World Class Standards

The ETSI Experience in supporting Standardization with methodologies

Dieter Hogrefe
ETSI TC MTS Chairman
6th December 2007

Terms of Reference for ETSI TC MTS (Methods for Testing and Specification)

- Methodology support to PTCC and ETSI Technical Bodies for:
  - Protocol specification, e.g. SDL, MSC, ASN.1, UML
  - Testing, e.g. TTCN, ASN.1
  - Technical quality, e.g. Validation, Consistency, Test suite structure & format
- Identification and definition of advanced specification and testing methodology
  - Formal approaches
  - Innovative techniques
  - Developments of guidelines, where necessary
- Language development and standardization
  - TTCN-3
  - TPLan

Terms of Reference for ETSI TC MTS

- Protocol standardization in the testing domain
  - TSP1 and TSP1+
- Development of generic test suites, in particular in the IP domain
  - IPv6
- Technical liaison with other standardization groups in the area
  - ITU-T SG 17
- Field trials of our methodologies

Major activities/deliverables

- Maintenance of TTCN-3
  - Resolution and integration of Change Requests
  - Delivery of updated version of TTCN-3 language standards
- Making Better Standards
  - Original “Making Better Standards” book published 1996 and based on methodologies which have been replaced
  - It has been brought up to date several times and is now published as a web site (and CD-ROM)
- IP Testing group (IPT)
  - Started late 2002 – interest is growing
  - Development of new or improved testing methodologies
  - Development of generic IP-related test specifications
  - IPv6 generic test suite for core, mobility, security, transition

Successes/failures

- Success of TTCN-3
  - Commercial TTCN-3 tools available (6 suppliers at last count)
  - Used in ETSI Tiphon SIP and OSP, IEEE firewire, IPv6 Plugtest events, Smart Cards, automotive industry
  - Certification scheme for TTCN-3 test engineers
- Success of IPT
  - Strong interest in testing IPv6
    - Ambitious project started in 2005 under eEurope
    - Good voluntary support
    - Development of openly available IPv6 test suite
    - counterweight to US and Asian influence on IPv6
  - Test specifications for SIGTRAN
    - Entirely voluntary activity together with TISPAN
- Failures: none (what do you expect?)

Globalization aspects

- WIs with mostly global interest
  - IPv6
  - TTCN-3
    - Strong US participation in mailing lists
    - Asia
    - Australia
- Close collaboration with ITU-T on
  - TTCN-3
  - UML
  - SDL
  - MSC
  - ASN.1

In summary, current main focus:

- Structured approach in test suite development
- Test Purpose Language TPLan
- New functionality for TTCN-3
- Generic IPv6 Test Specifications (including a library of reusable TTCN-3 modules) to support eEurope and IPv6 Forum
  - Re-usable and generic TTCN-3 test cases
  - No re-invention of the wheel
  - Tailored to specific applications like IPv6

Example for methodological support

ETSI IPv6 Activities

In the following…

- Overview of ETSI's IPv6 Testing Project
- ETSI's IPv6 Test Suite Development Methodology:
  - Requirements Extraction from RFCs
  - Specifying IPv6 Interoperability tests
  - Specifying IPv6 Conformance tests
  - IPv6 test specification library
- Current project status

Background

- 2004: EC awards eEurope funding for IPv6 testing
- 2005: IPv6 Core test development
- 2006: IPv6 Security (IPsec) test development
  MIPv6 test development
  IPv4 to IPv6 Transitioning test development

This is the first major testing project undertaken by ETSI where it has had no influence over the base protocol specifications

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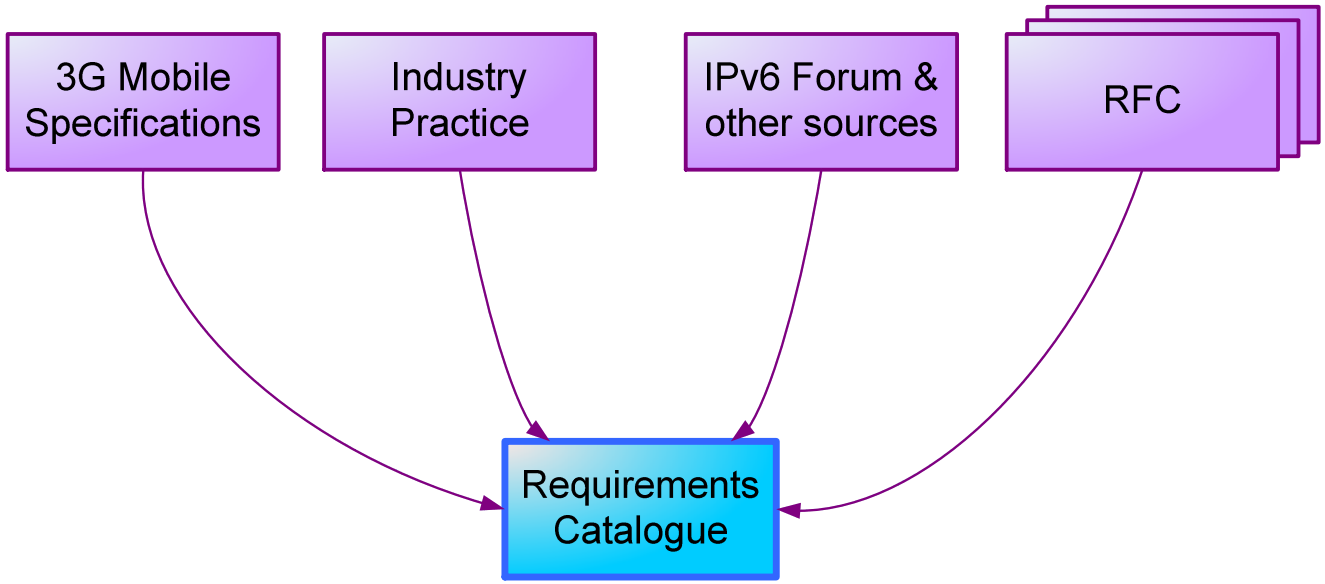
IPv6 Testing Framework

- Requirements Extraction
- Interoperability Test Development (using TS 102 237-1)
- Conformance Test Development (using ISO 9646)
- Library

IPv6 Testing Framework
Requirements Process



- Implemented as a scalable database containing all requirement elements
- Web interface offering:
  - Browsing by function
  - User-defined search
  - Links to RFC and related test specification

IPv6 Testing Framework
The Requirements Catalogue

- Each Requirement is categorized as follows:
  - Requirement type:
    - Mandatory (MUST, MUST NOT)
    - Recommended (SHOULD, SHOULD NOT)
    - Optional (MAY, MAY NOT)
  - Requirement target:
    - Host
    - Router
    - Etc.
  - Requirement text
  - Functional grouping :
    - Process Fragmented packet
    - Generate ICMPv6 Error Type
    - Etc.

IPv6 Testing Framework

Example Requirements

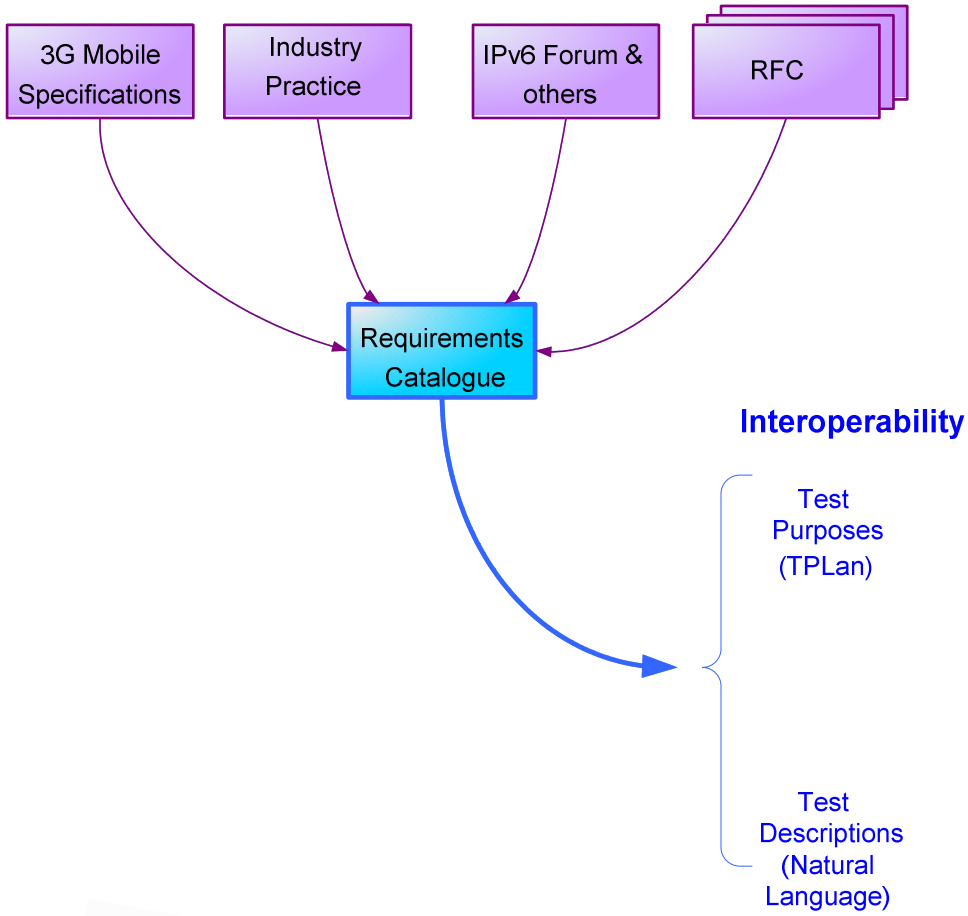
"A host implementation of IPsec MUST support tunnel mode "

"When an IPsec Host sends the first IP packet containing an Authentication Header (AH) on a particular unicast or single-sender multicast Security Association (SA), it MUST set the value in the Sequence Number field to one (1) "

"Packets may be routed to the mobile node using its home address regardless of the mobile node's current point of attachment to the Internet."

IPv6 Testing Framework

Interoperability Process



IPv6 Testing Framework
Interoperability Test Purposes

- Define the function being tested—the WHAT
- Do not define HOW to test the function
- Grouped into a logical structure (Test Suite Structure)
- One TP may test several Requirements
- One Requirement may spawn several TPs
- An interoperability TP is on the *functional* level
- Specified in ETSI's Test Purpose Language (TPLan)

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IPv6 Testing Framework
Test Purpose Notation (TPLan)

- Pseudo-code approach
  - Limited (but extensible) keyword set + free text linked together in a syntactical framework
- Base keywords and syntax provide clear and consistent structure
- User-defined keywords provide project-specific extensions
- Text provides test-specific information
- A TP's basic structure:
  - Header
  - Pre-conditions
  - Stimulus
  - Expected response
- Standardized in ES 202 553 (available 2007)

IPv6 Testing Framework

TPLan Example for Interoperability

```
TP id    : TP_COR_1719_02
Summary  : 'EUT sends packet to All-Routers Link-Local
           Multicast address'
RQ ref   : RQ_001_0327
Config   : CF_COR_21
TD ref   : TD_COR_1719_02

with {     QE1 configured as a router
       and QE2 configured as a router
     }
ensure that
     { when { EUT is requested to send
              packet to
              All_Routers_Link-Local_Multicast_address
            }
       then {    QE1 indicates receipt of the packet
             and QE2 indicates receipt of the packet
            }
     }
```

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IPv6 Testing Framework
Interoperability Test Descriptions

- Specify detailed steps to be followed to achieve stated test purpose
- Steps are specified clearly and unambiguously without unreasonable restrictions on actual method:
  - Example:
    - Answer incoming call

      NOT
    - Pick up telephone handset
- Written in a structured and tabulated natural language so tests can be performed manually
- Can be automated using TTCN-3 when EUT has software interfaces

IPv6 Testing Framework

Example Test Description

Test Description					
Identifier:	TD_COR_1100_01				
Summary	EUT reassembles a fragmented packet of an original length less than 1500 octets				
Test Purpose:	TP_COR_1100_01	**Reference:**	RQ_001_2935	**Configuration:**	CF_COR_11

```
with { the MTU on Link1 set to 1400 octets }

ensure that
     { when { QE is requested to send data requiring a packet_length
                                          greater than 1500 octets }
       then { EUT indicates receipt of the same data without modification }
     }
```

Pre-Test Conditions:	• MTU set to 1400 octets on link1		
Step	**Step**	**Verdict**	
		Pass	**Fail**
1	Cause QE to send an Echo Request to EUT with a packet size of 1450 octets and with each octet set to the hexadecimal value "F0"		
2	*Check: Does protocol monitor show that the Echo Request was sent from QE to EUT?*	Yes	No
3	*Check: Does QE receive an Echo Reply from EUT with the packet length the same as the Echo Request and with each octet containing the hexadecimal value "F0"?*	Yes	No
Observations			

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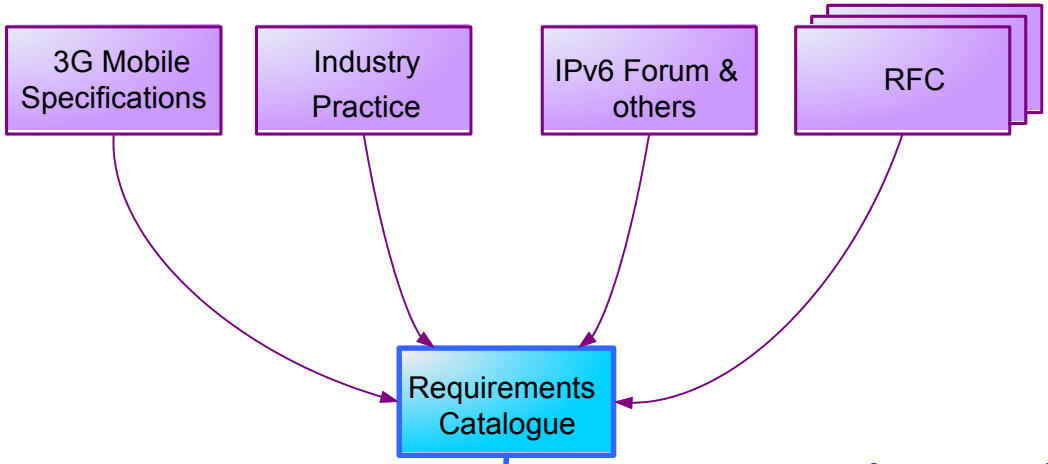
IPv6 Testing Framework

Conformance Process



Conformance

Test Specific Definitions (TTCN-3)

Test Purposes (TPLan)

IPv6 Specific Definitions (TTCN-3)

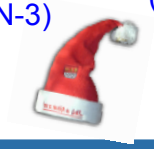
Common Definitions (TTCN-3)

Test Cases (TTCN-3)

Interoperability

Test Purposes

Test Descriptions



IPv6 Testing Framework
Conformance Test Purposes

- Define the function being tested—the WHAT
- Do not define HOW to test the function
- Grouped into a logical structure (Test Suite Structure)
- One Requirement may spawn several TPs
- One TP may test several Requirements
- A conformance TP is on the *protocol* level
- Specified in ETSI's Test Purpose Language (TPLan)

IPv6 Testing Framework
TPLan Example for Conformance

```
TP id    : TP_COR_2139_01
Summary  : 'hop limit of one'
RQ Ref   : RQ_001_0047
Config   : CF_COR_02
TC Ref   : TC_COR_2139_01
ensure that {
--Stimulus
    when { IUT receives Ipv6_packet from Host
                        containing IPv6_Header
                        indicating Hop_limit set to 1 }
--Expected response
    then { IUT sends ICMPv6_Time_Exceeded to Host
                     containing ICMP_code set to 0 }
             }
```

IPv6 Testing Framework
Conformance Test Cases

- Detailed TTCN-3 test script that implements test purpose
  - can be compiled and executed
- Composition
  - a preamble
  - test body (i.e., implementation of the Test Purpose)
  - A postamble
- Assigns test verdicts
- Handles unexpected behaviour as well as the behaviour in the test purpose
- Can be distributed over parallel test components
- Can be entirely automated
- Configurable at run-time, e.g., SUT address

IPv6 Testing Framework

Example TTCN-3 Test Case

```
testcase TC_COR_0047_01() runs on Ipv6Node system EtherNetAdapter {
  f_cf02Up();              // Configure test system for HS->RT
                           // No preamble required in this case
  f_TP_HopsSetToOne();     // Perform test
                           // No postamble required in this case
  f_cf02Down();            // Return test system to initial state
}
function f_TP_HopsSetToOne() runs on Ipv6Node {
   var Ipv6Packet v_ipPkt;
   var FncRetCode v_ret := f_echoTimeExceeded( 1, v_ipPkt );
   if ( v_ret == e_success and v_ipPkt.icmpCode == 0 )
   { setverdict(pass);}
   else { setverdict(fail); }
}
function f_echoTimeExceeded(in UInt8 p_hops, out Ipv6Packet p_ípPkt )
runs on Ipv6Node return FncRetCode {
   var Ipv6Packet v_ipPacket; var FncRetCode v_ret;
   ipPort.send( m_echoReqWithHops(p_hops) );
   alt {
     [] ipPort.receive( mw_anyTimeExceeded ) -> value p_ipPkt
        { return e_success }
     [] ipPort.receive { return e_error } }
}
```

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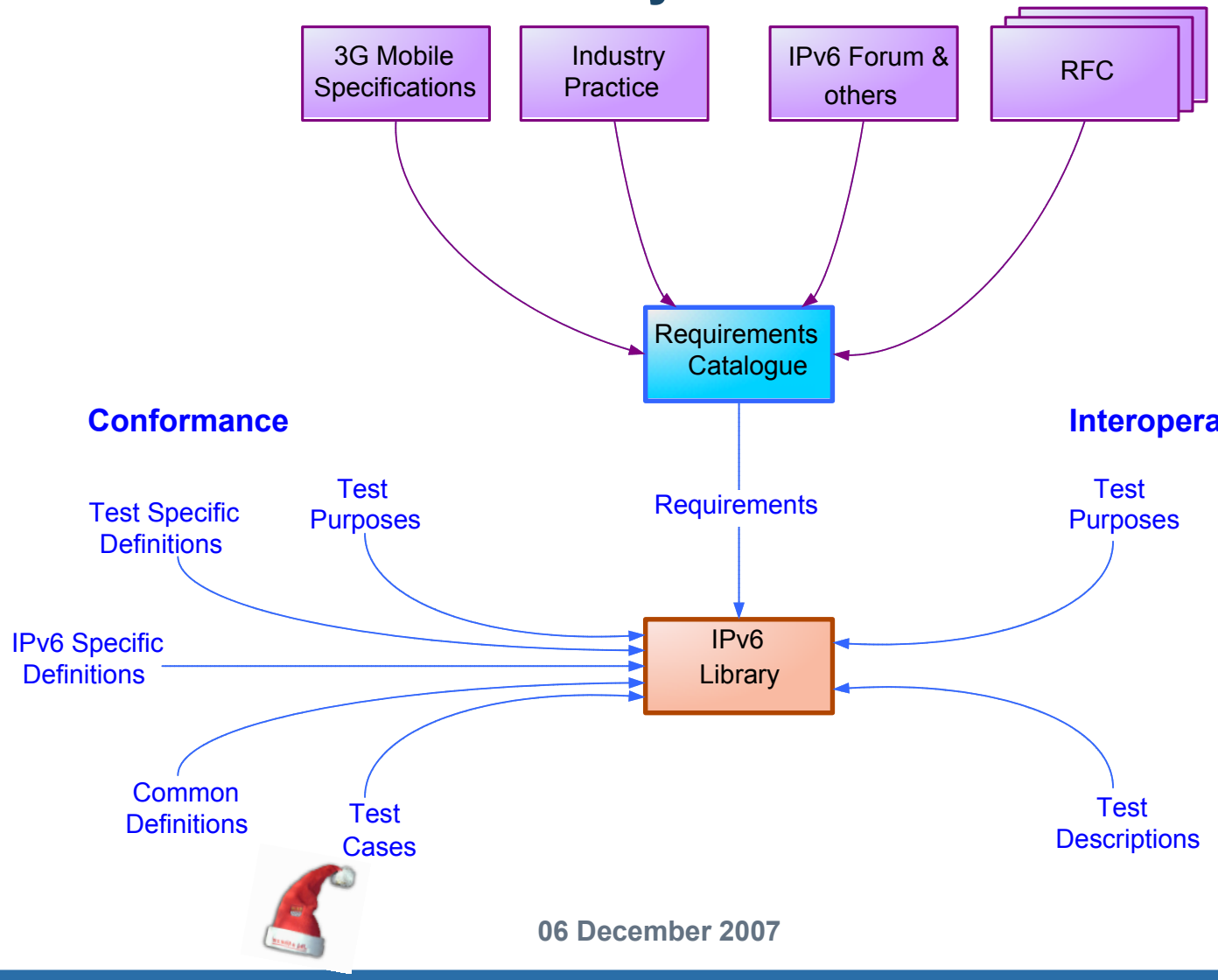
IPv6 Testing Framework

Library Process



IPv6 Testing Framework
The TTCN-3 Library

- Each test uses this library
  - Decreases test code size and improves its quality
  - Reduces time to develop new tests
- Contains useful definitions for different purposes
  - Test component synchronization
  - Basic IPv6 packet exchanges
  - Preamble, test purpose, and postamble code
  - Test configurations
  - Code for driving upper IPv6 interface
- Extensively documented
- Easily add tests to test suites
- Will be freely available on the web

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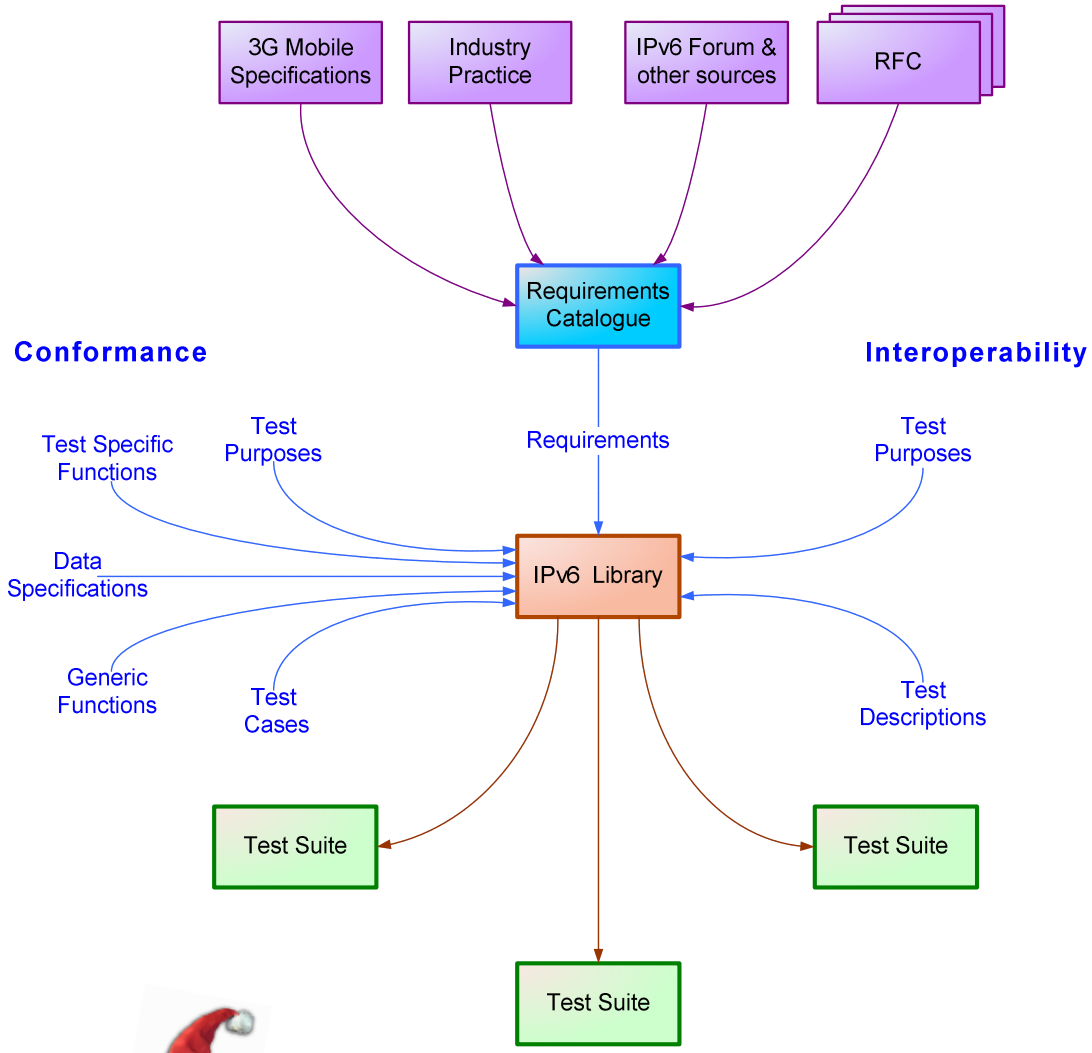
IPv6 Testing Framework

IPv6 Test Library



Project Status
Phase 1

- IPv6 Core RFCs
  - RFC2460 IPv6 Basic Specification
  - RFC2373 IPv6 Addressing Architecture
  - RFC2461 Neighbor Discovery & Redirect
  - RFC2462 Stateless Address Autoconfiguration
  - RFC2463 ICMPv6
  - RFC1981 Path MTU Discovery
  - RFC2675 IPv6 Jumbograms
- Results
  - 798 requirements
  - 356 validated conformance tests
  - 99 validated interoperability tests

Project Status
Phase 2 - Security

- Ipv6 Security (IPsec) RFCs
  - RFC4301 Security Architecture for the Internet Protocol
  - RFC4306 Internet Key Exchange (IKEv2) Protocol
  - RFC4302 IP Authentication Header
  - RFC4303 IP Encapsulating Security Payload (ESP)
  - RFC2405 The ESP DES-CBC Cipher Algorithm With Explicit IV
  - RFC2410 The NULL Encryption Algorithm and Its Use With IPsec
  - RFC4305 Cryptographic Algorithm Implementation Requirements for ESP and AH
- Results
  - 695 requirements
  - 89 validated conformance tests
  - 48 validated interoperability tests

Project Status
Phase 2 - Mobility

- IPv6 mobility (MIPv6) RFCs
  - RFC3775 Mobility Support in IPv6
  - RFC3776 Using IPsec to Protect Mobile IPv6 Signaling Between Mobile Nodes and Home Agents
  - RFC2473 Generic Packet Tunneling in IPv6
  - RFC4068 Fast Handovers for Mobile IPv6
- Results
  - 1165 requirements
  - 141 validated conformance tests
  - 119 validated interoperability tests

Project Status

Phase 2 – IPv4 to IPv6 Transitioning

- IPv4 to IPv6 Transitioning RFCs
  - RFC2529 Transmission of IPv6 over IPv4 Domains without Explicit Tunnels
  - RFC2765 Stateless IP/ICMP Translation Algorithm (SIIT)
  - RFC2766 Network Address Translation – Protocol Translation (NAT-PT)
  - RFC3056 Connection of IPv6 Domains via IPv4 Clouds
  - RFC4213 Basic Transition Mechanisms for IPv6 Hosts and Routers
  - RFC4214 Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)
- Results
  - 427 requirements
  - 106 validated conformance tests
  - 60 validated interoperability tests

Project Status
What Next?

- "Normalization" of Phase 1 and Phase 2 data
  - Use of similar terminology
  - Use of similar requirements structure
- Public availability on the web of:
  - Requirements Catalogue
  - Conformance and Interoperability Test Purposes
  - Conformance Test Suites (TTCN-3)
  - Interoperability Test Descriptions
- Test specifications used as the basis for 3G/NGN IMS test development

Thank you for your attention!

Questions?