Real time requirements in industrial automation

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ETSI Wireless Factory Starter Group
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Presence and Support worldwide

- 25 Regional PI Associations (RPA) worldwide
- 34 Competence Center (PICC) in 14 countries
- 8 Test Labs (PITL) worldwide for Certification and Compliance Tests

**Map showing presence and support worldwide:***

- **W. EU**
  - Belgium: RPA PICC
  - Denmark: RPA
  - Finland: RPA
  - France: RPA PICC
  - Great Britain: RPA PICC
  - Germany: RPA PICC
  - Austria: RPA PICC, PITL
  - Ireland: RPA PICC
  - Italy: RPA PICC
  - Netherlands: RPA PICC, PITL
  - Norway: RPA, PICC

- **E-EU**
  - Czech Rep.: RPA PICC, PITL
  - Poland: RPA, PICC
  - Russia: RPA
  - Slovakia: RPA

- **Asia**
  - China: RPA PICC, PITL
  - Japan: RPA PICC, PITL
  - Korea: RPA
  - S.-E.-Asia: RPA PICC, PITL
  - Thailand: RPA
  - Australia/New Zealand: RPA

- **America**
  - Brazil: RPA
  - USA: RPA PICC, PITL
  - S. Africa: RPA PICC
  - Australia: RPA PICC

*RPA = Regional PI Association  PICC = PI Competence Center  PITL = PI Test Laboratory*
The Profibus User Organisation (PNO) Germany carries the responsibility for the Development of PROFIBUS and PROFINET technologies as well as for the Certification of Products.
PI (PROFIBUS und PROFINET International)

- Regional PI Associations (RPA)
- PI Competence Center (PICC)
- PI Test Laboratories (PITL)

Technologies

- Fieldbus based Automation Technology
- Ethernet based Automation Technology
- Proxy Technology
4 Wireless Technologies for Industrial Automation

Factory and Process Automation
PNO Wireless Standards for Automation

Existing and in use:

- Industrial WLAN
- Industrial Bluetooth
- WirelessHART

Draft of specification until end of 2009:

- Wireless Sensor Actuator Network "WSAN"
WSAN Scope

- Typical Wireless Devices could be...
  - Proximity sensors (inductive, optical etc.)
  - Light barriers
  - Pilot devices
  - Pneumatic/hydraulic actuators
  - IO modules
  - ...

- They are...
  - part of an automation system
  - used for (real-time) control of the process
  - mounted „somewhere“ in the machine (FA) or field (PA)

- They should be...
  - easy to engineer with tools that are known to the customer
  - easy to set up & replace in case of service/maintenance
WSAN Scope

- Use of existing Engineering Tools
- Seamless integration into Profibus/Profinet infrastructure
WSAN Principles

Application Service Elements for a Wireless Sensor/Actuator (SA) according to [2]

- **IO Data:** SA have a relatively small amount of input/output data ("cyclic data"), e.g. 32 bit per SA
- **Process/Record Data:** SA have a limited amount of record data (e.g. parameters, service information), e.g. 255 records with 32 bit per record
- **Diagnosis:** SA can support diagnosis, e.g. 32 bit per SA, possibility to indicate diagnosis request from SA to basestation
- **Alarm, Management:** not needed for SA
- **Context:** Service needed for SA identification and system configuration.
- **Load region:** could be optional for firmware updates etc.
- **Function Invocation:** not needed
- **Time:** could be optional

**PROFIBUS/PROFINET Integration**

- Mapping can follow any of the suggested integration concepts described in [1].
- Addressing elements that need to be transmitted over the air (e.g. SA node number, record data addresses) should be limited to the absolute required minimum in order to optimize performance.
- Addressing elements should be sized in a reasonable way, but shall “fit” to PROFIBUS and PROFINET.

**System Configuration and Device Integration**

- System Configuration/Device Integration has to be solved by the means already defined by the PNO e.g. GSDML, GSD, FDT/DTM, EDDL
- Additional software for configuration/device integration is not acceptable.
- Additional software to monitor the wireless network can be an option, but shall not be mandatory.

2 Application Categories

The four wireless technologies of the PNO are clustered according to their transmission properties:

1. category: WLAN and Bluetooth allow the transmission of PROFINET-frames and thus the direct connection of wireless PROFINET IO-devices to the plant network. Even Safety-Communication using the PROFIsafe-Profile is possible.

2. category: WirelessHART and WSAN are not suitable for the transmission of PROFINET-frames because of the small packet size and low data rates. They will be connected to Profinet networks via gateways and thus allow the connection of widely distributed sensors or actuators in the process world and fast real time communication in manufacturing plants.
Factory Automation Requirements

WSAN

Factory automation in many cases requires a response time of less than 10ms for a machine with more than 100 sensors and/or actuators.

The PNO decided to base their FA-solution on ABB's WISA-Technology because the timing and robustness of the system is industry proven.

Three major enhancements are needed to cover the known use cases:

- Channel Blacklisting as one important method for coexistence
- Range extension up to 30m
- Compatibility to the IO-Link data models for sensors and actuators
WSAN Use Cases Coverage

Max. 

Total node number/ local application

With a Given PHY: - Determined!

Range m

Error rate (Zuverlässigkeit)

Avg. Node Density /m³

Delay (max.)

Energie

- Optimize/ Accept

WSAN Use Cases:

- Turntable Assembly (Rundteller)
- Robot Assembly (Rohbauzelle, BiW)
- Metal Stamping („Presse“)
- Tooling machines
- Peripheral devices (Geräteschlitten, Portale, Zufuhr)
- Transport Systems (FTS)

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WSAN Use Cases:

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WIFA 20.+21.10.2009
## Resulting Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless devices per application per 1 WSAN System</td>
<td>300</td>
</tr>
<tr>
<td>Overlapping WSAN Systems</td>
<td>5</td>
</tr>
<tr>
<td>Range</td>
<td>10 (30) m</td>
</tr>
<tr>
<td>Paket loss rate</td>
<td>&lt; 10E-9</td>
</tr>
<tr>
<td>Delay max. [ms]</td>
<td>10 ms *</td>
</tr>
</tbody>
</table>

* Scalable: 1-4 Uplinks -> 25 – 100 devices @2ms TDMA cycle time
High speed mode possible with shorter TDMA cycle
(-> 50 nodes @1ms TDMA cycle time ?)
IO-Link - WSAN Mapping

Master/Gateway

Only Parts of data Link and Phy have to be adapted

Data channel mapping

Application

... 

DLL

PHY

WSAN

IO-Link

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WSAN

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WSAN Repeated Code Performance vs Different CRC's

Comparison of different coding strategies:

CRC\textsubscript{23} and CRC\textsubscript{55} can be used if the repeated information space is used for extending the CRC for the short and long telegram

- Repeated Code, HD=8, \(1\times10^{-9}\)
- CRC\textsubscript{16}, HD=6, \(1.5\times10^{-5}\)
- CRC\textsubscript{23}, HD=8, \(1.2\times10^{-7}\)
- CRC\textsubscript{55}, HD\geq8, \(2.8\times10^{-17}\)

The Repeated code outperforms the CRC\textsubscript{16} and CRC\textsubscript{23} in all respects and even the CRC\textsubscript{55} when it comes to protection against white noise.
Coexistence is a must

PNO and ZVEI agreed on a coexistence guideline, that is widely accepted in the industry and was highly appreciated by end users and device manufacturers.

The brochure is available for download at:

Source: ZVEI
ETSI: Wireless Factory Automation (WIFA)

- Identification of potential standardization activities with regard to topics such as requirements, spectrum usage, co-existence, the DECT model, Ultra Wide Band, radio technology for real-time applications, architecture, network integration
- Interoperability and conformance testing
- Regulatory topics such as allocation of exclusive spectrum to wireless factory usage and the use of exclusive spectrum technologies such as Tetra and Femtocells.

- ETSI should help to promote and support available standards!
  Avoid redundant work in a new standardization group!
Have a successful day!