed commercial standards for more than 60 years. Today, IATA's mission is to represent, lead and serve the airline industry.

Internet: www.iata.org

Pepperl + Fuchs

Pepperl+Fuchs is a global manufacturer of electronic sensors and components for the automation market and employs more than 3450 employees. The company's aims are continuous innovation, enduring quality, and steady growth.

Internet: www.pepperl-fuchs.de

AIM RFID Expert Group

AIM Global is an industry trade association for RFID and automatic identification. The RFID Experts Group (REG) was originally founded by the U.S. Department of Defence in 2004. Later on it was assigned to AIM Global. REG's mission is to identify terms of reference and to develop specific implementation guideline documents for the use of governments, industry and individual companies.

Internet: www.aimglobal.org

ETSI ERM TG34

The European Telecommunications Standards Institute (ETSI) is an independent, non-profit organisation, who produces telecommunication standards. TG34 represents the interests of the RFID industry within ETSI. It develops deliverables for RFID technologies that are currently not covered by generic standards. TG34 also takes care of the co-existence of RFID devices and other products. TG34 cooperates with TG28 which also deals with RFID Standards.

Internet: www.etsi.org

CISC Semiconductor GmbH

CISC Semiconductor GmbH is a service company engaged in design and consulting for industries that develop embedded microelectronic systems, including RFID systems with extremely short time-to-market cycles. The company is privately owned at 100 % and was founded in 1999.

Internet: www.cisc.at

BITKOM

BITKOM represents telecommunications and new media industry in Germany. The organisation aims to optimise the political and economical framework for the IT-industry. Strengthening mid-sized ICT firms and promoting innovations are the main objectives of BITKOM. Economic growth and employment in Germany shall be supported and secured.

Internet: www.bitkom.org

7ID Technologies

7iD Technologies is an international RFID system integrator with headquarters in Graz, Austria. The company has long-time experience in the sector of modern RFID-technology and offers consulting for hardware and software components, as well as turnkey solutions in the areas of supply chain and asset management for pharmaceutical, paper and automotive industry.

Internet: www.7id.at

Infineon

Infineon Technologies offers semiconductor and system solutions. Thereby they are addressing three central challenges to modern society including energy efficiency, mobility and security. Approximately 42,000 employees (including approximately 12,000 Qimonda AG employees) are working for the company worldwide. With its global presence, Infineon operates through its main subsidiaries, such as: Milpitas, CA in the USA, Singapore in the Asian-Pacific region, and Tokyo, Japan.

Internet: www.infineon.com

EURO I.D. Identifikationssysteme

EURO I.D. Identifikationssysteme provides complete RFID system solutions to their customers. The working method of the company is to analyse the application first and then to provide an individual solution that cover all aspects in question. The company is located in Weilerswist.

Internet: euroid.com

Eurodata Council Stichting

EURODATA COUNCIL is an unincorporated association dealing with standardisation and harmonisation of solutions concerning supply chain management for cross industries. EURODATA COUNCIL was founded in 1997. The goal of the organisation is to assist industry members to optimise supply chain management projects by means of best industry practices and latest standards available.

Internet: www.eurodatacouncil.org/

University of Dortmund

At the University of Dortmund 3,000 scientists, including technical and other employees as well are working alongside approximately 24,000 students. The University of Dortmund combines academic tradition with modern approaches. Established in the 1960s as an answer to the structural crises of the former coal and steel district, it has enriched the educational scenery of Germany with new and partly unique study offers. Thus, the University of Dortmund has acquired the reputation of an innovative reformist university. The university has got partnerships and co-operations with universities and scientists all over the world.

Internet: www.uni-dortmund.de

Airbus

Airbus is one of the world leading manufacturers of airplanes. The company employs more than 10,000 people and its philosophy is to pay attention to the requirements and wishes of their customers. The development of new techniques, ideas and materials enabled Airbus to develop more comfortable and efficient airplanes. The headquarters of Airbus Deutschland are located in Hamburg.

Internet: www.airbus.com

Identec Solutions

IDENTEC SOLUTIONS takes an interest in the field of intelligent wireless identification technology. Founded in 1997, IDENTEC SOLUTIONS is a commercial supplier of long range RFID products and solutions. The company has got offices in Austria, Germany, the United States, Canada, and Sweden.

Internet: www.identecsolutions.com

In order to complement workshops and existing information, the additional contributors were able to provide already conducted web research as well as interviews and extensive networking. These activities had first started on an internal corporate level of the project partners, and were later extended to the complete CE RFID and external companies. These steps were performed because they guaranteed an easy access and provided a well-founded and widespread knowledge. Using this knowledge, external companies could be contacted and information could be specified and supplemented.

The contacted external companies are listed in the Stakeholder list of work package 3. The companies came from the following groups:

- RFID technology suppliers
  - Manufacturer
  - Solution provider
  - System integrator
- RFID users (based at the RFID reference model)
  - Logistical tracking & tracing
  - Production, monitoring and maintenance
  - Product safety, quality and information
  - Access control and tracking & tracing of individuals
  - Public services
- Business associations
  - General
  - SME
  - RFID and IT-specific
- Research & development
  - Applied research
  - Legal and Social Science
- Government and governmental organisations
  - International
  - European

  - National
- Quasi-autonomous and Non-governmental Organisation
  - Data protection agencies
  - Consumer organisation
- Standardisation organisations
  - International organisations
  - National bodies
  - Business driven organisation

2.2 Criteria for the assessment of current standards

All listed and described standards so far have been analysed in the same way. First, every application field has been examined for existing standards. After that, the by this means collected standards have been checked for usability. Moreover, the entire standards were analysed in order to find possible lacks and to verify that all standards together are covering the whole application field. Lacking standards were identified in order to make use of the full potential of the technology. Furthermore, it is necessary to check if there are competing standards. In this case, it must be evaluated whether competing standards have different characteristics. If characteristics are different and concerned standards thereby are specific to certain applications their existence is justified. Nevertheless, it seems desirable to minimise the full extent of standards where possible. Therefore, the necessity for standards in different fields and categories was evaluated, too.

Besides the consistence of all standards, the safety of users is another important criterion. The user of a certain technology has to be protected from dangerous radiations, voltages and currents. What is more, there have to be standards to protect the privacy of users. The utilisation of person related data must be regulated according to specific level of protection of individuals.

3 State-of-the-art and analysis

3.1 Findings of the projects COPRAS and No-REST

Amongst other things, the projects COPRAS and NO-REST promoted by the European Commission have also dealt with the topic of standardisation. Although they have not specifically focussed on RFID standardisation, the results are of big interest for this project and the problems of RFID standardisation.

3.1.1 No-REST

Information and communication technologies play a decisive role in today's world economy. ICT enables and triggers the reorganisation of business activities and became relevant in all business domains during the last 20 years. This led to a stronger collaboration between different organisations and a diffusion of inter-organisational networks.

In the world of networked and linked organisations the process of standardisation is an integral part and still becomes more and more important for the evolution of the information societies in Europe. For this reason, the European Commission founded the project NO-REST (Networked Organisations – Research into Standards and Standardisation).

The objectives of the project are to investigate the applicability and dynamics of standards in e-business and e-government sectors. Furthermore, guidelines for tools should be developed to assess their performance and their impact on networked organisations. In detail, this means the project will have to evaluate various platforms for standards development. In doing so, the evaluation will focus on standard developing organisations and the consortia's ability to adapt to the dynamics of changing environments. In addition, the effect of implementations on different standards is examined. This includes issues of backward compatibility, and how integrity of standards can be maintained over time. Another objective is the development of a methodology for an a-posterior performance assessment and an a-priori integrated impact assessment of standards. This methodology is based on the understanding of evolution, dynamics, and applicability of ICT standards in networked organisations in Europe.

The goal of the project is to apply new ideas by its framework for impact assessment. Businesses and governments should be able to understand the significance of standards and to assess the essential role standards have for their operations. To reach these goals, several general recommendations have been developed during the project. These are outlined briefly in the following scheme:

- Provide a useful definition of what establishes an open standard:
  - Potentially significant policy implications need a meaningful definition that should be provided through the collaborative efforts of all interested parties, taking into account the needs of policy makers, ESOs, and users.
- Revisit the distinction between SDOs and consortia:
  - The number of major consortia and standard development organisations which have similar memberships, processes and IPR regimes is rapidly increasing. The different standards have to be checked according to "value", "relevance" and "credibility".
- Improve co-ordination between ESOs and consortia:
  - Achieve an adequately flexible and speedy transposition process and a division of labour within the realm of consortia and the ESOs' New Deliverables.
- Improve co-operation of ESOs in e-business standardisation:
  - The current split between standardisation in "ICT infrastructure" and "e-business" is unhelpful. It is quite necessary to improve the co-operation and co-ordination between the organisations involved.
- Coordinate e-business and e-government standardisation:
  - Similar requirements should be considered and different demands should be taken into account.

- Move away from the ”user–supplier” or ”direct users–indirect users” dichotomy
- Determine policy-relevance of SDO deliverables
    - An initial “white list” of types of deliverables relevant to policies should be established. Furthermore, a thorough analysis of individual SDO processes and other characteristics should be performed.
- Encourage industry associations to act as ”brokers”:
    - The named associations should follow best practice guidelines. They are best placed to particular actors, as these usually are their members.
- Encourage SDOs to be open beyond their sectoral community:

Some of these recommendations are not far away from recommendations that were given by work package 3 of the CE RFID project. Both application fields, i.e. e-business as well as RFID, have to deal with the problem that there is a large number of different standard development organisations and according to that a large number of different standards as well. Overlaps and inconsistencies are the results. In general, both projects suggest strengthening co-operations between different standard development organisations. Particularly, there should be a closer collaboration between formal SDOs and user and industry organisations.

3.1.2 COPRAS

The project COPRAS (Cooperation Platform for Research and Standards) is a three-year Specific Support Action project in the EU 6th Framework Programme. Its members are the European Committee for Standardisation, the European Committee for Electrotechnical Standardisation (CENELEC) and the European Telecommunications Standards Institute (ETSI), together with the World Wide Web Consortium (W3C) and The Open Group. These Standardisation Organisations are all participating in the Information and Communication Technology Standards Board (ICTSB) which is the coordinating forum for ICT standardisation in Europe.

During duration of three years there were two core objectives that have been followed by COPRAS. At first, the project wanted to provide projects in FP6 IST Calls 1 & 2 with individual support. Specially, the communication and co-operation between them and standards organisations should be assisted. There are two basic goals which had been defined by members of the project COPRAS with respect to the impact of the Standardisation Action Plans. The target was to generate six tangible contributions to on-going standardisation work in total. This concerns technical specifications, the establishment of a new constituency, or contributions to increase the deployment of an existing standard. Further on, the results and experiences of the standardisation work are to be published in a set of ten so-called "case study brochures". These brochures aim to support future projects building an interface to standardisation into their project plans.

Moreover, a set of standardisation guidelines are to be developed. These guidelines shall help projects in subsequent calls and Framework Programmes to contact the right standards organisations and to build an interface to standardisation into their project proposals and work programmes. The cooperation with other projects, as well as their usage of standardisation guidelines was essential for COPRAS to achieve its goals so that the communication of its objectives and results played a vital part in the project's strategy.

Generally spoken, the project was able to reach its goals. Individual subordinate projects managed to generate impact in standardisation processes across at least 10 different areas, addressing standards organisations participating in COPRAS, in the ICTSB, and even on a global level. These subordinate projects shall be described briefly as follows:

- Embedded Systems Cluster:
  Creation of a new working group within the Java Community Process (JCP) that adopted HIJA project results as basis for a new safety-critical standard for the Java programming language.

- SIMILAR:
  Promotion of UsiXML as a new standard in W3C.

- GRID Cluster:
  Establishment of a new Technical Committee in ETSI, working towards a first set of specifications for new GRID standards.

- e-Learning Cluster:
  Dramatic increase of the number of “Units of Learning” produced using the IMS Learning Design standard specification.

- TALK:
  Creation of a constituency in W3C around the advanced research technologies developed within the project.

- POLYMNIA:
  Submissions to the W3C Semantic Web Deployment Working Group

- TEAHA:
  Submission of several UPnP contributions to the Home Gateway Initiative (HGI)

- Call 5 CWE Cluster:
  Formalising the process for establishing a common cross-architecture as a new industry reference for use in building collaborative working tools and applications

- EUAIN:
  Creation of CEN/ISSS Workshop on Accessible Document Processing.

- MediaNet:
  Contribution to a reference architecture to IETF; contributions to the DSL Forum as well as to ETSI TISPAN on Video over IP.

During its active work COPRAS produced a set of “case study brochures”. The brochures have the goal to communicate the results of individual projects which were achieved by the execution of the Standardisation Action Plans. Further on, the experiences of projects collaborating with standards organisations were explained. The following brochures were developed and published:

- ENTHRONE – Standardisation of technologies for the audio-visual chain

- GANDALF – Standardisation of combined wired and wireless technologies

- UNFOLD – Standardisation of e-learning technology for Europe

- HIJA – New programming standard for safety-critical embedded systems
- MediaNet – Standards that ease exchange of digital audio-visual content
- TEAHA – Interconnecting standards for home appliances and audio-visual applications
- TALK – Standardisation of multimodal dialogue context formats
- Telcert – Standards for interoperability of eLearning systems
- POLYMNIA - Improving personalized content detection in audio-visual standards
- COSPACES – Standardisation of a reference architecture for collaborative work
- EUAIN – Standards for accessibility of digital information for disabled citizens

During its progression, the members of COPRAS came to the following main conclusions:

- Generally spoken, standards establish a bridge between research results and the implementation of innovative products. Standardisation is therefore an essential component for boosting innovation.
- The current pace of technological development forces standardisation and research to proceed in parallel; starting standards activity as early as possible provides better chances for being successful.
- There are still many barriers for projects participating in standardisation, such as membership fees or confidentiality rules; also more tools are needed to find the right standards organisation and to determine the differences between various bodies.
- Competition between standards organisations forces the latter to put more effort into marketing, specifically towards the SME community.

- Interfacing with standardisation remains an important aspect in FP7. Additional measures and the continuation of COPRAS' efforts are needed to bring European research and standardisation closer to each other and to reinforce Europe's position as a leading provider of technologies for the global information society.

Because of these conclusions COPRAS has developed a set of guidelines to help projects to already build their standardisation activities into their initial project proposals. The guidelines allow the projects to exploit their research results to their maximum potential. The guidelines can be found at www.copras.org. There the benefits of standardisation for different projects are shown and help whether a project should plan to interface with standardisation or not is available. Also, an overview of the most common processes in standardisation is provided.

The project COPRAS divided different existing standards in a large number of categories which are also found to be very useful for RFID Standards. Therefore, they were taken up by work package 3 and enhanced. The categories are:

- Fundamental standards – concerning terminology, conventions, signs and symbols, etc;

- Test methods and analysis standards – measuring characteristics such as temperature or chemical composition;

- Specification standards – defining the characteristics of a product or service and their performance thresholds, e.g. inter-changeability, health and safety, or environmental protection;

- Organisation standards – describing the functions and relationships of a company, as well as elements such as quality assurance, maintenance, or production management, etc.

Moreover, the project tries to show the advantages and benefits of standardisation for different involved groups in order to convince them to take an active participation in standardisation. This is an aim of work package 3 as well. The groups are:

- industry, service providers and SME companies,

- academia, research institutes and professional bodies,
- governments and public authorities and
- consumers and society.

COPRAS also addressed the topic of organisations approaches and their deliverables and results. It is useful to divide different organisations in different groups according to their deliverables, members and tasks. One group includes public standards organisations, while others include industry consortia and trade organisations. Industry consortia usually address only specific elements within standardisation processes, for example: one organisation may concentrate on the development and maintenance of the actual specification, while others may be involved in developing implementation guidelines, reference implementations or test and certification procedures. A differentiation of standard development organisations and their deliverables is also useful for RFID standards and was also done by work package 3.

Intellectual property rights (IPR) also is an important topic within the field of standardisation. Sometimes there are different rules between the standards organisations with respect to confidentiality and intellectual property rights. On the one hand there are organisations that may work under an IPR regime offering their contributors opportunities for exploiting standardised technology through licensing. On the other hand there are organisations that require its members or participants to submit their contributions and technologies for free.

Usually, the work done by a standards body and most standardisation processes as well is open, i.e. documents discussed are accessible to all members of all organisations and in principle considered being in public domain. Nevertheless, special mechanisms exist to keep contributions confidential or to discuss issues in a confidential environment.

Work package 3 also deals with the topic of IPR. A more detailed explanation will follow in chapter 3.6.

3.2 Standard development organisations

Standard development organisations (SDOs) play a major role in respect of the design and relevance of international and national RFID standards and regulations. Therefore, it is not surprising that a large number of organisations exist. There are international organisations as well as national organisations, each with different tasks. Some of them, like ITU, are basic rules setting organisations. Others only have some specific tasks. They give recommendations and guidelines deal with local regulations or specify some special aspects of a topic. The members of these organisations come from different sectors. For example, EPCglobal is an organisation whose members are coming from the industry. On the other hand, the FCC is an organisation working for the US government. According to their responsibilities, their members and the type of standards they develop, SDOs can be divided into three major subgroups:

- basic rules setting organisations,
- formal RFID standard development organisations and
- user and industry organisations

The aim of this chapter is to describe the most important organisations in reference to the standards they develop. For each listed organisation information will be given about members (industry, public institutions, governments, users), subjects and the kind of standards that are developed.

After a short description of the characteristics of the most important standard development organisations dealing with RFID standards the process of standardisation will be described, too. This chapter also gives an overview of the European standardisation organisations in the context of international and national organisations.

3.2.1 Types of standard development organisations

RFID standard development organisations can be divided in three different types. Depending on the specific standards and regulations organisations develop, their members, fields of activity and responsibilities can be classified in:

- basic rules setting organisations,
- formal RFID standard development organisations and

- user and industry organisations.

Basic rules setting organisations like the ITU or the European Parliament have a decisive and groundbreaking role. Standards developed by these organisations usually serve as basis for mandatory and harmonised standards. Sometimes they even become a law. These organisations discuss and coordinate the basic regulations of global telecom networks and services. All other standards are oriented towards these laws and are based on these rules. Basic rules setting organisations are usually operating on an international level.

Formal RFID standard development organisations are operating on different levels. ISO or ETSI, for example, are international acting organisations, while organisations like DIN, AFNOR or BIS only develop standards for the use on a national level or on a specific topic. Formal RFID SDOs use the laws and regulations made by basic rules setting organisations as a starting point for their work. With their standards they define the specifications of a system and the environment around it.

User and industry organisations usually are subscriber-driven organisations. The developed standards are oriented on interests and requirements of the industry. Standards developed by user and industry organisations are generally voluntary. The most important organisation on this sector is EPCglobal. EPCglobal tries to press ahead the development of industry-driven standards for the Electronic Product Code (EPC). Standards developed by users and industries usually describe details of communication protocols and applications.

3.2.2 European Standards Organisations

ISO (International Standardisation Organisation), IEC (International Electrotechnical Commission) and ITU (International Telecommunication Union) are international standardisation organisations. They collaborate to coordinate the implementation of international standards. The headquarters of all three organisations are located in Geneva/Switzerland. The principal activity of ISO is the development of technical standards. ISO standards are well-known worldwide and have an important economic and social reputation. The IEC prepares and publishes international standards for all electrical, electronic and related technologies. These are to be used as a basis and reference for national standardisation as well as international tenders and contracts. An international cooperation for all questions and matters concerning electro-technical standardisation is promoted by its members. In ITU public and private sector meet in order to discuss and coordinate global telecom networks and services. The activities of ITUs subgroups cover many aspects to improve the telecommunication infrastructure within the developing world.

CEN, CENELEC and ETSI are the three public European standardisation organisations. Each of these organisations communicates with its superordinate global organisation. CEN is a private non-profit organisation. Since its foundation in 1961 its twenty-nine national members work together to develop voluntary European standards (ENs) in various sectors. CEN standards are tended to build a European internal market for goods and services and to position Europe within the global economy.

CENELEC was created in 1973 as an union of the two former European organisations CENELCOM and CENEL. The members of this non-profit organisation are the National Electro-technical Committees of 30 European countries and eight National Committees from neighbouring countries. The process of standardisation is oriented on requests by the market and harmonized standards in support of European legislation. The standards are voluntary.

ETSI is officially responsible for the development of standards for Information and Communication Technologies (ICT) within Europe. The 655 members of ETSI come from 59 countries all over the world. The members are no formal organisation but companies from different sectors: manufacturers, network operators, administrations, service providers, research bodies and users. The standards are close to market needs. The prime objective of the organisation is to support the global harmonisation by providing a forum in which all players can participate actively.

Several national bodies like AFNOR (Association française de Normalisation), BSI (British Standards Institution) and DIN (Deutsches Institut für Normungen) also contribute various standards with a wide impact. AFNOR was founded in 1926 and has a membership of approximately 3,000 companies. It controls the central standardisation system consisting of 31 sector-based standardisation offices, public authorities and 20,000 experts. AFNOR is the French member of CEN and ISO and responsible for all the tasks assigned to France in this respect. BSI British Standards is the UK's National Standards Body (NSB.) It represents the economic and social interests of the UK across all European and international standards organisations and develops business information solutions for British organisations of all sizes and sectors. The industry and several governments work together with BSI to facilitate the production of British, European and international standards. The German Institute for Standardisation (DIN) was founded in 1917. It is a registered association. Since 1975 DIN has been assigned by the German government to represent German interests as the national standards body at international and European level. The members of DIN are from manufacturing industries, consumer organisations, commerce, the trades, service industries, science, technical inspectorates and the government. DIN Standards have a large influence on the economic performance. The standardisation work is done by 26,000 extern experts who are operating in more than 4,000 different committees.

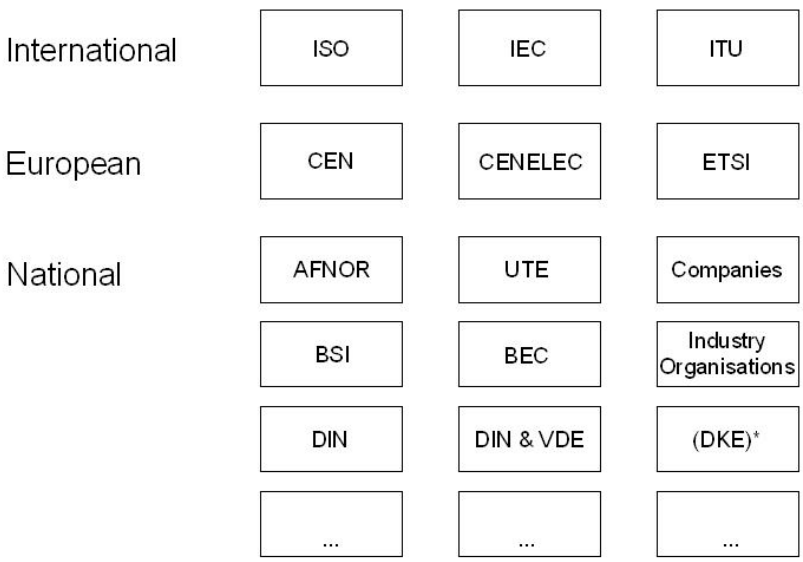

Figure 1 **European standard organisation in the context of international and national organisations**

* No formal member of ETSI

3.2.3 Organisations for radio regulation

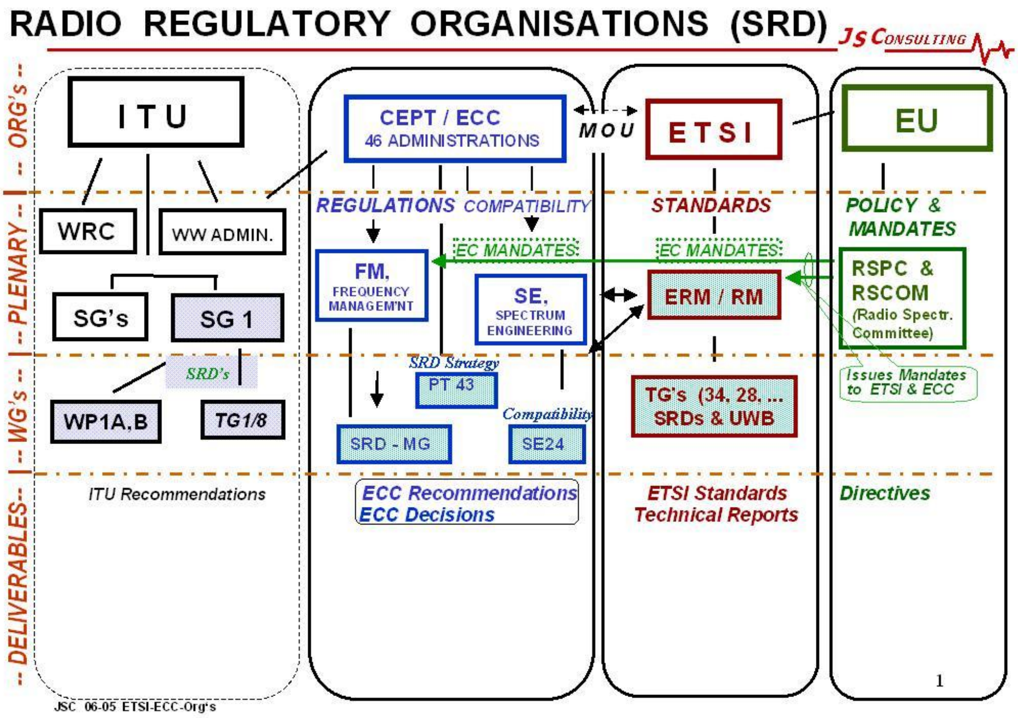

Figure 2 **Organisations for radio regulation (source: JS Consulting)**

SDOs developing radio regulations play an important and decisive role. Usually, radio regulations and air interface standards are mandatory. Very often there is a legal obligation for an execution of these regulations. Many other standards are only voluntary.

In Europe there are four major responsible organisations for radio regulation, which work together on several stages. These four organisations are the ITU, CEPT / ECC, ETSI and the EU.

The International Telecommunication Union (ITU) is an international organisation headed by the UN. At ITU governments and members of the private sector meet to discuss and coordinate global telecom networks and services. Its members are engaged in different fields of standardisation: policy-making and regulation of telecommunication, network operators, equipment manufacturers, hardware and software developers, organisations for regional standards and financing institutions. ITU’s activities, policies and strategic direction are determined and shaped by the industry it serves. Its internal organisation is as following:

On the plenary level there are three different institutions: The WRC, WW Administration and the Study Groups (SGs).

The World Radiocommunication Conference (WRC) takes place every three years. During the conference radio regulations, international treaties governing the use of radio-frequency spectrums as well as the geostationary-satellite and non-geostationary-satellite orbits are reviewed and revised (only if necessary). An agenda determined by the ITU Council is the basis for revision. Under the terms of the ITU Constitution, a WRC can:

- revise radio regulations and any associated assignments on frequencies and plans for allotment;
- address any radiocommunication matter of worldwide character;
- instruct the board for radio regulations and the Bureau for radiocommunication and review their activities;
- define questions for studies by the Radiocommunication Assembly and its Study Groups in preparation for future Radiocommunication Conferences.

The second institution is the Worldwide Administration. This part of the ITU is in contact with CEPT/ECC.

The third institution on the plenary level is the Study Groups. In these different Study Groups more than 1,500 specialists, from worldwide telecommunication organisations and administrations participate. The work of the Study Groups concerns about following topics:

- drafting technical bases for radiocommunication conferences,
- developing draft recommendations and
- compiling handbooks.

Following Study Groups are currently working for ITU:

- Study Group 1 (SG 1) - Spectrum management
- Study Group 3 (SG 3) - Radio wave propagation
- Study Group 4 (SG 4) - Fixed-satellite service
- Study Group 6 (SG 6) - Broadcasting services
- Study Group 7 (SG 7) - Science services
- Study Group 8 (SG 8) - Mobile, radio determination, amateur and related satellite services
- Study Group 9 (SG 9) - Fixed service
- Coordination Committee for Vocabulary (CCV)
- Conference Preparatory Meeting (CPM)
- Special Committee (SC)

The most important Study Group in the field of radio regulation is Study Group 1 – Spectrum Management. This Study Group develops principles and techniques for effective spectrum management. Furthermore, it provides assistance to developing countries in cooperation with the Telecommunication Development Sector.

Study Groups are divided in different working subgroups (WGs), which perform studies on analyzing and formulating different types and needs of standards. Such studies are carried out in response to specific questions concerning inter-service sharing and compatibility issues which have to be approved by the plenary SG1 group. The results delivered by these work groups result in ITU-R reports or recommendations.

The second organisation for radio regulation is CEPT/ECC. 47 administrations are members of the CEPT. Within the CEPT, the ECC operates with several management groups. The major ones are FM Frequency Management, SE Spectrum Engineering and RA Regulatory Affairs. The group Frequency Management deals with regulations and frequency decisions while the group Spectrum Engineering defines compatibility and sharing between different services and the SRDs. If necessary, they will perform studies on different topics of interest and conformity to other regulations.

There are different working groups headed by FM and SE. There, administrations, industries, ETSI and other organisations like radio astronomers, organisations concerning satellites and weather satellites work together for amending radio regulations in order to introduce new technologies or to avoid harmful interferences.

An important organisation for SRDs is the Short Range Device Maintenance Group (SRDMG). It reports to the plenary group Frequency Management and deals with the development of frequency regulations for SRDs. SE24 is the relevant working group for SRDs of SE, Spectrum Engineering and carries out necessary compatibility studies between different frequency user groups. SE24 issues technical reports that result in changes for the radio regulations by the FM.

Results delivered by CEPT/ECC are so-called ECC Recommendations and ECC Decisions. ECC Recommendations and Decisions from CEPT/ECC are not mandatory for CEPT countries or administrations. A number of SRD frequency recommendations of the ERC/REC 70-03 are accepted in other parts of the world and countries.

ETSI is a radio standardisation organisation for short range devices (SRD). IN ETSI ERM deals with SRD standards and standards for other radio systems. There are some 40 Task Groups (TG) under ETSI. ETSI is the most important TGs concerning radio regulation TG28, TG34 and TG 31A, TG31B and TG31C. These are designed for Short Range Devices, including RFID and the Ultra Wide Band (UWB). Deliverables from ETSI are so-called ETSI standards and technical reports or System Reference Docs (SRDocs).

Moreover, the EU plays a very decisive role in the field of radio regulations. The EU addresses EU policies regarding telecommunication field frequency and issues EC directives. These policies are worked out by the RSPC (Radio Spectrum Policy group). RSCOM (Radio Spectrum Committee) implements these policies in co-ordination with the CEPT/ECC.

Relevant actions are first defined by the RSCOM by using questionnaires and workshops. After this, the RSCOM formulates mandates to the CEPT for issuing or amending radio regulations for new technologies; then, mandates are issued for harmonised ETSI and/or CENELEC standards. EC mandates define the type of deliveries and the schedule for creation or amendments, e.g. ECC Decisions and ETSI standards. ECC decisions are reviewed by the RSCOM. EC decisions on the basis of the ECC reports and decisions are published for implementation in all member states. EC decisions are law and must be implemented according to the schedule defined in the EC decisions.

The EC R&TTE Directive regulates the market access for telecommunication products considering the national radio regulations for different radio frequency regulations and ETSI radio standards. The R&TTE has defined several essential requirements for placing products on the market. These essential requirements must be met by products placed on the market either meeting harmonised ETSI standards, by tests conducted by notified bodies or by assurance of the manufacturers in the form of a CE self-declaration to meet the essential requirements imposed by the R&TTE.

3.2.4 Standardisation processes

This chapter describes the process of developing a standard. As an example the development of an ISO standard is used. Of course each standard development organisation defines its own development process, but the approach and the used principles are usually the same and very similar. In general all developed standards are reviewed after a certain period of time by the organisation who created it, e.g. IATA annual reviews all standards.

Which standards should be developed?

If a business or industry sector detects that a standard for a special application or technology is missing, the requirement is reported to one of ISO’s national members. The national member proposes the requirement to the whole ISO. If the new work item is accepted, it is assigned to an already existing technical committee. The item will only be arranged, if there is a clear market that requires the standard.

Who develops the standards?

The work on standards performed by ISO is done by technical committees. Members of these committees are experts from the industrial, technical and business sectors, who have an immediate requirement for the standard. Sometimes these experts are joined by others with relevant knowledge, such as representatives of government agencies, testing laboratories, consumer associations, environmentalists and academic circles. All experts participate as national delegates, who are sent by the national ISO member standardisation organisations. According to ISO rules, the national standardisation organisation is expected to coordinate industry needs and interests in the standards under development as well as to present a consolidated, national (consensus) position to the technical committee.

How ISO standards are developed

In the first step the technical committee and all delegated national experts meet to discuss, debate and argue until they reach consensus on a draft agreement. This Draft International Standard (DIS) can be commented and balloted. If the draft version is accepted in the voting, the standard or possible modifications of the standard are circulated to the ISO members as a Final Draft International Standard (FDIS). If the following final vote is positive again, the standard is published as an International Standard. In conclusion one can say that an International Standard is the agreement between the member bodies of ISO.

The process of standard development can be divided in six different stages:

1) Proposal stage
2) Preparatory stage
3) Committee stage
4) Enquiry stage
5) Approval stage
6) Publication stage

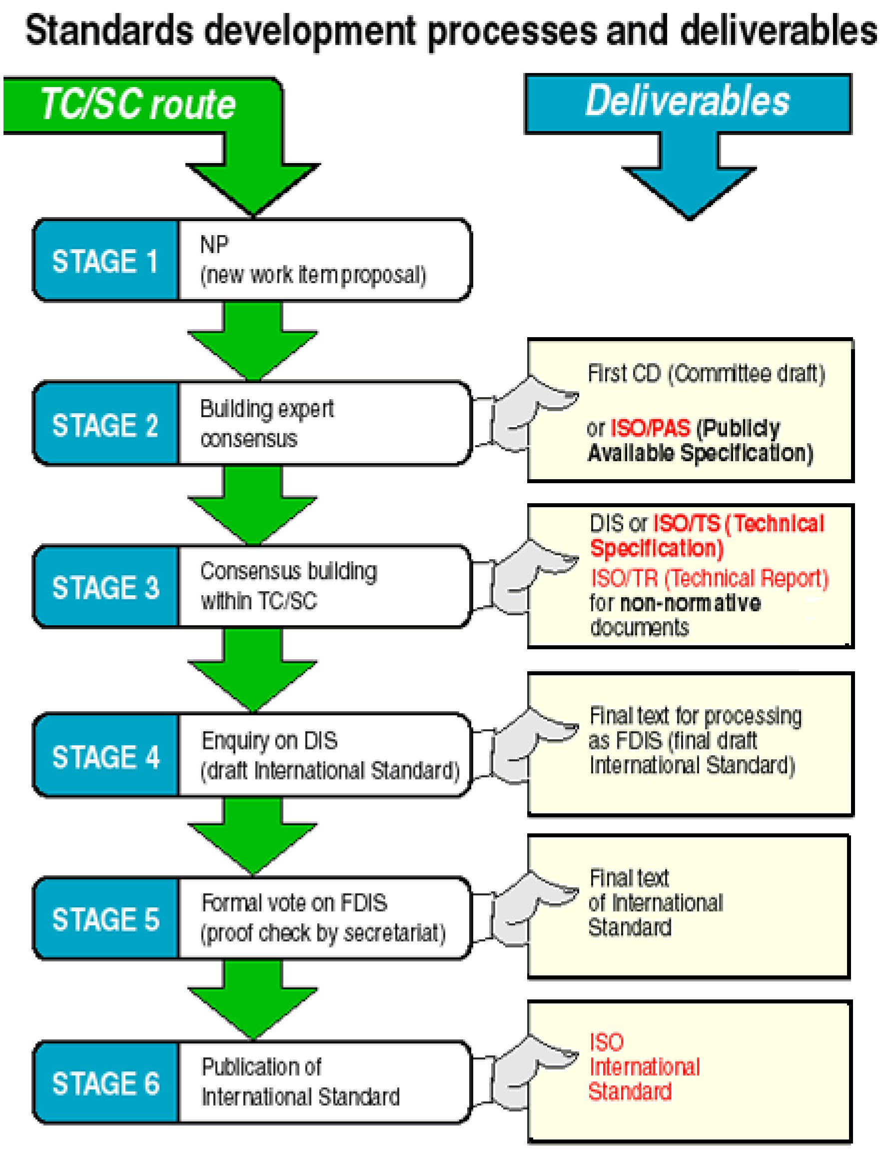

Figure 3 ISO Standards development processes (source: ISO)

3.2.4.1 Stage 1: Proposal Stage

The first stage in the development of a new International Standard is the Proposal Stage. During this time it must be confirmed that a particular International Standard is needed. If the need is successfully confirmed, a new work item proposal (NP) is submitted. The members of the responsible TC/SC vote about the work item either to include it into the programme of work or to dismiss it. To include the work item into the programme of work, the majority of the TCs/SCs P-members has to vote in favour of the item. Additional at least a minimum number of five P-members have to declare their commitment to participate actively in the new project. If five or even more members are willing to participate in the project, a project leader who is responsible for the work is appointed.

3.2.4.2 Stage 2: Preparatory Stage

In the second stage the TC/SC sets up a working group of experts to develop a working draft. The working draft is considered and modified until the experts of the working group are sure that they found the best technical solution to the addressed problem. If the expert group has finished their work on the draft version, it is forwarded to the working groups' parent committee for the consensus-building phase. Because of this process the developed paper is also-called a committee draft. Alternately to the committee draft the results can be published as a PAS – Publicly Available Specification. A PAS is only valid for a period of three years. After a time of three years the P-members of the TC/SC have to vote again about the PAS and to confirm it or to dismiss it.

3.2.4.3 Stage 3: Committee Stage

The ISO Central Secretariat registers the first committee draft as soon as it is available and distributes it for comments and if necessary a voting of the P-members. Successful committee drafts are considered and modified until a consensus is reached on the technical content within the TC/SC. After a consensus has been attained, the document is submissed as a Draft International Standard (DIS) or a Technical Specification. Non normative documents become a Technical Report.

3.2.4.4 Stage 4: Enquiry Stage

The ISO Central Secretariat forwards the Draft International Standard to all ISO member bodies. Within a period of five month the member bodies have the possibility to comment this draft version and to vote about it. If a two-third majority of the P-members vote in favour of the Standard and at least not more than a quarter of the votes are negative, the Draft International Standard is approved as a Final Draft International Standard (FDIS). If the P-members vote against the Standard, the document is given back to the TC/SC for further studies and modifications. The revised version of the text will be circulated again for comments and voting as a new Draft International Standard.

3.2.4.5 Stage 5: Approval Stage

In the fifth stage the Final Draft International Standard is forwarded by the Central Secretariat to all ISO member bodies for final Yes/No vote. If there are still technical comments coming in immediately before the vote they are registered for consideration during a future revision of the International Standard. The vote has to take place within a period of two month. The text is approved as an International Standard if a two-thirds majority of the P-members of the TC/SC are in favour and not more than one-quarter of the total number of votes cast are negative. If the members vote against the standard, the text is given back to the TC/SC for reconsideration.

3.2.4.6 Stage 6: Publication Stage

In the final stage the accepted FDIS is sent to the ISO Central Secretariat, which publishes the text as an approved ISO International Standard. After a period of three years, beginning with the publication of the standard, all International Standards have to be reviewed. A review by all ISO member bodies has to be done every five years. During the review the TC/SC decides, whether the International Standard should be confirmed, revised or withdrawn.

3.2.5 Characteristics of the individual standard development organisations

The following table shows standard development organisations (SDOs) as well as Committees, which are relevant for RFID standardisation.

Basic rules setting organisations		
Organisation	**Name of organisation**	**Geographic area**
European Parliament and Council		Europe
ITU	International Telecommunication Union	Global
ITU-R	International Telecommunication Union: Radiocommunication Sector	Global

Table 4 Basic rules setting organisations

Formal RFID standard development organisations		
Organisation	**Name of Organisation**	**Geographic area**
CENELEC	European Committee for Electrotechnical Standardisation	Europe
CENELEC TC106X	Electromagnetic fields in the human environment	Europe
CEN	European Committee for Standardisation	Europe
CEN TC183	Waste Management	Europe
CEN TC225	AIDC technologies	Europe
CEPT	European Conference of Postal and Telecommunications Administrations	Europe
ETSI	European Telecommunications Standards Institute	Europe

Formal RFID standard development organisations		
Organisation	**Name of Organisation**	**Geographic area**
ICNIRP	International Commission on Non-Ionizing Radiation Protection	Global
IEC	International Electrotechnical Commission	Global
IEC TC106	human exposure, assessment of electric, magnetic and electromagnetic fields	Global
ISO	International Organisation for Standardisation	Global
ISO/IEC JTC1 SC17	Cards and personal identification	Global
ISO/IEC JTC1 SC31	Automatic identification and data capture techniques	Global
ISO TC23 SC19	Agricultural electronics	Global
ISO TC46 SC4	Information and documentation - Technical interoperability	Global
ISO TC104	Freight containers	Global
ISO TC 104 SC4	Freight containers - Identification and Communication	Global
ISO TC122	Packaging	Global
ISO TC204	Intelligent transport systems	Global

Table 5 **Formal RFID standard development organisations**

User and industry organisations		
Organisation	**Name of organisation**	**Geographic area**
AIAG	Automotive Industry Action Group	Global
AIM global	Association for Automatic Identification and Mobility	Global
ATA	Air Transport Association	USA/Global

User and industry organisations		
Organisation	**Name of organisation**	**Geographic area**
AWWA	American Water Works Association	USA
EDItEUR	International Group for Electronic Commerce in the Book and Serials Sectors	Global
EHIBCC	European Health Industry Business Communications Council	Europe
EPCglobal	Electronic Product Code	Global
Eurocode IBLS (Eurocode ISBT)	International Blood Labelling Systems (Int. Society for Blood and Transfusion)	Global
IATA	International Air Transport Association	Global
ICAO	International Civil Aviation Organisation	Global
IEEE	Institute of Electrical and Electronics Engineers	USA/Global
JIAG		Global
MIL	Military Standards	USA/Global
Odette	Organisation for Data exchange by Tele Transmission in Europe	Global
SAE	Society of Automotive Engineers	Global
SEMI	Semiconductor Equipment and Materials International	Global
STANAG	NATO Standardisation Agreement	NATO
UPU	Universal Postal Union	Global
VDI	Verein Deutscher Ingenieure	German

Table 6 **User and industry organisations**

Examples of formal national organisations		
Organisation	**Name of organisation**	**Geographic area**

AFNOR	Association Française de Normalisation	France
ANSI	American National Standards Institute	USA/Global
BSI	British Standards Institution	UK/Global
DANSK	Danish Standards	Dansk
DIN	Deutsches Institut für Normung e.V.	German
DKE	Deutsche Kommission Elektrotechnik	German
ELOT	Hellenic Organisation for Standardisation	Greece
FCC	Federal Communications Commission	USA (South America, Asia)
International Affairs Department	Telecommunications Bureau	Japan
MII	Ministry of Information Industry	China

Table 7 Examples of formal national organisations

3.2.5.1 Basic rules setting organisations

3.2.5.1.1 European Parliament and Council

The European Parliament is the only directly-elected body of the European Union. It has 785 members representing all citizens from the 27 member states of the European Union. The members are elected once every five years by the 492 Million citizens entitled to vote. The European Parliament has an active role in the European legislation. Many new European laws are made jointly by the Parliament and the Council of Ministers, which represents the member states. The work in each sector is done by specialised committees.

The STOA (Scientific Technology Options Assessment) is the Parliament's own Scientific and Technological Options Assessment unit. STOA is an official organ of the European Parliament, but its work is carried out in partnership with external experts. In the field of RFID, STOA currently cares about the topic "RFID in the everyday life of Europeans: a citizen's perspective on Ambient Intelligence".

Internet: www.ec.europa.eu/index_en.htm

3.2.5.1.2 ITU

The International Telecommunication Union has its headquarter in Geneva, Switzerland. It is an international organisation where governments and the private sector meet each other to discuss and co-ordinate global telecom networks and services. The members of ITU are coming from different sectors: telecommunication policy-makers and regulators, network operators, equipment manufacturers, hardware and software developers, regional standard-making organisations and financing institutions. ITU’s activities, policies and strategic direction are determined and shaped by the industry it serves. The organisation is divided in three different sectors:

- Radiocommunication (ITU-R),
- Telecommunication Standardisation (ITU-T) and
- Telecommunication Development (ITU-D).

The activities of these three groups cover many aspects of telecommunication, from setting standards that facilitate seamless interworking of equipment and systems on a global basis to adopting operational procedures for the vast and growing array of wireless services and designing programmes to improve telecommunication infrastructure in the developing world.

Internet: www.itu.int

3.2.5.1.3 ITU-R

The ITU-R (International Telecommunication Union – Radiocommunication) is a sub-group of the ITU. This group is responsible for the management of radio-frequency spectrum and satellite orbits which are increasingly in demand from a large number of services such as fixed, mobile, broadcasting, amateur, space research, meteorology, global positioning systems, environmental monitoring and communication services that ensure safety of life on land, at sea and in the skies. Technical characteristics of terrestrial and space-based wireless services and systems are analysed by the ITU-R and operational procedures are developed. Also important technical studies which serve as a basis for the regulatory decisions are made by the ITU-R.

Working Group	Scope
SG1 – Study Group 1	Development of principles and techniques for effective spectrum management; Techniques for spectrum monitoring and long-term strategies for spectrum utilisation and economic approaches to national spectrum management

Table 8 **Scope of ITU-R working groups**

Internet: www.itu.int/ITU-R

3.2.5.2 Formal RFID standard development organisations

3.2.5.2.1 CENELEC

Cenelec is the European Committee for Electrotechnical Standardisation. It was created in 1973 as a conclusion of the two former European organisations CENELCOM and CENEL. Today the members are the National Electrotechnical Committees of 30 European countries. In addition, 8 National Committees from neighbouring countries are participating actively in CENELEC with an affiliate status. Since the 1950´s the different members have been working together for European harmonisation. The process of standardisation is oriented on requests by the market and harmonised standards in support of European legislation. All CENELEC standards are voluntary.

Internet: www.cenelec.org

3.2.5.2.2 CEN

The European Committee for Standardisation (CEN) was founded in 1961. The incorporators were the national standards bodies in the European Economic Community and EFTA countries.

Today CEN is contributing to the objectives of the European Union and European Economic Area with a number of technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement. All standards developed by CEN are voluntary.

Working Group	**Scope**
CEN TC183	Data Standards
CEN TC225	Development of a unique standard for barcode applications

Table 9 **Scope of CEN working groups**

Internet: www.cen.eu

3.2.5.2.3 CEPT

The European Conference of Postal and Telecommunications Administrations (CEPT), established on June 26, 1959, is a coordinating body for European state telecommunications and postal organisations. The acronym comes from the French version of its name Conférence européenne des administrations des postes et des télécommunications. Current CEPT organisations include:

- the European Radiocommunications Committee,
- the CERP (Comité européen des régulateurs postaux),
- the European Committee for Regulatory Telecommunications Affairs and
- the European Telecommunications Office.

Today regulatory authorities from 47 European countries are active members of the CEPT. They are working together to create regulations for postal and telecommunication applications in Europe.

Working Group	**Scope**
WGFM	Working Group Frequency Management
WGSE	Working Group Spectrum Engineering
WGRA	Working Group Regulatory Affairs
ECC	Electronic Communication Committee

Table 10 **Scope of CEPT working groups**

Internet: www.cept.org

3.2.5.2.4 ETSI

The European Telecommunications Standards Institute (ETSI), headquartered in Sophia Antipolis (France), is an independent and non-profit organisation. The organisations task is to produce telecommunications standards for today and for the future. It is officially responsible for the development of standards for Information and Communication Technologies (ICT) within Europe. These technologies include telecommunications, broadcasting and related areas such as intelligent transportation and medical electronics. Presently, the 655 members of ETSI are coming from 59 countries of all over the world. They are manufacturers, network operators, administrations, service providers, research bodies and users. ETSI is developing a wide range of standards and other technical documentation as Europe's contribution to worldwide ICT standardisations. These standards are close to market needs and have a wide acceptance. The primary objective of the organisation is to support the global harmonisation by providing a forum in which all players can participate actively. ETSI is reporting to the European Commission and officially recognised by the EFTA secretariat.

Working Group	**Scope**
TG28	Generic RFID
TG34	RFID in the UHF band
ERM	EMC and Radio Spectrum Matters

Table 11 Scope of ETSI working groups

Internet: www.etsi.org

3.2.5.2.5 ICNIRP

ICNIRP (International Commission on Non-Ionising Radiation Protection) is a body of independent scientific experts. It is consisting of a main Commission of 14 members, 4 Scientific Standing Committees covering epidemiology, biology, dosimetry and optical radiation and a number of consulting experts. ICNIRP aims to disseminate information on the potential health hazards of exposure to non-ionising radiation to everyone with an interest in the subject. ICNIRP's information and advice covers most non-ionising radiations including optical radiations (ultraviolet, visible and infrared as well as lasers), static and time-varying electric and magnetic fields as well as radiofrequency (including microwave) radiation and ultrasound. The organisation is supported with material and organisation capacities by the German government.

Internet: www.icnirp.de

3.2.5.2.6 IEC

The International Electrotechnical Commission is a global organisation that prepares and publishes international standards for all electrical, electronic and related technologies, which shall be used as a reference for national standardisation and international tenders and contracts. The Commission's objectives are to:

- meet the requirements of the global market efficiently,
- ensure primacy and maximum worldwide use of its standards and conformity assessment schemes,
- improve the quality of products and services covered by its standards,
- establish the conditions for the interoperability of complex systems,
- increase the efficiency of industrial processes,
- contribute to the improvement of human health and safety,
- contribute to the protection of the environment.

Internet: www.iec.ch

3.2.5.2.7 ISO

ISO (International Organisation for Standardisation) is one of the world's largest developer of standards. The principal activity of ISO is the development of technical standards. The standards are used by all different groups of the society: industrial and business organisations of all types, governments and other regulatory bodies, trade officials, conformity assessment professionals, suppliers and customers of products and services in both the public and the private sector. Standards have an important economic and social repercussion. ISO standards try to contribute to make the development, manufacturing and supply of products and services more efficient and safer, the trade between countries easier and fairer and to provide governments with a technical base for health, safety and environmental legislation.

Working Group	**Scope**
ISO/IEC JTC1 SC31 WG4	RFID air interface standards
ISO/IEC JTC1 SC31 WG3	AIDC – Conformance
ISO/IEC JTC1 SC17 WG8	Contact less Integrated Circuit(s) Cards, Related Devices And Interfaces
ISO TC 23 SC19 WG3	RFID LF air interface standards
ISO TC104	Application Standards
ISO TC122	Application Standards
ISO TC204	Transport Information and Control Systems
ISO TC46 SC4	Data and Application Standards

Table 12 Scope of ISO working groups

Internet: www.iso.org

3.2.5.2.8 ISO / IEC JTC1 SC17

In 1988 the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC) created a Joint Technical Committee on Information Technology (ISO/IEC JTC1). Sub-Committee 17 (SC17) is responsible for the development of standards for identification cards and personal identification. SC17 is divided in different working groups that are responsible for the different aspects of standardisation.

- WG1 – Physical Characteristics And Test Methods For Identification Cards
- WG3 – Machine Readable Travel Documents
- WG4 – Integrated Circuit Cards With Contacts

- WG5 – Registration Management Group
- WG7 – Financial Transaction Cards
- WG8 – Contact less Integrated Circuit(s) Cards, Related Devices And Interfaces
- WG9 – Optical Memory Cards And Devices
- OWG – Technology Co-Existence On Identification Cards
- WG10 – Motor Vehicle Driver Licences

Internet: www.sc17.com

3.2.5.2.9 ISO/IEC JTC1 SC31

Sub-Committee 31 of the ISO/IEC Joint Technical Committee cares about the development of standards for data formats, data syntax, data structures, data encoding, and technologies for the process of automatic identification and data capture. SC31 has 48 members. 24 of these 48 are participating and seven are observers from national bodies. The other 17 are liaison members. SC17 is divided in 4 working groups:

- WG 1 – Data Carrier
- WG 2 – Data Structure
- WG 3 – Conformance
- WG 4 – RFID for Item Management

Internet: www.iso.org

3.2.5.2.10 ISO TC23 SC19

TC23 SC19 specifies standards that define the structure of the radio-frequency (RF) identification code for animals. RF identification of animals requires that the bits transmitted by a transponder are interpretable by a transceiver. Usually the bit stream contains data bits, defining the identification code and a number of bits to ensure correct reception of the data bits.

Internet: www.iso.org

3.2.5.2.11 ISO TC46 SC4

ISO Technical Committee 46/Subcommittee 4 (TC46/SC4) is the International Organisation for Standardisation (ISO) Subcommittee responsible for technical standards used to facilitate interoperability of information services such as libraries, information centres, indexing and abstracting services, archives, and publishers. These technical standards include standards for information retrieval and interlibrary loan, applications of SGML, data elements directories, data formats, character sets, codes and user commands. Its scope is the standardisation of the methods and procedures for use of computers in information and documentation:

- communication, including application protocols and formats,
- data element directories, including interlibrary loan, acquisitions, etc.,
- computer aspects of electronic manuscripts and publications,
- data base management standards for information and documentation, including common command language,
- character sets and
- codes for computer usage.

Internet: www.iso.org

3.2.5.2.12 ISO TC 104

An ISO committee was installed concerning container dimensions - the "ISO Technical Committee 104 (TC104) on Freight Containers". ISO TC 104 members are coming from 57 countries all over the world and are split into 32 participating and 25 observing countries.

The scope of ISO TC 104 is the standardisation of freight containers, having an external volume of one cubic meter and larger, as regards terminology, classification, dimensions, specifications, handling, test methods, and marking. Within these activities the TC 104 is developing RFID application standards for freight container and returnable transport units. For this purpose the Joint Working Group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104 with the title "Supply Chain Applications on RFID" was founded.

Internet: www.iso.org

3.2.5.2.13 ISO TC 122

An ISO committee was installed concerning shipping labels and product packaging - the "ISO Technical Committee 122 (TC122) on Packaging". The ISO TC 122 members are coming from 71 countries all over the world and are split into 29 participating and 42 observing countries.

The scope of ISO TC 122 is the standardisation in the field of packaging with regard to terminology and definitions, packaging dimensions, performance requirements and tests. Excluded are matters falling within the scopes of particular committees (e.g. TC 6, 52 and 104).

Within these activities the TC 122 is developing RFID application standards for product tagging and packaging. For this purpose the Joint Working Group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104 with the title "Supply Chain Applications on RFID" was founded.

Internet: www.iso.org

3.2.5.2.14 ISO TC 204

An ISO committee was installed concerning surface transportation - the "ISO Technical Committee 204 (TC204) on Intelligent Transport Systems". The ISO TC 122 members are coming from 51 countries all over the world and are split into 24 participating and 27 observing countries.

The scope of ISO TC 204 is the standardisation of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field. Excluded are in-vehicle transport information and control systems (ISO / TC 22).

It should be noted, that ISO / TC 204 is responsible for the overall system aspects and infrastructure aspects of intelligent transport systems (ITS) as well as the coordination of the overall ISO work programme in this field including the schedule for standards development, taking into account the work of international standard bodies.

Internet: www.iso.org

3.2.5.3 User and industry organisations

3.2.5.3.1 AIAG

The Automotive Industry Action Group (AIAG) is a globally recognised organisation founded in 1982 by a group of managers from DaimlerChrysler, Ford Motor Company, and General Motors. The purpose was to provide an open forum where members co-operate in developing and promoting solutions that enhance the prosperity of the automotive industry. AIAG's focus is to continuously improve business processes and practices involving trading partners throughout the supply chain. Under the auspices of AIAG, volunteers from approximately 1,500 member companies have worked together to resolve issues critical to the automotive supply chain. AIAG offers standards, guidelines, reports and tools that cover a variety of areas in the automotive and truck as well as heavy equipment industries.

Internet: www.aiag.org

3.2.5.3.2 AIM global

The Association for Automatic Identification and Mobility is a global trade association with more than 900 members from 43 countries. The members are providers of components, networks, systems and services that manage the collection and integration of data with information management systems like radio frequency identification (RFID), bar code, card technologies (magnetic stripe, smart card, contact less card, optical card), biometrics, and electronic article surveillance (EAS). AIM is dedicated to accelerate the growth and use of auto-identification technologies and services around the world.

Internet: www.aimglobal.org

3.2.5.3.3 Air Transport Association (ATA)

The Air Transport Association of America (ATA) –formed in 1936 and headquartered in Washington, D.C. – is the premier trade organisation of the principal U.S. airlines. ATA members transport more than 90 percent of all U.S. airline passenger and cargo traffic.

Today, ATA membership comprises 12 passenger carriers, six all-cargo carriers and four associate (international) members. In June of 2005, the ATA board adopted a new class of membership, the industry member. There is also another distinct designation of industry partners. Membership entitles industry participants the opportunity to attend ATA committee meetings and get access to ATA materials. There are currently 30 non-airline companies that have made the decision to work with ATA in one of these ways.

The development of recommended specifications for industry is an important function of trade associations such as ATA. These specifications allow industry participants to achieve major cost savings through the use of common systems and procedures. ATA's role is to facilitate this process by bringing industry members together to reach a consensus that all can support and implement. Thus, ATA specifications are voluntary industry agreements on accepted means of communicating information, conducting business, performing operations or adhering to accepted practices.

Within these activities ATA is developing a RFID aviation maintenance specification, which defines a widely-used numbering scheme for aircraft parts and the appearance of printed aircraft maintenance information.

Internet: www.airlines.org

3.2.5.3.4 American Water Works Association (AWWA)

The American Water Works Association (AWWA) – founded in 1881 – is an international non-profit scientific and educational society dedicated to the improvement of water quality and supply. AWWA is defined by six core competencies, through which they communicate and interact with all of their audiences. Together, the competencies distinguish AWWA as the authoritative resource for knowledge, information, and advocacy to improve the quality and supply of water in North America and beyond.

AWWA is the largest organisation of water supply professionals in the world. Its more than 60,000 members represent the full spectrum of the water community: treatment plant operators and managers, scientists, environmentalists, manufacturers, academicians, regulators, and others who hold genuine interest in water supply and public health. Membership includes more than 4,700 utilities that supply water to roughly 180 million people in North America.

Within these activities AWWA is developing application standards for the use of RFID data in a major water utility.

Internet: www.awwa.org

3.2.5.3.5 EDItEUR

EDItEUR is the international group coordinating development of the standards infrastructure for electronic commerce in the book and serials industries. Established and sponsored by the Federation of European Publishers, the European Booksellers Federation and the European Bureau of Library and Documentation Associations EDItEUR provide its international membership with research, standards and guidance in areas such as:

- electronic Data Interchange (EDI) and other eCommerce standards for book and serial transactions,
- bibliographic and product information,
- the standards infrastructure for digital publishing,

- radio frequency identification tags and
- rights management and trading.

EDItEUR is an international organisation with 90 members from 17 countries, including Australia, Canada, Japan, South Africa, United States and most of the European countries.

Internet: www.editeur.org

3.2.5.3.6 EHIBCC

The European Health Industry Business Communications Council (EHIBCC) is a non-profit making, international association set up to develop and promote a uniform European standard for bar coding within health care. It was formed in 1988 to serve as a partner to the Health Industry Business Communications Council (HIBCC) and administer the Health Industry Bar Code (HIBC) Standard in Europe. The standard is maintained up-to-date by the HIBCC's Automatic Identification Technical Committee which is staffed by individuals who represent manufacturers, distributors, health care providers, and companies which develop and provide bar code equipment. About 300 companies serving international markets have since become members and adopted the standard, which has been recognised by CEN, the European standards coordinating organisation. HIBCC Standards use FACT Data Identifiers, a global ISO standard for bar coding in use by a multitude of industries.

Internet: www.ehibcc.com

3.2.5.3.7 EPCglobal

EPCglobal is leading the development of industry-driven standards for the Electronic Product Code (EPC) to support the use of RFID in trading networks. It is a sub-scriber-driven organisation comprised of industry leaders and organisations focused on creating global standards for the EPCglobal Network that provides means to share EPC related data via the Internet. Its goal is increased visibility and efficiency throughout the supply chain and higher quality information flow between companies and their key trading partners.

EPCglobal was formed in October, 2003 as the successor organisation to the MIT Auto-ID Centre, the original creator of the EPC technology. EPCglobal manages the EPC Network and standards, while its sister organisation, Auto-ID Labs, manages and funds research on the EPC technology.

Internet: www.epcglobalinc.org/

3.2.5.3.8 International Blood Labelling System (Eurocode IBLS)

The association Eurocode-IBLS – established in 1998 and headquartered in Kassel, Germany – provides an international non-profit standard for labelling blood products and tissue to enhance security in blood transfusion and tissue transplantation. Euro-code-IBLS is supporting and applying data structures, the electronic data interchange and standardised labelling in transfusion medicine in both national and international standardisation bodies (Council of Europe, EU, CEN, DIN, etc.). Within these activities Eurocode-IBLS is developing RFID application standards for labelling blood products and tissue in order to enhance the security on blood transfusion and transplantation.

Internet: www.eurocode.org

3.2.5.3.9 International Air Transport Association (IATA)

The International Air Transport Association (IATA) is an international industry trade group of airlines headquartered in Montreal, Quebec, Canada. IATA's mission – since 1945 – is to represent, lead and serve the airline industry. Its members comprise some 260 airlines from more than 140 nations – the world's leading passenger and cargo airlines among them - representing 94 percent of international scheduled air traffic. IATA's aim is to help airlines help themselves by simplifying processes and increasing passenger convenience while reducing costs and improving efficiency. Moreover, safety is another number one priority, and IATA's goal is to continually improve safety standards, notably through IATA's operational safety audit. Another main concern is to minimise the impact of air transport on environment. Within these activities IATA is also evaluating RFID manuals and recommendations for freight and baggage processes.

Internet: www.iata.org

3.2.5.3.10 International Civil Aviation Organisation (ICAO)

The International Civil Aviation Organisation (ICAO) as an agency of the United Nations – headquartered in Montreal, Quebec, Canada – and works since 1944 in close cooperation with other members of the United Nations family such as the World Meteorological Organisation, the International Telecommunication Union, the Universal Postal Union, the World Health Organisation and the International Maritime Organisation. ICAO works to achieve its vision of safe, secure and sustainable development of civil aviation through cooperation amongst its member States. Its members comprise representatives of council member states and of not member states as well as council members of the Air Navigation Commission, all in all some 64.

The ICAO Council adopts standards and recommended practices concerning air navigation, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation.

Within these activities ICAO is developing RFID application standards concerning to the e-passport.

Internet: www.icao.int

3.2.5.3.11 IEEE

The Institute of Electrical and Electronics Engineers (IEEE) is an international non-profit, professional organisation for the advancement of technology related to electricity. It has the most members of any technical professional organisation in the world, with more than 360,000 members in around 175 countries. Through its global membership, the IEEE is a leading authority on areas ranging from aerospace systems, computers and telecommunications to biomedical engineering, electric power and consumer electronics among others. IEEE performs its standards making and maintaining functions through the IEEE Standards Association (IEEE-SA). IEEE produces 30 percent of the world's literature in the electrical and electronics engineering and computer science fields, and has developed more than 900 active industry standards. One of the more notable IEEE standards is the IEEE 802 LAN/MAN group of standards which includes the IEEE 802.3 Ethernet standard and the IEEE 802.11 wireless networking standard.

Internet: www.ieee.org

3.2.5.3.12 Defence Standards

A United States Defence Standard, often called a military standard, "MIL-STD" or "MIL-SPEC", is used to help achieve standardisation objectives by the U.S. Department of Defence. Standardisation is beneficial in achieving interoperability; ensuring products meet certain requirements, commonality, reliability, total cost of ownership, compatibility with logistics systems, and similar defence-related objectives.

Defence Standards are also used by other non-defence government organisations, technical organisations, and industry. Within these activities a proposal guideline for the use of RFID-enabled labels in military logistics was developed.

Internet: www.dodssp.daps.dla.mil

3.2.5.3.13 ODETTE

ODETTE (formerly: Organisation for Data exchange by Tele Transmission in Europe) International is a non-profit making organisation, formed in 1984. Its members are national automotive organisations in Benelux, the Czech Republic, France, Germany, Italy, Spain, Sweden, the UK, Romania and Turkey. It sets the standards for e-business communications, engineering data exchange and logistics management. They link the 4,000 plus businesses in the European motor industry and their global trading partners.

Its mission in the global automotive industry is to develop tools and recommendations that improve the flow of goods, services, product data and business information across the whole supply chain, throughout the entire product lifecycle.

The principal areas of activity are:

- e-business communications,
- logistics management and

- engineering data exchange.

Internet: www.odette.org

3.2.5.3.14 Society of Automotive Engineers (SAE)

SAE International (SAE) – established in 1905 – is a professional organisation for mobility engineering professionals in aerospace, automotive and the commercial vehicle industries. A quarter of the society's membership today is from outside of North America. The society is a standards development organisation for the engineering of powered vehicles of all kinds, including cars, trucks, boats, aircraft and others. SAE has established widely-followed standards in all manner of things automotive, but the most familiar to the average American consumer are its standards for measuring automobile power in units of horsepower and its motor oil classification standards.

Within these activities SAE is developing RFID application standards for the labelling of aerospace parts.

Internet: www.sae.org

3.2.5.3.15 SEMI

Semiconductor Equipment and Materials International (SEMI) is a trade organisation of manufacturers of equipment and materials used in the fabrication of semiconductor devices such as integrated circuits, transistors, diodes, and thyristors. Among other activities, SEMI acts as a clearinghouse for the generation of standards specific to the industry and the generation of long-range plans for the industry.

The SEMI International Standards Programme operates as a neutral forum for the exchange of information among suppliers and users resulting in the production of technically accurate specifications and other standards of economic importance to the industry. Over 2,200 technologists worldwide, representing both device manufacturers and equipment and materials suppliers, participate in the programme. These individuals work toward resolving a variety of process and product related issues in both the front and back-end areas in device and flat panel display manufacturing.

SEMI standards are written documents in the form of specifications, guides, test methods, terminology, practices, etc. These documents are published in the 12 volume set of SEMI International Standards. SEMI standards try to cover every aspect of semiconductor manufacturing including safety related issues.

Internet: www.semi.org

3.2.5.3.16 NATO Standardisation Agreement (STANAG)

STANAG is the NATO abbreviation for Standardisation Agreement, which set up processes, procedures, terms, and conditions for common military or technical procedures or equipment between the member countries of the alliance. Each NATO state ratifies a STANAG and implements it within their military.

STANAG's are published in English and French, the two official languages of NATO, by the NATO Standardisation Agency in Brussels. The purpose is to provide common operational and administrative procedures and logistics, so one member nation's military may use the stores and support of another member's military. Within these activities STANAG developed RFID application standards for support consignment and asset tracking, applied to NATO operations.

Internet: www.nato.int

3.2.5.3.17 Universal Postal Union (UPU)

The Universal Postal Union (UPU) – established in 1874 and headquartered in Berne, Switzerland – is the primary forum for cooperation between postal-sector players and helps to ensure a truly universal network of up-to-date products and services. With 192 member countries, this specialised agency of the United Nations fulfils an advisory, mediating and liaison role, and renders technical assistance where needed. It sets the rules for international mail exchanges and makes recommendations to stimulate growth in mail volumes and to improve the quality of service for customers.

As a non-political organisation, it does not interfere in matters that fall within the domestic domain of national postal services. For example, Posts set their own postage rates, decide which and how many postage stamps to issue, and how to manage their postal operations and staff.

The UPU has for objective to develop social, cultural and commercial communication between people through the efficient operation of the postal service.

As an inter-governmental institution, the UPU is called upon to play an important leadership role in promoting the continued revitalisation of postal services.

Within these activities UPU is developing RFID standards for identification and marking.

Internet: www.upu.int

3.2.5.3.18 VDI

The Association of German Engineers is a financially and politically independent organisation. More than 130,000 engineers and natural scientists are organised in this association. More than 13,000 members are working in an honorary capacity for the VDI. The VDI was established in 1856. Today it is the largest engineering association in Western Europe. On of VDIs jobs is the training and technology transfer among experts. It is also a partner at the preliminary stages of the decision-making process in matters of technological policy and for all questions that engineers face in their professional or public lives. The specialised work on directivities is done by complimentary working experts. Today there are more than 1,700 valid VDI-regulations and technical rules. The role of the VDI in Germany is comparable to that of the American Society of Civil Engineers (ASCE) in the United States.

Internet: www.vdi.de

3.2.5.4 Examples for national organisations

3.2.5.4.1 Association française de Normalisation (AFNOR)

The French standards association (AFNOR) heads the AFNOR Group. AFNOR was founded in 1926 and is a state-approved organisation under the administrative supervision of the Ministry for Industry. It has a membership of approximately 3,000 companies. AFNOR controls the central standardisation system consisting of 31 sector-based standardisation offices, public authorities and 20,000 experts. AFNOR is the French member of CEN and ISO and responsible for all tasks assigned to France.

The pivotal company, AFAQ-AFNOR, whose capital is entirely owned by AFNOR, holds all the securities of the commercial subsidiaries. It incorporates the support resources that may be required to work with all the Group's operational and subsidiary entities. This company is responsible for the strategic and operational management and control of its subsidiaries and helps to ensure that they run smoothly.

AFNOR develops the reference systems required by economic players to promote their strategic and commercial development. As European and International standardisation represent more than 80 % of its work, AFNOR is influential in representing French interests within these standardisation authorities.

Internet: www.afnor.org

3.2.5.4.2 American National Standards Institute (ANSI)

The American National Standards Institute (ANSI) – founded in October 1918 – coordinates the development and use of voluntary consensus standards in the United States and represents the needs and views of U.S. stakeholders in standardisation forums around the globe.

Comprised of government agencies, organisations, companies, academic and international bodies, and individuals, the American National Standards Institute (ANSI) represents the interests of more than 125,000 companies and 3.5 million professionals.

The Institute – a non-profit organisation – oversees the creation, promulgation and use of thousands of norms and guidelines that directly impact businesses in nearly every sector: from acoustical devices to construction equipment, from dairy and live-stock production to energy distribution, and many more. ANSI has the mission to enhance both the global competitiveness of U.S. business and U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.

ANSI is also actively engaged in accrediting programmes that assess conformance to standards – including globally-recognised cross-sector programmes such as the ISO 9000 (quality) and ISO 14000 (environmental) management systems.

Within these activities ANSI is developing RFID application standards for re-turnable containers.

Internet: www.ansi.org

3.2.5.4.3 British Standards Institution (BSI)

BSI British Standards is the UK's National Standards Body (NSB). It was the first national Standard Body in the world. It represents UK economic and social interests across all of the European and international standards organisations and through the development of business information solutions for British organisations of all sizes and sectors. British Standards works with manufacturing and service industries, businesses, governments and consumers to facilitate the production of British, European and international standards.

BSI British Standards has a close working relationship with the UK government, primarily through the Department of Trade and Industry.

Internet: www.bsi-global.com

3.2.5.4.4 Danish Standards Association (DS)

Danish Standards Association – as a non-profit and private independent organisation – is Denmark's national standardisation body and one of the leading certification enterprises in Denmark.

In addition, Danish Standards Association has been designated as the National Enquiry Point for the World Trade Organisation. The WTO Enquiry Point is the official information centre for international standards, certification schemes and regulations in Denmark.

The aim of Danish Standards is to strengthen society and the corporate sector through their core activities – standardisation, certification and the dissemination of knowledge. Being a national standards body, Danish Standards work in close dialogue with their stakeholders to develop Danish and international standards, for the benefit of Danish society and corporate international growth.

Within these activities RFID supply chain application standards for containers are developed.

Internet: www.ds.dk

3.2.5.4.5 DIN

The German Institute for Standardisation (DIN) was founded in 1917. It is a registered association and has his head office in Berlin. In 1975 DIN has been assigned by the German government to represent German interests as the national standards body at international and European level. The members of DIN are from the manufacturing industries, consumer organisations, commerce, the trades, service industries, science, technical inspectorates and the government. The members define their specific standardisation requirements and report the results as German standard to the government. DIN Standards have a large influence on the economic performance. DIN Standards promote rationalisation, quality assurance, safety, and environmental protection as well as improving communication between industry, technology, science, government and the public domain. In DIN the standardisation work is done by 26,000 extern experts who are operating in more than 4,000 different committees. Draft standards are published for public comment, and all comments are reviewed before final publication of the standard. Published standards are reviewed for continuing relevance every five years, at least.

Internet: www.din.de

3.2.5.4.6 DKE

The DKE German Commission for Electrical, Electronic & Information Technologies of DIN and VDE is a modern, non-profit service organisation which ensures that electricity is generated, distributed and used in a safe and rational manner, thereby serving the good of the community at large. The results of DKE work form an integral part of the German collection of standards. As VDE specifications its electrotechnical safety standards also form the VDE Specifications Code of safety standards.

Internet: www.dke.de

3.2.5.4.7 ELOT

ELOT is the National Organisation of Greece. The tasks of ELOT are to elaborate the Hellenic National Standards, to maintain a central point for testing of materials, to assess managements and to certify products and services. It also provides public or on site training and technical information. The offices and laboratories of ELOT are located in Athens and Thessaloniki. ELOT represents Greece in several European and international organisations, and is also a member of the IQNET.

Internet: www.elot.gr

3.2.5.4.8 FCC

The Federal Communication Commission (FCC) is an agency of the United States government. It is independent but directly responsible to the Congress. Since its establishment in 1934 by the Communication act it is responsible for the regulation of interstate and international communications by radio, television, wire, satellite and cable. The jurisdiction of the FCC covers the 50 states, the District of Columbia, and U.S. possessions. The FCC is directed by five commissioners appointed by the US president and confirmed by the senate for five-year terms, except when filling an unexpired term. The President designates one of the commissioners to serve as chairperson. Only three commissioners may be members of the same political party. None of them can have a financial interest in any commission-related business. The commission staff is organised by function in seven operating bureaus and ten staff offices. While the bureaus are responsible for processing applications for licenses and other filings; analyzing complaints; conducting investigations; developing and implementing regulatory programmes; and taking part in hearings, the offices provide support services.

Internet: www.fcc.gov

3.2.5.4.9 International Affairs Department, Telecommunication Bureau

Under the jurisdiction of the International Affairs Department, the Japanese Telecommunications Council studies and discusses matters related to policies concerning the usage of radio waves and electro-magnetic distribution of information. They offer advice to the Minister of Internal Affairs and Communications in response to requests from the Minister. They also study and discuss important matters related to the postal service and offer advice to every minister concerned. Of their concern are also laws and regulations, such as the Cable Television Broadcast Law and the Telecommunications Business Law, hold under their jurisdiction.

Internet: www.soumu.go.jp

3.2.5.4.10 Ministry of Information Industry

As an integral part of the Chinese State Council, MII (Ministry of Information Industry) is a regulatory body in charge of the manufacture of electronic and information products, the communications and software industry, also the promotion of information of the national economy and social services in china.

Internet: english.gov.cn

The analysis of the different standard development organisations and of their work has shown that there are several things that could be improved.

The European Commission should strengthen and support cooperation between the different international and national standardisation organisations. They should encourage, set up and promote the dialogue between the several SDOs.

Furthermore, the cooperation between ISO and EPCglobal should be supported. EPCglobal has a strong end-user involvement and is ahead on software standards. ISO on the other hand has a wider standardisation scope and worldwide acceptance. Together they could complement one another.

Another important act would be the support of European involvement in international standardisation activities. In several ISO groups, e.g. WG4 SG1 Europe is not represented very well. The aim should be that Europe takes a leading role in international standardisation processes.

The support of SMEs in standardisation processes is a further action that should be taken. SMEs, organisations and consultants could represent their interests and customers in development processes. Travelling costs to meetings should be refunded. If the travel to a meeting is not related with high costs it is more attractive for companies to send their delegates into the committees.

Future and already existing standards should be improved continuously. It should be possible to apply these standards on an international level. Furthermore, it must be possible to get easy access to the needed standard and it should be easier to work with standards. In general fewer but broader accepted standards are needed and should be developed.

3.3 Categories and types of standards

RFID Standards can be analysed in categories and types. Categories and types are not the same. While categories are pointing to the subject of content, types are only pointing to the formal character of a standard. In the following chapter the word "standard" includes all kinds of regulations, directives and rules.

3.3.1 Categories of standards

The distribution in different categories is beneficial for a better structuring and classification. It provides a better overview and possibilities for comparison of the different standards and standards concerning the same topic. This division was already performed by the projects COPRAS and NO-REST. The members of the project COPRAS have identified during their work, the analyses of everyday standards, four major categories. These are:

- fundamental standards – concerning terminology, conventions, signs, and symbols, etc;
- established methods and analysis standards – measuring characteristics such as temperature or chemical composition;
- specification standards – defining the characteristics of a product or service and their performance thresholds, e.g. inter-changeability, health and safety, or environmental protection;
- organisation standards – describing the functions and relationships of a company as well as elements such as quality assurance, maintenance, or production management, etc.

The members of work package 3, concerning RFID standards, have overtaken this approach. They were able to divide the listed standards into twelve different categories. These categories are listed below:

- general standards
- EC legislation
- harmonised standards and frequency regulations

- air interface standards
- reader interface standards
- data management interface standards
- data standards
- sensor standards
- application interface atandards
- application standards
- information network service & interface standards
- guidelines

Main category	**Sub category**	**Remarks**
General		- Architecture - System concepts - Vocabulary
EC Legislation	- Directives - Decisions - Recommendations	
Harmonised Standards and Frequency Regulations	- Spectrum parameters - Radio parameters - Safety	Harmonised standards are listed under EC directives
Air Interface	- Protocol - Test	Tag–reader interface
Reader Interface	- Protocol - System management	Reader–middleware interface
Data Management Interface		Middleware–application interface
Data	- Tag data - Security	- Data structure - Data content
Sensors		

Main category	Sub category	Remarks
Application Interface	- Capture interface	Application-specific re-quirements
Application	- Logistical tracking & tracing - Production, monitoring and maintenance - Product safety, quality and information - Access control and tracking & tracing of individuals - Rental systems	
Information Network Services & Interface		
Implementation Guidelines		

Table 13 Categories of standards

3.3.1.1 General standards

General standards are describing the basics and the structure of a system. The architecture of a system is explained as well as the system concept. This should provide transparency to the different contributors and should guarantee a common understanding of the elements of an RFID system.

Furthermore, general standards are defining vocabularies. This has an important meaning for worldwide communication and trading. Through a unique denotation the barriers between different languages are eliminated and everybody around the world uses the same synonyms.

Examples for a general standard are the VDI documents 4472 Part 1 and the EPCglobal standard EPC AFD. VDI 4472 Part 1 describes the requirements which should be met by a transponder system for the use in the supply chain.

The EPC document defines and describes the EPCglobal Architecture Framework. The EPCglobal Architecture Framework is a collection of interrelated standards for hardware, software, and data interfaces, together with core services that are operated by EPCglobal and its delegates. They all work in service of a common goal of enhancing the supply chain through the use of Electronic Product Codes (EPCs).

3.3.1.2 EC legislation

A directive published by the European Commission is a legislative act which requires member states to achieve a particular result without dictating the means of achieving that result. The term EC legislation means documents which are made by the European Commission that have a legislative character. These documents are directives, decisions and recommendations. They can be distinguished from European Union regulations. These regulations are self-executing and do not require any implementing measures. Directives usually offer the members a certain amount of leeway in the adoption. Directives can be adopted by means of a variety of legislative procedures depending on subject matter of the directive. If a member state does not fulfil a directive the matter can be brought to the European Court of Justice.

One of the EC Directives concerning RFID is the R&TTE.

An example for an EC Decision is CEPT ERC/DEC 01-13 which decides

- to designate the frequency bands 9 – 59.750 kHz, 59.750 - 60.250 kHz, 60.250 – 70 kHz, 70 – 119 kHz, 119 – 135 kHz for the use of equipment for inductive applications which comply with the technical characteristics shown in Annex 1;
- to exempt Short Range Device equipment used for inductive applications covered by this decision from individual licensing;
- this decision shall enter into force on 12 March 2001;
- the CEPT Member Administrations shall communicate the national measures implementing this decision to the ERC Chairman and the ERO when the decision is nationally implemented.

Another example is the mandatory EC decision 2006/804/EC from November 2006. The decision says among other things:

Member states shall designate and make available, within six months after the entry into force of this decision and on a non-exclusive, non-interference and non-protected basis, the frequency bands for RFID devices, subject to the specific conditions, as laid down in the annex of this decision.

3.3.1.3 Harmonised standards

Harmonised standards are mandatory in the sense that they are implemented by law.

Harmonised standards are usually dealing with the topics of spectrum parameters, measurement procedures and limits, radio parameters and safety. Spectrum parameters can be found for example in the ERC/REC 70-03 or in relevant EC decisions. A decision for spectrum parameters defines for example the field strength of a signal in a special frequency range.

A standard on UHF RFID radio parameters is the ETSI document EN 302 208-1/-2. The standards on radio parameters are applicable for frequency ranges as specified by EC and ECC decisions.

A harmonised standard which cares about Safety is the EMF 50364/357. This regulation is caring about health and human exposure measurements and levels and has the aim to protect the user from dangerous radiations.

Another example is the CE marking. It is mandatory within Europe to show that the product is in conformance with requirements of the according to the EC-Directive R&TTE.

A harmonised standard is created on request of a mandate by the European standardisation organisation (CEN, CENELEC and/or ETSI) issued by the EC. The EC then officially publishes the standards in the Official Journal (OJ) of the EC.

Examples for such kind of harmonised standards are:

- EN 300 330 (radio emissions in the range 9 kHz to 30 MHz)
- EN 300 220 (radio emissions in the range 30 MHz to 1 GHz)
- EN 300 440 (radio emissions in the range 1 GHz to 40 GHz)
- EN 302 208 (radio emissions for RFID at 865-868 MHz)

- EN 301 489-1/3 (EMC for SRD’s in the range 9 kHz to 25 GHz) two Parts: 1 and 3 which include the generic parts from:
  - EN 55022 (Radio disturbance characteristics of IT equip.)
  - EN 50081 (Generic EMC Emissions)
  - EN 50082 (Generic EMC Immunity)
- EN 60950 (Safety of IT and Business Equipment)
- EN 50364 (EMF Assessment of EAS & RFID - Harmonised)
  - EN 50357 (EMF Assessment methods for EAS and RFID)

3.3.1.4 Air interface standards

Air interface standards are describing protocols and tests for the Tag-Reader interface. Examples for air interface standards which care about protocols are the EPCglobal standard EPC Gen2 1.0.9 or the different ISO standards from 18000-1 to 18000-7.1. Examples for standards that are describing tests are the ISO standards 18046 and 18047.

The EPC standard is commonly known as the "Gen 2" standard. This standard defines the physical and logical requirements for a passive-backscatter, Interrogator-talks-first (ITF), radio-frequency identification (RFID) system operating in the 860 MHz - 960 MHz frequency range. Standards from the ISO 18000-x series are defining parameters and protocol for all RFID frequency ranges. For example ISO/IEC 18000-6:2004 defines the air interface for radio-frequency identification (RFID) devices operating in the 860 MHz to 960 MHz industrial, scientific, and medical (ISM) band used in item management applications. Its purpose is to provide a common technical specification for RFID devices that may be used by ISO committees developing RFID application standards.

In ISO standard 18046 methods are described for measuring the identification range and rate, the read range and rate and the write range and rate. The test methods do not check the conformity to radio regulations or other standards. ISO standard 18047 checks the conformity to the air interface. This standard describes the measurement of the field strength and the amplitude of the tag backscatter. This standard is not intended to check conformity to other regulations, too.

3.3.1.5 Reader interface standards

Reader interface standards specify the protocols by which clients may communicate with RFID readers. These standards provide means for reader configuration, monitoring, and maintenance, and define ways how a reader informs the client of read tags and tag data.

A goal of the reader interface layer is to insulate clients from knowing the details of how readers and tags interact. While a reader may employ different protocols to interrogate tags, the communication protocol between reader and client stays the same. Nevertheless, a reader interface needs to allow clients to configure the RFID parameters of a reader for each protocol in detail.

3.3.1.6 Data management interface standards

Data management interface standards provide interfaces for higher level business software to communicate with RFID middleware, i.e. the software components that process the raw data coming from RFID tags. Through these interfaces clients may obtain filtered, aggregated, and grouped data from tags in a high level representation that is easily processible by business software.

Typically, such interfaces establish a layer of abstraction that hides the complexities of the actual reader infrastructures by combining several physical reading devices to a single data source, often called "location". This allows for changes in the device infrastructure, e.g. replacing a single reader with two antennas at a loading dock gate with three collaborating readers, without affecting client software applications.

3.3.1.7 Data standards

Data standards specify the structure and interpretation of data on a tag. In fact, there are two groups of data standards: one that standardises the tag identifiers and the other that deals with the user data stored on a tag.

The tag identifier standards propose a numbering system for the unique identifier stored on a tag or define how different existing numbering systems may be federated to form unique identifiers. They specify different representations for the unique identifiers, e.g. human readable, binary representations, or such for use in information systems, and the algorithms to convert one representation to another.

Tag data standards unify the way that additional data (user data) is stored onto the tag. They define data objects and the mapping of these objects to tag memory. By storing meta-data about the data objects onto the tag, systems reading the binary tag data are able to reinterpret these data as objects.

Additionally, data security standards may ensure the confidentiality and/or the data integrity by cryptographic means.

3.3.1.8 Sensor standards

Standards belonging to this category specify the combination of RFID tag and sensor functionality. Currently the IEEE organisation is developing some standards in this area.

The IEEE activities specify the communication interface between the RFID tag and the connected sensor (mounted on the same RFID tag). The aim is to combine any kind of sensor via a standardised interface with the RFID chip like the SPI or I²C communication standard.

The most auspicious chances of success concerning to RFID sensor technology will have an extension of the IEEE 1451.5 standard especially related to RFID, which is currently under development.

3.3.1.9 Application interface standards

The available standard for the application interface is strong related to the EPCglobal architecture framework.

The capturing application supervises the operation of the lower architecture framework elements, and provides business context by coordinating with other sources of information involved in executing a particular step of a business process. The capturing application may, for example, coordinate a conveyor system with Filtering & Collection events, may check for exceptional conditions and take corrective action, may present information to a human operator, etc. The capturing application understands the business process step or steps during which the data capture takes place. This role may be complex, involving the association of multiple Filtering & Collection events with one or more business events, as in the loading of a shipment. Or it may be straight forward, as in an inventory business process where there may be “smart shelves” deployed that generate periodic observations about objects that enter or leave the shelf. Here, the Filtering & Collection-level event and the capturing application level event may be so similar that no actual processing at the capturing application level is necessary, and the capturing application merely configures and routes events from the Filtering & Collection interface directly to a capturing application enabled repository.

The capture interface through which the data is delivered to enterprise-level roles, including repositories, accessing applications, and data exchange with partners. Events at this interface say, for example, “At location X, at time T, the following contained objects (cases) were verified as being aggregated to the following containing object (pallet).”

3.3.1.10 Application standards

The application standards will content all kind of standards which are strong related to applications like

- architecture of the RFID system,
- mechanical application of the RFID tags or antennas of the RFID readers,
- definition of RFID tags i.e. size, housing, etc.,
- definition of application related data stored on the RFID tag,

3.3.1.10.1 Logistical tracking & tracing

The scope of standards, belonging to this category is to specify the use of RFID capabilities in order to support consignment and asset tracking and tracing at associated logistical processes. Consignment and asset tracking and tracing systems are installed by the use of RFID tracking and tracing modules.

The implementation of the standards by these systems allow a reduction in errors and an increased accountability by monitoring the receipt of shipments through provided features like the item lifecycle history or the information concerning to the current position. In general, the implementation of logistical tracking and tracing standards will help to secure the integrity of any logistic supply chain by providing the necessary information.

3.3.1.10.2 Production, monitoring and maintenance

Standards belonging to this category specify the use of RFID capabilities in order to support the production as well as the production monitoring and the production maintenance of defined manufacturing processes by the use of RFID technology. The implementation of the standards by the use of RFID systems is targeted to manufacturers who consistently experience bottlenecks, desire traceability, or who want to reduce the labour required forcosts associated with materials management and replenishment.

3.3.1.10.3 Product safety, quality and information

Standards belonging to this category specify the use of RFID capabilities in order to support the product safety, the product quality and the product information of manufactured parts by the use of RFID technology. The implementation of these standards by the use of RFID technology makes it easier to ensure that products are authentic, and it also creates an electronic pedigree, or record of the chain of custody, from the point of manufacturing to the point of product dispensing. In the case, that the products are medications or food, electronic pedigrees will improve the consumers' safety and protect the public health by allowing wholesalers and retailers to rapidly identify, quarantine, and report suspected counterfeit drug or food and conduct efficient, targeted recalls.

3.3.1.10.4 Access control and tracking & tracing of individuals

The scope of standards, belonging to this category is to specify the use of RFID capabilities in order to support access control as well as the tracking and tracing of individuals at particular areas. The implementation of these standards allows, that the RFID technology can be used for the identification and location tracking of a person carrying the tag (which can be embedded into an identification card) and can be used to verify a person's right to enter a particular building or even to access a service.

3.3.1.10.5 Rental systems

Standards belonging to this category specify the use of RFID capabilities in order to support rental systems. The implementation of these standards by the use of RFID systems allow an increasing of the efficiency inside of a rental system chain. This will be reached by reducing the likelihood of theft, by improving the stocktaking, and through a significantly speed up of issue and return procedures. Other benefits are the self-returning possibility and the rapid location checking of rental items.

3.3.1.11 Information network services & interface

Standards belonging to this category enable disparate applications to share RFID-related data, both within and across enterprises. RFID-related data comprises the actual data obtained from RFID tags combined with data from the associated business processes to form so-called business events.

These standards propose the data repositories which store these business events as well as the interfaces that allow to insert new business events to the repository and to query for specific events. They define mechanisms to restrict the access to data repositories on a role based scheme and also to secure the communication on the network. Furthermore, the standards specify the network infrastructure that is needed to find the data repository of an enterprise associated with the unique identifier of an RFID tag.

3.3.1.12 Implementation guidelines

The implementation guidelines do not attempt to solve every possible problem that might arise concerning to a specific RFID thematic. These guidelines exist in order to help to know, what is necessary to achieve.

The implementation guidelines represent a general guidance on how to approach particular RFID issues and identify other sources of guidance. They are made by the different SDOs and have the aim to support the use of other standards.

An example for an implementation guideline is the ETSI technical report TR 102 436 V1.1.1 (2005–12). The technical report contains recommendations for installation and arranging of RFID systems in the UHF band. Furthermore, guidelines for the best possible use of the spectrum, based on EN 302208, are provided. The report also deals with the use of RFID devices with reduced power. Handheld readers or RFID printers can be operated on the basis of EN 300220. The document also covers possibilities for minimizing interference between adjacent interrogators.

3.3.2 Types of standards

In the field of RFID there are a large number of standard development organisations and standardisation activities. According to this there are a large number and different kinds of deliverables from these SDOs. The different types of deliverables will be explained in the following chapter at the example of the founding's of Project NO-Rest and ISO.

The project NO-REST has found five different types of standardisation deliverables and results.

Formal standards ('de jure' standards), are normative documents from formal standards bodies and have passed through a full and open consensus process. They are implemented on national level and there is strong pressure to apply them. Formal standards have a legal basis and can be made mandatory, but considerable time (up to four years) is needed for completing the full approval process.

Technical or industry specifications are based on consensus among members of standards bodies, consortia or trade organisations and do not have a formal character or legal basis; they are recommendations and require less time to produce (one to three years) but when widely accepted and used in practice by relevant market players they can become 'de facto' standards.

Workshop agreements are industry recommendations developed by interested stakeholders through a short-track process (6-12 months) facilitated by several formal standards bodies; workshop agreements serve as industrial consensus documents between participating individuals and organisations, and can be revised quite easily.

Conformance, test applications, reference implementations and guidelines aim to support interoperability between and easy rollout by market players of equipment and services based on formal standards or industry specifications. They have an informative character and are usually produced in a relatively short timeframe (six to twelve months).

Technical reports are informative documents supporting further standardisation work, e.g. by identifying the need for additional technical clarifications in – or between – existing specifications, standards, or guideline documents.

The described types of standards are very similar to the steps ISO has implemented in its systems. Usually each standards development organisation has its own scheme, but the basics are in general the same.

Deliverables produced by ISO can be divided into the following types:

- International Standard (IS)
- Publicly Available Specification (PAS),
- Technical Specification (TS),
- Technical Report (TR),
- International Workshop Agreement (IWA).

An international standard is an agreement between the ISO member bodies. Each developed standard has to be transmitted by vote of the member bodies from a draft standard into an international standard. During the development process each member has the possibility to give comments on the standard. If the final vote is negative, the supposed international standard is given back to the experts group for review.

A PAS (Publicly Available Specification) is a normative document which represents the consensus within a working group. At the beginning of the development process the TC/SC may decide that a particular work item should result in publication of a PAS. Normally this decision should be agreed simultaneously with approval of the New Work Proposal Item (NP). The document is developed during the prepatory stage within the working group. The acceptance of the document as a PAS requires the simple majority of the P-members of the responsible TC/SC. A PAS shall be reviewed at least every three years to decide either to confirm the PAS for a further three years, revise the PAS, process the PAS further to become either a technical specification or an international standard, or to withdraw the PAS.

An ISO/TS – Technical Specification is an understated form of an International Standard. The TC/SC can decide straight at the beginning of the development to deliver a technical specification, but usually a Technical Specification is produced if the TC/SC discovered that there was insufficient support for the publication of a standard.

An ISO/TR - Technical Report is an informative document containing information of a different kind from those normally published in a normative document. There are three types of ISO Technical Reports:

The first one are documents which had been intended to become a standard but for which the required votes could not be collected. The second one are Technical Reports which describe either the directions of standardisation in particular fields or in some instances to make available an experimental standard for trial use. The third report is for information only.

An IWA – International Workshop Agreement represents a technical document developed by a workshop outside of the technical structure of ISO with administrative support from a designated member body. The publication of these documents will include an indication of the participating organisations involved in the development of an IWA. The main benefit of the workshop mechanism is that it enables a more rapid response to requirements for standardisation in areas where ISO does not have existing technical structures or experts.

Examples for a Formal Standards are the ISO standards 15963 and 18000-3. These standards describe the behaviour and the operation of RFID systems in the HF frequency band (13.56MHz).

An example for a Technical Specification is the ETSI document TS 102 562. This specification describes the synchronisation of LBT for the operation of a UHF Reader in Dense Reader Mode.

Examples for Technical Reports are the documents TR 18046, TR 18047 and ETSI TR 102 436. These Technical Reports describe performance test methods, test methods for the air interface communication in the different frequency bands and the installation and commissioning of RFID equipment.

An example for a Workshop Agreement is the CEN agreement CWA 14838 Part1-3. This agreement concerns „Facilitating Smart Card Technology for Electronic Ticketing and Seamless Travel".

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has developed the Guideline 494-522; Health Physics 74 (4). This Guideline specifies the "Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)".

In general it is very useful to divide the deliverables into different types. The most used and important types in the field of RFID standardisation are Formal Standards, Technical Specifications and Technical Reports.

3.4 Application independent standards

The following chapter will give an overview over some general application independent RFID Standards. These standards are concerning frequency bands, radio regulations and spectrum matters, air interface protocols, testing, health and safety, the environment and waste management.

3.4.1 RFID frequency bands and air interface standards

RFID Systems are emitting electromagnetic waves. They can be seen as a radio installation. Through the operation of RFID systems other devices and systems shall not be disturbed. Due to this fact only frequency bands can be used for RFID which are reserved for special industrial, scientific and medical applications. These are the worldwide available ISM frequency bands (Industrial-Scientifical-Medical).

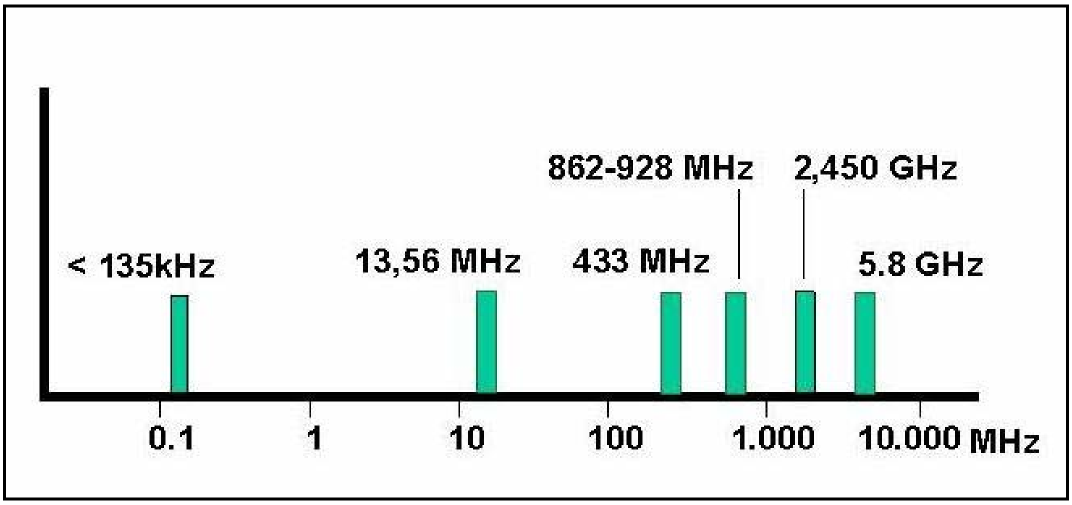

Figure 4 **RFID frequency bands**

3.4.1.1 Frequency band 9–135 KHz

This LF frequency band is frequently used by different radio installations and not declared as an ISM band. The propagation characteristics of these long wave signals allow it with only a small technical effort to cover an area with a radius of approximately 1,000km. Fixed services, military, air and sea navigation systems or time signal systems usually use this frequency band. E.g. the time signal system DCF77 located in Mainflingen (D) is operating with a frequency of approximately 77.5 KHz. An RFID system operating at this frequency would cause a malfunction of all radio-controlled clocks within a radius of several hundred meters. To avoid collisions, most radio regulations reserve a protection area around relevant frequencies.

The conditions for operating an RFID system in the LF frequency band are specified by EC and/or ECC decisions, ECC recommendations are defined in the following standards:

- harmonised standards
  - ETSI EN 300 330 – radio regulations and spectrum matters

- air interface protocol standards
  - ISO/IEC 18000-2 - air interface protocol
  - ISO 11785 - air interface for the identification of animals
  - ISO 14223-1 - advanced air interface for the identification of animals
- air interface test standards
  - ISO/IEC TR 18047-2 - test methods and data capture techniques

The ETSI standard EN 300 330 describes the technical details and test methods of a device.

The ISO/IEC 18000-2 defines the air interface for radio-frequency identification (RFID) devices used in item management applications. It describes also some technical attributes and the communications protocol used in the air interface. ISO standard 11785 describes the technical concept for the identification of animals. It is specified how a transponder is activated and how the stored information is transferred to a transceiver. ISO 14223-1 specifies the air interface between the transceiver and an advanced transponder used in the radiofrequency identification of animals under the condition of full upward compatibility according to ISO 11785.

The ISO/IEC Technical Report TR 18047-2 defines automatic identification and data capture techniques for air interface communications below 135 KHz.

This frequency band seems to be appropriate and is accepted worldwide. A problem is that this frequency band is used frequently and that RFID systems can interfere with other devices. Especially the frequency at 77.5 KHz is critical because of the time signalling system. The future German regulation for inductive radio systems 220ZV 122 will declare a protection area between 70KHz and 119KHz to avoid interferences with frequently used devices and applications. Lately the number of applications operating at this frequency has decreased. E.g. the Deutsche Wetterdienst (DWD) has already stopped sending his weather information at this frequency band in 1996.

This frequency as well as HF frequencies is very suitable for the identification of animals. The waves have the property that they are able to percolate through aqueous materials. LF and HF are inductive coupled systems. Another advantage of the LF frequency band is that the reading field can be defined very easy. Through all this facts there will be a future need for this frequency band.

The LF frequency band is mostly used for one transponder applications. It has very low data rates. The current frequency range is sufficient for RFID applications in this band. The band should be protected and available in the future.

3.4.1.2 Frequency band 13.56 MHz

The conditions in this short wave band (13.553...13.567MHz) allow it to transmit information transcontinentally. The resource is used by different kinds of users, like press agencies and telecommunication companies. Typical applications for this frequency band are telecontrol systems, personal signalling devices, remote controls and demonstration facilities.

The most important RFID standards for this frequency band are:

- harmonised standards
  - ETSI EN 300 330 – radio regulation and spectrum matters
- air interface standards
  - ISO/IEC 18000-3 – air interface protocol
  - ISO/IEC 15693 – field characteristics, protocols and commands
  - EPCglobal HF Generation 2 - air interface protocol standard (under development)
- air interface test standards
  - ISO/IEC TR 18047-3 - test methods and data capture techniques

The ETSI standard specifies technical details and test methods for devices operating in this frequency.

The HF standard ISO 18000-3 provides physical layer, collision management system and protocol values for RFID systems in accordance with the requirements of ISO 18000-1. Furthermore, two modes of operation are described, intended to address different applications. ISO/IEC 15693 specifies the nature and characteristics of the fields to be provided for power and bi-directional communications between vicinity coupling devices (VCDs) and vicinity cards (VICCs). Furthermore, it describes protocols and commands as well as methods for anti-collision. The EPCglobal HF Generation 2 air interface protocol defines the physical and logical requirements for a passive load-modulated, interrogator-talks-first (ITF), radio-frequency identification (RFID) system operating at 13.56 MHz frequency range. The system comprises interrogators, also known as readers, and tags, also known as labels.

The ISO/IEC Technical Report TR 18047-3 defines automatic identification and data capture techniques for air interface communications at 13.56 MHz.

The HF 13.56 MHz band is a very successful and widely used RFID frequency. The spectrum is harmonised nearly worldwide. The behaviour during transmission is similar to the LF band. It is easy to define the reading area. The waves are able to transmit through aqueous materials.

With the HF frequency much higher data rates are possible. The HF standard has its roots in the identification of persons. The first ISO standards were developed for such applications (ISO 15693). Later also standards for the identification of goods were developed. Current RFID standards are well qualified for applications with a limited number of transponders. For the future there is the need for a worldwide accepted HF high speed RFID standard, to realise high data rates. Furthermore, the field strength should be increased to a level of 60dBµA. With higher field strength higher reading distances could be realised.

Mobile RFID becomes more and more important for this frequency band. Mobile RFID has been standardised within the Near Field Communications (NFC) Forum at 13.56MHz. Numerous organisations are already expanding the scope of mobile RFID, including:

- NFC Forum/ECMA (ISO/IEC 18092, 22536, 21481, 28361),

- ITU-T (Joint Coordinating Activity – Network ID, including RFID),
- SC31/WG6 (Ad Hoc Formed).

The aim for the future should be to establish a new work area for mobile RFID, which includes optically readable web-based services and sensor networks. Presumably there will be a formation of a Joint Working Group (JWG) between JTC1/SC31, JTC1/SC6 and ITU-T.

In the upcoming area of mobile RFID Europe should take a leading role.

3.4.1.3 Frequency band 433 MHz

The frequency range from 430 MHz to 440 MHz is used worldwide by radio amateurs. They transmit speech as well as data and use them for communication with self-made satellites. The propagation of waves in this UHF frequency band is approximately optically. Buildings and other barriers have a large influence in form of strong reflexion and attenuation on the electromagnetic wave. Dependent on the output, power and operating method distances between 30km and 300km can be reached. Next to radio amateurs this ISM band is frequently used by other devices and applications. Especially baby phones, keyless entry systems and several telemetric transmitters use these frequencies. Very often there are several interferences between these different devices in this frequency band. So it is sometimes quite hard to run an RFID system in this frequency band. The most important RFID standards for this band are:

- harmonised standards
  - ETSI EN 300 220 – radio regulation and spectrum matters
- air interface standards
  - ISO/IEC 18000-7 – air interface protocol for active tags
- air interface test standards
  - ISO/IEC TR 18047-7 – test methods for active RFID communication

The ETSI standard describes the electromagnetic compatibility and radio spectrum Matters (ERM) for Short Range Devices (SRD) used in the 25MHz to 1.000MHz frequency range with power levels ranging up to 500mW.

ISO/IEC 18000-7 defines the air interface for radio-frequency identification (RFID) devices operating as an active RF Tag in the 433MHz band used in item management applications. The Standard also defines technical attributes and the communications protocol used in the air interface.

ISO/IEC 18047-7 explains test methods for active RFID air interface communications at 433MHz.

This VHF frequency band is only used by RFIDs for a few applications. The most typical application is the identification of containers. For the future there is no need to work on standards and changes for this frequency band.

3.4.1.4 Frequency band 840–960 MHz

This frequency band is for RFID UHF applications. The used frequency is dependent on the availability in the different countries:

- China: 840–845 MHz and 920–925 MHz
- Europe: 865–868 MHz
- United States: 902–928 MHz
- Japan: 952–954 MHz

An overview over the different RFID frequency bands can be found on the EPCglobal website (www.epcglobalinc.org).

The European UHF frequency band has been approved for short range applications since 1997. The European Commission has made it mandatory for all member states to provide this frequency band for RFID UHF application till May 2007. Also in many countries in the Far East they are thinking about an approval of this frequency band. The frequency band from 902...928MHz is only used in the United States and in Australia for backscatter applications. In Europe this band is used for mobile phones.

The most important RFID standards for this frequency band are:

- harmonised standards
  - ETSI EN 300 220 – radio regulation and spectrum matters
  - ETSI EN 302 208 – radio regulation and spectrum matters
  - ETSI TS 102 562 – dense reader mode in Europe
- air interface standards
  - ISO/IEC 18000-6 – air interface protocol
  - EPC Gen2 V1.0.9 – air interface protocol
  - ANSI/INCITS 256 – US standard, included in ISO 18000-6
- air interface test standards
  - ISO/IEC TR 18047-6 - test methods and data capture techniques
  - EPCglobal UHF Class 1 Gen 2 V. 1.0.9 - standard conformance requirements
  - EPCglobal Interoperability Test – methodology v1.2.4 for UHF Gen2 RFID devices
  - EPCglobal tag performance parameters and test methods v1.1.0
- Implementation Guidelines
  - ETSI TR 102 436 installation and commissioning

Technical characteristics and test methods for short range devices operating in the UHF frequency band with a maximum output power of 500mW are specified in the standard EN 300 220. This standard was developed by ETSI. The ETSI Standard EN 302 208 concerns the electromagnetic compatibility and radio spectrum matters (ERM) of Radio Frequency Identification equipment operating in the band 865MHz to 868MHz with power levels up to 2W. There are gives several technical requirements and methods of measurement.

The Technical Specification TS 102 562 was published in March 2007. This document will provide some regulations for the implementation of the dense reader mode in conformance with the current European UHF standard. It describes a new four channel plan and methods for the synchronisation of the listen-before-talk-process.

A new version of the ISO 18000-6 standard is currently under development. It describes parameters for the air interface communications at 860-960MHz. The EPC Class1 Gen2 standard is commonly known as the "Gen 2" standard. This standard defines the physical and logical requirements for a passive-backscatter, interrogator-talks-first (ITF), radio-frequency identification (RFID) system operating in the 860 - 960MHz frequency range. The standard is corresponding to the ISO 18000-6c standard.

ANSI/INCITS 256 defines a standard for Radio Frequency Identification (RFID) for use in item management. This standard is intended to allow for compatibility and to encourage interoperability of products for the growing RFID market in the United States. It establishes a technical standard for a family of compatible RFID devices, specifically, RFID devices operating in freely available international frequency bands at license free power levels. Its purposes are as follows:

- promote interoperability and compatibility between RFID devices by defining a common API and limited physical and data link layer options.

- support item management applications and provide flexibility in the physical layer definitions to allow additional features for uses that value such enhancements.

The standard cares about frequencies, interface definitions, RDID system definition, minimum features, compliance requirements, document structure and references, tag identification number, manufacturer's tag identification number (MfrTagID) and user's tag identification number (UserTagID). The current version of the document ANSI/INCITS 256 was published in 2001.

The technical report 18047-6 describes test methods for air interface communications at 860-960MHz. The EPCglobal document “UHF Class 1 Gen 2 V1.0.9 standard conformance requirements” specifies and defines

- compliance requirements for physical interactions (the signalling layer of the communications) between interrogators and tags and
- compliance requirements for interrogator and tag operating procedures and commands

The test standard interoperability test methodology v1.2.4 for UHF Gen 2 RFID devices specifies the design of an interoperability test system. It serves for testing the end-to-end functionality between two communicating RFID hardware devices. This is required by "EPCTM Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID protocol for communications at 860–960 MHz, Version 1.0.9".

The performance characteristics of tag and reader devices may vary drastically due to application factors as well as the particulars of the RF air interface (frequency, modulation, inventory algorithm, etc.). Of key concern is the matching of the various performance characteristics to the user application. Additionally, in an open environment users of RFID technology demand multiple sources for these devices from technology providers. A key challenge is a method of evaluating the differences between various technology providers' products in a consistent and equitable manner.

The document tag performance parameters and test methods v1.1.0 contains performance metrics and means for testing these metrics for a Class-1 radio-frequency identification (RFID) tag compliant with the EPCglobal™ Class-1 Generation-2 UHF RFID protocol for communications at 860–960MHz (the Protocol). This document is intended to serve the industry by providing a systematic means for evaluating tags and ultimately optimising performance in the field.

The ETSI Technical Report TR 102 436 can be seen as an implementation guideline. It includes guidelines for the installation and commissioning of Radio Frequency Identification (RFID) equipment at UHF frequencies.

The UHF frequency band is an important frequency range for logistical applications. Unfortunately there are currently no unique regulations across Europe. A first step was made through the EC Decision 2006/804/EC. This decision makes it mandatory for all member states to make available the frequency bands as they are described in the ETSI standard EN 302208. This standard provides 15 UHF RFID channels with a bandwidth of 200 KHz in the range between 865MHz and 868MHz. From these 15 channels only 10 channels are high power channels and can operate with a maximum output power of 2 Watts. The tag backscatter is located in the same channel as the reader to tag signalling. This procedure requires a listen-before-talk-system. A problem of this system is, however, that only a maximum number of ten readers can operate simultaneously within an environment. Another problem is that listen-before-talk requires a special hardware which makes the readers more expensive. To solve these problems the dense reader mode has been developed. The dense reader mode allows it to run a large number of readers within one environment. Each reader will use the same channel to transmit his information to a tag. This is possible through the fact that the tag backscatter is separated spectrally from the reader to tag signalling. The tag information is transmitted Miller-coded on a sub carrier frequency. The frequency division multiplexing moves the tag backscatter into the adjacent channels. This requires a new channel plan for Europe. The new 4-channel plan says that only 4 channels from the 10 available high power channels shall be used. The space between the channels (600 KHz) is reserved for the tag backscatter.

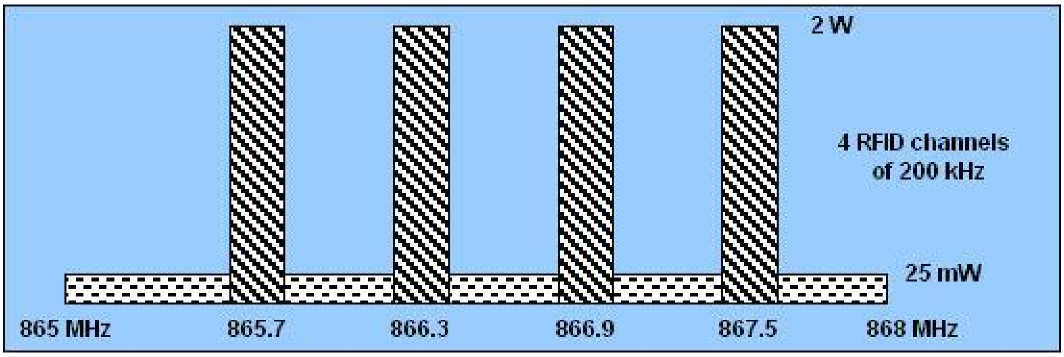

Figure 5 **UHF 4 channel plan**

The implementation of the dense reader mode is described in the new Technical Specification TS102562. This standard describes the new four-channel plan and shows methods for the synchronisation of the listen-before-talk-process to be conform to the current European regulations. One possibility for synchronisation is the so-called in-band radio approach. In this case the reader sends out a pre-pulse over the air interface to synchronise with all other readers in the environment. Next to this method there are several other methods for synchronisation described in this standard, but the pre-pulse of the in-band radio approach is mandatory for all methods. To eliminate this problem ETSI is currently working on a new version of the Standard EN 302208 in which the listen-before-talk-process is eliminated. It is planned to adopt the new version of the standard at the beginning of 2008. This would also cause a change in the ERC/REC 70-03. This process should be supported by the European Commission. The United Kingdom, for example, has already eliminated the listen-before-talk-process. In Germany it can also be disabled with a special approbation. Another disadvantage is that there are no unique global frequencies in the UHF band. The UHF frequency band in the different countries reaches from 840MHz up to 960MHz. That requires different types of readers and reduces the performance of the tags through the wide adjustment range. For the future there should be a larger UHF frequency spectrum. In the United States the spectrum has a bandwidth of 26MHz while in Europe currently only a 3MHz spectrum is available. That's a big disadvantage. Further higher power levels could be very useful to improve the performance and read rates of an RFID system. The maximum allowed power level of two Watts e.r.p causes only a limited transmission through the different materials.

3.4.1.5 Frequency band 2,45GHz

The frequency range between 2,400 GHz and 2,485 GHz is partly overlapping with frequency ranges of radio amateurs' applications and radar systems. The propagation characteristic for this UHF frequency band is nearly optically. Buildings and other barriers act as good reflectors and attenuate an electromagnetic wave very strong during transmission. The most used applications next to backscatter systems are telemetric transmitters and wireless LAN.

The most important RFID standards are:

- harmonised standards
  - ETSI EN 300 440 – radio regulation and spectrum matters
- air interface protocol standards
  - ETSI EN 300 683 – electromagnetic compatibility
  - ETSI EN 300 761 – automatically vehicle identification for railways
- air interface standards

- ISO/IEC 18000-4 – air interface protocol

- air interface test standards
  - ISO/IEC TR 18047-4 – test methods for air interface communication

ETSI EN 300440 describes the electromagnetic compatibility and radio spectrum matters (ERM) for short range devices operating in a frequency range from 1GHz to 40GHz.

The ETSI EN 300683 standard cares about the topic of electromagnetic compatibility (EMC) of short range devices (SRD) operating on frequencies between 9 kHz and 25GHz. This standard together with ETSI EN 300761 is intended to become a harmonised standard. EN 300761 describes the automatic vehicle identification for railways operating in the 2.45 GHz frequency range.

ISO/IEC 18000-4 was published in 2004. A new version of this standard is currently under development. It describes the automatic identification and data capture techniques for Radio Frequency Identification systems for air interface communications at 2.45GHz.

Test methods for air interface communications at 2.45GHz are described in the Technical Report 18047-4.

This frequency range is a very wide and frequently used ISM band. Special problems are the frequently use of wireless LAN and Bluetooth applications. If an application wants to use the whole frequency band it is only possible to run active systems because of the low transmit power of 10 mWatts. For the future there is a need to define special frequencies for RFID applications and WLAN applications and to separate them strictly from each other. Furthermore, the implementation of passive systems should be supported in this frequency band. Therefore an 8MHz wide band, where RFID systems are allowed to transmit with a power level of two Watts e.r.p. is implemented.

3.4.1.6 Frequency band 5.8 GHz

The ISM range from 5,725–5,875 GHz is partially overlapping with frequency bands of radio amateur applications and radar systems. Typical ISM applications are motion detectors e.g. for door openers in warehouses and backscatter systems. The most important RFID standards for this frequency range are:

- harmonised standards:
  - ETSI EN 300440 - radio regulation and spectrum matters
- Air interface protocol standards:
  - ETSI ETS 300 683 – electromagnetic compatibility
  - ETSI EN 300 674 – road transport and traffic telematics

The electromagnetic compatibility and radio spectrum matters (ERM) for short range devices operating in a frequency range from 1GHz to 40GHz is described in ETSI EN 300 440.

The ETSI EN 300 683 standard cares about the topic of electromagnetic compatibility (EMC) operating on frequencies between 9 KHz and 25GHz. The Standard EN 300 674 describes road transport and traffic telematics operating in the 5.8GHz ISM band. Part one of this standard describes general characteristics and test methods for road side units and onboard units while part 2 specifies the requirements for the onboard units.

This frequency is used for some specific applications. Currently there is no need for acting in view to standardisation.

In the fields of radio regulations and air interface standards there are several things that could be improved. Especially in the UHF frequency band there is large need for doing something. The implementation of ERC/REC 70-03 should be mandatory for all European countries. A first step in this direction was made through the EC Decision 2006/804/EC from November 2006 which forces the member states to provide a UHF spectrum according to REC/ERC 70-03 within six months. The establishment of standards which allow large scale implementations to be supported. That means activities like the synchronisation standard TS102 562, the adoption of frequency channels which are reserved for RFID applications and the elimination of listen-before-talk for these channels. These activities are already ongoing and should be supported. Only in this way Europe is able to compensate the given disadvantages in comparison to the United States. In the long term an adequate UHF spectrum should be provided for high-performance readers and also for low-cost readers.

There is also a need for some action in the HF spectrum. This is a widely used frequency band. The implementation of Annex 9F11 of ERC/REC 70-03 should be mandatory for all European countries. The modulation mask should be amended to higher field strength of 60dBµA/min. In the long term it is necessary that an adequate spectrum for HF high speed applications is provided.

To harmonise the frequency landscape it could be helpful to work towards a single frequency authority in Europe. This point could be discussed with the member states.

In the fields of air interface protocols a uniform global standard for all industry sectors such as the compatible standards ISO 18000-6c and EPC Gen2 should be established. Furthermore, the establishment of a worldwide accepted high speed HF standard should be supported.

3.4.2 EC directives and decisions

The following chapter gives a short overview on the most important and relevant EC directives and decisions concerning RFID. These are the following directives:

3.4.2.1 R&TTE 1999/5/EC

Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on Radio and Telecommunications Terminal Equipment (R&TTE) and the mutual recognition of their conformity

The R&TTE Directive is an EC Directive on radio laws in Europe. It applies to all "radio" equipment operating at frequencies higher then 9 KHz. The directive includes several other directives like:

- 73/23/EEC Low Voltage Directive
- 89/336/EEC EMC Directive
- 1999/519/EC EMF Recommendation

According to the directive, the following essential requirements are applicable to all apparatus:

- The protection of the health and safety of the user and any other person, including the objectives with respect to safety requirements contained in Directive 73/23/EEC, but with no voltage limit applying;

- The protection requirements with respect to electromagnetic compatibility contained in directive 89/336/EEC.

In addition, radio equipment shall be constructed in a way that it effectively uses the spectrum allocated to terrestrial/space radiocommunication and orbital resources so as to avoid harmful interference.

All RFID systems and applications are under the R&TTE directive. The directive refers to several mandated standards and is the most important EC directive for RFID applications.

3.4.2.2 2006/804/EC

Commission decision 2006/804/EC of 23 November 2006 on harmonisation of the radio spectrum for radio frequency identification (RFID) devices operating in the ultra high frequency (UHF) band

The European Commission has confirmed its objective to harmonise the European UHF frequency spectrum. In November 2006 the Directive 2006/804/EC was adopted. This directive makes it mandatory for all European member states to make a unique frequency spectrum available within 6 months. The spectrum parameters are based on the ERC/REC 70-03 and on the ETSI standard EN 302 208. Through this fact there are also several restrictions. The spectrum is only usable for smaller applications, because listen-before-talk is required and there is no plan which describes the operation of more then one reader on a channel. Further steps will be the adoption of a new channel plan and the implementation of synchronisation methods for listen-before-talk. This is already done in the Technical Specification TS 102 562, which was published in March 2007. In the long term listen-before-talk will be eliminated. This leads to a change of the EN 302 208 standard and the REC 70-03 planned for early 2008. The United Kingdom has already eliminated the listen-before-talk process in accordance with the implementation of this directive.

The harmonisation of the frequency spectrum should support the development of the European RFID technology.

3.4.2.3 2006/24/EC

Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending directive 2002/58/EC.

The directive specifies the management, the storage and the access to individual data captured by public electronic communications services. The harmonisation of the data management should ensure that the data are available for the purpose of the investigation, detection and prosecution of serious crimes, as defined by each member state in its national laws. Access to the data should be provided only to the competent national authorities in specific cases and in accordance with national laws.

The directive corresponds to the following directives:

- 95/46/EC
- 2002/58/EG

Usually RFID data do not fall in the directive about data retention.

3.4.3 Health & safety

RFID transponders are using electromagnetic waves to transmit stored data to a reader. Due to this fact the question is correct, if exposure to these electromagnetic fields can have an influence on the health of an individual or an offspring. This discussion is not new. Even fifty years ago when the first radio devices were sold people were concerned about this topic. The discussion came back through the fast expansion of mobile phones and wireless networks. There is no question about the fact that electromagnetic waves have an influence on the human body. People sitting in front of a tiled stove become heated through the emitted heat. The emission of light and heat are special kinds of electromagnetic waves. The proof able effects of emitted warmth have normally no damaging influence on the human body. Worldwide more then 20,000 studies about the exposure of human beings to electromagnetic fields have been done. Out of these 20,000 several thousand are addressing the emission through mobile phones. While it seems to be proofed that thermal effects have nearly no hazardous influence on the human body, it can not be excluded that the induction of electromagnetic fields and currents has an influence on the epithelium and cell membranes.

An interaction between electromagnetic waves and the human body is possible in two different ways. There are thermal effects and non thermal effects. Thermal effects occur at frequencies larger than 100 KHz. In this frequency range electromagnetic waves are absorbed which lead to a warming of the tissue. E.g. the warming of the head close to the ear after a longer call with a mobile phone is caused in this effect. This warming is measured in Watts per Kilogramme of body weight (SAR-Value). An impact on the human body can be detected up from an SAR value of 4W/kg. The limits allowed by law are set to a value of 0.4 for workers and 0.08 for the public. These values are at least factor 10 below the critical value. At frequencies below 100 KHz changing magnetic fields are able to induct electric fields and electric current in the human body. It can not be excluded that these effects have influence on the potential of the cell membrane. Used RFID systems are operating usually at much higher frequencies. The strength of non thermal effects is dependent from the power flux density. The power flux density is measured in Watts per m². Based on test results it is recommended to operate mobile phones in the future with a maximum power level of 0,5W/m². These values are still fulfilled by RFID systems. Just in an area of approximately 70cm in front of an RFID antenna which is supplied with the maximum power, higher values can be measured.

Cardiac pacemaker, insulin pumps and other electronic implants can be influenced through electromagnetic waves. Patients are advised to keep switched-on mobile phones away from their implants. People with a cardiac pacemaker should stay away a minimum of 25cm from an operating RFID system. Transponders which are e.g. included into the clothes pose no danger. They are passive systems which are only reflecting an incoming wave. People who are wearing auditory prosthesis can hear humming noise when using a mobile or cordless phone within an area up to 70cm. Because of the analogue behaviour between mobile phones and RFID, a similar security distance is recommended.

ISO/IEC/JTC/SC31 requests that JTC1 should immediately require that all conformance standards for devices emitting RF energy (both electrical and magnetic) include a conformance clause noting: "device manufacturers claiming conformance to this standard shall self-certify that RF emissions do not exceed the maximum permitted exposure limits recommended by either IEEE C95.1:2005 or ICNIRP according to IEC 62369-1. If a device manufacturer is unsure as to which recommendation to cite for compliance, the manufacturer shall self-certify to ICNIRP levels." This demand has already been realised in the EU in form of the R&TTE.

For devices emitting RF (both electrical and magnetic) in a health care setting ISO/IEC/JTC1/SC31 requests that JTC1 should immediately require that all conformance standards include a conformance clause noting: "device manufacturers claiming conformance to this standard shall self-certify that RF emissions and susceptibility comply with IEC 60601-1-2."

3.4.3.1 General standards, recommendations or guidelines

3.4.3.1.1 ICNIRP 494-522; health physics 74 (4)

Guidelines for limiting exposure to time-varying electric, magnetic and electro-magnetic fields (up to 300 GHz)

This standard has the objective to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects. The document describes studies on both direct and indirect effects of EMF. While direct effects result from direct interaction of fields with the body, the indirect effects involve interactions with an object at a different electric potential from the body. The restrictions in these guidelines are only based on scientific data. The currently available knowledge indicates that these restrictions provide an adequate level of protection from exposure to time-varying EMF. The standard presents two classes of guidance:

- basic restrictions
- reference levels

Basic restrictions are restrictions on exposure to time-varying fields that are based directly on established health effects. Reference levels are provided for practical exposure assessment purposes. Some reference levels are derived from relevant basic restrictions using measurement and/or computational techniques, and some address perception and adverse indirect effects of exposure to EMF.

The compliance with the reference level will ensure the compliance with the relevant basic restriction. To test compliance with the relevant basic restriction is necessary whenever a reference level is exceeded. The guidelines written down in this standard do not directly address product performance standards, which are intended to limit EMF emissions under specified test conditions. Nor does the document deal with the techniques used to measure any of the physical quantities that characterise electric, magnetic, and electromagnetic fields. Furthermore, the compliance with the present guidelines may not necessarily preclude interference with, or effects on, medical devices such as metallic prostheses, cardiac pacemakers and defibrillators, and cochlear implants. Interference with pacemakers may occur at levels below the recommended reference levels.

3.4.3.2 EC legislation

The European Parliament and the Council have published two relevant directives. Recommendation 1999/519/EC deals with the limitation of exposure of the general public to EMF (0 Hz-300 GHz). Directive 2004/40/EC regulates the minimum health and safety requirements regarding the exposure of workers to the risks arising from EMF.

3.4.3.2.1 1999/519/EC - Exposure of the general public to electromagnetic fields

This EC recommendation defines the limitation of exposure of the general public to electromagnetic fields in a frequency range from 0Hz to 300GHz. Currently there are no maximum values for the power flux density. All current limits are based on permanent control of new scientific knowledge or technical developments and include a security increase of at least factor ten. The conformity of a device with this regulation is controlled by the CE marking. A product can only be sold and operating if all applicable European regulations are fulfilled and an inspection of conformity is done.

3.4.3.2.2 2004/40/EC - Health and safety requirements regarding the exposure of workers to the risks arising from physical agents

The EC directive 2004/40/EC was published in April 2004. The directive defines the requirements for the protection of workers from the exposure of electromagnetic fields. The European Standards Development Organisation CENELEC was mandated by the European Commission to develop a standard with the title: "Assessment, measurement and calculations of human exposure at the workplace for persons bearing active implantable medical devices in electric, magnetic and electromagnetic fields with frequencies from 0 to 300GHz".

	Public		**Workers**	
	SAR (W/kg)	**Power Flux Density (W/m²)**	**SAR (W/kg)**	**Power Flux Density (W/m²)**
0...1Hz	/	/	/	/
1Hz...4Hz	/	/	/	/
4Hz...1KHz	/	/	/	/
1KHz...100KHz	/	/	/	/
100KHz...10MHz	0,08	/	0,4	/
10MHz...10GHz	0,08	/	0,4	/
10GHz...300GHz	/	10	/	50

Table 14 Maximum limits for the public and for workers

It is developed by the committee CLC/TC 106X. The standard will not define new limits, but is based on already existing standards and should close loops between the regulations. According to the standard every workplace must have an EMF evaluation, even shops, offices and other non-risk environments. Specifically sites with active implantable medical devices (AIMD) need an EMF evaluation.

3.4.3.2.3 2002/95/EC – RoHS

The Restriction of Hazardous Substances Directive (RoHS) 2002/95/EC was adopted in February 2003 by the European Union. This directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. These materials are:

- lead
- mercury
- cadmium
- hexavalent chromium (chromium VI or Cr6+)
- polybrominated biphenyls (PBB)
- polybrominated diphenyl ether (PBDE)

To conform to the original version of the directive these materials in general have to be excluded. The problem was, that this demand can not be realised in the production. It would also not be possible to proof this in an analytic way. So the directive was changed in 2005 and limits for the number of each homogenous material in a product were defined.

The directive is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC which sets collection, recycling and recovery targets for electrical goods.

3.4.3.3 Harmonised standards

3.4.3.3.1 EN 50364 (EMF Assessment of EAS & RFID - Harmonised)

The standard EN 50364 is about electromagnetic fields, electromagnetic radiation, dose limits, physiological effects on the human body, radiation hazards, identification methods, frequencies, radiocommunication, and radio waves. It is a harmonised standard, which will be updated to use IEC62369 (EN62369) for assessment methods. It is currently in development phase.

3.4.3.3.2 EN 50357 (EMF Assessment methods for EAS and RFID)

The standard EN50357 will be withdrawn. The IEC group PT62369 cares about EMF exposure, EAS and RFID. They want a globalisation of EN50357. This contains the same methods and no limits and will not be EU harmonised. It allows the assessment by field measurement, simple modelling and complex system and body modelling. All these standards are only about thermal effects. The influence on nerves and cells is not considered.

3.4.3.3.3 prEN 50XXX-1 (Monitoring and alarm receiving centre — Part 1: Requirements)

The standard prEN 50XXX-1 is currently under development. A first draft of the standard is expected for October 2007. It considers EMF assessment with respect to active implantable medical devices in electric, magnetic and electromagnetic fields.

A good overview over existing national health and safety standards can be found on the WHO webpage:

Internet: www.who.int/en/

3.4.4 Environment

The discussion about environment and legislation is not new at all. Several laws already exist. But not all problems are identified and thus have no been meet yet. Currently, there are three rules that are of great importance in regard to this objective. These are:

- 2002/96/EC - Waste Electrical and Electronic Equipment (WEEE)
- 2002/95/EC - Reduction of Hazardous Substances (RoHS)
- 94/62/EC - Packaging Waste Directive

The Waste Electrical and Electronic Equipment Directive (WEEE Directive) is the European Community directive 2002/96/EC on waste of electrical and electronic equipment. The directive became European Law in February 2003, setting collection, recycling and recovery targets for all types of electrical goods. The directive makes the manufacturers responsible for waste disposal of electrical and electronic equipment. The producing and manufacturing industry should establish an infrastructure for collecting WEEE. Consumers should be able to return electrical and electronic equipment from private households free of charge. The EU member states were obliged by the directive to implement its provisions into national law until August 2004. As the national transposition of the WEEE directive varies between the member states, a patchwork of requirements and compliance solutions is emerging across Europe.

The WEEE directive can also be applied to RFID systems and antennas. Tags and labels are under the requirements of the device they are attached to. Until now, there is no regulation found which specifies the waste management of transponders. A future clarification would be helpful. If the tag is put on the equipment, the producer of the equipment, whatever the subject may be is responsible for recycling.

The EC directive 2002/95/EC Reduction of Hazardous Substances was also established in February 2003. This directive forces manufacturers to prohibit different kinds of materials like lead, mercury and cadmium. The directive was changed in 2005, because it was not possible to exclude these materials from all production processes. Since 2005, the usage of such material for a product is limited to a maximum. This regulation is mandatory for RFID Readers and Tags as well. RFIDs meet the definition of electrical and electronic equipment provided for in the WEEE and RoHS Directives and thus can be considered to come under Category 3 "IT and telecommunication equipment". RFIDs are covered by the RoHS Directive.

A more detailed description can be found in the chapter above.

Moreover, Directive 94/62/EC covers all packaging placed on the market and all packaging waste. In this connection it is of no deeper importance whether packaging is just used or released at the industrial or commercial sector, or at offices, shops, services, households etc. It is mandatory for all kinds of packaging materials. The criteria for clarifying the definition of the term "packaging" are stated in directive 2004/12/EC. The Packaging Waste Directive requires member states to take measures, such as national programmes, to prevent unnecessary packaging waste, and encourages them to develop reuse systems for packaging.

Such systems for returning and recycling packaging should fulfil the following targets:

- by no later than 30 June 2001, between 50 and 65 % of the weight of packaging waste was sought to be recovered or incinerated at waste incineration plants with energy recovery;
- by no later than 31 December 2008, at least 60 % of the weight of packaging waste is sought to be recovered or incinerated at waste incineration plants with energy recovery;
- by no later than 30 June 2001, between 25 and 45 % of the weight of the total of packaging materials contained in packaging waste were sought to be recycled (with a minimum of 15 % by weight for each packaging material);
- by no later than 31 December 2008, between 55 and 80 % by weight of packaging waste to be recycled;
- by no later than 31 December 2008 the following targets for materials contained in packaging waste must be attained: 60 % by weight for glass, paper and board; 50 % by weight for metals; 22.5 % by weight for plastics and 15 % by weight for wood.

The Commission has to promote the development of European standards relating to these essential requirements. Provisions concerning proof of conformity with national standards must be applied immediately. To provide the necessary community data on waste management, the member states must ensure that databases on packaging and packaging waste are established on a harmonised basis so that the realisation of the targets of this directive can be monitored.

3.4.5 Data and network standards

Data and network standards define the SW layers between RFID readers and application SW. ISO and EPCglobal have driven this topic up to now. Standards are available in varying stages of implementation and different level of detail from both organisations. In the following chapter the available standards are described and evaluated according to the project targets. Reader interface standards, data management interface standards, data standards, application interface standards and information network service and interface standards are described. Most of the ratified standards are quite new. The usage up to now is limited to data standards. Nevertheless, the market relevance grows with the emergence of big scale applications.

3.4.5.1 EPCglobal standards

As small scale RFID implementations emerged earlier, it is understandable that the development of data and network standards began later than the definition of air interface standards. Also, it is obvious that the topic is heavily driven by EPCglobal, since the vision of having worldwide access to product information can only be realised by standardised infrastructure. First steps of defining a software architecture were taken by the Auto ID Center. After its take over by EPCglobal a set of standards has been worked out and released. The activities have been implemented partly without taking into account existing ISO standards. However, EPCglobal Standards are royalty free, which cannot be said about every ISO standard.

3.4.5.1.1 Architectural Framework Document

The Architectural Framework Document (AFD) defines and describes the EPCglobal architecture framework which is a collection of interrelated standards for hardware, software, and data interfaces, together with core services that are operated by

EPCglobal and its delegates, all in service of a common goal of enhancing the supply chain through the use of Electronic Product Codes (EPCs). The document outlines the top level architecture of core services that are operated by EPCglobal and enumerates. At a high level, it also displays all hardware, software, and data standards that are part of the EPCglobal Architecture Framework and how they are related. Additionally, the design principles that underlie all parts of the framework are explained.

The current version of the specification was published on 1 July 2005.

Figure 3 shows the architecture framework. Within the diagram green boxes represent the interfaces specified by EPCglobal standards, whereas the blue boxes signify defined roles. The actual implementation of software satisfying a certain role lies beyond the scope of EPCglobal standards, i.e. only the interfaces used in the communication of interacting roles are standardised.

The concept describes the function of roles and interfaces and supports the idea to organise access to product related data provided by various players within the supply chain. The concept of an "Internet of Things" implies that owners of product data are asked to put the relevant information into their EPC IS repository and to keep it up to date. Furthermore, the concept implies n to m data transfers between participants of the supply chain. As each of its participants may store information about an item, smart data replication algorithms have to be found. Research organisations have started to work on this topic.

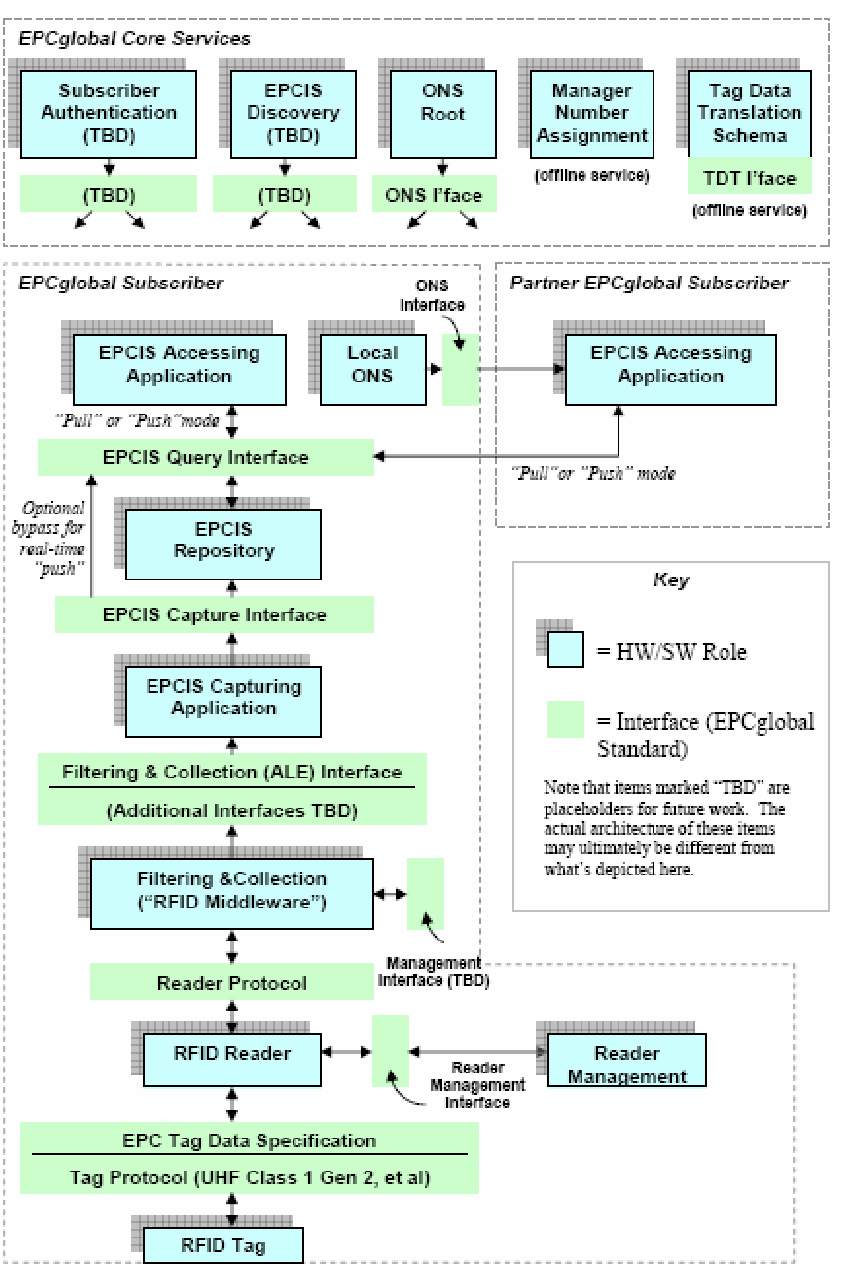

Figure 6 **EPCglobal architecture framework**

3.4.5.1.2 EPC Tag Data Standard

The EPC Tag Data Standard (TDS) defines the overall structure of the Electronic Product Code (EPC), i.e. the particular portion of EPC tag data standardised by EPCglobal. It specifies different coding schemes combining existing numbering structures like the GS1 family of coding schemes with the US Department of Defence's CAGE/DoDAAC scheme.

For each of these coding schemes, there are binary representations for use on RFID tags (i.e. the EPC Tag Encodings) and text representations for use within information system layers of the EPC Systems Network (i.e. the EPC URI or Uniform Resource Identifier Encodings). Last but not least, rules for converting one representation into another exist as well. The EPC URI Encodings provide means for application software to process EPC Tag Encodings either at the bit level or at various other levels of semantic abstraction independent of tag variations (i.e. the EPC Pure Identity URI). Moreover, a pattern URI representation is defined that does not represent a single EPC, but rather refers to a set of EPCs.

The current version 1.3 of the specification comprises encodings for EPCs of 96 to 202 bits length.

It cannot be assumed that all worldwide market segments will accept the EPCglobal schemes; rather it is very likely that important market players will set up their own numbering standards. Many ISO air interface standards support permanent UIDs, having the advantage that the uniqueness of the identifier is guaranteed by the semiconductor supplier. Hence, there is no need to program unique codes outside the semi-conductor foundries. To avoid interoperability problems, superior ISO standards like ISO15963 are of major advantage.

3.4.5.1.3 EPC Tag Data Translation Standard

EPC Tag Data Translation (TDT) specification is concerned with a machine-readable version of the EPC tag data standards specification. The machine-readable version can be used for validation of EPC formats as well as for automatic translation between different levels of representation in a consistent way. The specification describes how to interpret the machine-readable version. It contains details of the structure and elements of the machine-readable mark-up files and provides guidance on how it might be used in automatic translation or validation software, either standalone or embedded in other systems. A software implementation of this standard may automatically become aware of new EPC formats enabling translation and validation. It might do so by providing these formats with an updated version of the TDT mark-up files (published by EPCglobal) comprising new EPC formats.

The current version 1.0 of the TDT specification is compatible to TDS 1.1 revision 1.27.

3.4.5.1.4 Reader Protocol Standard

The RFID reader transforms information transferred via air interface into a digital domain. Reader Interface Standards define the designs of data exchange, configuration and reader management functions. Often, many different types of readers are required within one single RFID project. Modules inserted in printers or mobile computers, desk top terminals or enormous standalone readers at doc-doors ask for a modular concept and specific means to ensure quality and reliability aspects.

The reader protocol (RP) standard defines the protocol by which tag readers interact with EPCglobal compliant software applications (e.g. an EPC-aware middleware). The terms "tag reader" or "reader" include RFID tag readers, supporting any combination of RF protocols, fixed and handheld, etc. It also includes readers of other kinds of tags, such as barcodes. Tag readers, despite their name, may also have the ability to write data into tags. In particular, the Reader Protocol is intended to provide complete access to all capabilities of the UHF Class 1 Gen 2 Tag Protocol including modulation formats, data rates sessions, and passwords, as well as reading, writing, locking, and killing tags. The latest working draft version 1.1 of the reader protocol specification does not fully realise this goal, but it is the intent of EPCglobal to address this issue in the next version of the protocol.

An important goal of the reader protocol is to insulate software applications from knowing the details of how reader and tags interact. Readers may employ a variety of protocols to interact with tags, but the same reader protocol is used for communication between application and reader.

Only a minimum set of commands specified by the standard is obligatory to be supported by a reader. Therefore, most of the commands are optional and compliant readers may differ heavily in their supported functionality: A high-end reader may asynchronously inform the application of tags entering or leaving the reader's field, while a low-end reader needs to be polled for current tags. The reader protocol conformance requirements will be developed to categorise readers by their functionality.

The specification provides means (and a compliant reader may support these) to control the smoothing of tag events, to filter and aggregate captured EPC data.

The current version of the RP specification is 1.1. The protocol is unaware of air interface and also supports existing HF protocols or a barcode reader.

EPCglobal decided to add an additional reader protocol standard, the so-called low level reader protocol which is described below. Therefore, the standardisation working groups will deliver two different documents: The High Level Reader Protocol (HLRP) and the Low Level Reader Protocol (LLRP). HLRP is sought to be the next version of RP 1.1. As a high level reader protocol, HLRP is unaware of air protocols.

In contrast to this, LLRP is a low level reader protocol and therefore aware of air protocols. Thus, it should support full access to Gen2 air protocol. Hence, the first focus within this subpart will be on specifying LLRP. After that, a further description of HLRP shall be given as well.

3.4.5.1.5 Low Level Reader Protocol Standard

The Low Level Reader Protocol (LLRP) specifies an interface between RFID readers and clients. In contrast to RP 1.1, the LLRP explicitly controls the RFID air protocol operation timing and the access to air protocol command parameters, even though only UHF Class 1 Gen2 specific parameters are currently supported.

The LLRP allows retrieving reader device capabilities, which are needed to command a reader to inventory tags, read tag data, write tags, and execute protocol-dependent commands such as "kill" and "lock". Additionally, for enhancing the simultaneous operation of RFID readers in a dense environment, it provides means to control the forward and reverse RF link operation to manage RF power levels and spectrum utilisation, and assess RF interference.

The communication performed by LLRP is based on messages and the only encoding specified is a binary one.

The current version of the LLRP specification is 1.0.

The structure of the standard is well-organised. The standard is open for adding support of additional air interfaces. The handling of optional commands has been improved. The complete function set of Gen2 air interface standard is supported. Secure data transfer to the back end systems is foreseen as optional. Management functions such as firmware update and diagnosis are described.

It has to be noted that for the implementation of the complete functionality a certain level of computing power is needed. Binary binding for the protocol has been chosen to limit hardware costs resulting in high implementation efforts.

Up to now, there are no readers available on the market supporting this standard.

3.4.5.1.6 Reader Management Standard

The Reader Management (RM) standard defines the wire protocol used by management software to monitor the operating status and health of EPC-global compliant tag readers. It complements the RP which defines the collection of tag data between reader and application.

The specification provides means to query the configuration of a reader, such as its identity or number of antennas, and to monitor its operational status like the number of tags read, the status of communication channels, antenna connectivity, or transmit power levels. The protocol also allows controlling the configuration of a reader, e.g. enabling or disabling specific antennas or features, and may support access to additional management functions including discovery, firmware configuration and updates, and managing reader power consumption.

The current version of the RM specification is 1.0.

The consequent separation of reader protocol standards and reader management standards permits that applications supporting critical business processes like supply chains and manufacturing lines become controlled by RFID. In this case specific system management software can be used in order to guarantee a high level of system availability at low service cost. Reader suppliers, who do not want to support this specific market segment, might choose not to implement that standard.

3.4.5.1.7 Application Level Events Standard

The Application Level Events (ALE) standard specifies an interface through which clients may obtain filtered, consolidated EPC data from various sources. Its role in the EPCglobal framework is "Filtering & Collection", i.e. reducing the volume of data that comes directly from EPC data sources (readers) into coarser "events" of interest to applications. The ALE interface also provides independence between the components performing the Filtering & Collection of EPC data and the applications that depend on the data (similarly the reader protocol decouples the infrastructure components that acquire the raw EPC data from the Filtering & Collection components). Therefore, it abstracts multiple readers of different kinds to a single, logical data source.

ALE provides declarative means for client applications to specify what mode of processing to perform on EPC data, including filtering, aggregation, grouping, counting and differential analysis (i.e. reporting only changes in the set of read EPCs). Client applications may choose to request the processed data on demand or as standing request ("synchronous" or "asynchronous" delivery). Both requests and reports containing processed data poses standardised representations that are forward compatible with future revisions of the standard.

However, the current version 1.0 of the ALE specification lacks the functionality for writing EPCs and for accessing user data on tags. For this reason it may only be applied to use cases where tags are inventoried (i.e. EPCs carried on tags are read). Both issues, as well as security and role management are to be addressed in the up-coming version 1.1 of the ALE standard.

The ALE standard 1.0 was released in September 2005 and is used frequently. The event methodology is very efficient and well accepted. The standard is open to all available air interface standards.

3.4.5.1.8 Object Naming Service Standard

The Object Naming Service (ONS) Standard specifies how the Domain Name System is used to locate authoritative metadata and services associated with a given EPC. In particular, the specification explains how the EPC Manager Number and object class parts contained in the SGTIN EPC scheme are transformed into a domain name. This domain name is resolved by the EPCglobal ONS root server (which is in fact a DNS server). For further resolving of the SGTIN object class encoded, the domain name then is delegated to the ONS/DNS server of the corresponding EPC Manager. The current version 1.0 of the ONS specification only addresses the ONS lookup mechanism for the SGTIN EPC scheme. Future work by the ONS Working Group will address how ONS is used for other namespaces that build the EPC and that are outlined in the EPCglobal TDS.

The principle of ONS is that product information shall be found on request. As a precondition, this information has to be made available by the participants of the supply chain. However, for this purpose a tremendous amount of data management efforts have to be met and a commitment for making data available outside the company is needed as well. Today, ONS servers are provided by the US company VeriSign only.

3.4.5.1.9 EPCglobal Certificate Profile Standard

The EPCglobal architecture framework document describes how security functions such as authentication, access control, validation, and privacy protection of individuals and corporations will be distributed across many of the roles/interfaces operating within the EPCglobal network. For instance, EPCIS interface responsibilities may include means for mutual authentication of two parties exchanging EPCIS data via that interface.

The authentication of entities (subscribers, services, physical devices) operating within the EPCglobal network serves as the foundation of any security function incorporated into the network. The EPCglobal architecture allows the use of a variety of authentication technologies via its defined interfaces. It is expected, however, that the X.509 authentication framework will be widely employed within the EPCglobal network.

To ensure broad interoperability and rapid deployment while ensuring secure usage, the Certificate Profile Standard defines a profile of X.509 certificate issuance and usage by entities in the EPCglobal network. The document specifies the signature algorithms and minimum key lengths to use as well as the certificate profile for the different types of entities.

The current version of the specification is 1.0.

By this standard the basic security mechanisms between the software components of the EPCglobal framework are defined. It does not specify any security related to the air interface.

3.4.5.1.10 EPC Information Services

The goal of EPC Information Services (EPCIS) standards is to enable disparate applications to leverage EPC data by EPC-related data sharing, both within and across enterprises. Ultimately, this mode of sharing is aimed at allowing participants in the EPCglobal Network to gain a shared view of the disposition of EPC-bearing objects within a relevant business context.

The currently unreleased specification is intended to provide only a basic capability that the user community has identified as a minimally useful set and is expected to be extended in follow-on versions of the standard.

Via the defined EPCIS capture interface an application can communicate EPC-related business events to an EPCIS Repository for storing. An event contains data representing four dimensions ("what, when, where, and why"): (1) the object(s) or other entities that are the subject of the event ("what?"); (2) the date and time ("when?"); (3) the location at which the event occurred ("where?"); (4) the business context ("why?").

The EPCIS Repository stores these events plus metadata concerning the locations and business contexts referred to in the events and provides the EPCIS Query Interface whereby an application can request and query for event and metadata. In the first version of this specification there will be no standard way of defining these metadata though.

The current version of the specification is 1.0.

3.4.5.1.11 Application Level Events (ALE) Standard V. 1.0 conformance requirements

Technical implementations of the Application Level Events (ALE) specification may vary due to distinct interpretations of the specification and/or the use of proprietary technologies during developing systems that implement the EPCglobal Architecture Framework. Compliance testing provides a mechanism to ensure that solutions adhere to and are compatible with specified standards. The Application Level Events (ALE) conformance requirements document makes a benchmark available to solution providers for assuring product functionality according to the ALE specification 1.0. In the meantime, confidence to potential buyers shall be imparted, especially relating to the operational capability of implementation of specific ALE interface products.

3.4.5.1.12 EPC Information Services (EPCIS) 1.0 conformance requirements

The EPCIS 1.0 Specification defines specific functionality for valid EPCIS implementations. The document outlines specific requirements that must be tested according to this specification. Each test requirement entry references the EPCIS 1.0 Specification and the test case requirement (TCR) used to verify functionality as defined in section two of this document.

3.4.5.1.13 Low Level Reader Protocol (LLRP) 1.0 conformance requirements

Technical implementations of the Low Level Reader Protocol (LLRP) specification may vary due to distinct interpretations of the specification and/or use of proprietary technologies when implementing the EPCglobal architecture framework. Conformance testing provides a mechanism to ensure that solutions adhere to and are compatible with the specified standards. This document outlines the approach to conformance testing for the EPCglobal Low Level Reader Protocol 1.0 specification.

3.4.5.1.14 Reader Management (RM) 1.0.1 conformance requirements

This document outlines the approach to conformance testing for the EPCglobal Reader Management (RM) 1.0 specification.

3.4.5.1.15 Reader Protocol (RP) 1.1 conformance requirements

This document outlines the approach to conformance testing for the EPCglobal Reader Management (RM) 1.0 specification. It specifies all commands and functionalities that must be implemented.

3.4.5.2 ISO / IEC Standards

In order to secure interoperability of RFID related software and the uniqueness of serial numbers, ISO defined a set of data and network standards. All ISO air interface standards are supported. These standards have been available before EPCglobal activities started. ISO standards represent a set of minimum requirements and deliberately do not define very specific rules for software implementation to broaden the field of applications the standards may be applied to.

Figure 7 shows a system diagram of the software architecture defined by ISO.

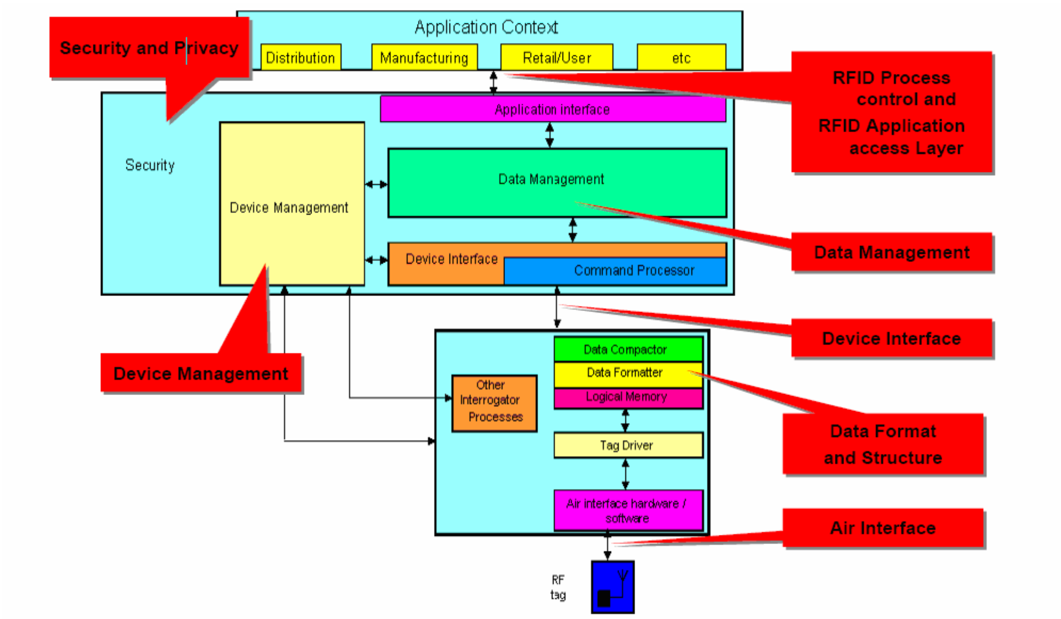

Figure 7 **ISO Software Architecture (source: 7iD Technologies GmbH)**

3.4.5.2.1 ISO / IEC 15961 (reader interface standard)

The data protocol used to exchange information in a radio-frequency identification (RFID) system for item management is specified in ISO/IEC 15961 and in ISO/IEC 15962. Both are required for a complete understanding of the data protocol in its entirety; but each focuses on one particular interface: ISO/IEC 15961 addresses the information interface with the application system, whereas ISO/IEC 15962 deals with the basic processing of data and its presentation to the RF tag.

ISO/IEC 15961 "Radio frequency identification (RFID) for item management – Data protocol: application interface" focuses on the interface between the application and the data protocol processor, i.e. an intelligent reader or a middleware. It includes the specification of the transfer syntax and definition of application commands and responses.

The standard provides guidelines how tag data shall be presented as objects made up of fundamental primitive types and how these objects are identified. The defined commands allow reading, modifying, and deleting the existing objects and creating new objects on a specific tag. Data and commands are specified in a standardised way, independent of the particular air interface of ISO/IEC 18000.

ISO/IEC 15961 is expected to serve as a standardised interface which software for particular RFID applications is based on.

The current version of the specification is ISO/IEC 15961:2004. It is a very basic rule set to define read and write commands. Neither communication bindings nor air interface specific commands are represented. The quite abstract approach results in high complexity which renders the implementation of the standard in current interrogator firmware practically impossible. In contrast to most interfaces specified by EPCglobal, ISO 15961 does only provide a synchronous interaction mode. The standard has not been reflected in available products up to now.

ISO/IEC 15961 is a three-piece document:

- ISO/IEC NP 15961-1 information technology — Radio frequency identification (RFID) for item management — data protocol — Part 1: Application interface.
  This part defines the transfer of data to and from the application, supported by appropriate application commands and responses.

- ISO/IEC CD 15961-2 information technology — radio frequency identification (RFID) for item management — data protocol — Part 2: registration of RFID data constructs.
  This part defines the registration procedure of RFID data constructs to ensure that the data protocol supports new applications, in a relatively straightforward manner, as they adopt RFID technology. This can be achieved by the registration authority publishing regular updates of

RFID data constructs that have been assigned, and for a means of incorporating these updates into the processes of ISO/IEC 15961-1.

- ISO/IEC CD 15961-3Information technology — radio frequency identification (RFID) for item management — data protocol — Part 3: RFID data constructs.
  This part defines the RFID data constructs and the rules that govern their use.

3.4.5.2.2 ISO/IEC 15962 (data standard)

ISO/IEC 15962 "Radio frequency identification (RFID) for item management – Data protocol: data encoding rules and logical memory functions" focuses on encoding the transfer syntax, as defined in ISO/IEC 15961 according to the application commands defined in that standard. It defines how objects including their identifiers are encoded and mapped in a logical memory as a software analogue of the physical memory of the RF tag being addressed by the interrogator.

Furthermore, it describes the so-called tag driver as an interface to the air interface definitions of ISO/IEC 18000.

As a consequence, tags will not only contain user data, but also metadata allowing an interpretation of the tag data as objects. The structure of a specific object is determined by its object identifier included in the metadata. Object identifiers are structured hierarchically and therefore ensure the uniqueness of data objects.

The current version of the specification is ISO/IEC 15962:2004.

This standard defines rules for optimised memory access even for user. For very small memories the concept is too complex, thus it suits applications with tags holding big amounts of user data.

3.4.5.2.3 ISO/IEC 15963 (data standard)

ISO/IEC 15963:2004 "Radio frequency identification for item management – Unique identification for RF tags" describes numbering systems available for the identification of RF tags.

Unique IDs are required as part of the write operation to RFID tags. These IDs guarantee that the information written to a tag is written to the correct data carrier (tag) unambiguously. Also, unique IDs are required in many read situations where the contents of a tag are tied to a specific item and that item needs to be identified unambiguously.

The specification differentiates between permanent unique and virtual IDs. Permanent unique IDs are completely and globally unique and shall be programmed into the tag. A virtual tag ID is a temporary ID that may vary over the life of the tag and that needs to be unique only for all tags present to a specific interrogator at a given time. The standard outlines advantages and disadvantages of these two types of IDs.

The current version of the specification is ISO/IEC 15963:2004.

This standard both supports permanent unique IDs programmed into the chips by semiconductor suppliers (ISO UIDs) as well as virtual IDs (EPCglobal Gen 2 Standard). Furthermore, it defines an allocation class, i.e. an identification of the identifier issuer, for EAN.UCC or EPCglobal, respectively.

3.4.5.2.4 ISO/IEC 24791 (all categories)

ISO/IEC 24791 "Radio Frequency Identification (RFID) for item management – Software system infrastructure" (formerly known as ISO/IEC 24752) is an extension to ISO/IEC 15961 and 15962 and defines the software infrastructure that readers are embedded in. The six parts comprise the areas architecture, data management, device management, application interface, device interface, and security.

This sort of specification has only just begun. By comparing the ISO with the EPCglobal architecture, big gaps necessary to be filled can be found, especially between ISO 15961 and ISO 15962. Furthermore, efforts are made to incorporate EPCglobal standards, i.e. an alignment with EPCglobal has been initiated.

For further information on ISO standards visit the homepage at Internet: www.iso.org.

3.4.5.3 Comparison EPCglobal / ISO

Figure 8 gives an overview how the software layers for RFID systems are covered by ISO and EPCglobal.

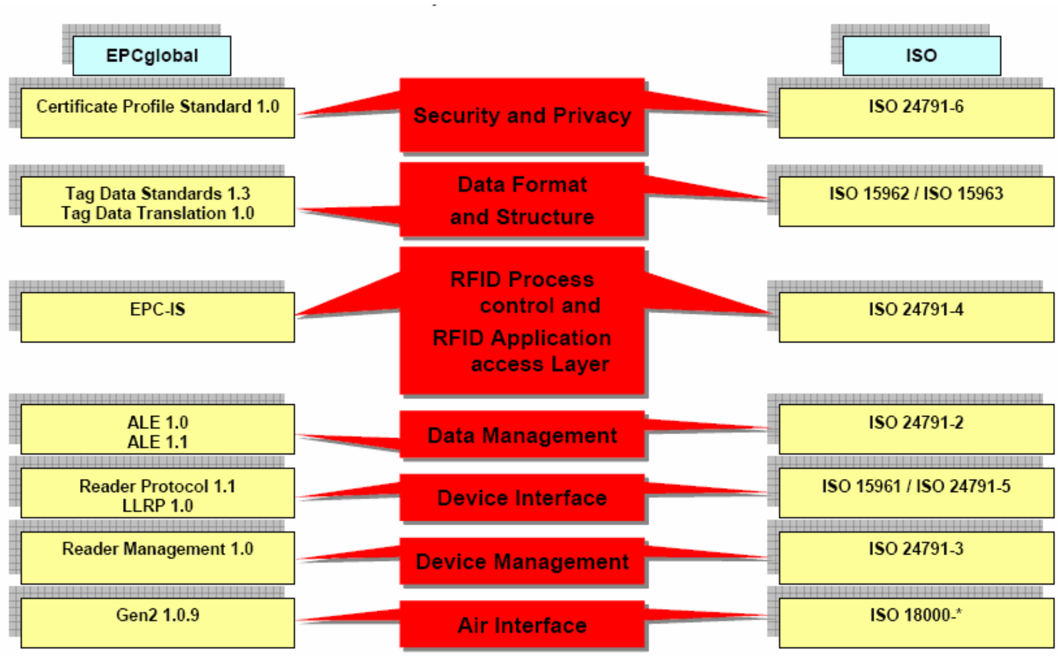

Figure 8 **EPCglobal vs. ISO architecture (source: 7iD Technologies GmbH)**

3.5 RFID standards in the individual application fields

3.5.1 RFID reference model

The term "RFID technology" sums up a vast field of applications. When people talk about RFID technology they might talk about simple anti-theft devices, about animal identification systems, or even about smart objects finding their destined way within logistic applications. When an application field is so wide it is obvious that it is difficult to classify findings and to realise which of these findings are relevant for a specific application area. The RFID reference model targets at solving this problem. Applications have been merged to RFID-application fields. Table 1 shows the resulting eight application fields (A.-H.).

	RFID application fields	Description
Mainly object tagging	A. Logistical tracking & tracing	Solely identification and location of goods and returnable assets (e.g. pallets or containers)
	B. Production, monitoring and maintenance	Smart systems in combination with RFID technology to support production, monitoring and maintenance of goods and processes
	C. Product safety, quality and information	Applications to insure quality (e.g. sensors to monitor temperature) and product safety (e.g. fight against counterfeiting)
Tagging with reference or potential reference to people	D. Access control and tracking & tracing of individuals	Single function tags for identification and authorisation applications for entries and ticketing
	E. Loyalty, membership and payment	Smart card based identification and authorisation systems for multifunctional applications (e.g. loyalty, payment and banking systems)
	F. eHealth care	Systems for hospital administration and smart systems to support and monitor health status
	G. Sport, leisure and household	Sports applications, rental systems (e.g. cars or books), smart home
	H. Public services	Systems mandated by law to meet public duties (e.g. ID-Cards, health insurance cards, road tolling systems)

Table 15 **Application fields**

The application fields A. to C. (according to the part coloured yellow in Table 15) can be described as "Mainly Object Tagging Applications". In contrast, the application fields D. to H. describe tagging fields with "Reference or Potential Reference" to people (coloured orange).

Different applications within the RFID-Application Fields are called subcategories. Examples of subcategories within the RFID-application field "A. Logistical Tracking & Tracing" are "In-house Logistics", "Open Logistics" or "Postal Applications". These examples show obviously that, for instance, regulatory challenges, open questions, and relevant stakeholders for these subcategories can differ.

The RFID-Application fields and subcategories are listed on the horizontal axis of the matrix. The first column will be used for relevant issues and open questions that are to be answered for all subcategories (e.g. frequencies used in each subcategory, existence of different kinds of data standards…).

This report covers RFID standardisation within the following RFID-Application fields:

A. Logistical tracking and tracing of goods

B. Production, monitoring and maintenance of goods and processes

C. Applications to ensure product safety, quality and information of goods and processes

The subcategories

- DA. - access control systems
- DC. - personal tracking
- GB. - rental systems

will also be considered.

This chapter deals with application specific standards. Standards which are mainly independent of applications are analysed in the previous chapter.

The WP3 matrix of the reference model gives an overview of existing standards and more importantly shows where standards are currently missing or hindering the further development and implementation of RFID technology.

Frequency and air interface standards are not specific for applications. They are attached to all kind of applications operating in the corresponding frequency band. An appropriate analyse can be found in chapter 3.3.

Furthermore, the relevance for data and network standards, the availability of products and the necessity of standardisation activities in the fields of reader interface standards, data standards and information network service & interface standards has been analysed.

3.5.1.1 Reader interface standards

Reader interface standards specify the protocols by which IT systems communicate with RFID readers. RFID data transfer, reader commands, reader configuration and reader management are described. Ideally, a reader protocol standard represents the whole functionality of the air interface while allowing integration in heterogeneous environments.

The functionality of readers may vary significantly. While a small reader module in a printer carries out simple read/write operations, stationary readers in dock doors featuring multi-antenna setups and external I/O devices like sensors, require advanced configurability. It furthermore makes a major difference if a RFID reader is integrated in local application software, or if it is used in multi-enterprise solutions within an international logistic chain. Therefore, reader protocol standards have high priority in big scale RFID solutions.

As logistic processes represent key processes for small as well as big enterprises, reader management standards play an important role to ensure reliability, stability and maintainability.

3.5.1.2 Data standards

Data standards define the structure and interpretation of data stored on tags which can be tag identification data, user data or both. Another topic covered by data standards is the translation of existing data schemes such as EAN into unique identifiers.

While in closed-loop applications like in-house logistics, access control or facility management the owner and interpreter of the data is a single entity, this is not the case for open loop logistic chains. In this case it is a must to have international standards for the interpretation and translation of data in order to make it usable for all participants in the supply chain of products. Only a centralised numbering scheme is able to guarantee interoperability of global solutions. In closed loop applications it is desirable to follow these schemes as well. By doing this, interference of tags can be avoided as they are not part of the specific application.

3.5.1.3 Information network services & interface standards

Information network services & interface standards deal with data management within and across companies. Local applications like access control, archive systems, or facility management do not necessarily have the need to transfer data among sites or even from one company to another. Therefore, this type of standards is not relevant for such kind of applications.

Especially for big scale applications concerning tracking and tracing goods between continents reliable data transfer and organisation of information access is a key element. Comprehensive standards are a very important precondition for world wide success of RFID in logistics.

As this is most relevant to the clientele of GS1 EPCglobal has launched standardisation activities in order to approach the vision of the "Internet of Things". ONS (Object Naming Service) and EPCIS (EPC Information Service) follow a concept to provide item information in a similar way as WEB pages are accessible on the Internet.

The WP3 matrix of the RFID reference model specially applied to RFID application standards gives an overview of existing application standards in the different RFID application fields and their basic subordinate areas.

Later on, a first analysis shows which kind of standards are currently missing. The final analysis including recommendations will be found in chapter 4.

3.5.2 A. Logistical tracking and tracing of goods

The application field "A – logistical tracking and tracing" can be subdivided into six different subcategories.

AA. In-house logistics

AB. Closed loop logistics

AC. Open logistics

AD. Postal applications

AE. Dangerous goods logistics

AF. Manufacturing logistics

3.5.2.1 Frequencies and air interface standards

RFID application fields	**A. Logistical tracking & tracing**					
Basic application area	**Object tagging**					
Subcategories	**AA. – In-house logistics**	**AB. - Closed loop logistics**	**AC. - Open logistics**	**AD. - Postal applications**	**AE. - Dangerous goods logistics**	**AF. - Manufacturing logistics**
Frequencies and air interface standards						
Used air interfaces in current applications Y(Yes): used, blank: not used						
LF <134 kHz	Y	Y		Y	Y	
HF 13.56 MHz	Y	Y	Y	Y	Y	Y
UHF 433 MHz (active)	Y	Y			Y	

UHF 860-960 MHz	Y	Y	Y	Y		Y
UHF 2,4 GHz	Y	Y			Y	
SHF 5,8 GHz						
Availability of air interface protocol standards: yes / no Y(Yes): Published standards or standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
European standards						
National standards						
Importance of standards (High/Low)	L	L	H	H	H	L

Table 16 Air interface standards of A. Logistical tracking & tracing

In application field "AA – In-house logistics" systems from all existing RFID frequency bands are used. These are the LF frequency band (125 KHz), the HF frequency band (13.56 MHz), the UHF frequency band for active systems (433 MHz), the UHF band (860-960 MHz) and the 2.4GHz band. Logistics applications are applied by only one user, and only for internal purposes. Because of this fact there is only a small need for overall regulations or standards.

In the application field "AB – Closed loop logistics" also systems from all available frequency bands are used. Closed loop logistics applications cover a small number of different users (e.g. a manufacturer and several suppliers or retailers). In this case there is a need for internal standards only, but not for overall regulation.

For application field "AC – Open logistics" only systems operating in the HF and UHF frequency band are used. Open logistics operations involve a large and variable number of participants. European and global standards are quite necessary. The value chain gains should be facilitated and large-scale implementation should not be blocked.

The application field "AD – postal applications" uses three different frequency bands. These are the 125 KHz LF band, the 13.56 MHz HF band and the UHF band. This RFID application is either used by national postal services for parcels and letters or by private sector parcel services (e.g. DHL). For national postal services, international regulations are needed (e.g. by the Universal Postal Union) to ensure cross-border delivery of mail. In contrast, private sector parcel services, closed loop or internal logistics do not need such standards.

The application field "AE - Dangerous goods logistics" is used by every frequency band except the 860 – 960 MHz UHF band. In this field RFID applications are used to monitor and track the transportation of dangerous goods e.g. chemicals, hazardous materials and nuclear materials. The implementation is usually mandated by the EU or by national law. Thus, a large degree of standardisation activities and government regulations is needed.

The application field "AF – Manufacturing logistics" only uses HF and UHF band. These logistics applications involve manufacturing processes that can be either internal or open, such as just-in-time logistics. Within this field standards are needed to ensure the compliance and interoperability of all parties involved.

Standards are also used for internal logistic systems because of ecological reasons.

3.5.2.2 Data and network standards

RFID application fields	**A. Logistical tracking & tracing**
Basic application area	**Object tagging**

Subcategories	AA. – In-house logistics	AB. - Closed loop logistics	AC. - Open logistics	AD. - Postal applications	AE. - Dangerous goods logistics	AF. - Manufacturing logistics
Data and network standards						
Used data and network standard categories in current applications Y(Yes): used, blank: not used						
Reader interface						
Data			Y	Y	Y	Y
Data management interface			Y	Y	Y	Y
Information network services & interface						
Availability of data and network standards: yes / no Y(Yes): Published standards or standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
European standards						
National standards						
Do competing standards exist?	Y	Y	Y	Y	Y	Y
Importance of standards (High/Low)	L	L	H	H	H	H

Table 17 **Data and network standards of A. Logistical tracking & tracing**

AA. – In-house logistics

There is no need to use complex software standards. To use data standards is recommended to avoid conflicts with other applications on the same location.

AB. – Closed loop logistics

There is no need to use complex data and network standards. To use data standards is recommended to avoid conflicts with other applications on the same location.

AC. – Open logistics

Only data standards are used up to now. Many projects are performed with proprietary software solutions.

AD. – Postal applications

Data standards are used. Additional data and network standards are required for this kind of applications.

AE. – Dangerous goods logistics

Data and network standards are required for this type of applications.

AF. - Manufacturing logistics

Many proprietary solutions are used today. Standardisation is required to lower system cost.

3.5.2.3 Application standards

The application standards will content all kinds of standards strongly related to applications like

- architecture of the RFID system
- mechanical application of the RFID tags or antennas of the RFID readers
- definition of RFID tags i.e. size, housing, etc.
- definition of application related data stored on the RFID tag

RFID application fields	**A. Logistical tracking & tracing**					
Basic application area	**Object tagging**					
Subcategories	**AA. – In-house logistics**	**AB. - Closed loop logistics**	**AC. - Open logistics**	**AD. - Postal applications**	**AE. - Dangerous goods logistics**	**AF. - Manufacturing logistics**
Application standards						
Availability of generic application standards valid for the complete application field: Y(Yes): Published generic standards or generic standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
European standards						
National standards	Y	Y	Y	Y	Y	Y
Availability of special application standards related to only one subcategory of the application field: I (International): Published international standards or international standards under development E (European): Published European standards or European standards under development N (National): Published national standards or national standards under development Y (Yes): Published special standards or special standards under development Blank: no standards, no projects						
AB. - Freight containers: supply chain management		I				

RFID application fields	A. Logistical tracking & tracing					
Basic application area	**Object tagging**					
Subcategories	**AA. – In-house logistics**	**AB. - Closed loop logistics**	**AC. - Open logistics**	**AD. - Postal applications**	**AE. - Dangerous goods logistics**	**AF. - Manufacturing logistics**
Application standards						
AB. - Freight containers: coding, identification and marking		I				
AB. - Freight containers: system specification for automatic identification and electronic data transfer		I				
AB. - Freight containers: environmental characteristics for electronic seals		I				
AB. - Returnable containers: specification for application programming interface (API)		N				
AB. - Returnable transport items/units: requirements for RFID tags		I				
AB. - Returnable transport items/units: requirements for RFID systems		N				
AB. - Unit load devices: identification and marking of container and pallets for air freight		I				
AB. - Transportable gas cylinders: identification and marking		I				
AB. - Transportable gas cylinders: identification and marking		E				
AB. - Disposal logistics: methods of identification of waste containers and/or determination of the quantity of waste		E				

RFID application fields	A. Logistical tracking & tracing					
Basic application area	Object tagging					
Subcategories	AA. – In-house logistics	AB. - Closed loop logistics	AC. - Open logistics	AD. - Postal applications	AE. - Dangerous goods logistics	AF. - Manufacturing logistics
Application standards						
AB. - Disposal logistics: requirements for RFID systems for waste containers		N				
AB. - Disposal logistics: identification of waste containers by using of LF RFID systems		N				
AC. - Baggage: specification for baggage tag design for air transportation			I			
AC. - Baggage: specification for UHF RFID systems for identification and marking for air transportation			I			
AE. - Military consignment and asset: marking and tracking					I	
Importance of standards (High/Low)	L	H	H	H	H	H

Table 18 **Application standards of A. Logistical tracking & tracing**

There are some generic RFID application standards for supply chain applications developed by VDI (German) and EPCglobal. VDI standards contain requirements concerning transponder systems, i.e.: requirements for usage, cost assessments, security aspects and the management of RFID projects. The EPCglobal standards contain a recommendation for the design and use of standard logistic labels, including data backup functions as well as test methodologies for tag performance of door portals and conveyer portal applications.

Due to the fact that logistics is an international business it will be helpful if international standards are available to rule the basic issues of this application field.

AA. - In-house logistics

There were no application standards identified. Due to the fact that in-house logistics is usually an internal business there is no need to rule such issues.

AB. - Closed loop logistics

Within this subcategory many application standards exist. The identified applications could be clustered in two groups of applications:

On the one hand there are many international and national (e.g. German) standards for the use of containers, freight containers and transport items/units.

On the other hand there is a sub-group of standards for special applications. The standards are related to ULDs for air transport (international), transportable gas cylinders (international and European) and for waste containers for disposal logistics (European and national).

Due to the fact that closed loop logistics is often an international business like for retail of consumer goods it will be absolutely helpful if international standards are available. In special cases of closed loop logistics like disposal logistics or for transportable gas cylinders it will be sufficient if European and national standards are available.

AC. - Open logistics

In this subcategory there were only international IATA standards identified which concern baggage handling in the business of air transportation.

Due to the fact that open loop logistics also often is an international business it will be absolutely helpful if international standards are available like there are in the case of retail business.

AD. - Postal applications

No application standards were identified.

Due to the fact that postal applications are also often an international business it will be absolutely helpful if international standards are available as there are for international parcel services.

AE. - Dangerous goods logistics

In this subcategory only international military standards for marking and tracking of military consignments and assets could be identified.

Due to the fact that dangerous goods logistics is also often an international business it will be absolutely helpful if international standards are available as already are for military logistics or special kind of disposal logistics (toxic or acid goods).

AF. - Manufacturing Logistics

No application standards could be identified.

Due to the fact that manufacturing logistics today usually is an international business it will be absolutely helpful if international standards are available as there already are for automotive industry.

In the following section a short abstract of the identified application standards shall be given. They are related to their respective application field (e.g. A.) or sub-categorical application field (e.g. AA., AB., etc.).

3.5.2.4 A. - Logistical tracking and tracing of goods

VDI 4472

"Requirements to be met by transponder systems for use in the supply chain"

Guideline VDI 4472 offers assistance to users for the application/mission of RFID technology and summarises different application orientated valid concepts.

VDI 4472 consists of eleven different parts. Whereas four parts concern the general character of RFID applications within logistical tracking & tracing, one part is related to the air interface and two parts are related to closed loop logistics (within logistical tracking & tracing). The last four parts are related to the application field of product safety and quality (textile goods, fresh/perishable foods and pharmaceuticals). These parts shall be summarised briefly as follows:

VDI 4472 Part one

"Requirements to be met by transponder systems for use in the supply chain – General"

Part one describes general requirements for the use of transponder systems in supply chain applications. The current version of document VDI 4472 Part 1 was published in 2006.

VDI 4472 Part four

"Requirements to be met by transponder systems for use in the supply chain – Cost assessment of RFID systems"

Part four of the document concerns requirements for cost assessment for the use of transponder systems in supply chain applications. This part is still under development.

VDI 4472 Part eight

"Requirements to be met by transponder systems for use in the supply chain – Guide for the management of RFID projects"

Part eight of the document describes requirements for the management of RFID projects in supply chain applications. This part is still under development.

VDI 4472 Part 11

"Requirements to be met by transponder systems for use in the supply chain – Guide to transponder systems under security aspects"

Part 11 of the document describes the requirements on security aspects for the use of transponder systems in supply chain applications. This part is still under development.

Internet: www.vdi.de

ISO 17358

"Supply chain applications of radio frequency identification (RFID) – application requirements"

A detailed description is unfortunately not available.

The current version of document ISO 17358 was published in 2005.

Internet: www.iso.org

EPCglobal - Conveyor Portal Test Methodology v1.1.4

"Applied Tag Dynamic Testing"

The purpose of this document is to define criteria for testing the performance of RFID tagged cases with respect to readability within conveyor portal configurations. The intention is to achieve a consistent performance for the reading of RFID tags as they pass through conveyor portals in actual supply chain implementations. This document may also be used as guideline to assist the development and implementation of conveyor portal RFID systems. This document covers the requirements for testing the performance of selected and applied tags on product cases. This especially concerns goods packaged as are those for sea freight. The cases to be tested are goods packaged within the case or carton exactly as they are to be packaged when shipped through the supply chain. Therefore, the respective tag is such as the one intended to be used for sea freight purposes. Analogously, the location of the tag on the case will be the same as the one for shipped goods as well. The tags to be tested by portal structures are anticipated to be in the UHF band of ~850 – 960 MHz. The test criteria outlined in this document will be performed on passive tags.

Internet: www.epcglobalinc.org

EPCglobal - Door Portal Test Methodology v1.0.9

"Applied Tag Dynamic Testing"

This draft document defines test methodology for testing the readability of RFID tagged cases or pallets as they travel through door portals, one of several dynamic system elements under the dynamic test scenarios for "Applied Tag Performance" (ATP).The purpose of this document is to define criteria to test the performance of RFID tagged cases or pallets with respect to readability within door portal configurations. The intent is to achieve consistent performance for the reading of RFID tags that will pass through the portals. This document may also be used as a guideline to assist the development and implementation of door portal RFID systems.

Internet: www.epcglobalinc.org/

EPCglobal - EPC/RFID Label Solution

"Recommendation for the Design and Use of a Standard RFID/EPC Logistic Label, including Data Backup Function"

The aim of this recommendation is to describe an RFID/EPC logistic label for RFID/EPC applications in order to constitute a migration and orientation guide for the mass use of RFID/EPC technology. This recommendation relates to pallet tagging of sandwich, mixed or homogenous standard pallets.

Internet: www.epcglobalinc.org

3.5.2.4.1 AA. - In-house logistics

In this subcategory no application standards were identified.

3.5.2.4.2 AB. - Closed loop logistics

ISO 17363

"Supply chain applications of radio frequency identification (RFID) - Freight containers"

ISO 17363 was prepared by the Joint Working Group (JWG) within the ISO Technical Committee 122 and ISO Technical Committee 104. This standard defines the usage of RFID (read/write) tags specified for cargo shipment to be used on freight containers for supply chain management purposes ("shipment tags").

ISO 17363 applies to freight containers as defined in ISO 668 and to freight containers that are not defined by other ISO standards. It complements ISO 10374, freight containers - RF automatic identification for container tags.

This international standard does not address “smart” container technologies affixed to or inside freight containers for supply chain management purposes, e.g. sensors. However, these issues will be addressed in future iterations of the standard.

The current version of the document ISO 17363 was published in 2005.

Internet: www.iso.org

ISO 17364

“Supply chain applications of radio frequency identification (RFID) – returnable transport items”

ISO 17364 was prepared by the Joint Working Group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104. This standard defines the requirements for RFID tags for Returnable Transport Items (RTI). RTIs are defined as all means to assemble goods for transportation, storage, handling and product protection within the supply chain, but are returned for further usage. These means include for example pallets with and without cash deposits as well as all forms of reusable crates, trays, boxes, roll pallets, barrels, trolleys, pallet collars and lids.

In this connection the use cases of such things as “unitised loads”, pallets and returnable transport items play an important role within this concept. The way a pallet is used may determine whether it is covered under this standard as a “returnable transport item” or as a “transport unit” which is concerned in ISO 17365.

This difference can explained as follows: If the title of ownership of the transport item remains with its owner then the applicable standard is ISO 17364. If the title of ownership of the transport item is transferred to the customer as part of a “unitized load” then it becomes “unitized load” and thus is covered under ISO 17365.

The placement of tagged packed products and products inside the RTI is specific for RTIs in general.

Owners and other users of RTIs can use this standard as well. It ensures the unambiguous and optimal use of RTIs within the supply chain. In conjunction with other standards, a seamless application of the RTIs within the total supply chain is enabled.

The current version of document ISO 17364 was published in 2005.

Internet: www.iso.org

ANSI / MH 10.8.4

"Unit Loads and Transport Packages - RFID Tags for Returnable Containers"

The national standard ANSI/MH 10.8.4 was prepared by the working group ANSI MH 10/SC 8/WG 4.

ANSI MH 10/SC 8 defines the Radio Frequency Identification (RFID) standard for returnable containers. This standard is intended to allow compatibility and to encourage interoperability of products for the growing RFID market in the United States.

This standard defines a single Application Programming Interface (API), which will be shared by all compliant RFID implementations and provide a common interface to application programmes.

The applications for returnable containers addressed by this standard, including cable reels, typically require ranges greater than one meter.

The goal of this standard is to serve current and future users and manufacturers by encouraging the development of open, dynamic systems.

This standard supports national and international standards for data semantics, data syntax, transfer syntax, and a radiofrequency air interface.

The current version of document ANSI/MH 10.8.4 was published in 2002.

Internet: www.ansi.org

CEN PREN 13818

"Transportable Gas Cylinders - Identification and Marking Using Radio Frequency Identification Technology"

The European standard CEN PREN 13818 - which consists of two parts - was prepared by the working group CEN/TC 23/SC 3/WG 3.

CEN PREN 13818-1

"Reference Architecture and Terminology"

This European standard is to establish a common framework for data structure for unambiguous identification of gas cylinders and for other common data elements in this sector.

The scheme and reference model architecture proposed is designed to be an enabling structure to allow harmonisation between different commercial systems and not to be prescriptive in determining systems. It is not specific for frequency or air interface protocols, but provides maximum interoperability, a high population capability and the possibility of upwards migration to more capable systems.

The current version of document CEN PREN 13818-1 was published in 2000.

CEN PREN 13818-2

"Framework for Data Structure"

This European standard establishes a common framework for data structure to enable the unambiguous identification within GC applications and for other common data elements in this sector.

This standard enables a structure to allow harmonisation between different systems and does not prescribe any of them. It is not specific for frequency or air interface protocols, but provides maximum interoperability, a high population capability, the possibility of upwards migration to more capable systems and fits the reference model architecture. However, subsequent chapters of this standard may include specific structures that are specific enough to frequency and air interface protocols to meet requirements of defined user communities.

The current version of the document CEN PREN 13818-1 was published in 2001.

Internet: www.cenelec.org

ISO 21007

"Gas cylinders – Identification and marking using radio frequency identification technology"

The standard CEN PREN 13818 consists of two parts.

ISO 21007-1

"Reference architecture and terminology"

This international standard delivers a common framework for data structures concerning unambiguous identification of single or manifold gas cylinders and other common data elements within this sector. It also serves as a terminological document for the area of radio frequency identification (RFID) technology. The proposed scheme and reference model architecture is designed to be a structure enabling harmonisation between different commercial systems and to be non-prescriptive towards any system. It is not specific to frequency or air interface protocols, provides maximum inter-operability, a high population capability and the possibility of upwards migration to more capable systems.

ISO 21007-1 provides a reference structure where the core elements of the data structure allow an unambiguous identification. This structure may for example be used to identify a certain message as the message from a gas cylinder within an electronic data interchange (EDI) environment. Moreover, it may provide an application reference for identifying different data structure within the message.

The current version of the document ISO 21007-1 was published in 2006.

ISO 21007-2

"Numbering schemes for radio frequency identification"

This international standard establishes a common framework for data structure to enable the unambiguous identification in gas cylinder applications and for other common data elements in this sector. ISO 21007-2 enables a structure to allow some harmonisation between different systems. However, it does not prescribe any system and has been written in a non-mandatory style for not to make it obsolete to changes in technology. The main body of ISO 21007-2 excludes any data elements that form transmission or storage protocols such as headers and checksums.

The current version of document ISO 21007-2 was published in 2006.

Internet: www.iso.org

IATA RP1640

"Use of Radio Frequency Technology for the automatic identification of unit load devices"

RP1640 recommends locations where the use of RF technology for the automatic identification of unit load devices (Olds) would be desired.

This recommended practice provides automatic identification of ULDs by using a RF tag and the electronic transfer of information contained in such a tag to data processing systems.

The standard embodied in this recommended practice is not restricted. It is intended that one of the manufacturer's tags may be read by other manufacturer's sensing or reading equipment and vice versa.

The publishing date of the current version of document IATA RP1640 is not available.

Internet: www.iataonline.com

VDI 4472

"Requirements to be met by transponder systems for use in the supply chain"

The guideline VDI 4472 offers assistance for the application/mission of RFID technology to the user and summarises different application orientated concepts.

VDI 4472 consists of eleven different parts: whereas four parts characterise the general design of the RFID application within the logistical tracking & tracing, one part is related to the air interface and two parts are related to closed loop logistics (within the logistical tracking & tracing). Four parts are related to the application field of product safety and quality (textile goods, fresh/perishable foods and pharmaceuticals).

VDI 4472 Part five

“Requirements to be met by transponder systems for use in the supply chain – Use of transponder systems in returnable transport items logistics”

Part five of the document describes the requirements for the use of transponder systems for returnable transport item logistics. The current version of the document VDI 4472 Part five was published in 2007.

VDI 4472 Part seven

“Requirements to be met by transponder systems for use in the supply chain – Use of transponder systems in disposal logistics”

Part seven of the document describes the requirements for the use of transponder systems for disposal logistics. The document VDI 4472 Part seven is still under development.

Internet: www.vdi.de

ISO 17365

“Supply chain applications of radio frequency identification (RFID) - Transport units”

ISO 17365 was prepared by the Joint Working Group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104. This standard defines the requirements for RFID tags transport units. Here, transport units are defined as either a transport package or a unit load.

In this connection the use cases of such things as "unitised loads", pallets and returnable transport items play an important role within this concept. The way a pallet is used may determine whether it is covered under this standard as a "returnable transport item" or as a "transport unit" which is concerned in ISO 17365.

This difference can be explained as follows: If the title of ownership of the transport item remains with its owner then the applicable standard is ISO 17364. If the title of ownership of the transport item is transferred to the customer as part of a "unitized load" then it becomes "unitized load" and thus is covered under ISO 17365.

The grouping of (packaged) products in order to make these more suitable for efficient and effective transport and distribution is very specific for transport units. A transport unit provides an added value for the product being sold, mostly in terms of logistics performance. RFID tagged transport units should furthermore optimise the supply chain.

This standard is intended for the use by owners and users of transport units, manufacturers and logistic service providers. It ensures the unambiguous and optimal use of transport units in the supply chain. In conjunction with other standards, a seamless application of transport units within the total supply chain is enabled.

The current version of document ISO 17365 was published in 2005.

Internet: www.iso.org

ISO 10374.2

"Freight containers – Automatic identification"

ISO 10374.2 specifies a system for automatic identification of freight containers and for the electronic transfer of their identity and permanent related information to third parties in a standard format. It is intended that the Automatic Equipment Identification (AEI) system will facilitate documentation, resource control, and communication (including electronic data processing systems). Visual markings for container identification specified by ISO 6346 are not affected by it. Future additions to this international standard will specify modulation, encoding and an open protocol.

The current version of document ISO 10374.2 was published in 1991.

Internet: www.iso.org

ISO 18185-3

"Freight containers - Electronic seals - Part 3: Environmental characteristics"

ISO 18185-3 specifies the minimum of environmental characteristics for electronic seals. It also describes environmental requirements for the ISO 18185 series, for ISO 10374 (Freight containers - RF automatic identification) and for ISO 17363 (Supply chain applications of RFID - Freight containers), since it is expected that the implementation of these international standards will face the same environmental conditions. Each of these international standards has its own unique requirements independent of environmental conditions. The current version was published in 2006.

Internet: www.iso.org

ISO 6346

"Freight containers - Coding, identification and marking"

ISO 6346 provides a system for general application regarding identification and presentation of information concerning freight containers. The standard specifies an identification system with mandatory marks for visual interpretation, optional features for automatic identification, electronic data interchange and a coding system for data on container size and type.

The current version of the document ISO 6346 was published in 1995.

Internet: www.iso.org

CEN PREN 14803

"Identification and/or determination of the quantity of waste"

This standard specifies general requirements and verifications for methods of identification of waste containers and/or determination of the quantity of waste.

The current version of document CEN PREN 14803 was published in 2003.

Internet: www.cenelec.org

DIN 30745

“Radio frequency identification of waste containers by transponder technology using frequencies below 135 kHz”

This standard describes the radio-frequency identification of waste containers by transponder technology using frequencies below 135 kHz.

The current draft version of document DIN 30745 was published in 2006.

Internet: www.din.de

3.5.2.4.3 AC. - Open logistics

IATA Baggage Services Manual (BSM)

IATA’s BSM serves as a key industry reference concerning baggage handling at airports. It benefits airlines, airports and ground handling service providers with its comprehensive treatment of the acceptance handling and security to baggage.

The manual includes useful information related to RFID, prorate baggage claim profiles, baggage tag design guidelines, luggage construction standards and baggage message descriptions.

The IATA manuals normally will be revised and published annually.

Internet: www.iataonline.com

IATA RP1740c

“RFID Specifications For Interline Baggage”

RP1740c establishes a more efficiently handling (e.g. sortation, reconciliation, etc.) of baggage, utilising the license plate concept defined in Resolution 740. The compatibility of the RFID technology with airline data systems and the ability of RFID to be used in the interline baggage handling environment shall also be ensured.

The current version of document RP1740c Version 2.3 was published in 2005.

Internet: www.iataonline.com

3.5.2.4.4 AD. - Postal applications

In this subcategory no application standards were identified.

3.5.2.4.5 AE. - Dangerous goods logistics

NATO STANAG 2233

"NATO consignment and asset tracking by Radiofrequency Identification"

STANAG 2233 references existing ISO standards for both active and passive RFID utilising the infrastructures of nations involved. Changes to the edition already in progress reflect the rapidly evolving RFID market, and the applicable ISO standards.

This STANAG only applies to NATO operations while nations (including NATO agencies) are also encouraged to utilise the provisions of this STANAG internally. This STANAG excludes radio frequency data communications and the application of RF tracking using satellite tracking capabilities and Real Time Locating Systems (RTLS). This STANAG supplements the requirements of STANAGs 2494 and 4281.

The current version of the document NATO STANAG 2233 was published in 2005.

Internet: www.nato.int

MIL-STD-129

"Military Marking for Shipment and Storage"

The objective of MIL-STD-129 is to provide background, reference information, and practical knowledge concerning the selection and application of "RFID enabled" media – i.e. conventional labels, tickets and tags with embedded or attached RFID transponders – to the labelling of military goods and assets.

This standard does not address "smart packaging", where the transponder is embedded in the container itself.

The current version of document MIL-STD-129 was published in 2004.

Internet: dodssp.daps.dla.mil

3.5.2.4.6 AF. - Manufacturing logistics

In this subcategory no application standards were identified.

3.5.3 B. Production, monitoring and maintenance of goods and processes

The application field B: "production, monitoring and maintenance" can be divided into seven different subcategories:

- BA. Archive systems
- BB. Asset management
- BC. Facility management
- BD. Vehicles
- BE. Airplanes
- BF. Automotion / process control
- BG. Food and consumer goods

3.5.3.1 Frequencies and air interface standards

RFID application fields	**B. Production, monitoring and maintenance**						
Basic application area	**Object tagging**						
Subcategories	**BA. – Archive systems**	**BB. – Asset management**	**BC. – Facility management**	**BD. - Vehicles**	**BE. - Airplanes**	**BF. – Automotion / process control**	**BG. – Food and consumer goods**
Frequencies and air interface standards							
Used air interfaces in current applications Y(Yes): used, blank: not used							
LF <134 kHz		Y	Y	Y		Y	
HF 13.56 MHz	Y	Y	Y	Y	Y	Y	Y
UHF 433 MHz (active)							
UHF 860-960 MHz	Y	Y	Y	Y	Y	Y	Y
UHF 2,4 GHz				Y		Y	
SHF 5,8 GHz							
Availability of air interface protocol standards: Y(Yes): Published standards or standards under development Blank: no standards, no projects							
International standards	Y	Y	Y	Y	Y	Y	Y
European standards							
National standards							

Importance of standards (High/Low)	L	L	L	H	H	H	H

Table 19 **Air interface standards of B. Production, monitoring and maintenance**

In application field BA the HF band and the UHF band are used. RFID is used to track files and documents, especially for public administrations and other offices, also for all kinds of archives. Most applications are stand-alone solutions, so that there is only a small need for overall regulations and interoperability.

The application field BB: "asset management" uses LF, HF and UHF frequency band. RFID systems are used to track and monitor commodities and movables, such as office furniture, computer equipment or other valuables. Similar uses include the implementation of RFID to monitor the environment, e.g. trees. A general standardisation is not needed.

The application field BC: "facility management" uses the same frequencies as application field BB. RFID is used to limit the access to buildings or to monitor building functions like air-conditioning/heating, cleaning etc. For this application field no overall standards are necessary. Stand-alone solutions are possible.

In the application field BD: "vehicles" all frequencies except the 433 MHz UHF frequency band are used. RFID is provided in this field for manufacturing and logistic purposes such as in-house or closed loop applications as well as maintenance applications (e.g. vehicle diagnosis systems) for regular service intervals or constant monitoring of vehicle functions (e.g. tire pressure). For vehicle applications sector-wide standards are needed to support wide-spread applications.

The application field BE: "airplanes" only uses the HF band and the UHF band. Here, RFID systems are used for manufacturing and maintenance purposes, e.g. monitoring of maintenance operations or prevention of counterfeit spare parts (Concorde crash). Global standards are needed in order to ensure global applications and critical sectors to airline safety risks.

In the application field BF: "automotion and process control" nearly all frequencies are used. Only the 433 MHz UHF frequency band is not used. Smart systems monitor and control processes. Here, the need for global standards is high.

In the application field BG: "food and consumer logistics" the HF band and the UHF band were used. RFID is used in production environments, such as mixing food ingredients or for monitoring bottling and packaging operations. In these cases it is used for mainly internal purposes, stand-alone solutions or in-house logistics. RFID can be one solution to realise the traceability in compliance with EG directive 178/2002 and EG directive 1835/2004.

3.5.3.2 Data and network standards

RFID application fields	**B. Production, monitoring and maintenance**						
Basic application area	**Object tagging**						
Subcategories	**BA. – Archive systems**	**BB. – Asset management**	**BC. – Facility management**	**BD. - Vehicles**	**BE. - Airplanes**	**BF. – Automotion / process control**	**BG. – Food and consumer goods**
Data and network standards							
Used data and network standard categories in current applications Y(Yes): used, blank: not used							
Reader interface							
Data	Y	Y	Y	Y	Y	Y	Y
Data management interface				Y	Y	Y	Y
Information network services & interface							
Availability of data and network standards: Y(Yes): Published standards or standards under development							

Blank: no standards, no projects							
International standards	Y	Y	Y	Y	Y	Y	Y
European standards							
National standards							
Do competing standards exist?	Y	Y	Y	Y	Y	Y	Y
Importance of standards (High/Low)	H	H	H	H	H	H	H

Table 20 **Data and network standards of B. Production, monitoring and maintenance**

BA. – Archive systems

It is sufficient to use data standards and data management standards for this type of application, as it is small-scale and local.

BB. – Asset management

Asset management solutions can be of very large scale. For big scale applications it is recommended to use data and network standards as much as possible.

BC. – Facility management

It is sufficient to use data standards and data management standards for this type of application, as it is small-scale and local.

BD. – Vehicles

Vehicle logistics imply very critical business processes. The need for detailed standardisation of software is mandatory.

BE. – Airplanes

Airplane logistics imply very critical business processes. The need for detailed standardisation of software is mandatory

BF. – Automation / process control

RFID delivers an additional sensor in existing software infrastructure for automation / process control. Therefore, data standards are sufficient.

BG. – Food and consumer goods

Food and consumer goods imply very critical business processes. The need for detailed standardisation in software is mandatory

3.5.3.3 Application standards

Application standards contain all kind of standards strongly related to applications such as

- architecture of the RFID system
- mechanical application of RFID tags or antennas of RFID readers
- definition of RFID tags concerning size, housing, etc.
- definition of application related data stored on the RFID tag

RFID application fields	**B. Production, monitoring and maintenance**						
Basic application area	**Object tagging**						
Subcategories	**BA. – Archive systems**	**BB. – Asset management**	**BC. – Facility management**	**BD. - Vehicles**	**BE. - Airplanes**	**BF. – Automotion / process control**	**BG. – Food and consumer goods**
Application standards							
Availability of generic application standards valid for the complete application field: Y(Yes): Published generic standards or generic standards under development Blank: no standards, no projects							

International standards							
European standards							
National standards							
Availability of special application standards related to only one subcategory of the application field: I (International): Published international standards or international standards under development E (European): Published European standards or European standards under development N (National): Published national standards or national standards under development Y (Yes): Published special standards or special standards under development Blank: no standards, no projects							
BD. - Vehicles: automotive common requirements on RFID				I			
BD. - Vehicles: parts identification and tracking for automotive				I			
BD. - Vehicles: RFID methodology for the use for tire and wheel label for automotive				I			
BE. - Airplanes: passive RFID for aerospace parts and systems in airborne applications					I		
BE. - Airplanes: technical requirements on passive UHF RFID for the use in aircrafts					I		
BE. - Airplanes: requirements for part/product identification and traceability schema for life cycle management					I		
BE. - Airplanes: passive UHF RFID for identification of parts and their traceability					I		
BF. - Semiconductor industry: RFID air interface for production and material handling equipment						I	
BF. - Manufacturing: Specification of data carriers for tools and chucking devices						N	

BF. - Maintenance: RFID based wireless smart transducer interface for sensors and actuators						I	
Importance of standards (High/Low)	L	L	L	H	H	M	H

Table 21 **Application standards of B. Production, monitoring and maintenance**

No generic RFID application standards for production, monitoring and maintenance applications could be identified.

Due to the fact that production, monitoring and maintenance are very widespread and complex businesses it will be neither possible nor necessary to get standards for the complete application area.

BA. - Archive systems

No application standards could be identified.

Today, archive systems, e.g. for data archiving in companies or administrations, are often proprietary systems or strong customised commercial solutions. It could be helpful if a couple of international standards would be available to rule basic requirements in order to get more user-friendly products.

BB. - Asset management

No application standards could be identified.

A trend for the use of RFID transponders of type or rating plates on industrial equipment was identified. Its aim is to advance asset management. Thus, the development of according standards would help to ease the application.

Apart from that, the asset management usually is an internal business of a company without a need to rule such internal issues.

BC. - Facility management

No application standards were identified.

Due to the fact that facility management usually is an internal business there is no need to rule such internal issues.

BD. - Vehicles

Three different international (AIAG) application standards could be identified within this subcategory. The first standard specifies common requirements of the automotive community regarding the use of RFID technology. The second standard specifies the application concerning the use of RFID for part identification and tracking. The third standard specifies the use of RFID for product identification of tires and wheels.

Due to the fact that the application area of vehicles, i.e. the automotive industry, usually is an international business, it will be absolutely helpful if international standards are available– as it is the case for manufacturing and maintenance.

BE. - Airplanes

A group of international application standards (SAE, ISO and ATA) were identified within this subcategory. The already existing standards (SAE and ISO) specify the use of RFID for identification and tracking of aircraft as well as the technical requirements on RFID technology for this application. Additionally, the ATA standards (presently under development) specify the use of RFID for enhanced maintenance aspects like the tracing of aircraft parts during its complete lifecycle.

Due to the fact that the application area of airplanes, i.e. the aviation industry, is an international business it will be absolutely helpful if international standards are available. This international standardisation process has already begun.

BF. - Automotion / process control

National (German DIN) and international application standards (IEEE and SEMI) could be identified within this subcategory.

The identified standards have application areas equal to those for manufacturing/production and maintenance.

Depending on the nature of the application it is necessary to have international standards like those for manufacturing/production as well as for maintenance applications. For more user specific applications it seems likely sufficient to have national standards because the relevant processes can sometimes only be found inside a single company and nowhere else.

Furthermore, a trend for the use of RFID transponders of type or rating plates on industrial equipment was identified. This trend aims to advance maintenance processes so that the development of according standards will help to ease the application.

BG. - Food and consumer goods

No application standards could be identified.

Due to the fact that the application area of food and consumer goods today usually is an international business like that for multimedia goods it will be absolutely helpful if international standards are available.

In the following section a short abstract of the identified application standards related to their application field (B.) or subcategory of application field (BA., BB., etc.) is given.

3.5.3.4 B. - Production, monitoring and maintenance of goods and processes

No general application standards were identified within this category.

3.5.3.4.1 BA. – Archive systems

No application standards were identified within this category.

3.5.3.4.2 BB. - Asset Management

No application standards were identified within this category.

3.5.3.4.3 BC. – Facility Management

No application standards were identified within this category.

3.5.3.4.4 BD. - Vehicles

AIAG ARF-1

"Application standard for RFID devices in the automotive industry"

This standard presents a common understanding of the requirements of the automotive user community for radio frequency identification (RFID) systems.

The current version of document AIAG ARF-1 was published in 1991.

Internet: www.aiag.org

AIAG B-4

"Parts identification and tracking application standard"

In particular, the automotive standard AIAG B-4 consists of:

- specification of parts to be marked
- data fields, data identifiers, numerous symbologies (linear & 2D) are addressed and definitions critical to this standard are provided.
- specifications for both direct marking and labelling of individual parts, kits and assemblies/subassemblies

The current version of document AIAG B-4 was published in 2003.

Internet: www.aiag.org

AIAG B-11

"Tire and wheel label and radio frequency identification (RFID) standard"

This application specification provides a methodology for the use of 2D symbologies (on labels) and RFID technology on tires and wheels for product identification. The standard is designed to help to automate the collection of data from tires and wheels. Revision provides a data syntax to allow retail applications.

In particular AIAG B-11 includes:

- electronic means for transferring data from the tire to anywhere it needs to go.
- the ability to use labels and RFID tags.

The current version of document AIAG B-11 was published in 2004.

Internet: www.aiag.org

3.5.3.4.5 BE. - Airplanes

SAE AS5677

"Passive radio frequency identification (RFID) for aerospace applications"

SAE AS5677 provides development standards and specifications for passive radio frequency identification (RFID) and "smart labels" used for identifying aerospace parts and systems that shall be used in airborne applications.

The usage of such technologies for aerospace implies increased requirements for qualification and regulatory compliance (e.g., FAA, EASA, etc.). Considering the higher per part costs due to the named additional aerospace requirements, the low manufacturing volumes (compared to other industries) and the longer life span of aerospace processes, technologies, and implementations, it seems useful to standardise parts and use cases in order to minimise maintenance and operational disruptions by aircraft operators.

At present, document SAE AS5677 has a pending status.

Internet: www.sae.org

SAE AS5678

"Passive RFID tags intended for aircraft use"

The scope of this standard is to:

- Provide a document of requirements for RFID tag manufacturers to produce passive RFID tags for the Aerospace industry that shall only use UHF.
- Identify the minimum performance requirements specific to the passive UHF RFID tags to be used on aircraft parts, to be accessed only during ground operations.
- Specify the test requirements specific to passive UHF RFID tags for airborne use, in addition to RTCA DO-160E's compliance requirements (which are called out separately within this document).

- Identify existing standards applicable to passive UHF RFID tags.
- Provide a certification standard for RFID tags which will use permanently affixed installation on aircraft and aircraft parts.

At present, document SAE AS5678 has a pending status.

Internet: www.sae.org

ISO 21849

"Aircraft and space Industrial data Product identification and traceability-First Edition"

ISO 21849 specifies the requirements for a product identification and traceability scheme for lifecycle management of aircraft and space products/parts. It specifies the minimum of essential identification information needed for traceability of a product for its lifecycle. It also provides the data structures for automatic identification technologies that support product/part life cycle data management activities.

It defines a structure and rules for establishing a unique identifier for product/part identification and traceability. Rules and structures offer sufficient options to support various business practices. Also, they provide the minimum amount of standardisation required to support interoperability, improved business processes and efficiency across multiple users and applications of machine readable media technologies.

ISO 21849 also defines and establishes repeatable processes to allow efficient exchange of product data for life-cycle product/part traceability, configuration, reliability, maintenance and product performance management purposes.

It specifies the data carriers appropriate for representing the product data in a machine readable form and associated dimensional and quality parameters. Industries or trading partners will need to develop specific implementation guidelines to employ the principles defined in ISO 21849.

Although primarily intended for aircraft and space products/parts, ISO 21849 may be used for other products/parts if desired.

The current version of document ISO 21849 was published in 2003.

Internet: www.iso.org

ATA-Spec2000 (Chapter 9)

"Chapter 9: Automated Identification and Data Capture"

ATA Spec 2000 Chapter 9, Automated Identification and Data Capture (AIDC) extract is the commercial aviation industry standard for the permanent identification of parts, the identification of shipping/receiving information, and traceability.

The permanent part-marking standards include barcoding, data matrix and Radio Frequency Identification (RFID). The traceability standard describes information that companies must keep in order to provide.

The current version of document ATA Spec 2000, Chapter 9 was published in 2006.

Internet: www.ataebiz.org

3.5.3.4.6 BF. – Automotion / Process control

SEMI E144-0306

"Provisional Specification for RF Air interface between RFID tags in Carriers and RFID Readers in Semiconductor Production and Material Handling Equipment"

SEMI E144-0306 provides public specifications for the required elements of new carrier radio frequency (RF) identification tags to make them 100% backward compatible to existing equipment installations.

In particular, SEMI E144-0306 includes:

- a description of RF air interfaces associated with such tags.
- a description of common communication protocols for the purposes of Radio Frequency Identification regarding semiconductor production and material handling.
- definitions of HDX RFID systems operating at a frequency of 134.2 kHz.

- the requirements for parameters such as frequency, modulation, data rate, data format, read/write capabilities, memory capability, etc.
- it is based on the RFID parameters currently being used in the majority of semiconductor equipment production use applications.
- compatibility with ISO/IEC 18000-02 except where noted.
- Extensions and specifications of this standard for applications in semiconductor device and integrated circuit manufacturing.

Other RFID related physical parameters are beyond the scope of this specification, and are to be addressed in standards yet to be developed.

This specification describes common communications protocols for the purposes of Radio Frequency Identification for semiconductor production and material handling.

It defines two types of interfaces:

1) Type 1) RI-TRP-DR2B HDX MPT
2) Type 2) ISO/IEC 18000-02 Type B (HDX)

Remark: This standard does not intend to address safety issues, if any, associated with its use. Every user of this standard is responsible to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use. The current version was published in 2005.

Internet: www.semi.org/

SEMI PR10-1105

“Proposed Specification for RF Air Interface between RFID Tags in Carriers and RFID Readers in Semiconductor Production and Material Handling Equipment”

The document description is identical with the description of SEMI E144-0306 (according to Internet: webstore.ansi.org).

The current version of the document E144-0306 was published in 2005.

Internet: www.semi.org/

DIN 69873

"Specification of data carriers for tools and chucking devices, dimensions of data carriers and their installation space"

A more detailed description of the document is not available.

The current version of document DIN 69873 was published in 2005.

Internet: www.din.de

IEEE P1451.5

"Standard for a smart transducer interface for sensors and actuators - wireless communication protocols and Transducer Electronic Data Sheets (TEDS) Formats"

The IEEE 1451 group develops standards for smart sensor networking and integration. Many applications and products, including supply chain integration, pharmaceutical products, and defence applications, require sensor data integrated with RFID data. The 1451 group is in close contact to the ISO SC31 committee which is responsible for development of international RFID (Radio Frequency Identification) standards.

The ISO RFID standards committee wishes to integrate physical and logical interfaces between RFID and sensors. In addition, the ISO committee considers the current IEEE 1451.4 standard to be a possible candidate for integration with ISO RFID standards.

Document IEEE P1451.5 is currently under development.

Internet: www.ieee.org

3.5.3.4.7 BG. – Food and consumer goods

No application standards were identified within this subcategory.

3.5.4 C. Product safety, quality and information of goods and processes

The application field C: "Product safety, quality and information of goods and processes" can be divided into six different subcategories:

CA. Fast moving consumer goods

CB. Electronic goods

CC. Textile goods

CD. Fresh / perishable foods

CE. Pharmaceuticals

CF. Customer information systems

3.5.4.1 Frequencies and air interface standards

RFID application fields	**C. Product safety, quality and information**					
Basic application area	**Object tagging**					
Subcategories	**CA. – Fast moving consumer goods**	**CB. – Electronic goods**	**CC. – Textile goods**	**CD. – Fresh / perishable foods**	**CE. - Pharmaceutical**	**CF. – Customer information systems**
Frequencies and air interface standards						
Used air interfaces in current applications Y(Yes): used, blank: not used						
LF <134 kHz	Y	Y		Y	Y	
HF 13.56 MHz	Y	Y	Y	Y	Y	Y
UHF 433 MHz (active)	Y	Y			Y	
UHF 860-960 MHz	Y	Y	Y	Y		Y
UHF 2,4 GHz	Y	Y			Y	
SHF 5,8 GHz						
Availability of air interface protocol standards: Y(Yes): Published standards or standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
European standards						

National standards						
Importance of standards (High/Low)	H	H	H	H	H	H

Table 22 Air interface standards of C. Product safety, quality and information

In the application field CA: "Fast moving consumer goods" RFID systems from all available frequency bands are used. The main applications are batch-level and item-level applications. The applications usually are from the retail area. The tag-price is the major limiting factor for wide-spread applications. Standardisation is necessary to ensure interoperability of consumer goods, manufacturers and retailers, e.g. by self-regulation of industry (EPCglobal).

RFID systems operating in application field CB: "Electronic goods" also use all available frequency bands. In this field RFID is used to improve product safety (by preventing counterfeiting) as well as warranty and customer services. There is a big need for standards aiming to ensure the interoperability of manufacturers and retailers.

In the application field CC: "Textile goods" only the HF band and the UHF band (860–960 MHz) are used. In this application field RFID is used for logistics and anti-counterfeiting purposes. Also, standardisation is necessary to ensure the interoperability of manufacturers and retailers. During standardisation processes for this application field there has to be a special attention on privacy issues.

The application field CD: "Fresh / perishable foods" uses the LF (125 KHz) band, the HF (13.56 MHz) band and the UHF (860–960MHz) frequency band. RFID systems are used to track and monitor perishable foods during their transport (e.g. meat products, frozen foods). In this case the RFID technology is combined with sensors. To realise traceability in compliance with EG Directive 178/2002 and EG Directive 1835/2004 RFID can be a possible solution. Therefore, standards are quite necessary.

In the application field CE: "Pharmaceutical" nearly every frequency band can be used. The only frequency band which not used is the UHF band for passive systems. In pharmaceutical applications the RFID technology is used for tracking and tracing. This technique can be used to ensure product safety by preventing counterfeiting and to offer better patient safety by monitoring correct fulfilment of prescriptions. In this application field traceability is required as well, so far as RFID can provide a solution. Standardisation and cooperation are needed to ensure interoperability of pharmaceutical companies and wholesalers as well as pharmacies and health care providers.

The last application field from this sector is the category CF: "Customer information systems". Here, RFID can be used to especially provide customers in retail environments, but in other areas as well, using additional information on products or services. Other application areas include museums, tourism, etc. Systems in this application field can operate as stand alone systems and in operability with other systems. Standards are necessary.

3.5.4.2 Data and network standards

RFID application fields	**C. Product safety, quality and information**					
Basic application area	**Object tagging**					
Subcategories	**CA. – Fast moving consumer goods**	**CB. – Electronic goods**	**CC. – Textile goods**	**CD. – Fresh / perishable foods**	**CE. - Pharmaceutical**	**CF. – Customer information systems**
Data and network standards						
Used data and network standard categories in current applications Y(Yes): used, blank: not used						
Reader interface						
Data	Y	Y	Y	Y	Y	Y
Data management interface	Y	Y	Y	Y	Y	Y
Information network services & interface						

Availability of data and network standards: yes / no Y(Yes): Published standards or standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
European standards						
National standards						
Do competing standards exist?	Y	Y	Y	Y	Y	Y
Importance of standards (High/Low)	H	H	H	H	H	L

Table 23 **Data and network standards of C. Product safety, quality and information**

CA. – Fast moving consumer goods

Fast moving consumer goods imply very critical business processes. A detailed standardisation of software is mandatory.

CB. – Electronic goods

Electronic goods imply very critical business processes. A detailed standardisation of software is mandatory.

CC. – Textile goods

Textile goods imply very critical business processes. A detailed standardisation of software is mandatory.

CD. – Fresh / Perishable food

Fresh / perishable food implies very critical business processes. A detailed standardisation of software is mandatory.

CE. - Pharmaceutical

Pharmaceutics imply very critical business processes. The need for a detailed standardisation of software is mandatory

CF. – Customer information systems

Customer information systems may vary from local implementations to centralized content management systems. Depending on the size of the solution data and network standards are required.

3.5.4.3 Application standards

The application standards will content all kind of standards which are strongly related to applications like

- Architecture of the RFID system,
- Mechanical application of the RFID tags or antennas of the RFID readers,
- Definition of RFID tags i.e. size, housing, etc.,
- Definition of application-related data stored on the RFID tag.

RFID application fields	C. Product safety, quality and information					
Basic application area	Object tagging					
Subcategories	CA. – Fast moving consumer goods	CB. – Electronic goods	CC. – Textile goods	CD. – Fresh / perishable foods	CE. - Pharmaceutical	CF. – Customer information systems
Application standards						
Availability of generic application standards valid for the complete application field: Y(Yes): Published generic standards or generic standards under development Blank: no standards, no projects						
International standards	Y	Y	Y	Y	Y	Y
C. - Generic: basic features of RFID for product packaging						
C. - Generic: RFID based item management						
European standards						
National standards	Y	Y	Y	Y	Y	Y
C. - Generic: anti theft systems						
C. - Generic: electronic article surveillance systems						
C. - Generic: selection / integration of safety mechanism labels						

Availability of special application standards related to only one subcategory of the application field: I (International): Published international standards or international standards under development E (European): Published European standards or European standards under development N (National): Published national standards or national standards under development Y (Yes): Published special standards or special standards under development Blank: no standards, no projects						
CA. - Fast moving Consumer Goods: selection / integration of safety mechanism labels	N					
CB. - Fast moving Consumer Goods: selection / integration of safety mechanism labels		N				
CC. - Textile Goods: requirements for the use of HF and UHF RFID systems for textile applications			N			
CC. - Textile Goods: application instructions for clothes, shoes, leather goods, home textiles			N			
CD. - Fresh / Perishable Foods: traceability within agricultural and food branches				N		
CD. - Fresh / Perishable Foods: tracking and tracing of water bottles				N		
CD. - Fresh / Perishable Foods: requirements for cool chain applications				N		
CD. - Fresh / Perishable Foods: requirements for beverage logistics				N		
CD. - Fresh / Perishable Foods: perishable cargo handling in aviation				I		
Importance of standards (High/Low)	H	H	H	H	H	H

Table 24 Application standards of C. Product safety, quality and information

There were some RFID application standards for product safety, quality and information applications identified. Especially some generic international standards for item management and some national standards for anti theft systems and for electronic article surveillance are available. These national standards of the German VDI are internationally used because there are no comparable and suitable international standards available.

In the area for customer information systems there are no generic standards available.

Due to the fact that product safety, quality and information are international issues, it will be helpful to have some international standards for the complete application area which rules the basic aspects in this business.

CA. - Fast moving consumer goods

In this subcategory only one national standard of the German VDI was found which supports the selection and integration of safety mechanism labels.

Due to the fact that today the application area of fast moving and consumer goods is an international business like manufacturing, it would be absolutely helpful for nearly every kind of food, if international standards were available to ensure and increase quality.

CB. - Electronic goods

In this subcategory also only one national standard of the German VDI was found which supports the selection and integration of safety mechanism labels.

Like the application before, the business of electronic goods is usually an international business, especially for entertainment electronics and so it would be absolutely helpful if international standards were available to prevent and to reduce the plagiarism of products.

CC. - Textile goods

In this subcategory also only some national standard of the German VDI were identified which describe the requirements as well as the application of the RFID technology in the area of textile goods.

The same situation as before, due to the fact that the textile business is usually an international business, it would be absolutely helpful and needed if international standards were available. Especially the reduction and the prevention of plagiarism of products is a very big issue in this business area.

CD. - Fresh / perishable foods

There were four national standards from France, USA and Germany identified which deal on the one hand with very special issues like agricultural goods tracing, water bottles or beverage logistics. On the other hand one of the national standards of the German VDI and the international guideline of IATA dealing with cool chain handling in general and especially for air transportation were identified.

Due to the fact that the branch of fresh / perishable foods often is an international business it will be helpful if international standards would be available. But for special national solutions like tracking of water bottles, it could be sufficient to have national or European standards.

CE. - Pharmaceutical

There were no application standards identified.

Due to the fact that the logistics of pharmaceutical goods are usually an international business, it would be absolutely helpful if international standards wee available.

Also for pharmaceutical goods the reduction and prevention of plagiarism of products is a very big issue.

CF. - Customer information systems

There were no application standards identified.

In view of the customer information systems for application areas like retail stores, museums or exhibits, it would be helpful if international standards were available. Especially, if in the near future customers use their own technical means like their mobile phones for the usage of these services, it would be absolutely useful to have international standards to ensure an interoperation between the systems.

In the following section a short abstract of the identified application standards related to application field (C.) or sub-category of application field (CA., CB., etc.) is given.

3.5.4.4 C. - Product safety, quality and information

ISO 17366

"Supply chain applications of radio frequency identification (RFID) - product packaging"

ISO 17366 was prepared by the joint working group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104. This international standard defines the basic features of RFID for the use in the supply chain when applied to product packaging.

In particular ISO 17366:

- provides specifications about the encoded identification of product packaging.
- makes recommendations about additional information on RF tag.
- specifies the semantics and data syntax to be used.
- specifies the data protocol to be used to interface with business applications and the RFID system.
- specifies the minimum performance requirements.
- specifies the air interface standards between the RF interrogator and RF tag.

The current version of the document ISO 17366 was published in 2005.

Internet: www.iso.org

ISO 17367

"Supply chain applications of radio frequency identification (RFID) - product tagging"

ISO 17367 was developed by the joint working group (JWG) of ISO Technical Committee 122 and ISO Technical Committee 104.

A more detailed description of the document is not available.

The current version of the document ISO 17367 was published in 2005.

Internet: www.iso.org

ISO/IEC TR 18001

"Information Technology, Automatic Identification and Data Capture Techniques - Radio Frequency Identification (RFID) for Item Management - Application Requirements Profiles"

This international standard focuses on applications for radio frequency identification (RFID) in an item management environment. It provides an explanation of the issues associated with the parameters of distance and number of tags within an RFID interrogator's field of view.

The current version of the document ISO/IEC TR 18001 was published in 2004.

Internet: www.iso.org

VDI 4470

"Anti theft systems for goods"

With the guideline VDI 4470, an acceptance guideline for electronic article security systems (EAS) is present for the fight against shoplifting.

Actually this guideline is – also internationally – unique of its kind and is approved from world wide offerors of active safety mechanism and by the trade. This practice-oriented guideline can serve besides the inspection and decrease of the systems.

VDI 4470 consists of the followed two parts:

1) Part 1: Detection Gates Inspection Guidelines for Customers,

2) Part 2: Deactivation Devices Inspection Guidelines for Customers.

The current version of the document VDI 4470 was published in 1997.

Internet: www.vdi.de

VDI 4471

"Electronic article surveillance systems (EAS)"

The guideline VDI 4471 is to facilitate a fast and wide introduction of the source safety mechanism as a shape of the electronic article safety mechanism (EAS), most effective for the retail trade. It treats therefore the harmonisation of the technologies used thereby.

Part 1 of the guideline generally describes the state of the art apart from the requirements of the source safety mechanism.

Part 2 to 4 contain the accurate specifications of the three most important technologies: acousto-magnetic, electro-magnetic and radio-frequency technology. For each technology the parameters serving for the description are deduced – measurement setups and measuring procedures are also described.

VDI 4471 consists of the following four parts:

1) Part 1: General,

2) Part 2: Acousto-magnetic EAS technology,

3) Part 3: Electro-magnetic EAS technology,

4) Part 4: Radio-frequency EAS technology.

The current version of the document VDI 4471 was published in 2002.

Internet: www.vdi.de

VDI 4473

"Quality assurance of EAS- and RFID-Labels"

A more detailed description of the documents is not available.

VDI 4473 consists of the followed four parts:

1) Part 1: General,

2) Part 2: EAS Label,

3) Part 3: RFID Label,

4) Part 4: RFID Hard Tags.

All parts of the document VDI 4473 are presently under development.

Internet: www.vdi.de

VDI 4475

“Sectoral implementation of source tagging”

The guideline VDI 4475 contains reliable reference points for the correct selection and integration of safety mechanism labels to users and responsible persons in trade as well as in industry.

VDI 4475 consists of four different parts, all of these parts belonging to application field “Product Safety and Quality”. Part 1 has a general character, whereas part 2 is related to “Fast Moving Consumer Goods”, part 3 is related to “Electronics Goods” and part 4 is related to “Textile Goods”.

VDI 4475 Part 1

”Sectoral implementation of source tagging – Application fundamentals”

Part 1 represents the bases for the use of EAS systems. It categorises the individual steps of the source safety mechanism such as manipulation protection, technical expenditure of the integration, hiding of product information, placement of the fuse elements, protection of metalliferous products and packaging.

The current version of the green paper document VDI 4475 Part 1 was published in 2006.

Internet: www.vdi.de

3.5.4.4.1 CA. – Fast moving consumer goods

VDI 4475

“Sectoral implementation of source tagging”

The guideline VDI 4475 gives reliable reference points for the correct selection and integration of safety mechanism labels to users and responsible persons in trade as well as industry.

VDI 4475 consists of four different parts, all of these parts belonging to application field "Product Safety and Quality". Part 1 has a general character, whereas part 2 is related "Fast Moving Consumer Goods", part 3 is related to "Electronics Goods" and part 4 is related to "Textile Goods".

VDI 4475 Part 2

"Sectoral implementation of source tagging – Application instructions for building centre"

Part 2 is an application note to the conversion of safety mechanisms in the branch of building centres. The defaults for the selection and integration of safety mechanism labels, described there, represent a minimum requirement. They guarantee a reliable detection in goods protection systems and a safe deactivation at the cash.

The current version of the green paper document VDI 4475 Part 2 was published in 2006.

Internet: www.vdi.de

3.5.4.4.2 CB. – Electronic goods

VDI 4475

"Sectoral implementation of source tagging"

The guideline VDI 4475 contains reliable points of reference for the correct selection and integration of safety mechanism labels to users and responsible persons in trade as well as industry.

VDI 4475 consists of four different parts, all of these parts belonging to the application field "Product Safety and Quality". Part 1 has of a general kind, part 2 is related to "Fast Moving Consumer Goods", part 3 is related to "Electronics Goods" and part 4 is related to "Textile Goods".

VDI 4475 Part 3

”Sectoral implementation of source tagging – application instructions for multimedia and electrical products”

Part 3 is an application note to the conversion of safety mechanisms in the branch of multimedia and electrical products. The defaults for the selection and integration of safety mechanism labels, described there, represent minimum requirements. They guarantee reliable detection in goods protection systems and a safe deactivation at the cash.

The current version of the green paper document VDI 4475 Part 3 was published in 2006.

Internet: www.vdi.de

3.5.4.4.3 CC. – Textile goods

VDI 4472

”Requirements to be met by transponder systems for use in the supply chain”

The guideline VDI 4472 offers assistance to users for the application/mission of RFID technology and summarises different application-orientated valid concepts.

VDI 4472 consists of eleven different parts; four parts are of a general kind of RFID application within logistical tracking & tracing. One part is related to air interface and two parts are related to closed loop logistics (within logistical tracking & tracing). Four parts are related to the application field of product safety and quality (textile goods, fresh/perishable foods and pharmaceutical).

VDI 4472 Part 2

“Requirements to be met by transponder systems for use in the supply chain – use of transponder systems in the textile chain (HF systems)”

Part 2 of the document describes the requirements for the use of HF RFID systems for textile applications in the supply chain.

The current version of the document VDI 4472 Part 5 was published in 2006.

VDI 4472 Part 3

"Requirements to be met by transponder systems for use in the supply chain – Use of transponder systems in the textile chain (UHF systems)"

Part 3 of the document describes the requirements for the use of UHF RFID systems for textile applications in the supply chain.

The document VDI 4472 Part 3 is still under development.

Internet: www.vdi.de

VDI 4475

"Sectoral implementation of source tagging"

The guideline VDI 4475 gives reliable reference points for the correct selection and integration of safety mechanism labels to users and responsible persons in trade as well as industry.

VDI 4475 consists of four different parts, all of these parts belonging to the application field "Product Safety and Quality". Part 1 is of a general kind and, part 2 is related to "Fast Moving Consumer Goods". Part 3 is related to "Electronics Goods" and part 4 is related to "Textile Goods".

VDI 4475 Part 4

"Sectoral implementation of source tagging – application instructions for clothes, shoes, leather goods, home textiles"

Part 4 is an application note to the conversion safety mechanisms in the branch of clothes, shoes, leather goods and home textiles. The defaults for the selection and integration of safety mechanism labels, described there, represent minimum requirements. They guarantee the reliable detection in the goods protection systems and a safe deactivation at the cash.

The current version of the green paper document VDI 4475 Part 4 was published in 2006.

Internet: www.vdi.de

3.5.4.4.4 CD. – Fresh / Perishable foods

AFNOR FD V01-020

“Agriculture and food industry - guidelines for the setting up of a traceability approach within agricultural and food branches”

A more detailed description is not available.

The active national AFNOR standard FD V01-020 was published in 2002.

Internet: www.afnor.org

AWWA IMT61457

“The Use of Mobile and RFID Data and Field Force Integration in a Major Water Utility”

The intended application of this standard is the tracking and tracing of water bottles. A more detailed description is not available.

The publishing date of the current document AWWA IMT61457 is not known.

Internet: www.awwa.org

VDI 4472

”Requirements to be met by transponder systems for use in the supply chain”

The guideline VDI 4472 offers assistance to users for the application/mission of RFID technology and summarises different application-orientated valid concepts.

VDI 4472 consists of eleven different parts, four parts are of a general kind of RFID applications within the logistical tracking & tracing, one part is related to the air interface and two parts are related to closed loop logistics (within the logistical tracking & tracing) and four parts are related to the application field of product safety and quality (textile goods, fresh/perishable foods and pharmaceuticals).

VDI 4472 Part 6

“Requirements to be met by transponder systems for use in the supply chain – use of transponder systems in the cool chain”

Part 6 of the document describes the requirements for the use of transponder systems for cool chain applications within the supply chain.

The document VDI 4472 Part 6 is still under development.

VDI 4472 Part 9

“Requirements to be met by transponder systems for use in the supply chain – Use of transponder systems in beverage logistics”

Part 9 of the document describes the requirements for the use of transponder systems for beverage logistics.

The document VDI 4472 Part 9 is still under development.

Internet: www.vdi.de

IATA Perishable Cargo Manual (PCM)

IATA’s PCM has become world standard for the preparation, packaging and handling of perishable goods for air transportation. The PCM is applicable to all IATA member airlines accepting time and temperature sensitive products. As a leader in cold chain management for pharmaceutical products and non hazardous biological material, the PCM will assist in reducing perishable losses and minimising related claims and insurance premiums by providing best practices for shipping perishable cargo through the entire supply chain. From growers to retailers, IATA’s PCM increases the operational efficiency and reduces the financial exposure for perishable operations.

The document was expanded by the challenges and opportunities by using radio frequency identification (RFID) in the perishable supply chain shipment of pharmaceutical products.

The first issue of the IATA Perishable Cargo Manual where the use of RFID is mentioned was published in 2006.

Internet: www.iataonline.com

3.5.4.4.5 CE. - Pharmaceutical

In this subcategory no application standards were identified.

3.5.4.4.6 CF. – Customer information systems

In this subcategory no application standards were identified.

3.5.5 Different subcategories

There are still three subcategories from different application categories which have to be considered. The subcategories have been selected under the aspect of wide use and importance, respectively expected importance. These are the subcategories:

- DB. - Access control systems
- DD. - Personal tracking
- GB. - Rental systems

The subcategories DB – access control systems and DD – personal tracking are belonging to the main category D - access control and tracking & tracing of individuals. The subcategory GB – rental systems is belonging to main category G - sports, leisure and household.

3.5.5.1 Frequencies and air interface standards

RFID application fields	
Basic application area	

Subcategories	DB. – Access control systems	DD. – Personal tracking	GB. – Rental systems
Frequencies and air interface standards			
Used air interfaces in current applications Y(Yes): used, blank: not used			
LF <134 kHz	Y		
HF 13.56 MHz	Y	Y	Y
UHF 433 MHz (active)			
UHF 860-960 MHz	Y		
UHF 2,4 GHz			
SHF 5,8 GHz			
Availability of air interface protocol standards: yes / no Y(Yes): Published standards or standards under development Blank: no standards, no projects			
International standards	Y	Y	Y
European standards			
National standards			
Importance of standards (High/Low)	L	L	L

Table 25 Air interface standards of the subcategories

The LF, HF and UHF band are used for application field DB – access control systems. RFID systems are used to control access to buildings and critical installations (security areas, power stations, etc.) as well as parking garages. The systems for building and parking garage access often use the same infrastructure and are based on similar or the same technology components. The need for standardisation is low, because the installations are stand-alone systems. There are special demands in terms of application security and cryptography to ensure authorised access only. Since people will carry around their access cards, tracking and profiling are concerns that should be addressed when drafting standards for this application field.

In the application field DD – personal tracking the operating systems only use the HF frequency band. Typical applications for the tracking of people are the tracking of small children (application in use in Legoland amusement parks), or the tracking of inmates. The different applications are usually closed loop applications. Because of this there is only a low need for application specific standards. Special attention has to be brought towards privacy concerns. The tracking of individuals has to be a reasonable measure considering the privacy implications it might have. Standards in this field should address privacy and surveillance issues und should make sure that basic privacy principles such as information, consent and proportionality are considered.

The application field GB – rental Systems from the main category G - sports, leisure and household uses only the HF frequency band. The RFID technology can be used to ease and speed-up the rental processes, e.g. for rental cars, videos/DVDs, libraries or work wear garments. RFID-enabled rental bikes are already in use in various locations in Europe and elsewhere. Usually the systems are closed loop applications, so no general standardisation is needed. However, privacy implications have to be considered. People will carry RFID tags on clothing, books or vehicles and could therefore be considered as „tagged". Standards should therefore take into account possible privacy risks and should be drafted based on a broad consensus amongst stakeholders.

Data and network standards

RFID application fields			
Basic application area			
Subcategories	**DB. – Access control systems**	**DD. – Personal tracking**	**GB. – Rental systems**
Data and network standards			
Used data and network standard categories in current applications Y(Yes): used, blank: not used			
Reader interface			
Data	Y	Y	Y
Data management interface			
Information network services & interface			
Availability of data and network standards: yes / no Y(Yes): Published standards or standards under development Blank: no standards, no projects			
International standards	Y	Y	Y
European standards			
National standards			
Do competing standards exist?			
Importance of standards (High/Low)	L	L	L

Table 26 **Data and network standards of the subcategories**

DB. - Access control systems

Access control systems are local proprietary implementations. Data standards are sufficient. Depending on the level of required security, it might be necessary to use security standards.

DD. - Personal tracking

Personal tracking is mainly used for local in-house services. The use of data standards may be sufficient.

GB. - Rental systems

In most cases rental systems are closed loop applications. The use of data standards may be sufficient.

The subcategories DB – access control systems and DD – personal tracking are belonging to the main category D – access control and tracking & tracing of individuals. The subcategory GB – rental systems is belonging to main category G – sports, leisure and household.

3.5.5.2 Application standards

The application standards will content all kind of standards which are strong related to applications like

- architecture of the RFID system,
- mechanical application of the RFID tags or antennas of the RFID readers,
- definition of RFID tags i.e. size, housing, etc.,
- definition of application-related data stored on the RFID tag.

RFID application fields			
Basic application area			
Subcategories	**DB. – Access control systems**	**DD. – Personal tracking**	**GB. – Rental systems**
Application standards			
Availability of generic application standards valid for the complete application field: Y(Yes): Published generic standards or generic standards under development Blank: no standards, no projects			
International standards			
European standards			
National standards			
Availability of special application standards related to only one subcategory of the application field: I (International): Published international standards or international standards under development E (European): Published European standards or European standards under development N (National): Published national standards or national standards under development Y (Yes): Published special standards or special standards under development Blank: no standards, no projects			
DD. - Access control: ICAO e-passport		I	
GB. - Library: implementation of data model for libraries			I
Importance of standards (High/Low)	M	M	M

Table 27 Application standards of the subcategories

DB. - Access control systems

There were no application standards identified.

In the area of access control systems the applications are very wide spread. This could be for facility entrance at international companies or administrations, but also for small and local solutions like for a small company. Due to this it may be helpful if international standards were available but often national standards would be sufficient or proprietary systems could be suitable for local and closed applications.

DD. - Personal tracking

In this subcategory only one international standard of the ICAO so-called e-passport was identified. This example shows how important the existence of an international standard will be – a huge set of countries will stick to this standard like to ease their boarder controls or passenger handling at airports. Due to this fact it is obvious, how important the existence of international standards in this special application area would be.

GB. - Rental systems

In the subcategory of rental systems only one international standard of ISO was identified. The standard defines the data model for the use of RFID technology for libraries.

In this area the applications also could be widespread, e.g. internationally for car rental companies or very locally for libraries. Due to this it may be helpful if international standards were available but often national standards would be sufficient or proprietary systems could be suitable for local and closed applications.

In the following section a short abstract of the identified application standards related to their subcategory of application field (DA., DD. and GB.) is given.

3.5.5.3 DB. - Access control systems

In this subcategory no application standards were identified.

3.5.5.4 DD. - Personal tracking

ICAO Doc9303 MRTD

A machine readable travel document (MRTD) is an international travel document (e.g. a passport or visa) containing eye and machine readable data. Each type of MRTD contains in a standard format the holder's identification details, including a photograph or digital image, with mandatory identity elements reflected in a two-line machine readable zone (MRZ) printed in optical character recognition-B (OCR-B) style. All participating countries agree to standardisation of elements in travel documents.

The standard for the e-passport is based on ISO 14443 data standard for RFID.

ICAO Doc9303 MRTD consists of the following three parts:

Part 1: machine readable passports (published in 2006; consists of 2 volumes)

Volume 1 sets forth the specifications for a machine readable passport (MRP), characterised by a visual inspection zone and a machine readable zone (MRZ), containing essential identification and document details in OCR-B typeface.

Volume 2 sets forth the specifications for biometric enhancement of the MRP to become an "e-passport".

Part 2: machine readable visas (published in 2005)

Specifications provide for a visa format in two sizes - format A, sized to fill a passport page, and the smaller format B. Like the MRP the machine readable visa is a standard format consisting of a visual inspection zone and a machine readable zone. However, the third edition requires that a space be provided for a portrait of the holder, and fewer layout options than the previous edition allowed.

Part 3: size-1 and size-2 machine readable official travel documents (published in 2003, a revision is planned in 2007)

Specifications provide for machine readable cards in two sizes: TD-1, an ID-1 size plastic card, and TD-2 having the dimensions defined for the ID-2 type card (ISO/IEC 7810). In addition to the visual inspection zone and the machine readable zone the specifications provide for the addition of "optional capacity expansion technologies" to increase data storage on the documents.

This current version of the e-passport document was published in 2006.

Internet: www.icao.int

3.5.5.5 GB. - Rental systems

ISO/NP 28560

“Information and documentation - data model for use of radio frequency identifier (RFID) in libraries”

ISO/NP 28560 describes the implementation of an international data model application standard for information and documentation concerning the use of radio frequency identifier (RFID) in libraries.

The proposal for this new standard, which is currently under development, was published in 2006.

Internet: www.iso.org

3.6 Intellectual property rights

The field of intellectual property rights (IPR) is very wide and sometimes not very transparent. Standard development organisations do not always have the same rules with regard to confidentiality and intellectual property rights. Sometimes before becoming a member of an organisation, the applicant has to sign the licensing conditions of the organisation.

ISO, IEC and ITU have a common patent policy. The objective of their policy is to ensure world-wide compatibility of technologies and systems. To reach this common aim it is necessary that all participants make their deliverables accessible to everybody. This should be possible without undue constraints. To meet this requirement in general is the sole objective of the code of practice.

The code of practice declares that the organisation is not in the position to give authoritative or comprehensive information about evidence, validity or scope of patents or similar rights. But every member participating in ISO, IEC or ITU should be anxious to disclose the fullest available information. The validity of such information can not be confirmed and checked by the organisation.

If a member is willing to disclose a development or a deliverable three different scenarios are possible:

- The patent holder is willing to negotiate licences free of charge with other parties on a non-discriminatory basis on reasonable terms and conditions. Such negotiations are left to the parties concerned and are performed outside ITU-T/ITU-R/ISO/IEC.

- The patent holder is willing to negotiate licences with other parties on a non-discriminatory basis on reasonable terms and conditions. Such negotiations are left to the parties concerned and are performed outside ITU-T/ITU-R/ISO/IEC.

- The patent holder is not willing to comply with the provisions of either of the two former paragraphs; in such case, the deliverable shall not include provisions depending on the patent.

In this case the expression "reasonable" can mean different things to an owner or buyer of technology. In general there is no single right answer to the meaning of reasonable. The threshold for what is reasonable is dependent on the chosen standard and the nature of the invention.

Independent on the case which applies, the patent holder has to provide a written statement to be filed in ITU, ISO or IEC form. This statement with respect to the appropriate "Patent statement and licensing declaration" form must not include additional provisions, conditions, or any other exclusion clauses in excess.

The Intellectual Property Rights Policy, which was established by the general assembly of ETSI is slightly different to the one of ISO, IEC and ITU. The objective of ETSIs IPR policy is to reduce the risk to ETSI, members of ETSI and others applying ETSI standard that investment in the preparation, adoption and application of standards could be wasted as a result of an essential IPR for a standard being unavailable. The ETSI policy tries to create a balance between the needs of standardisation for public use in the field of telecommunications and the rights of the owners of IPR. ETSI is the only organisation which also specifies the role of a third party who is neither an ETSI member nor an affiliate of a member. The policy says that all IPR holders should be adequately and fairly rewarded for the use of their IPR in the implementation of standards and technical specifications. To ensure as far as possible that all activities which relate to the preparation, adoption and application of standards and technical specifications are available to potential users in accordance with the general principles of standardisation.

If an essential IPR which relates to a particular standard or specification is brought to ETSI, the owner is requested to give within three months an undertaking in writing that it is prepared to grant irrevocable licences on fair, reasonable and non-discriminatory terms and conditions under such IPR to at least the following extent:

- manufacture, including the right to make or have made customised components and sub-systems to the licensee's own design for use in manufacture;
- sell, lease, or otherwise dispose of equipment so manufactured;
- repair, use, or operate equipment; and
- use methods.

As long as the requested undertaking of the IPR owner is not granted, the committee chairman has to judge whether or not the committee should suspend work on the relevant parts of the standard until the matter has been resolved.

If the European Commission requests for a specific standard, ETSI shall investigate in competent and timely manner. The investigation has to include an IPR search with the objective of ascertaining whether IPR exist or are likely to exist which may be or may become of importance for the standard.

EPCglobal is a user-driven organisation. It works together with retailers, manufacturers as well as hardware, software, and integration solutions providers to create and share intellectual property that will benefit the entire subscriber base. The policies of EPCglobal are committed to an open use of the EPCglobal Network while the network integrity is protected. The IP policy ensures that all companies subscribing to the organisation have open, neutral access to EPC Global network technology and standards. With the agreement it is guaranteed that the technology remains non-proprietary for the benefit of industry as a whole. Companies which want to participate in any action group or working group are required to sign the appropriate EPCglobal intellectual property (IP) policy and forward it to the responding EPCglobal affiliate. The organisations' objective with this policy is to encourage the development, exploitation and competition of proprietary technology and innovative approaches to implementing such specifications, while avoiding blocking proprietary claims or monopolisation of use of the specifications.

Different groups are getting in touch with the topic and problems of intellectual property rights. These groups have different views on the issue, depending on their own interests. The most important groups are:

- users,
- technology companies,
- SMEs – small and medium-sized enterprises.

It would be in the interest of the users that developments and technologies are not linked with licensing costs. Users want to be able to modify a bought product or technology and to use it for all different kinds of applications without any restrictions. Furthermore, the technique should be widely available. In their opinion also all developed standards should be free of licences.

The situation for technology companies is more complex. It is a permanent conflict with no easy solution. Their opinion is depending on whether they are the owner of an IP or if they want to use a technology developed by another company. If they are the holder of an IP they want to have high licence fees. Thus, they want to protect or sell their knowledge. The earned money can be used to invest in other research and development projects. One problem is that IPR very often only have a small extent of protection and are only representing small investments. IPs are usually protecting ideas. Another problem is that complex and long licence negotiations can constrain the development of new technologies and products. On the other hand, if a technology company needs information from another company or an IPR is applied in a project, they want the fees to be small and to buy and receive the required information for as little costs as possible. Another argument is that IPR can help to protect smaller companies and their ideas from large companies who are market leaders.

Small and medium enterprises have a similar opinion like users. SMEs are usually small companies that do not have the time and the money to take an active participation in standardisation. They usually advance the view to produce and use license free standards.

It is a danger that patents could lead to long-standing trade disputes, thus creating insurmountable cost barriers for technology adopters, especially for SMEs. On the one hand the formation of patent pools is an appropriate way to share patents and make innovations like RFID accessible to a greater number of interested businesses. This may be beneficial for the technology as such. But nevertheless on the other hand patent situation could become a real problem, if European RFID industry depends from US-companies holding patents. All current existing patent pools are settled in the United States.

In the fields of intellectual property rights following recommendations can be given:

For the future it would be very important to create and support a unique and harmonised IPR landscape across Europe. That means a European patent should be introduced. Currently, patents are only valid for some specific regions and countries. It should be possible for technology developing companies to receive a European wide patent on a development without going to different national organisations. Further the jurisprudence according to IPR matters should be the same across Europe. Very often there is the problem of different laws and conditions between the member states. This also impedes the introduction of a European patent.

A further minor point is the influence of IPR in standardisation. Many standardised technologies and procedures are the intellectual property of somebody. Everybody who wants to release a product conform to a standard has to pay for it. It should be ensured that the most relevant standards are free of any licences. Only in this way the market is able to develop freely and without any hindrances.

Another recommendation is that the different organisations should specify clear RAND (reasonable and non-discriminating) and FRAND (fair, reasonable and non-discriminating) conditions. It has to be written down which conditions are reasonable and non discriminating. Everything must be unfolded, limits must be specified and IPR holders must be compelled to give an offer for a contract to an interested party within short time.

Further on the European industry should be encouraged to co-operate with existing patent pools. Especially within the UHF bandwidth, there is a risk that European companies will be prevented from market entry by U.S. competitors due to the patent situation. European companies should participate in the existing U.S. patent pool.

3.7 Data protection and data security

Privacy and data protection is an important and frequently discussed topic in the field of RFID applications. Many people are afraid that their private sphere is violated and that relevant information about them will be stored. Several standards already exist to protect the privacy of the user and the general public that might be affected by this technology. The most important privacy and data protection standards are:

- 95/46/EC – on the protection of individuals with regard to the processing of personal data and on the free movement of such data,
- 2002/58/EC – directive about the processing of personal data and the protection of privacy in the electronic communications sector (directive on privacy and electronic communications),
- 2006/24/EC – directive on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks.

Directive 95/46/EC regulates the processing of personal data, regardless if the processing is automated or not. Personal data are any kind of information which can be linked to an identified or identifiable natural person. This definition is meant to be very broad. Some examples of personal data are: address, credit card number, bank statements, criminal record, etc.

The principles of the directive are that personal data should not be processed at all, except when certain conditions are met. These conditions fall into three categories:

- transparency,
- legitimate purpose and
- proportionality.

New advanced digital technologies (like RFID) are being introduced in public communications networks in the public, which give rise to specific requirements concerning the protection of personal data and privacy of the user. The development of the information society is characterised by the introduction of new electronic communications services.

Directive 2002/58/EC regulates the processing of personal data and the protection of privacy in the electronic communications. This directive seeks to respect the fundamental rights. The directive wants to guarantee the confidentiality of communications in accordance with the international instruments relating to human rights.

Directive 2006/24/EC is on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks. The document is amending to directive 2002/58/EC. The directive aims to harmonise member states' provisions concerning the obligations of the providers of publicly available electronic communications services or of public communications networks with respect to the retention of certain data which are generated or processed by them. This ensures that the data are available for the purpose of the investigation, detection and prosecution of serious crime, as defined by each member state in its national law.

Technology concerning RFID security standards does not yet exist. In this field there is a need for the development of suitable security protocols which are application specific. Different application areas need a different level of security.

However, data protection is basically not only a RFID problem. The radio communication between reader and tag is a specific RFID characteristic – the basic questions that arise from using the technology are the same as in the case of IT or telecommunications applications. As a general note, privacy and data protection issues have to be addressed on a broader scale. The principle of technology neutrality in privacy legislation should not be compromised. Special legal acts for specific technologies will make the legal framework incomprehensible to the majority of people, causing the opposite of what was intended: not more clarification and security for the individual, but confusion and uncertainty as well as new challenges for innovation in Europe.

To inform the public about a potential privacy risk, all RFID tagged goods shall be marked with an emblem. AIM and EPCglobal have already developed a standard and an emblem to provide full transparency about tagged goods to the user. ISO has not developed a standard up to date. There is also a need for an ISO standard which forces tagged goods to be marked.

3.7.1 Safety risks

Another important fact is the topic of data security. The use of RFID systems in industry and development allows an easy tracking and tracing of goods and an improvement of manufacturing procedures. Several safety risks exist, as shown in the diagram below.

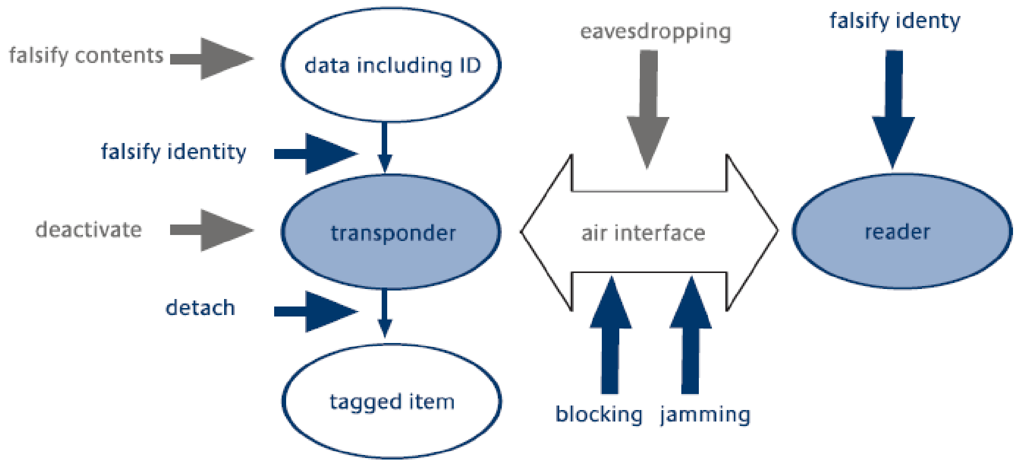

Figure 9 **Basic types of attack on RFID systems; Source: BSI**

3.7.1.1 Falsification of contents

Unauthorised write access to a tag can cause falsified contents. This type of attack is suitable for targeted deception only, if, when the attack is carried out, the ID (serial number) and any other security information that might exist (e.g. keys) remain unchanged. In this case the reader does not recognise a manipulation of the tag and will still recognise the identity of the transponders correctly. This kind of attack is only possible in addition to ID and security information. Other information is stored on the tag.

3.7.1.2 Falsification of identity (transponder)

This kind of attack led to the results that several transponders with the same serial number are being in circulation. The attacker obtains the ID and any security information of a tag and uses these to deceive a reader into accepting the identity of this particular tag. This attack can either be performed by using a device that is capable of emulating any kind of tag or by producing a new tag which is a clone of the old one.

3.7.1.3 Deactivation

Physical destruction or an unauthorised application sending delete or kill commands can result into the deactivation of a tag. Depending on the used method of deactivation, there are two possibilities. Either the reader can no longer detect the identity of the tag, or the presence of the tag in the reading range can not be detected.

3.7.1.4 Detaching the tag

Transponders applied to labels or the outside of the packaging materials can easily be removed or exchanged, much like a price tag in retail today. A transponder is separated physically from the tagged item and may be placed on a different item. This type of attack is a fundamental security problem. RFID systems are completely dependent on the unambiguous attribution to the item to be tagged.

3.7.1.5 Eavesdropping

The air interface between reader and tag is probably the only RFID specific security risk. The communication between both devices via the air interface can be monitored by intercepting and decoding the radio signals.

3.7.1.6 Blocking

This attack is performed with the use of so-called blocker tags. These tags simulate the presence of any number of transponders to the reader. In this way the reader is blocked. A blocker tag must be configured for the used anti-collision protocol.

3.7.1.7 Jamming

Jamming is also a potential risk to attack the air interface. The data exchange can be disturbed passive or active. A passive disturbance could be a metal shielding. Active disturbance could be performed through so-called jamming transmitters. Even simple measures can be very effective because the air interface is not very robust.

3.7.1.8 Falsifying identity (reader)

If a potential aggressor wants to read the data of a tag with his own reader, it must fake the identity of an authorised reader. In a secure RFID system the reader must prove its authorisation to the tag. Performing such a kind of attack can be very easy up to nearly impossible. It is depending on the security measures in place. A possible solution is that the reader might need access to a backend system in order to retrieve keys that are stored there.

Currently there is still a lack in methods and standards which allow companies to use RFID in a wide, efficient and safe way. Necessary security methods can not be realised with all existing RFID systems. Low-cost-tags for example are not able to support cryptographic techniques which are necessary for authentication, ciphering and the protection of integrity and access.

3.7.2 Privacy enhancing technologies

The document MEMO/07/159 – privacy enhancing technologies, which was published in form of a press release by the European Commission, describes several technologies to increase the security of privacy and data. Technologies that can be used for RFID are the so-called encryption tools. Encryption tools prevent hacking when the information is transmitted over the Internet and support the data controller's obligation to take appropriate measures to protect personal data against unlawful processing.

3.7.3 Data security measures in air interface standards

Several air interface standards are still offering possibilities to increase data security. The following table gives a short overview which possibilities are supported or can be integrated in transponders using the corresponding air interface standard.

Standards	**Memory locking**	**Unique identifier**	**Random identifier**	**Data covering**	**Authentication***	**Encryption***
ISO 14443		X	X		X	X
ISO 15693	X	X				
ISO 18000-6c / EPC Gen2	X		X	X		
EPC HF	X		X	X		

Table 28 Air interface standards and data security

Memory locking is a possibility to protect storaged data against unauthorised changes like deleting or overwriting the memory. Usually a bit is set, which prevents the change of the memory.

A unique identifier is a unique number of a device. It can be used as copy and clone protection as well as for data encryption and data covering.

If a device uses a random identifier, a new random number is generated after each reset of the system, which replaces the old UID. The random UID can

* These features are not defined in the standard but the standard refers to another standard which describes the methods, e.g. ISO 7816.

also be used for data covering. The random identifier reduces the risk of eavesdropping since one transponder can not be tracked.

Data covering describes several methods to protect data. These methods do not provide full protection, because the encryption only takes place on a low level. The data are not fully encrypted, but scrambled or deferred. Like the random identifier data covering reduces the risk of eavesdropping of the data content.

Authentication is the act of establishing or confirming of the identity of the devices. The process of authentication can depend upon one or more authentication factors.

Possibilities for authentication are described in ISO standard 9798. One method is the so-called "Three Pass Mutual Authentication". During the process of authentication both communication partners check the knowledge of a secret cryptographic key. All devices operating in the same application know the same cryptographic key.

In cryptography, encryption is the process of transforming information (referred to as plaintext) to make it unreadable to anyone except those possessing special knowledge, usually referred to as a key. The result of the process is encrypted information

Transponders which are conforming to ISO standard 14443 can either have implemented within a unique or a random identifier. Furthermore, these transponders offer the possibility to use methods for authentication and encryption in accordance with ISO 7816. In this case the tag is compliant to ISO 14443-4.

ISO 15693 compliant tags offer the possibility to lock memory blocks. This feature is mandatory for tags which are compliant to this standard. A unique identifier is implemented within ISO 15693 tags.

ISO standard 18000-6c is in conformance with EPC Class1 Gen2 Standard. Both standards support the memory locking functionality and provide a random identifier. Further possibilities for data covering are provided.

Only if data are protected in a certain way, manipulation and system errors can be avoided. The success of RFID technology will be dependent on the fact how good it is possible to implement suitable data protection and security methods. It is necessary to develop application specific data protection and data security standards which consider the required protection level as well as the capability of the technology.

A detailed description of the topic privacy and data protection can be found in the report of work package 5.

3.8 Database

During the process time the project partners of work package 3 developed a standards database. The aim was to collect all available RFID standards from the main standard development organisations to get a good and easy overview over available standards. The database includes approximately 180 standards which are sorted for the development organisations. Standards developed by following organisations were collected and listed:

- EC - European Authorities
- CEPT - European Conference of the Postal and Telecommunications Administrations
- ETSI - Institut européen des normes de telecommunication
- CEN - European Committee for Standardisation
- CENELEC - European Committee for Electrotechnical Standardisation
- ISO - International Organisation for Standardisation
- IEC - International Electrotechnical Commission
- ISO/IEC SC31
- ISO/IEC SC31 Data
- ISO/IEC SC17
- ISO TC122-104
- AFNOR - Association française de Normalisation

- DIN - Deutsches Institut für Normung
- DANSK - Danish Standards
- ANSI - American National Standards Institute
- EPCglobal - Electronic Product Code
- IEEE - Institute of Electrical and Electronics Engineers
- VDI - Verein Deutscher Ingenieure
- ICAO - International Civil Aviation Organisation
- IATA - International Air Transport Association
- ATA - Air Transport Association
- AIAG - Automotive Industry Action Group
- AWWA - American Water Works Association
- SAE - Society of Automotive Engineers
- SEMI - Semiconductor Equipment and Materials International
- MIL - Military Standard
- STANAG - NATO Standardisation Agreement
- ECMA
- AIM – Association of Automatic Identification and Mobility
- ICNIRP - International Commission on Non-Ionizing Radiation Protection

The database provides information about the identity number and the title of the standard, the category it belongs to, the working group that developed it, the status of the standard, its publishing date and the content of the standard. Additionally there is an Internet link for more detailed information.

4 Conclusions

The first subsection of this chapter summarises the main results of the state-of-the-art analysis and sums up the evaluation of the preceding section 3 by means of a SWOT (strengths, weaknesses, opportunities, threats) analysis for Europe's situation regarding to the main topic of this work package: RFID Standardisation.

In a second subsection all consequential recommendations are summarised.

4.1 Summary

The following chapter will give a short and compact overview over the current situation of RFID standardisation. For this purpose, a SWOT Analyse is used. The following tables will show the strengths (S), the weaknesses (W) of standardisation as well as opportunities (O) and threats (T) for standardisation.

Two different SWOT tables are printed below. The first one shows the situation of RFID standardisation in general. The second SWOT diagram will show the additional European aspects.

4.1.1 SWOT analysis on RFID standardisation processes

Strengths	Weaknesses
Mayor SDOs are working on RFID standards Involvement of European technology provider and user The structure of ETSI allows an effective development of standards by an active participation of companies	Lack of cooperation between standardisation organisations European standard development organisations suffer from the specific European structure, i.e. a duality between European and national standard development organisations European stakeholders are not sufficiently represented in some international standard activities
Opportunities	**Threats**
Support the European involvement in international standardisation activities Take a leading role in international RFID standardisation Support the SME involvement in international standardisation activities Support the involvement of end users in standardisation. Establish the possibility for companies to participate directly in the work of European SDOs CEN and CENELEC. The structure of ETSI allows an effective development of standards by an active participation of companies.	Competing standards from different SDOs can constrict the use of RFID Market hindrance because of standards of national or regional SDOs Global standards are being dominated by non-European organisations and non-European technologies Standards are mainly influenced by large organisations; SME only have limited possibilities to influence standards Placement of de-facto standards by global players Standards are being used as a marketing instrument Slow development of necessary standards

Table 29 SWOT analysis on RFID standardisation processes

4.1.2 SWOT analysis on RFID frequency and air interfaces standards

Strengths	**Weaknesses**
Globally established frequency bands like the HF band benefit the use of RFID International accepted air interface standards like ISO 18000-6C / EPC UHF Generation 2 exist	Lack of globally harmonized frequency spectrum Very slow speed of creating RFID regulations and provision of radio spectrum Lack of sufficient UHF frequency spectrum
Opportunities	**Threats**
International harmonised and accepted high performance standards for relevant HF air interfaces Implementation of existing UHF regulation in all EU member states Improve UHF radio regulation (eliminate LBT) Provide additional UHF spectrum to improve the performance of RFID systems Work towards a single frequency authority in Europe Provide an ITU preferred service state for RFID	Restricted spectrum resources limit the performance of RFID systems Fragmented frequency bands increase the costs of RFID systems Regulatory restrictions like Listen-before-talk limit the usability of RFID. Standards are used as a marketing instrument

Table 30 SWOT analysis on RFID frequency and air interfaces standards

4.1.3 SWOT analysis on data and network standards

Strength	Weaknesses
Data standards are well defined and widely used Number of standards has increased significantly during recent months Quality level of standards has risen Alignment between ISO and EPCglobal has been initiated	Standards besides data standards are available, but not implemented in products yet Activities in ISO 24971 standardisation are moving only slowly Available standards are rarely used till now Green field approach standards have no pilot prove till now EPC IS approach has limited field prove Gaps in describing methodologies for managing complete sets of product data from different EPC IS repositories Involvement of European companies in standardisation activities is still poor Limited expert involvement in privacy issues and data security
Opportunities	**Threads**
Ensure the data interoperability between different code issuing agencies Develop alternative concepts to ONS based on R&D activities Run standard based pilots to prove the concepts	Non-European companies dominate and decide the standardisation process for data and network standards Single companies get major control of RFID system and data

Table 31 SWOT analysis on data and network standards

4.1.4 SWOT analysis on application standards

Strengths	Weaknesses
The stakeholders have recognised that standards will have a real benefit in general Many of the application fields like aviation, automotive, retail, textile goods, etc. have recognised that mainly international standards will bring a real benefit	Not all application fields are yet covered by standards Many of the existing standards are only available as national standards but international standards are needed more often Many standards have a very narrow focus i.e. solve only one special problem, but there often are application areas very similar to each other where a need for more generic standards exists
Opportunities	**Threats**
The globalisation of commerce will enforce the development of international standards to solve common problems like plagiarism New standards of emerging technologies like those for integrated sensors on RFID tags will help to establish new technologies in the market. For this, general issues like sensor data and data transfer mechanism should be standardised The acceptance of standards by users (like for retailer textile goods) will be increased if more international standards will be available because their business is international	International and national standardisation processes as well consume a lot of time and cost The acceptance of standards is an important and difficult issue in general An overall (international) coordination of application standards is missing, i.e. standardisation normally is driven by the stakeholders' organisations. This could result in the existence of many similar standards that might compete against each other.

Table 32 SWOT analysis on application standards

4.1.5 SWOT analysis on IPR regarding to RFID standards

Strengths	**Weaknesses**
Most of the important SDOs have defined IPR regimes to ensure the basic usability of standards.	The existing IPR regimes of official SDOs do not prevent standards from being burdened by substantial IPR costs. SDOs cannot assure that standards are not covered by IPR of organisations, which are not involved in the standardisation process, and this IPR can inhibit the use of standards IPR on standards often only have a narrow scope of protection, but it is inevitable to acquire the respective rights.
Opportunities	**Threats**
Work towards the minimisation of the cost of usage of standards. Review and optimise the IPR regimes of the formal SDOs. Licence free standards support the development of the market. Develop guidelines regarding licensing conditions. Establish the European Patent	High costs on standards can hinder the use of standards and the use of RFID IPR of organisations not involved in the standardisation processes can inhibit the use of standards Standards are used as a marketing instrument.

Table 33 SWOT analysis on IPR regarding to RFID standards

4.1.6 SWOT analysis on standards on data protection and data security

Strengths	**Weaknesses**
Existing standards already contain provisions for the implementation of data security Contactless chip cards standards could be a starting point for the development of data security standards	Lack of guidelines how to implement existing data protection laws in RFID applications
Opportunities	**Threats**
Establish a set of guidelines, which cover the requirements of different RFID application fields	Unclear requirements and implementation standards could hinder the use of RFID

Table 34 SWOT analysis on standards on data protection and data security

4.2 Recommendations

This subsection summarises the recommendations for the different European stakeholders (according to the RFID Stakeholder model) regarding the topics of work package 3. During the progress of this work package several recommendations for all kinds of standards concerning RFID have been developed. The following recommendations are addressed to the European Commission and all formal standard development organisations, like e.g. ISO, as well as to all user and industry organisations. Recommendations on radio regulations and air interfaces are especially addressed to different frequency authorities as ITU.

4.2.1 General recommendations

Support basic standards like frequency allocations, air interface protocols and tag data specifications

On the one hand there is the field of frequencies and air interface protocols. Only if frequency bands and air interface protocols are harmonised, complementing development of standards is possible. Harmonised regulations for Europe will also strengthen the position of technology providers, who do not want to waste effort, time and money to develop different types of hardware, which is adapted to several local regulations. In this way globally harmonised standards and frequency regulations can help to reduce costs.

Detailed recommendations regarding frequencies and air interface protocols are given in the corresponding subchapters.

On the other hand there is the field of tag data. This concerns specially identifiers and codes. The compatibility between different identifier and codes from different Issuing agencies has to be ensured.

Detailed recommendations regarding frequencies and air interface protocols are given in the corresponding subchapters.

4.2.1.1 Create fewer but broader accepted standards

Further on, it would be important to create fewer but broader accepted standards. This would provide more possibilities for technology providers as well as for users of a product. Unfortunately, there is still a lack of well-established standards. Many standards are in place, but there is a weak agreement on which ones shall stay. This problem exists particularly with respect to data and network standards.

4.2.1.2 Review the initiation process of new standardisation work items

To minimise the number of standards it is recommended to review the process to initiate new standardisation work items. Each standardisation organisation has a prescribed process, which must be followed to start a new standardisation work item. The criteria, which must be met by new standardisation proposals, should be more restrictive. Only really new standardisation proposals should be accepted. It must be avoided that standards are used as marketing instruments.

4.2.1.3 Set up a coordinated standardisation roadmap between ISO and EPCglobal

At present, ISO and EPCglobal are the most relevant standardisation organisations. A coordinated standardisation road map would help to avoid competing standards and to make the standardisation work more efficient.

4.2.1.4 Make it easier to understand and work with standards

Another important step would be to make it easier to understand and work with standards. The European Commission should support activities to communicate the relevant standards to the stakeholders of the RFID business. CE RFID will publish information on standards on the project website.

4.2.1.5 Avoid national and regional standards

From an industry prospective European and national RFID Standards are not necessary. National standards can cause market barriers. The aim should be to develop international and widespread RFID standards with a broad acceptance, like the ISO standard 18000-6c and EPCglobal Class1 Gen2. Internationally accepted standards would increase the international interoperability. Free usable standards, as well as an easy access to the standard will support the development of the market.

4.2.2 Recommendations on standardisation processes

4.2.2.1 Co-operation between SDOs in general

The co-operation between different international and national standardisation organisations should be improved and supported by the European Commission. The Commission should encourage and promote the dialogue between the SDOs. This would help to avoid overlapping and lacks in standardisation. One possibility to establish such a co-operation could be a forum under the umbrella of the planned European RFID network.

4.2.2.2 Support co-operation between ISO and EPCglobal

Another important step would be to support the co-operation between ISO and EPCglobal. On the one hand, ISO has a wider standardisation scope and worldwide acceptance, while EPCglobal as a user organisation has a strong enduser involvement and is ahead on software standards. Combining both could help to complement them and provide strong and trend-setting standards which could be used for all kinds of applications.

4.2.2.3 Support the European involvement

Another important act would be the support of European involvement in international standardisation activities. In several ISO groups, e.g. WG4 SG1 Europe is not represented very well. This makes it easier for organisations and companies from other parts of the world to be considered decisive for RFID developments and the definition of the basic infrastructure.

4.2.2.4 Support SMEs

The support of small and medium sized enterprises (SMEs) in standardisation processes is a further action that should be taken. SME organisations are often not able to participate in international standardisation activities. Travelling costs to meetings should be reimbursed. As soon as business trips are not linked to high costs it will be more attractive for companies to send their delegates to important committees. On that account, the creation of standards nowadays is still mainly influenced by large organisations and companies.

4.2.2.5 Direct participation of companies in CEN and CENELEC

An option for companies to participate in the work of European SDOs, CEN and CENELEC directly should be established. The structure of ETSI e.g. allows the effective development of standards by an active participation of companies.

4.2.2.6 Establish a single European Radio Regulation Authority

Another recommendation is to initiate talks with member states for setting up a European radio regulation authority under the European Commission. It would be helpful to bring relevant industry and users together to support the European Commission at this point. This would also help to harmonise the frequency bands on an international level.

4.2.3 Recommendations on radio regulations and air interface protocols

Recommendations on radio regulations can be given for the two most important frequency bands. These are the HF band at 13.56MHz and the UHF band from 860-960MHz. In both fields, several things could be improved. Particularly in the UHF frequency band there is big need for changes. Other frequencies like LF or 2.45 GHz are mainly used in stand-alone applications.

4.2.3.1 CEPT ERC/REC70-03 should be mandatory (10 UHF channels with 2 W)

A first step would be to make the implementation of ERC/REC 70-03 mandatory for all European countries. It also seems to be a good start to prevail the EC Decision 2006/804/EC from November 2006 to be mandatory, as it forces the member states to provide a UHF spectrum according to ERC/REC 70-03 within six month.

4.2.3.2 Eliminate the necessity for listen-before-talk

The elimination of listen-before-talk is supposed to take place by the year 2008. For instance, the United Kingdom has already eliminated it. After its elimination changes in the ERC/REC 70-03 will be performed. This is planned for the beginning of 2008.

4.2.3.3 Provide additional UHF spectrum

An additional UHF spectrum should be provided to improve Europe's situation on the RFID market and to improve the performance of RFID systems. In the long run an adequate UHF spectrum should be provided for high-performance readers and for low-cost readers as well.

4.2.3.4 Implement CEPT ERC/REC 70-03 Annex 9F11 (HF)

There also is a need for some activity in the HF spectrum. This is a widely used frequency band. The implementation of Annex 9F11 of ERC/REC 70-03 should be mandatory for all European countries. The modulation mask should be amendment to higher field-strength of 60dBµA/m. In the long run, it is necessary that an adequate spectrum for HF high-speed applications will be provided.

4.2.3.5 Implement broad accepted air interface standards

In the fields of air interface protocols, a uniform global standard for all industry sectors such as for the compatible standards ISO 18000-6c and EPC Gen2 should be established.

Furthermore, the establishment of a worldwide-accepted high-speed HF standard should be supported. This will help to improve the performance of different HF applications and to manage large numbers of tags within a short time.

4.2.3.6 Provide an ITU-R service state for RFID

The ITU-R should be requested to provide an international service status, e.g. a secondary or permitted service for RFID. At present, RFID like other SRD have no status or rights for the use of frequencies; they are co-users and have to accept any interference from other services, which presents a performance risk for all users.

4.2.4 Recommendations on data and network standards

4.2.4.1 Use synergies between "Internet of Things" and RFID emergence

It is a great challenge to work out sustainable application independent data and network standards. As the characteristics of RFID components and the complexity of the system may vary significantly from application to application, the standards have to meet the middle course between regulation and flexibility. The definition of the system architecture clustered in building blocks separated by well defined interfaces is crucial. It is evident that due to the novelty of most interface standards, optimisation of single standards is still going on.

The stage of maturation is decreasing from interface definitions close to the reader to the network infrastructure of the World Wide Web.

Discussions about data management over web are very much influenced by the idea of the "Internet of Things".

Over a decade ago Mark Weiser developed a vision of technological ubiquity, meaning that the availability of local processing power is combined with miniaturisation to a degree that makes it possible to have online connection of anything, anytime and anywhere. It is anticipated that the technological development for miniaturised computer power as well as hardware elements like sensors and nanotechnology will enable applications that include objects transferring information about themselves or their environment to relevant addressees by them. Connections will multiply and create an entirely new dynamic network of networks – the "internet of things". The mobile phone can be regarded as an early form of this type of ubiquitous information network. In mid-2005 the number of mobile phones sold worldwide surpassed 2 billion. Such a kind, people in principle can communicate on a worldwide basis. The idea of the internet of things includes the concept of having communicating objects in addition.

This vision includes a big number of different technologies, like smart sensor networks, RFID, Nanotechnology etc. RFID is only one part of this new technology and developed somehow independently from the big vision. Regarding data and network standards, some of the basic ideas of the internet of things are reflected in the ONS (Object Naming Service) defined by EPCglobal. It can be expected that further development of this concept will be linked more to the emergence of the internet of things than now. RFID applications of today and the near future can be built without the usage of ONS.

The emergence of ONS will very much depend on the market needs and user acceptance.

The recommendation therefore is to foster R&D activities to look for alternative concepts to fulfil market needs and privacy and synchronise standardisation activities accordingly.

4.2.4.2 Speed up the development of standard compliant products

As the network standards defined by EPCglobal have been released recently, the number of standard compliant products available today is very limited. Most RFID projects are integrated still basing on proprietary protocols. Therefore, the integration effort and project cost is high. As there is still risk that recently released standards will be updated, suppliers hesitate to replace their proven proprietary solutions. In the future market there will be needs for main drivers. Especially in case of data and network standards the involvement of end users will thus play a major role. Due to the organisational impact caused by data exchange, the specific requirements of end users should be incorporated. More European end users should be involved in the standardisation process.

Stand-alone systems can be organised without the usage of ONS. Most applications today organise their data exchange without ONS by defining bilateral standard data exchange methods. There is no need for new standardisation activities regarding ONS at the moment.

4.2.4.3 Review network standards against suitability for specific applications

The level of data security and privacy measures is defined by the needs for specific applications. As data and network standards are defined independent of applications, existing standards used in various applications have to be tested from case to case whether they still fulfil relevant requirements or not.

Moreover, many applications have a need to transfer additional data to RFID data, typical examples are global master item data or additional multimedia data.

4.2.5 Recommendations on application standards

The analysis of the different application standards leads to the following recommendations:

4.2.5.1 Recommendations on application area A. “Logistical Tracking & Tracing”

4.2.5.1.1 Rule of the basic conditions for “Logistical Tracking & Tracing”

This application area usually is an international and more often a transcontinental business. The only exception is "in-house logistics” which normally is an internal and local restricted application, for instance for a company for whom a proprietary or none-standardised solution can be sufficient.

Nearly all of applications in this area are related to an international business which has a strong need for international standards ruling basic conditions of logistical tracking and tracing as well as the data and interfaces for data exchange.

4.2.5.1.2 Harmonisation of the standards for closed loop logistics

In the subcategory of "closed loop logistics” like for retail of consumer goods it will be absolutely helpful if more international standards exist.

In this area a lot of national standards as well as international standards were identified. However, a harmonisation of standards could be useful in order to get more international standards like those for returnable transport items which are presently only available as national standards.

Only in special cases like for disposal logistics it will be sufficient if European or national standards are available. Nevertheless, international standards will be not hindering in any case as each European country has to deal with the same duties.

4.2.5.1.3 International standards for "open logistics", "postal applications", "dangerous goods logistics" or "manufacturing logistics"

In the subcategories "open logistics", "postal applications", "dangerous goods logistics" or "manufacturing logistics", which all belong to international business areas, it was also clearly asserted that international standards would be very useful to ease this businesses as well. However, up to now no mentionable standards can be identified except for baggage handling in aviation.

4.2.5.2 Recommendations on application area B. "Production, Monitoring and Maintenance"

Due to the fact that the areas of production, monitoring and maintenance are very wide spread and complex businesses it will be neither possible nor necessary to have standards to cover the complete application area.

4.2.5.2.1 Rule of the general issues like data and interfaces for data exchange for "archive systems", "asset management" and "facility management":

In the subcategories "archive systems", "asset management" and "facility management" requirements are very special and solutions are insulated so that common standards are only needed to rule general issues like data and interfaces for data exchange.

In the area "vehicles" and "airplanes" the international standardisation process is already going on and is co-ordinated by industrial organisations.

In the area "automotion and process control" it is most likely not to achieve common standards as the area is to heterogeneous i.e. most of the applications are isolated and therefore need special solutions.

4.2.5.2.2 International standards for "food and consumer goods"

In the area of "food and consumer goods" no standards are identified, but it will be helpful if international standards would be available.

4.2.5.3 Recommendations on application area C. "Product Safety, Quality and Information"

4.2.5.3.1 International standards for the complete application area "Product Safety, Quality and Information" to rule the basic aspects

As this application area generally is an international issue it also would be useful to have international standards for the complete application area. This area rules basic aspects in this business like data and interfaces for data exchange.

4.2.5.3.2 International standards for "anti-theft systems and electronic article surveillance" based on already existing and established national standards

In the case of anti-theft systems and electronic article surveillance which is relevant to all its subcategories as well, presently there are only some national standards available. Here it would be very useful to have international standards which could base on already established national standards.

In all related subcategories there are only national standards defined if there are any available at all. The only exception is the subcategory "fresh and perishable foods", where an international IATA standard is available because of aviation issues.

4.2.5.3.3 International standards for reduction and the prevention of plagiarism of products

For each of the subcategories of this application area a strong need for international standards was identified. In all of subcategories the reduction and prevention of plagiarism of products is a very urgent and important issue which could be supported by having international standards.

4.2.5.3.4 International standards to support the establishing of "customer information systems"

Within the emerging application area of the subcategory "customer information systems" no standard are available at present. However, there is a strong need for international standards identified for establishing these applications.

4.2.5.4 Recommendations on "Different Subcategories" DB., DD., and GB.

4.2.5.4.1 International standards to harmonise the technology of "access control systems"

The requirements for the subcategory DB. "access control systems" are so broad that it does not seem to be possible to cope all its aspects with generic standards. This is due to the fact that many of these applications can only be found in local regions and are closed to companies and administrations. However, it may be helpful if some generic standards would be available to harmonise the used technology in order to ease their application.

4.2.5.4.2 International standards for "personal tracking" e.g. to get an EU common ID card

In the subcategory DD. "personal tracking" with a definite need for international standards there only exists one but very good example for international standardisation: the so-called ICAO "e-passport" standard. This could be a good example for how harmonised solutions can look, especially for applications within the European Union, such as how to receive an EU common ID card, an EU common social insurance card etc.

It is obvious that there is a strong need for more international standards in this special application area.

4.2.5.4.3 Generic international / national standards for "rental systems"

Subcategory GB. "rental systems" on the one hand is very widespread as is the case for international car rental companies , while on the other hand it is very local and closed at the same time. Due to the fact that it may be helpful especially for libraries if generic international standards are available, although in this case national standards often are sufficient for local and closed applications as well.

4.2.5.5 Recommendations on Sensor Standards for RFID Tags

Another important issue is the availability of RFID tags combined with sensors functionality. In different businesses like retail, pharmacy, aviation, etc. there is a need for sensor functionality combined with RFID identification.

For many applications like for retail pallets with vegetables it will be sufficient to have very simple sensor functionality to measure the current temperature so that there is no need for data storage and data processing.

In special cases like valuable pharmaceutical products, such as serums or system health monitoring in aviation, it will be useful to have advanced sensor functionality with integrated data storage and maybe data processing (if feasible).

Up to now there is only the initiative of IEEE to start the development of standardized sensor interfaces for RFID tags combined with sensors.

It would be helpful if RFID sensor standards are available to push the technological development of standardised infrastructures in order to get a standardised infrastructure (sensor data, data transfer, etc.) for RFID sensor products. By doing this the economic risk for developing companies with a low chance of success will be reduced.

4.2.5.6 Recommendations on Packaging Standards for RFID Tags

For many RFID applications in harsh environments like logistics or industrial manufacturing processes it is necessary to have RFID tags with special housings so that these are resistant against temperature, mechanical impact, corrosion etc.

Currently, only standard paper based RFID tags and inlays are "really" cheap and can be mass-produced. If a RFID tag for special use or for harsher environment is required, like for open space or within industrial areas the price for the tags increases drastically.

For this, the EC could support the technological development by pushing the establishment of standards for the use of RFID tags in harsh environments to a technical performance standard for harsh environments.

This will also reduce the economical risk of developing companies and will push this special kind of RFID technology to become a cheap mass product.

4.2.5.7 General Recommendations on Application Standards

4.2.5.7.1 General need for international standards and their harmonisation

The analysis of different application areas and their subcategories shows that there is a strong need for international standards which most likely is driven by the more and more international commerce in combination with the more international flow of goods.

In many application areas it would seem a proper solution if new international standards will be based on existing and already established national standards like in the area of product safety and quality.

4.2.5.7.2 Application standards / guidelines as well as tools and methods for RFID application

If there are adequate standards for all different application areas available companies applying RFID technology as well as end-customers will have a much bigger confidence in RFID technology.

Initiating application standards and application guidelines as well as tools and methods for RFID application will be very useful in order to support the use of RFID technology. This is caused by the fact that many small and medium enterprises will not use RFID technology as long as there is a big uncertainty as to RFID technology because:

- They do not know which RFID technology is most suitable for their application area,
- The risk of high and maybe wrong investments in RFID technology causes to much uncertainty,
- The return of invest often cannot be calculated seriously.

4.2.5.7.3 International cooperation of RFID standardisation

Furthermore, it is important to foster the international cooperation of RFID standardisation organisations as national legal organisations, international legal organisations, industrial organisations, etc. They should cooperate and align their activities in standardisation to prevent the establishment of competitive national and international standards. The existence of competitive standards will increase the uncertainty of users of RFID technology and will weaken the RFID standardisation and technology in general.

In summary, the development of international RFID application standards is a very important issue in order to push the RFID technology in Europe and worldwide.

4.2.6 Recommendations on intellectual property rights

4.2.6.1 European Patent

The creation and support of a uniform and harmonised IPR landscape across Europe will be a very important task in the near future. To realise this aim the European patent should be introduced in that way that a granted EP-patent becomes automatically valid and accepted in all member states without any national phase. Currently, patents are only valid for designated states. It should be possible for technology development companies to receive a Europe-wide patent on a development without going to different national organisations. According to this, the jurisprudence concerning IPR matters should be harmonised across Europe.

4.2.6.2 License free standards

A further point that should be concerned is the influence of IPR on standardisation. The influence of IPR into existing and future standards should be minimised. It should be ensured that the most relevant standards are free from any licences. Only this way the market is able to develop freely and without any hindrances. Currently, many standardised technologies and procedures are the intellectual property right of somebody. Everybody who wants to release a product which is conform to a standard has to pay for it.

4.2.6.3 Develop guidelines on licensing conditions for standards related IPR

FRAND (Fair, Reasonable and Non Discriminatory) and RAND (Reasonable and Non Discriminating) conditions should be clearly specified by different organisations. It has to be layed down which arguments are reasonable and non-discriminating. IPR holders must be compelled to give an offer for a contract to an interested party within short time. Further on, everything must be unfolded and limits must be specified.

4.2.6.4 Patent pools

Another recommendation is that the European industry should be encouraged to co-operate with existing patent pools. Within the UHF area, there is a risk that European companies will be prevented from market entry by U.S. competitors due to the patent situation.

4.2.7 Recommendations on Data Protection and Security

4.2.7.1 Identify the needs for data protection and data security of different application fields and develop corresponding guidelines

RFID is used in a variety of applications. Passports are equipped with RFID and RFID tags control the production of cars within automotive factories. These different application fields have different needs for data protection and data security. The requirements of specific application fields regarding data protection and data security should be identified and corresponding guidelines should be developed.

4.2.7.2 Develop suitable security standards

Further, there is a need for the development of suitable security protocols, which are specific for certain applications. Different application areas need different levels of security. Two options are possible: Either existing standards from other technologies like smart cards can be transferred to RFID or new technologies regarding security standards are developed. Thereby the performance of different tags has to be taken into account. Cheap and easily constructed tags are able to fulfil only a minimum level on security.

4.2.7.3 Develop standards for the marking of tagged items

RFID tagged goods should be marked with a special label. EPCglobal and AIM have already developed a standard and an emblem to label transponders. Still, an ISO standard is missing though needed.

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6 Appendices

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10.1	France Union Technique de l'Electricité Tour Chantecoq 5, Rue Chantecoq F - 92808 PUTEAUX Cedex	Phone: + 33 1 49 07 62 00 Fax: + 33 1 44 78 73 51 E-Mail: ute@ute.asso.fr Internet: www.ute-fr.com
11.1	Greece Hellenic Organisation for Standardisation 313, Acharnon Street GR - 111 45 ATHENS	Phone: + 30 210 212 01 00 Fax: + 30 210 228 30 34 E-Mail: info@elot.gr Internet: www.elot.gr

12.1	Hungary Hungarian Standards Institution Ulloi ut, 25 H - 1091 BUDAPEST	Phone: + 361 45 66 800 Fax: + 361 45 66 884 E-Mail: szt.electr.dept@mszt.hu Internet: www.mszt.hu
13.1	Iceland Icelandic Standards Laugavegur- 178 IS - 105 REYKJAVIK	Phone: + 354 520 7150 Fax: + 354 520 7171 E-Mail: stadlar@stadlar.is Internet: www.ist.is
14.1	Ireland Electro-Technical Council of Ireland Limited Unit H12, Centrepoint Business Park Oak Road IRL - DUBLIN 12	Phone: + 353 1 42 90 088 Fax: + 353 1 42 90 090 E-Mail: info@etci.ie Internet: www.etci.ie
15.1	Italy Comitato Elettrotecnico Italiano Via Saccardo, 9 I - 20134 MILANO	Phone: + 39 02 21 00 61 Fax: + 39 02 21 00 62 10 E-Mail: cei@ceiweb.it Internet: www.ceiweb.it
16.1	Latvia Latvian Standard K. Valdemara Street, 157 LV - 1013 RIGA	Phone: + 371 7371 308 Fax: + 371 7371 324 E-Mail: lvs@lvs.lv Internet: www.lvs.lv

17.1	Lithunia Lithuanian Standards Board T. Kosciuskos g., 30 LT - 01100 VILNIUS	Phone/Fax: + 370 5 212 62 52 E-Mail: lstboard@lsd.lt Internet: www.lsd.lt
18.1	Luxembourg Service de l'Energie de l'Etat - Organisme Luxembourgeois de Normalisation B.P. 10 L - 2010 LUXEMBOURG	Phone: + 352 46 97 46 1 Fax: + 352 46 97 46 39 E-Mail: see.normalisation@eg.etat.lu Internet: www.see.lu
19.1	Malta Malta Standards Authority Second Floor, Evans Building Merchants Street MT - VLT 03 VALLETTA	Phone: + 356 21 24 24 20 E-Mail: fran-cis.farrugia@msa.org.mt Internet: www.msa.org.mt
20.1	Netherlands Netherlands Elektrotechnisch Comité Vlinderweg, 6 Postbus 5059 NL - 2600 GB DELFT	Phone: + 31 15 269 03 90 Fax: + 31 15 269 01 90 E-Mail: nec@nen.nl Internet: www.nen.nl
21.1	Norway Norsk Elektroteknisk Komite Strandveien 18 P.O. Box 280 N - 1326 Lysaker	Phone: + 47 67 83 31 00 Fax: + 47 67 83 31 01 E-Mail:post@nek.no Internet: www.nek.no

22.1	Poland Polish Committee for Standardisation ul. Swietokrzyska, 14 P.O. Box 411 PL - 00 - 950 WARSZAWA	Phone: + 48 22 55 67 591 Fax: + 48 22 55 67 786 E-Mail:intdoc@pkn.pl Internet: www.pkn.pl
23.1	Portugal Instituto Português da Qualidade Rua António Gião, 2 P - 2829-513 CAPARICA	Phone: + 351 21 294 81 00 Fax: + 351 21 294 81 01 E-Mail: ipq@mail.ipq.pt Internet: www.ipq.pt
24.1	Romania Romanian Standards Association Str. Mendeleev, 21-25 RO - 010362 BUCHAREST 1	Phone: + 40 21 316 32 96 Fax: + 40 21 316 08 70 E-Mail: asro@asro.ro Internet: www.asro.ro
25.1	Spain Asociación Española de Normalización y Certificación C/ Génova, 6 E - 28004 MADRID	Phone: + 34 902 102 201 (Info Service) E-Mail: norm.clciec@aenor.es Internet: www.aenor.es
26.1	Slovakia Slovak Electrotechnical Committee Slovak Standards Institution Karloveska, 63 P.O. Box 246 SK - 840 00 BRATISLAVA 4	Phone: + 421 2 6029 4589 Fax: + 421 2 6542 1272 E-Mail:reserse@sutn.gov.sk Internet: www.sutn.gov.sk

27.1	Slovenia Slovenian Institute for Standardisation Smartinska, 140 SI - 1000 LJUBLJANA	Phone: + 386 1 478 30 13 Fax: + 386 1 478 30 94 E-Mail: sist@sist.si Internet: www.sist.si
28.1	Sweden Svenska Elektriska Kommissionen Kistagangen, 19 Box 1284 S - 164 29 KISTA	Phone: + 46 84 44 14 00 Fax: + 46 84 44 14 30 E-Mail:sek@sekom.se Internet: www.sekom.se
29.1	Switzerland Swiss Electrotechnical Committee Luppmenstrasse, 1 CH - 8320 FEHRALTORF	Phone: + 41 44 956 11 11 Fax: + 41 44 956 11 22 E-Mail: ver-band@electrosuisse.ch Internet: www.electrosuisse.ch
30.1	United Kingdom British Electrotechnical Committee British Standards Institution 389, Chiswick High Road GB - LONDON W4 4 AL	Phone: + 44 (0)20 8996 7459 Fax: + 44 (0)20 8996 7460 E-Mail: mike.graham@bsi-global.com Internet: www.bsi-global.com

Table 36 **Members of CENELEC**

6.3 Members of CEN

1.1	Austria Österreichisches Normungsinstitut (ON) Heinestraße 38 AT-1020 Wien	Tel: + 43 1 213 00 Fax: + 43 1 213 00 650 www.on-norm.at
2.1	Belgium Bureau de Normalisation/Bureau voor Normalisatie (NBN) Avenue de la Brabançonne 29 Brabançonnelaan 29, BE-1000 Brussels	Tel: + 32 2 738 01 11 Fax: + 32 2 733 42 64 www.nbn.be
3.1	Bulgaria Bulgarian Institute for Standardisation (BDS) 3A, 165 str. Izgrev Complex BG-1797 Sofia	Tel: + 359 2 817 45 04 Fax: + 359 2 873 55 97 www.bds-bg.org
4.1	Cyprus Cyprus Organisation for Standardisation (CYS) Limassol Avenue and Kosta Anaxagora 30, 3rd Floor CY-2014 Nicosia	Tel: + 357 22 411 411 Fax: + 357 22 411 511 www.cys.org.cy
5.1	Czech Republic Czech Standards Institute (CNI) Biskupský dvur 5 CZ-110 02 Praha 1	Tel: + 420 221 802 802 Fax: + 420 221 802 301 www.cni.cz

6.1	Denmark Danish Standards (DS) Kollegievej 6 DK-2920 Charlottenlund	Tel: + 45 39 96 61 01 Fax: + 45 39 96 61 02 www.ds.dk
7.1	Estonia Estonian Centre for Standardisation (EVS) Aru Street 10 EE-10317 Tallinn	Tel: + 372 605 50 50 Fax: + 372 605 50 70 www.evs.ee
8.1	Finland Suomen Standardisoimisliitto r.y. (SFS) Maistraatinportti 2 FI-00240 Helsinki	Tel: + 358 9 149 93 31 Fax: + 358 9 146 49 25 www.sfs.fi
9.1	France Association Française de Normalisation (AFNOR) 11, avenue Francis de Pressensé FR-93571 Saint-Denis La Plaine Cedex	Tel: + 33 1 41 62 80 00 Fax: + 33 1 49 17 90 00 www.afnor.org
10.1	Germany Deutsches Institut für Normung e.V. (DIN) Burggrafenstraße 6 D-10787 Berlin	Tel: + 49 30 26 01 0 Fax: + 49 30 26 01 12 31 www.din.de

11.1	Greece Hellenic Organisation for Standardisation (ELOT) 313, Acharnon Street GR-TK 111 45 Athens	Tel: + 30 210 21 20 100 Fax: + 30 210 22 83 034 www.elot.gr
12.1	Hungary Hungarian Standards Institution (MSZT) Üllõi str. 25 HU-1091 Budapest	Tel: + 36 1 456 68 00 Fax: + 36 1 456 68 84 www.mszt.hu
13.1	Iceland Icelandic Standards (IST) Laugavegur 178 IS-105 Reykjavik	Tel: + 354 52 07 150 Fax: + 354 52 07 171 www.stadlar.is
14.1	Ireland National Standards Authority of Ireland (NSAI) Glasnevin IE-Dublin 9	Tel: + 353 1 807 38 00 Fax: + 353 1 807 38 38 www.nsai.ie
15.1	Italy Ente Nazionale Italiano di Unificazione (UNI) Via Sannio, 2 IT-20137 Milano	Tel: + 39 02 70 02 41 Fax: + 39 02 70 10 61 06 www.uni.com

16.1	Latvia Latvian Standards Ltd (LVS) K. Valdemãra Street 157 LV-1013 Riga	Tel: + 371 7 371 308 Fax: + 371 7 371 324 www.lvs.lv
17.1	Lithuania Lithuanian Standards Board (LST) T. Kosciuškos g. 30 LT-2600 Vilnius	Tel/Fax: + 370 5 212 62 52 www.lsd.lt
18.1	Luxembourg Service de l'Energie de l'Etat (SEE) Organisme Luxembourgeois de Normalisation 34 avenue de la Porte-Neuve (3ème etage) LU-2227 Luxembourg	Tel: + 352 46 97 46 1 Fax: + 352 46 97 46 39 www.see.lu
19.1	Malta Malta Standards Authority (MSA) Second Floor, Evans Building Merchant Street MT-Valletta VLT 03	Tel: + 356 21 24 24 20 Fax: + 356 21 24 24 06 www.msa.org.mt
20.1	The Netherlands Nederlands Normalisatie-instituut (NEN) Vlinderweg 6 NL-2623 AX Delft	Tel: + 31 15 2 690 390 Fax: + 31 15 2 690 190 www.nen.nl

21.1	Norway Standard Norge (SN) Strandveien 18 NO-Lysaker	Tel: + 47 67 83 86 00 Fax: + 47 67 83 86 01 www.standard.no
22.1	Poland Polish Committee for Standardisation (PKN) Swietokrzyska 14 PL-00-050 Warsaw	Tel: + 48 22 55 67 591 Fax: + 48 22 55 67 786 www.pkn.pl
23.1	Portugal Instituto Português da Qualidade (IPQ) Rua António Gião, 2 PT-2829-513 Caparica	Tel: + 351 21 294 81 00 Fax: + 351 21 294 81 01 www.ipq.pt
24.1	Romania Romanian Standards Association (ASRO) Str. Mendeleev 21-25 RO-010362 Bucharest 1	Tel: + 40 21 316 32 96 Fax: + 40 21 316 08 70 www.asro.ro
25.1	Slovakia Slovak Standards Institute (SUTN) Karloveská 63 PO Box 246 SK-840 00 Bratislava	Tel: + 421 2 60 29 44 74 Fax: + 421 2 65 41 18 88 www.sutn.gov.sk/

26.1	Slovenia Slovenian Institute for Standardisation (SIST) Šmartinska cesta 140 SI-1000 Ljubljana	Tel: + 386 1 478 30 13 Fax: + 386 1 478 30 94 www.sist.si
27.1	Spain Asociación Española de Normalización y Certificación (AENOR) Génova, 6 ES-28004 Madrid	Tel: + 34 91 432 60 00 Fax: + 34 91 310 31 72 www.aenor.es
28.1	Sweden Swedish Standards Institute (SIS) Sankt Paulsgatan 6 SE-118 80 Stockholm	Tel: + 46 8 555 520 00 Fax: + 46 8 555 520 01 www.sis.se
29.1	Switzerland Schweizerische Normen-Vereinigung (SNV) Bürglistraße 29 CH-8400 Winterthur	Tel: + 41 52 224 54 54 Fax: + 41 52 224 54 74 www.snv.ch
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Table 37 Members of CEN

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2.1	Australia AUSTRALIAN NATIONAL COMMITTEE OF IEC Standards Australia GPO Box 476 SYDNEY NSW 2001	Tel: +61 2 8206 6000 Fax: +61 2 8206 6001 Website: Internet: www.standards.org.au
3.1	Austria AUSTRIAN ELECTROTECHNICAL COMMITTEE c/o Oesterreichischer Verband für Elektro-technik (OVE) Eschenbachgasse 9 AT-1010 WIEN	Tel: +43 1 587 63 73 Fax: +43 1 586 74 08 Website: Internet: www.ove.at
4.1	Belarus BELARUSSIAN NATIONAL COMMITTEE OF THE IEC (BELST) 93, Starovilensky Trakt BY-220053 MINSK	Tel: +375 17 233 52 13 Fax: +375 17 233 25 88 Website: Internet: www.gosstandart.gov.by

5.1	Belgium COMITE ELECTROTECHNIQUE BELGE Diamant Building Boulevard A. Reyers, 80 BE-1030 BRUXELLES	Tel: +32 2 706 85 70 Fax: +32 2 706 85 80 Website: Internet: www.bec-ceb.be
6.1	Bosnia & Herzegovina IEC Natl. Com. of Bosnia & Herzegovina The Institute for Standardisation of B&H Hamdije Cemerlica 2/7 BA-71000 SARAJEVO	Tel: +387 57 31 0585 Fax: +387 57 31 0575
7.1	Brazil BRAZILIAN NATIONAL COMMITTEE OF THE IEC Electrical, Electronics, Illumination & Telecommunications Brazilian Committee Av. Paulista, 1439, 11°andar, cj. 114 BR-01311-200 - SAO PAULO - SP	Tel: +55 11 3371 5601 Fax: +55 11 3289 2179 Website: Internet: www.cobei.org.br
8.1	Bulgaria BULGARIAN NATIONAL COMMITTEE OF THE IEC BULGARIAN INSTITUTE FOR STANDARDISATION (BDS) "Izgrev" Komplex, 165 Str., Nr 3A BG-1797 SOFIA	Tel: +359 2 81 74 523 Fax: +359 2 873 55 97 Website: Internet: www.bds-bg.org

9.1	Canada CANADIAN NATIONAL COMMITTEE OF THE IEC Standards Council of Canada 270 Albert Street, Suite 200 OTTAWA, ONT. K1P 6N7	Tel: +1 613 238 32 22 Fax: +1 613 569 78 08 Website: Internet: www.scc.ca
10.1	China CHINESE NATIONAL COMMITTEE OF THE IEC Standardisation Administration of China (SAC) No.9 Madian East Road, Haidian District BEIJING 100088	Tel: +86 10 8226 2628 Fax: +86 10 8226 0673 Internet: www.sac.gov.cn or www.cnca.gov.cn
11.1	Colombia Instituto Colombiano de Normas Técnicas y Certificacion (ICONTEC) Carrera 37 N° 52 - 95 Edificio ICONTEC, P.O. Box 14237 SANTAFE DE BOGOTA, D.C.	Tel: +57 1 315 03 77 Fax: +57 1 222 14 35 Internet: www.icontec.org.co
12.1	Croatia CROATIAN STANDARDS INSTITUTE (HZN) Ulica Grada Vukovara 78 p.p.167 HR-10002 ZAGREB	Tel: +385 1 610 60 95 Fax: +385 1 610 93 21 Internet://www.hzn.hr

13.1	Cyprus EC NATIONAL COMMITTEE OF CYPRUS Cyprus Organisation for Standardisation Leoforos Lemesou & Kosta Anaksagorou 30 3rd floor CY-2014 NICOSIA	Tel: +357 22 411 411 Fax: +357 22 411 511 Internet://www.cyc.org.cy
14.1	Czech Republic CZECH NATIONAL COMMITTEE OF THE IEC CZECH STANDARDS INSTITUTE (CNI) Biskupsky dvùr 5 CZ-110 02 PRAHA 1	Tel: +420 2 21 802 100 Fax: +420 2 21 802 311 Internet: www.cni.cz/
15.1	Denmark DANSK STANDARD Danish Standards Kollegievej 6 DK-2920 CHARLOTTENLUND	Tel: +45 39 96 61 01 Fax: +45 39 96 61 02 Internet: www.ds.dk
16.1	Egypt THE EGYPTIAN NATIONAL COMMITTEE Ministry of Electricity & Energy Abbassia Post Office CAIRO	Tel: +20 2 261 91 66 Fax: +20 2 261 91 66

17.1	Estonia ESTONIAN NATIONAL COMMITTEE OF THE IEC Estonian Centre for Standardisation(EVS) 10, Aru Street EE-10317 TALLINN	Tel: +372 6 055 050 Fax: +372 6 055 070 Internet: www.evs.ee
18.1	Finland Finnish National Committee of the IEC SESKO STANDARDISATION IN FINLAND P.O. Box 134 FI-00211 HELSINKI	Tel: +358 9 696 391 Fax: +358 9 677 059 Internet: www.sesko.fi
19.1	France UNION TECHNIQUE DE L'ELECTRICITE (UTE) Comité Electrotechnique Français Tour Chantecoq 5, rue Chantecoq FR-92808 PUTEAUX CEDEX	Tel: +33 1 49 07 62 00 Fax: +33 1 47 78 73 51 Internet: www.ute-fr.com
20.1	Germany DEUTSCHES KOMITEE DER IEC Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN & VDE Stresemannallee 15 DE-60596 FRANKFURT AM MAIN	Tel: +49 69 630 80 Fax: +49 69 96 31 52 18 Internet: www.dke.de

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22.1	Hungary MAGYAR SZABVANYÜGYI TESTÜLET HUNGARIAN STANDARDS INSTITUTION (MSZT) Ülloi ut 25 POB 24 HU-1091 BUDAPEST	Tel: +36 1 4566 800 Fax: +36 1 4566 823 Internet: www.mszt.hu
23.1	Iceland IEC National Committee of Iceland Icelandic Standards (IST) Laugavegur 178 IS-105 REYKJAVIK	Tel: +354 520 7150 Fax: +354 520 7171 Internet: www.stadlar.is
24.1	India BUREAU OF INDIAN STANDARDS Manak Bhavan 9, Bahadur Shah Zafar Marg NEW DELHI 110002	Tel: +91 11 2323 7991 Fax: +91 11 2323 9399 Internet: www.bis.org.in

25.1	Indonesia National Standardisation Agency of Indonesia (BSN) Gedung Manggala Wanabakti Blok IV Lt. 4 Jl. Jenderal Gatot Subroto, Senayan JAKARTA 10270	Tel: +62 21 574 70 43 Fax: +62 21 574 70 45 Internet: www.bsn.or.id
26.1	Iran Institute of Standards & Industrial Research of Iran (ISIRI) INEC Secretariat 7th floor, Southern corner/Vanak square IR-14155-6139 TEHRAN	Tel: +98 21 8879471 Fax: +98 261 2803869 Internet: www.inec.ir
27.1	Ireland ELECTROTECHNICAL COUNCIL OF IRELAND LIMITED (ETCI) Unit H12, Centrepoint Business Park Oak Road DUBLIN 12	Tel: +353 1 429 0088 Fax: +353 1 429 0090 Internet: www.etci.ie
28.1	Israel THE STANDARDS INSTITUTION OF ISRAEL 42, Chaim Levanon Street TEL-AVIV 69977	Tel: +972 3 64 65 154 Fax: +972 3 64 19 683 Internet: www.sii.org.il

29.1	Italy COMITATO ELETTROTECNICO ITALIANO Via Saccardo, 9 IT-20134 MILANO	Tel: +39 02 21 00 61 Fax: +39 02 21 00 6210 Internet: www.ceiweb.it
30.1	Japan JAPANESE INDUSTRIAL STANDARDS COMMITTEE c/o Tech.reg., Stds & Conf.Ass.Pol. Unit Ind.Sc. & Technol.Pol.& Env.Bureau, METI 3-1, Kasumigaseki 1-chome, Chiyodaku TOKYO 100-8901	Tel: +81 3 3501 9471 Fax: +81 3 3580 8637 Internet: www.jisc.go.jp/
31.1	Kazakhstan KAZAKHSTAN NATIONAL COMMITTEE OF THE IEC Committee for Technical Regulation and Metrology of the Ministry of Industry and Trade (KAZMEMST) 35str., building 11 "Etalon Center" KZ-010000 ASTANA CITY	Tel: +7 3172 24 02 48 Fax: +7 3172 24 19 04 Internet: www.memst.kz
32.1	Kenya IEC National Committee of Kenya Kenya Bureau of Standards (KEBS) Kapiti Road, Off Mombasa Road P.O. Box 54974 NAIROBI 00200	Tel: +254 20 605490 Fax: +254 20 609660 Internet: www.kebs.org

33.1	Korea, Dem.People's Rep.of IEC National Committee of DPR of Korea State Administration for Quality Management (SAQM) Inhung 1-Dong, Moranbong District PYONGYANG	Tel: +850218111ext3818989 Fax: +850 2 381 4480
34.1	Korea, Republic of KOREAN NATIONAL COMMITTEE OF IEC Korean Agency for Technology and Standards (KATS), MOCIE 2, Joongang-dong KWACHON KYUNGGI-DO, 427-010	Tel: +82 2 507 4369 Fax: +82 2 503 7977 Internet: www.ats.go.kr
35.1	Latvia LATVIAN NATIONAL COMMITTEE OF THE IEC Latvian Standard Ltd. (LVS) 157 K. Valdemara Street RIGA 1013	Tel: +371 7 371 308 Fax: +371 7 371 324 Internet: www.lvs.lv
36.1	Lithuania LITHUANIAN NATIONAL COMMITTEE OF THE IEC LITHUANIAN STANDARDS BOARD (LST) T. Kosciuskos g. 30 LT-2600 VILNIUS	Tel: +370 5 270 93 60 Fax: +370 5 212 62 52 Internet: www.lsd.lt

37.1	Luxembourg SERVICE DE L'ENERGIE DE L'ETAT (SEE) Organisme Luxembourgeois de Normalisati-on B.P. 10 LU-2010 LUXEMBOURG	Tel: +352 46 97 46 (1) Fax: +352 46 97 46 39 Internet: www.etat.lu/SEE/
38.1	Malaysia MALAYSIAN NATIONAL COMMITTEE OF THE IEC Standards Malaysia Level 1 & 2, Block C4, Parcel C Federal Government Administrative Centre MY-62502 PUTRAJAYA	Tel: +60 3 888 58 000 Fax: +60 3 8888 5060 Internet: www.dsm.gov.my
39.1	Malta IEC Maltese National Committee Malta Standards Authority (MSA) Second Floor, Evans Building Merchants Street VALETTA VLT 03	Tel: +356 21 24 24 20 Fax: +356 21 24 24 06 Internet: www.msa.org.mt

40.1	Mexico DIRECCION GENERAL DE NORMAS Normalización Internacional Comité Electrotécnico Mexicano (CEM/IEC) Av. Puente de Tecamachalco No. 6 Col. Lomas de Tecamachalco Secc. Fuentes MX-53950 NAUCALPAN DE JUAREZ, EDO. DE MEXICO	Tel: +52 55 57 29 94 80 Fax: +52 55 55 20 97 15 Internet: www.economia.gob.mx/?P=85
41.1	Netherlands NETHERLANDS ELECTROTECHNICAL COMMITTEE (NEC) Vlinderweg 6 P.O. Box 5059 NL-2600 GB DELFT	Tel: +31 15 2 690 390 Fax: +31 15 2 690 190 Internet: www.nen.nl
42.1	New Zealand NEW ZEALAND ELECTROTECHNICAL COMMITTEE Standards New Zealand Private Bag 2439 WELLINGTON 6020	Tel: +64 4 498 5990 Fax: +64 4 498 5994 Internet: www.standards.co.nz

43.1	Nigeria NIGERIAN NATIONAL ELECTROTECHNICAL COM. Standards Organisation of Nigeria (SON) Plot 13/14 Northern Business District Victoria Arobieke Street Lekki Peninsula Scheme 1 YABA, LAGOS PMB 2102	Tel: +234 1 27 08 247 Fax: +234 1 27 08 246 Internet: www.sononline-ng.org
44.1	Norway NORSK ELEKTROTEKNISK KOMITE (NEK) Postboks 280 Strandveien 18 NO-1326 LYSAKER	Tel: +47 67 83 31 00 Fax: +47 67 83 31 01 Internet://www.nek.no
45.1	Pakistan PAKISTAN NATIONAL COMMITTEE OF THE IEC Pakistan Standards and Quality Control Authority (PSQCA) Block 77, Pakistan Secretariat KARACHI 74400	Tel: +92 21 920 62 60 Fax: +92 21 920 62 63

46.1	Phillipines EC Nat. Committee of the Philippines Bureau of Product Standards (BPS) Trade and Industry Building 361 Sen. Gil J. Puyat Avenue MAKATI CITY 1200, METRO MANILA	Tel: +63 2 890 4965 Fax: +63 2 890 52 25 Internet: www.dti.gov.ph/bps/
47.1	Poland POLISH NATIONAL COMMITTEE OF THE IEC Polish Committee for Standardisation Ul. Swietokrzyska 14 PL-00-050 WARSZAWA	Tel: +48 22 55 67 591 Fax: +48 22 55 67 786 Internet: www.pkn.pl
48.1	Portugal PORTUGUESE NATIONAL COMMITTEE OF THE IEC IPQ - INSTITUTO PORTUGUES DA QUALIDADE Rua Antonio Giao, 2 PT-2829-513 CAPARICA	Tel: +351 21 294 81 00 Fax: +351 21 294 81 01 Internet: www.ipq.pt
49.1	Romania ROMANIAN NATIONAL COMMITTEE OF THE IEC Romanian Standards Association (ASRO) Str. Mendeleev nr. 21-25 RO-70168 BUCHAREST 1	Tel: +40 21 211 32 96 Fax: +40 21 210 08 33 Internet: www.asro.ro

50.1	Russian Federation Russian National Committee for the IEC The Federal Agency on Technical Regulating & Metrology Leninsky pr., 9 V-49, GSP-1 RU-119991 MOSCOW	Tel: +7 495 236 40 44 Fax: +7 495 236 62 31
51.1	Saudi Arabia SAUDI ARABIAN NATIONAL COMMITTEE OF THE IEC Saudi Arabian Standards Org. (SASO) PO Box 3437 RIYADH 11471	Tel: +966 1 452 00 00 Fax: +966 1 452 00 86 Internet: www.saso.org.sa
52.1	Serbia INSTITUTE FOR STANDARDISATION OF SERBIA (ISS) IEC National Committee of Serbia Stevana Brakusa 2 RS-11030 BELGRADE	Tel: +381 11 2547 096 Fax: +381 11 3541 258
53.1	Singapore SINGAPORE NATIONAL COMMITTEE OF THE IEC c/o STANDARDS, PRODUCTIVITY & INNOVATION BOARD (SPRING Singapore) Podium Block,Lev.5 - 2 Bukit Merah Cent.	Tel: +65 6278 6666 Fax: +65 6278 6990 Internet: www.spring.gov.sg/

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54.1	Slovakia SLOVAK ELECTROTECHNICAL COMMITTEE (SEV) Slovak Standards Institute (SUTN) Karloveska 63 P.O. Box 246 SK-840 00 BRATISLAVA 4	Tel: +421 2 6029 4468 Fax: +421 2 6541 1888 Internet: www.sutn.gov.sk
55.1	Slovenia SLOVENIAN IEC NATIONAL COMMITTEE SLOVENIAN INSTITUTE FOR STANDARDISATION (SIST) Smartinska cesta 140 SI-1000 LJUBLJANA	Tel: +386 1 478 30 13 Fax: +386 1 478 30 94 Internet: www.sist.si
56.1	South Africa SOUTH AFRICAN NATIONAL COMMITTEE OF THE IEC South African Bureau of Standards Private Bag X191 PRETORIA 0001	Tel: +27 12 428 79 11 Fax: +27 12 344 15 68 Internet: www.sabs.co.za/

57.1	Spain COMITE NACIONAL ESPANOL DE LA CEI AENOR Génova, 6 ES-28004 MADRID	Tel: +34 91 432 60 00 Fax: +34 91 310 45 96 Internet: www.aenor.es
58.1	Sri Lanka NATIONAL ELECTROTECHNICAL COMMITTEE OF SRI LANKA (NECSL) Sri Lanka Standards Institution (SLSI) N°17, Victoria Place Elvitigala Mawatha COLOMBO-08	Tel: +94 11 267 1567-72 Fax: +94 11 267 1579 Internet: www.nsf.ac.lk
59.1	Sweden SVENSKA ELEKTRISKA KOMMISSIONEN Box 1284 SE-164 29 KISTA	Tel: +46 8 444 14 03 Fax: +46 8 444 14 30 Internet: www.sekom.se
60.1	Switzerland SWISS ELECTROTECHNICAL COMMITTEE (CES) Electrosuisse Luppmenstrasse 1 CH-8320 FEHRALTORF	Tel: +41 44 956 11 72 Fax: +41 44 956 11 90 Internet: www.electrosuisse.ch

61.1	Thailand THAI NATIONAL COMMITTEE OF THE IEC Thai Industrial Stand. Institute (TISI) Ministry of Industry Rama VI Street BANGKOK 10400	Tel: +66 2 354 33 79 Fax: +66 2 247 8741 Internet: www.tisi.go.th
62.1	Tunisia COMITE NATIONAL TUNISIEN DE LA CEI Institut National de la Normalisation et de la Propriété Industrielle (INNORPI) Rue n°8451, n° 8 par la rue Alain Savary BP 57 TN-1003 CITÉ EL KHADHRA, TUNIS	Tel: +216 71 785 922 Fax: +216 71 781 563
63.1	Turkey TURKISH NATIONAL COMMITTEE OF THE IEC Türk Standardlari Enstitüsü Necatibey Caddesi, 112 BAKANLIKLAR / ANKARA	Tel: +90 312 416 62 64 Fax: +90 312 416 66 10 Internet: www.tse.org.tr
64.1	FYRep of Macedonia IEC National Committee of the Former Yugoslav Republic of Macedonia Standardisation Institute of the Republic of Macedonia Vasil Glavinov bb, blok 10 - mezanin MK-1000 SKOPJE	Tel: +389 2 329 89 44 Fax: +389 2 329 89 45

65.1	Ukraine UKRAINIAN NATIONAL COMMITTEE OF THE IEC State Committee of Ukraine on Technical Regulation and Consumer Policy (DSSU) 174, Gorliy St. UA-03680 KIEV-150	Tel: +380 44 226 2971 Fax: +380 44 226 2970 Internet: www.dssu.gov.ua/
66.1	United Kingdom BRITISH ELECTROTECHNICAL COMMITTEE British Standards Institution 389 Chiswick High Road LONDON W4 4AL	Tel: +44 208 996 7459 Fax: +44 208 996 7460 Internet: www.bsi-global.com
67.1	United States of America U.S. NATIONAL COMMITTEE OF THE IEC ANSI 25 West 43rd Street, 4th Floor NEW YORK, NY 10036	Tel: +1 212 642 4900 Fax: +1 212 398 0023 Internet: www.ansi.org
68.1	Viet Nam IEC Vietnamese National Committee Directorate for Standards and Quality (STAMEQ) 8, Hoang Quoc Viet Street Cau Giay District HANOI	Tel: +84 4 7911633 or 629 Fax: +84 4 7911605 or 595 Internet: www.tcvn.gov.vn

Table 38 Members of the IEC

6.5 Members of ISO

Country (Organisation)	Kind of Membership
Afghanistan (ANSA)	Correspondent members
Albania (DPS)	Correspondent members
Algeria (IANOR)	Member bodies
Angola (IANORQ)	Correspondent members
Antigua and Barbuda (ABBS)	Subscriber members
Argentina (IRAM)	Member bodies
Armenia (SARM)	Member bodies
Australia (SA)	Member bodies
Austria (ON)	Member bodies
Azerbaijan (AZSTAND)	Member bodies
Bahrain (BSMD)	Member bodies
Bangladesh (BSTI)	Member bodies
Barbados (BNSI)	Member bodies
Belarus (BELST)	Member bodies
Belgium (NBN)	Member bodies
Benin (CEBENOR)	Correspondent members
Bhutan (SQCA)	Correspondent members
Bolivia (IBNORCA)	Correspondent members
Bosnia and Herzegovina (BAS)	Member bodies
Botswana (BOBS)	Member bodies
Brazil (ABNT)	Member bodies

Brunei Darussalam (CPRU)	Correspondent members
Bulgaria (BDS)	Member bodies
Burkina Faso (FASONORM)	Correspondent members
Burundi (BBN)	Subscriber members
Cambodia (ISC)	Subscriber members
Cameroon (CDNQ)	Correspondent members
Canada (SCC)	Member bodies
Chile (INN)	Member bodies
China (SAC)	Member bodies
Colombia (ICONTEC)	Member bodies
Congo, Democratic Republic of (OCC)	Member bodies
Costa Rica (INTECO)	Member bodies
Croatia (HZN)	Member bodies
Cuba (NC)	Member bodies
Cyprus (CYS)	Member bodies
Czech Republic (CNI)	Member bodies
Côte-d'Ivoire (CODINORM)	Member bodies
Denmark (DS)	Member bodies
Dominica (DBOS)	Subscriber members
Dominican Republic (DIGENOR)	Correspondent members
Ecuador (INEN)	Member bodies
Egypt (EOS)	Member bodies
El Salvador (CONACYT)	Correspondent members

Eritrea (ESI)	Correspondent members
Estonia (EVS)	Correspondent members
Ethiopia (QSAE)	Member bodies
Fiji (FTSQCO)	Member bodies
Finland (SFS)	Member bodies
France (AFNOR)	Member bodies
Georgia (GEOSTM)	Correspondent members
Germany (DIN)	Member bodies
Ghana (GSB)	Member bodies
Greece (ELOT)	Member bodies
Guatemala (COGUANOR)	Correspondent members
Guinea (INNM)	Correspondent members
Guinea-Bissau (DSNPQ)	Correspondent members
Guyana (GNBS)	Subscriber members
Honduras (COHCIT)	Subscriber members
Hong Kong, China (ITCHKSAR)	Correspondent members
Hungary (MSZT)	Member bodies
Iceland (IST)	Member bodies
India (BIS)	Member bodies
Indonesia (BSN)	Member bodies
Iran, Islamic Republic of (ISIRI)	Member bodies
Iraq (COSQC)	Member bodies
Ireland (NSAI)	Member bodies

Israel (SII)	Member bodies
Italy (UNI)	Member bodies
Jamaica (JBS)	Member bodies
Japan (JISC)	Member bodies
Jordan (JISM)	Member bodies
Kazakhstan (KAZMEMST)	Member bodies
Kenya (KEBS)	Member bodies
Korea, Democratic People's Republic (CSK)	Member bodies
Korea, Republic of (KATS)	Member bodies
Kuwait (KOWSMD)	Member bodies
Kyrgyzstan (KYRGYZST)	Correspondent members
Lao People's Democratic Rep (DISM)	Subscriber members
Latvia (LVS)	Correspondent members
Lebanon (LIBNOR)	Member bodies
Lesotho (LSQAS)	Subscriber members
Libyan Arab Jamahiriya (LNCSM)	Member bodies
Lithuania (LST)	Correspondent members
Luxembourg (SEE)	Member bodies
Macau, China (CPTTM)	Correspondent members
Madagascar (BNM)	Correspondent members
Malawi (MBS)	Correspondent members
Malaysia (DSM)	Member bodies
Malta (MSA)	Member bodies

CE RFID

Mauritius (MSB)	Member bodies
Mexico (DGN)	Member bodies
Moldova, Republic of (MOLDST)	Correspondent members
Mongolia (MASM)	Member bodies
Morocco (SNIMA)	Member bodies
Mozambique (INNOQ)	Correspondent members
Myanmar (MSTRD)	Correspondent members
Namibia (NSIQO)	Correspondent members
Nepal (NBSM)	Correspondent members
Netherlands (NEN)	Member bodies
New Zealand (SNZ)	Member bodies
Nicaragua (DTNM)	Correspondent members
Nigeria (SON)	Member bodies
Norway (SN)	Member bodies
Oman (DGSM)	Member bodies
Pakistan (PSQCA)	Member bodies
Palestine (PSI)	Correspondent members
Panama (COPANIT)	Member bodies
Papua New Guinea (NISIT)	Correspondent members
Paraguay (INTN)	Correspondent members
Peru (INDECOPI)	Member bodies
Philippines (BPS)	Member bodies
Poland (PKN)	Member bodies

Portugal (IPQ)	Member bodies
Qatar (QS)	Member bodies
Russian Federation (GOST R)	Member bodies
Rwanda (RBS)	Correspondent members
Saint Lucia (SLBS)	Member bodies
Saint Vincent & the Grenadines (SVGBS)	Subscriber members
Saudi Arabia (SASO)	Member bodies
Senegal (ASN)	Correspondent members
Serbia (ISS)	Member bodies
Seychelles (SBS)	Correspondent members
Singapore (SPRING SG)	Member bodies
Slovakia (SUTN)	Member bodies
Slovenia (SIST)	Member bodies
South Africa (SABS)	Member bodies
Spain (AENOR)	Member bodies
Sri Lanka (SLSI)	Member bodies
Sudan (SSMO)	Member bodies
Swaziland (SQAS)	Correspondent members
Sweden (SIS)	Member bodies
Switzerland (SNV)	Member bodies
Syrian Arab Republic (SASMO)	Member bodies
Tajikistan (TJKSTN)	Correspondent members
Tanzania, United Republic of (TBS)	Member bodies

Thailand (TISI)	Member bodies
The former Yugoslav Republic of Macedonia (ISRM)	Member bodies
Togo (CSN)	Correspondent members
Trinidad and Tobago (TTBS)	Member bodies
Tunisia (INNORPI)	Member bodies
Turkey (TSE)	Member bodies
Turkmenistan (MSST)	Correspondent members
USA (ANSI)	Member bodies
Uganda (UNBS)	Correspondent members
Ukraine (DSSU)	Member bodies
United Arab Emirates (ESMA)	Member bodies
United Kingdom (BSI)	Member bodies
Uruguay (UNIT)	Member bodies
Uzbekistan (UZSTANDARD)	Member bodies
Venezuela (FONDONORMA)	Member bodies
Viet Nam (TCVN)	Member bodies
Yemen (YSMO)	Correspondent members
Zambia (ZABS)	Correspondent members
Zimbabwe (SAZ)	Member bodies

Table 39 Members of ISO