ACHIEVING INTEROPERABLE STANDARDS
-THE ETSI APPROACH

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World Class Standards

Presentation Outline

- About ETSI
- What Interoperability Means to ETSI
- Is Interoperability Important?
- The ETSI Approach
  - Validation
  - Testing
- Use of TTCN-3 at ETSI
- Conclusions

ETSI – Shaping the Future

- European standards organisation setting globally-applicable standards in ICT (Information Communication Technology)
  - Including fixed, mobile, radio, converged, broadcast and Internet technologies
- Independent, not-for-profit, created in 1988
  - Based in the South of France
- More than 760 Member companies and organisations from 63 countries and 5 continents
- Founder member of 3GPP
- Over 23,000 publications – available for free!
  - http://www.etsi.org/WebSite/homepage.aspx

ETSI – World Class Standards

- GSM™ – Developed by ETSI
  - Over 3.5 billion users in over 200 countries and growing
  - 1.3 million new users EVERY DAY!

- ETSI's Lawful Interception standard
  - Being deployed in Europe, USA and Australia, where laws are being introduced to comply with the ETSI Standard

- DECT™ – Digital Enhanced Cordless Telecommunications
  - Adopted in over 110 countries, with over 670 million devices sold and more than 100 million devices being added every year.

ETSI – World Class Standards

- TETRA (Terrestrial Trunked Radio)
  - 2000 contracts in more than 100 countries
  - Emergency services (Fire, Police, Ambulance …)

- DVB/DAB (Digital Video/Audio Broadcasting)
  - Services available on every continent
  - DVBH (mobile DVB)

- TISPAN (Home for NGN)
  - Next Generation Networks standardisation

- 3GPP LTE
  - The Mobile Broadband Technology

New Growth Areas

- M2M Communications (Machine2Machine)
- Reconfigurable Radio Systems
- Multimedia Content Distribution
- Grid Computing & Clouds
- RFID (Radio Frequency Identification)
- Intelligent Transport Systems
- Emergency alerting, e-call
- GSM on aircraft
- Quantum Key Distribution
- Self-managing Internet
- Energy Efficiency
- …

Creator of the TTCN-3 Standard

http://www.ttcn-3.org

- **TC MTS (Methods for Testing and Specification)**
  - Developed TTCN-3
  - ETSI Standard (ES)
- **Key TTCN-3 Standards**
  - ES 201 873-1: TTCN-3 Core Language
  - ES 201 873-5: TTCN-3 Runtime Interface (TRI)
  - ES 201 873-6: TTCN-3 Control Interfaces (TCI)
  - ES 201 873-7 and upwards: ASN.1, XML, IDL, Code Documentation
  - also all endorsed by ITU-T SG17 (Z.140 Series)
- **New Extension Packages (drafts)**
  - Configuration and Deployment Support
  - Performance Testing
  - Real-time testing
  - And others ...

ETSI and Interoperability (IOP)

- Standardisation enables interoperability
  - One main aim of standardisation is to enable interoperability in a multi-vendor, multi-network, multi-service environment

- IOP is the red thread running through the entire ETSI standards development process
  - Interoperability is specified from the beginning
  - Not something 'bolted on' at the end

- ETSI philosophy
  - Interoperability should be built-in!

Is Interoperability Important?

- We live in an interconnected world and interoperability is key to drive it forward
  - Digital Home, Smart House
  - M2M (embedded communication)
  - Internet of Things, Intelligent Transport Systems etc.
- Users benefit from increased choice from multiple manufacturers
  - Business, Governmental, Private Consumer
  - And they expect 'stuff to work' (Plug&Play)
- Manufacturers benefit from an increased market
  - Economies of scale

Different 'Levels' of Interoperability

No single definition of Interoperability

– The ability of two or more systems or components to exchange and use information

– ...

Syntactical Interoperability

Technical Interoperability

Semantic Interoperability

Organisational Interoperability
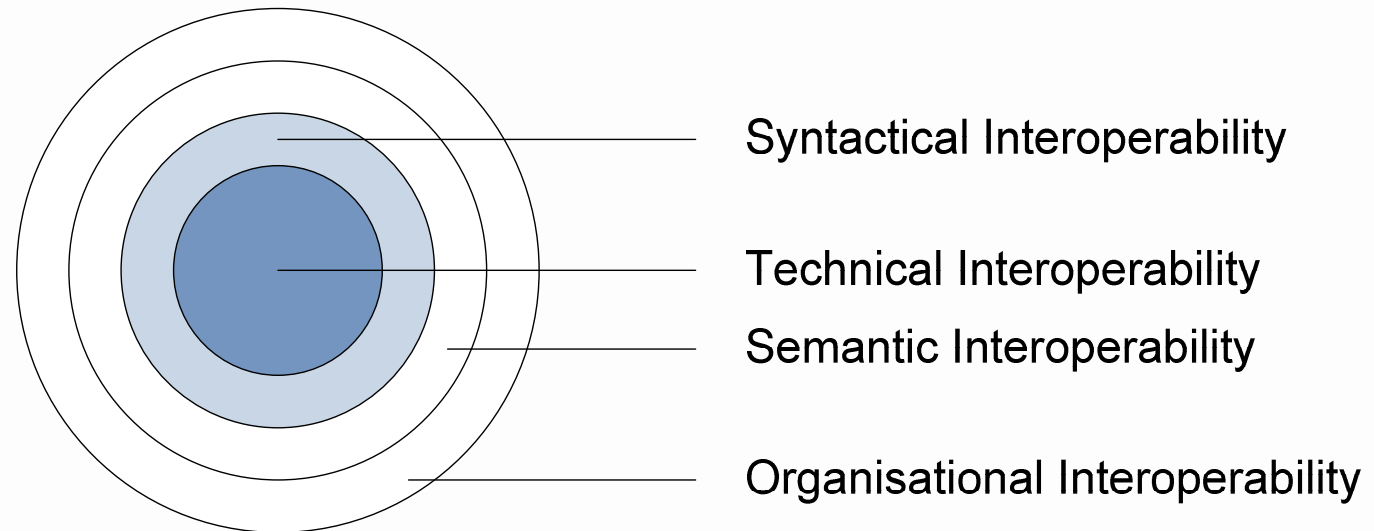
IOP and Complex Standards

- Complex ICT standards are increasingly specified by 'islands of standards'
  - From different standardisation bodies
  - Or developed for a different (original) use
  - Complete system not specified in detail
- Results in potentially non-interoperable standards and/or products

# Typical Causes of Non-interoperable Standards

- Requirements not well identified or missing

- Ambiguous requirements

- Varying technical quality and use of language

- Inadequate handling of options

- Lack of clear system overview

- Loose definition of interfaces (reference points)

- Poor maintenance

- Using standards beyond their original purpose

- …

Poor Interoperability Can be Expensive

- Bad publicity
  - For the technology
  - For the manufacturer
- Annoyance to the end customer
  - Damage to brand name
- Loss of customer base
  - Allegiances change rapidly
- May affect uptake of new technology
- Loss of investor confidence

- We can no longer afford to get it wrong!

The ETSI Approach
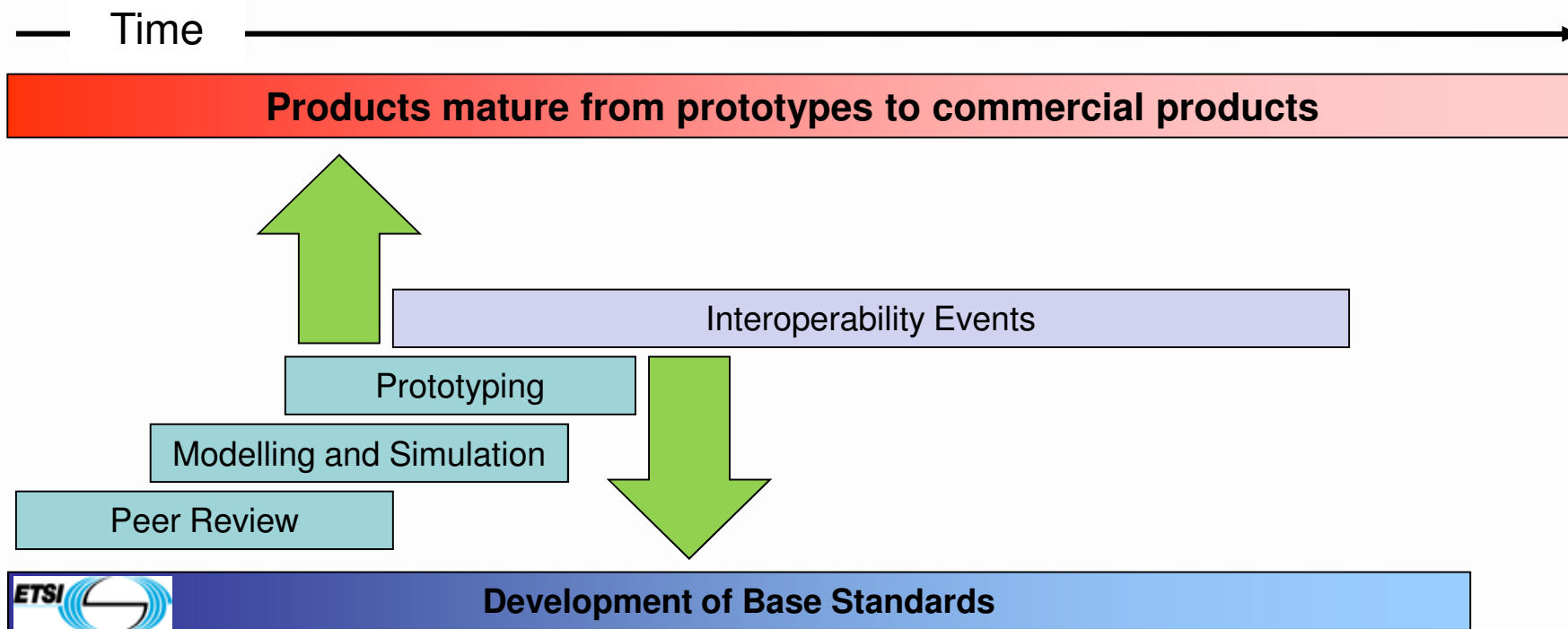

SPECIFICATION

VALIDATION

TESTING
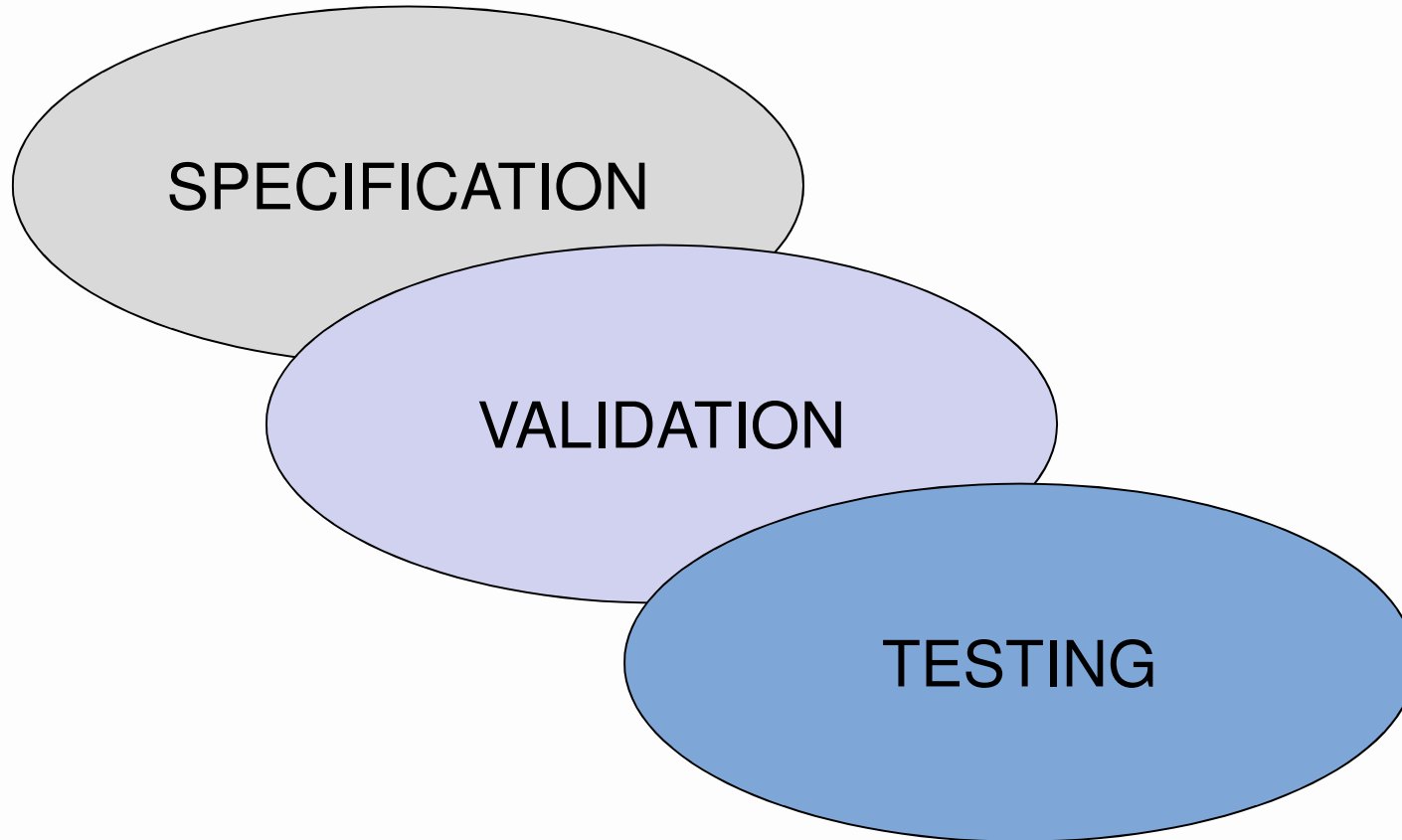
Why Validate Standards?

- Validation reveals problems/errors in
  - Standards and Products
- Validated standards give a higher chance of interoperable products
  - Assurance that they provide the right functionality
  - Gives manufacturers and operators confidence to implement and go to market
- Provides an opportunity to correct errors in a controlled manner
  - Decreases time to market
  - Late fixes in the product cycle are more expensive than early ones

Validation of Standards …

Time →

Products mature from prototypes to commercial products

Interoperability Events

Prototyping

Modelling and Simulation

Peer Review

Development of Base Standards

Validation through IOP Events

- ETSI Plugtests events
  - Open to members and non- members
- Aim is to validate *standards*
  - Feedback (*Change Requests*) to relevant technical bodies
  - A tool to develop and mature standards
- But testing and debugging are useful by-products
  - Vendors validate their understanding of standards and their implementation
  - Achieve in one week what would otherwise take months
- Promote technology and community
  - Develop new ideas, confirm existing ones

Series of IOP Events

Maturity of the Standard (y-axis). Events (x-axis): Event 1, Event 2, ..., Event nn
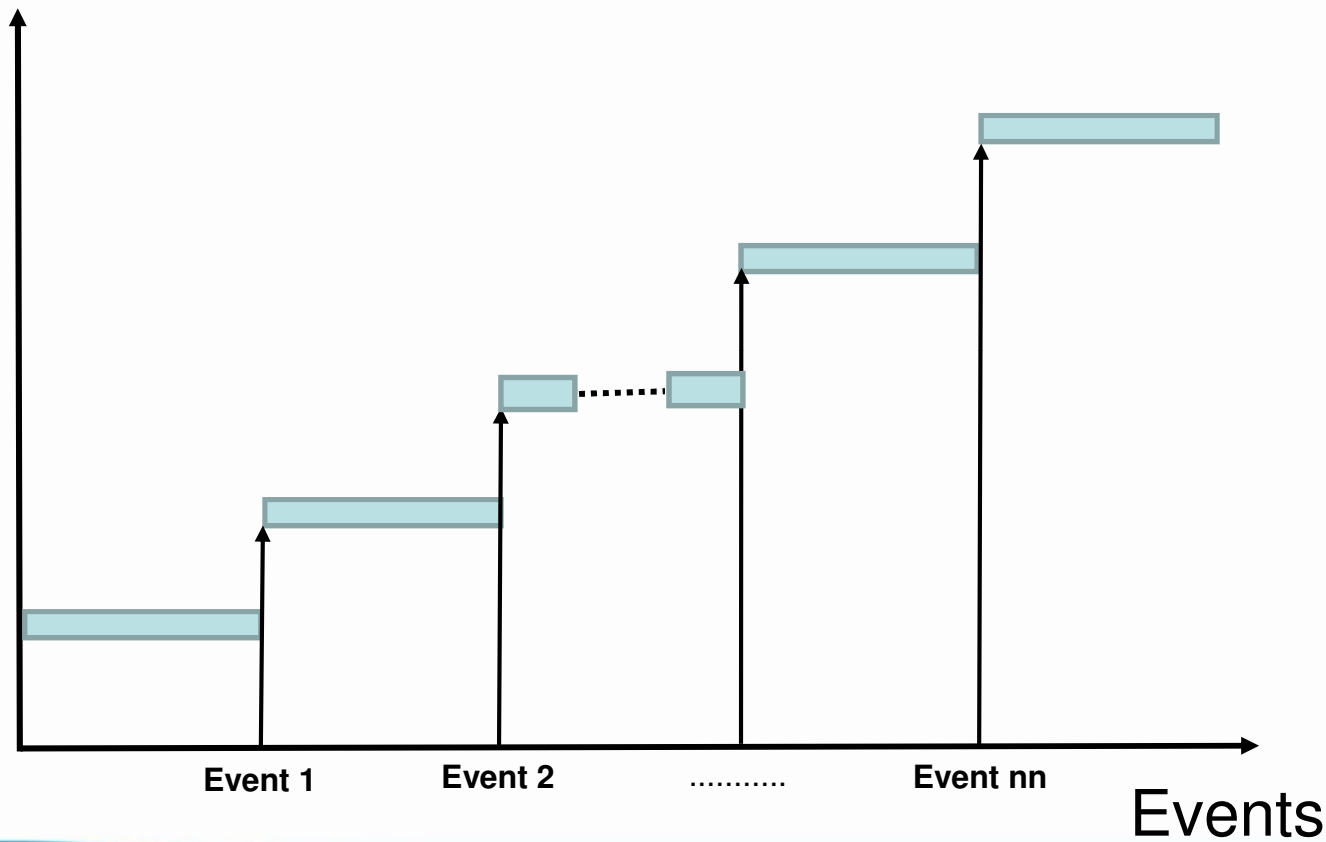
Plugtests™ can look like this...

Des experts en télécommunications venus de toute la planète testent entre eux aux Ursulines les produits qui seront demain sur le marché.

Achieving Interoperable Standards

... or this (Car2Car Interop)
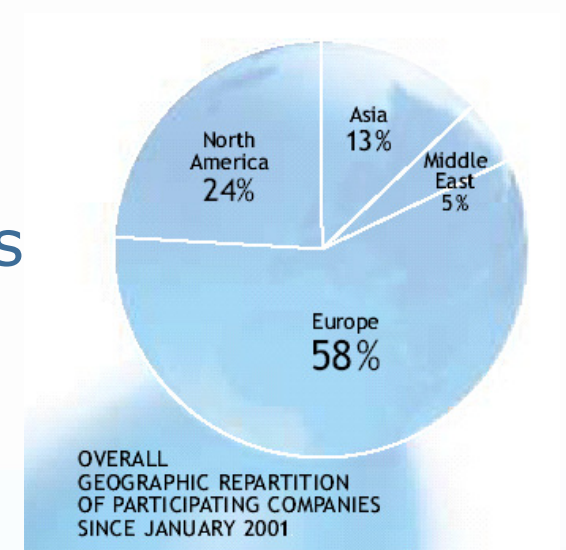
Typical ETSI PLUGTESTS INTEROP EVENTS

- ❏ **In operation since 1999**
- ❏ **Over 100 events, more than 3000 engineers**
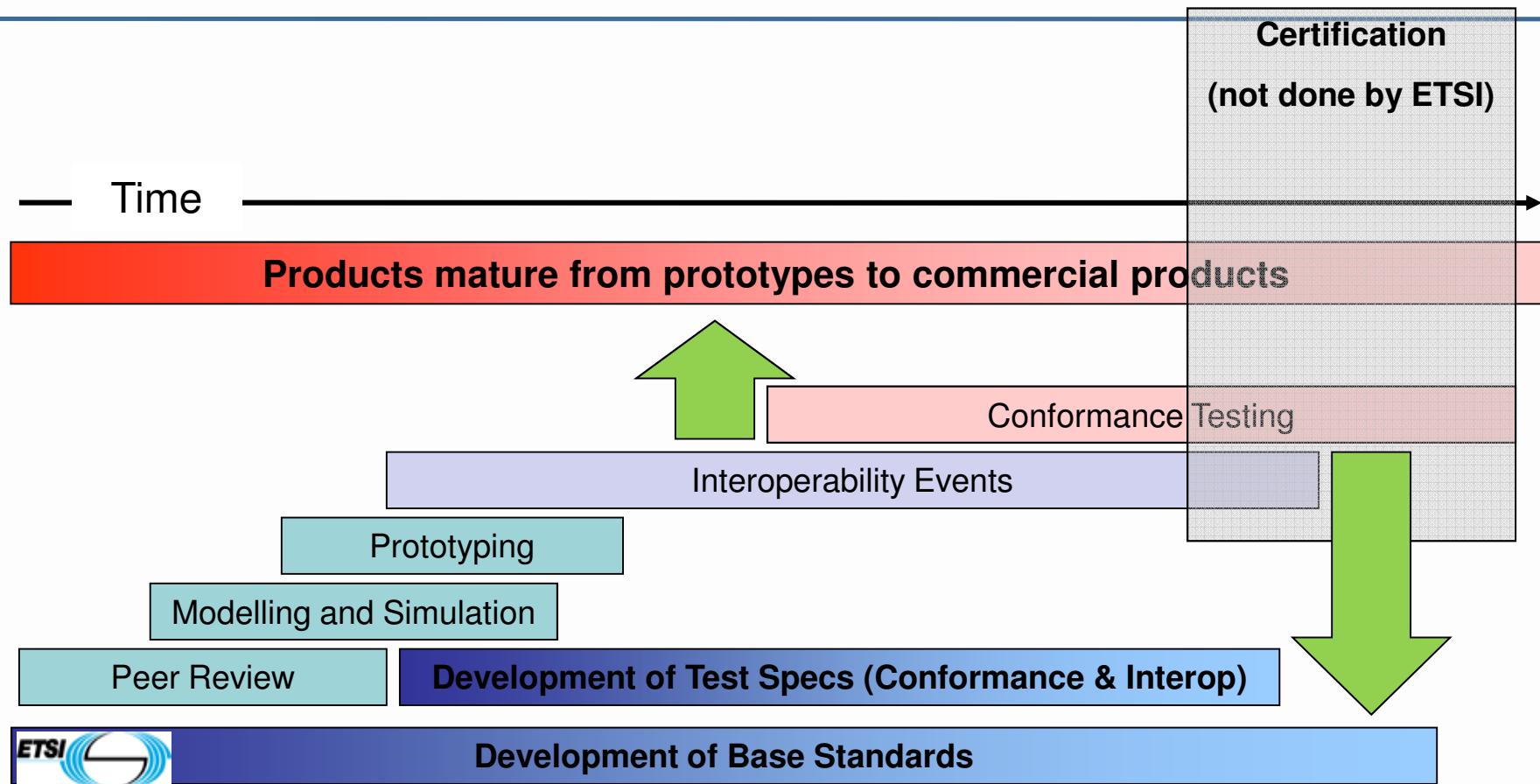- ❏ **Technologies include:**

- **IMS**
- **Bluetooth**
- **IPv6**
- **Triple Play over xDSL**
- **SIM/Handset**
- **WLAN IRAP**
- **RFID**
- **STQ (Speech Quality)**
- **WiMAX**
- **SIGTRAN**
- **Femtocell**
- **OSA/Parlay (ParlayX)**

- **B2B (Business-to-Business)**
- **SIPiT**
- **J2ME**
- **HDMI**
- **Air Traffic Control (EUROCAE)**
- **Electronic Signature (XadES, CadES)**
- **Lawful Interception**
- **Optical Fibre (GPON)**
- **Power Line (PLT)**
- **Intelligent Transport Systems**
- **Femtocell**
- **Fixed Mobile Convergence (FMCA)**
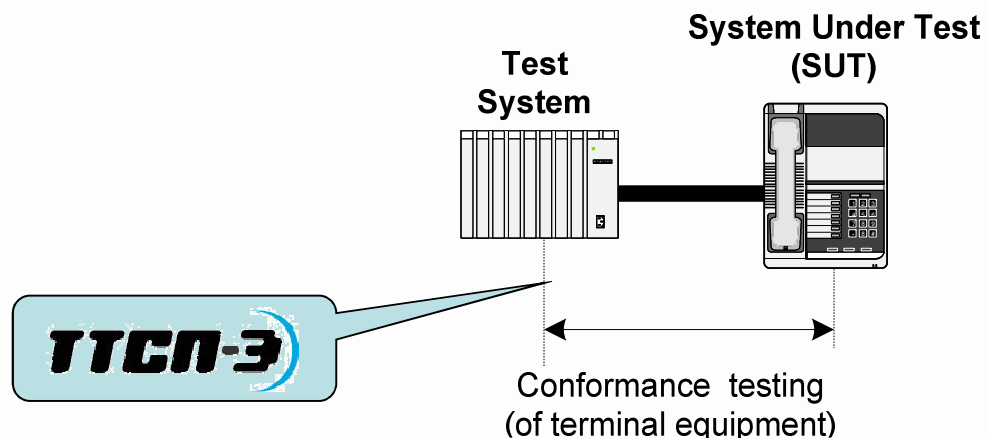
Who attends Plugtests™ events?

- Participants do NOT have to be ETSI members
- Plugtests™ are addressed to any company developing a product such as operators, vendors or equipment manufacturers, content or application providers
- Standardization Bodies, Fora or interest groups may also attend
- Plugtests™ also welcome Universities and Research Institutes

North America 24%
Asia 13%
Middle East 5%
Europe 58%

OVERALL GEOGRAPHIC REPARTITION OF PARTICIPATING COMPANIES SINCE JANUARY 2001

... and Testing

Certification
(not done by ETSI)

Time

Products mature from prototypes to commercial products

Conformance Testing

Interoperability Events

Prototyping

Modelling and Simulation

Peer Review

Development of Test Specs (Conformance & Interop)

ETSI

Development of Base Standards

Conformance Testing

Test System

System Under Test (SUT)

TTCN-3

Conformance testing
(of terminal equipment)

Tests a specific (part of a) product for compliance to requirements in a Base Standard

Characteristics of Conformance Testing

- **Gives a high-level of confidence that the standardised parts of a product are working as specified**
- It is component (Black Box) testing
  - Usually *One requirement -> One test*
- Requires a test system (i.e., executable test cases)
  - Test execution is automated and repeatable
  - Tests in controlled conditions
- High degree of control and observation
  - Can provoke and test non-normal (but legitimate) scenarios
  - Can explicitly test error behaviour (robustness)
- Tests are thorough and accurate but limited in scope
  - At level of detailed protocol messages, service primitives, or procedure calls

Limitations of Conformance Testing

- **Does not necessarily prove interoperability with other products**
- Tests are focussed on part of a product
  - A system is often greater than the sum of its parts!
  - Does not test the user's 'perception' of the system
  - Standardised conformance tests do not include proprietary features
- Test systems may be expensive
  - But cost may be relative to size of the market

Case Study – 3GPP UE Testing

- 3GPP mobile protocol / signalling testing
- Project was started in 2000
- 40 companies involved
    - a large extent of test industry involved
- 16 experts led by ETSI CTI
    - total budget > 90 person months / year (in 2009)
- 28 Test Suites
    - more than 1400 Test Cases
    - running on 4 System Simulator platforms
- Delivery every 3 weeks
- Deployed by GCF / PTCRB for UE certification

Interoperability Testing

Equipment Under Test

Equipment Under Test

Interoperability testing (of terminal equipment)
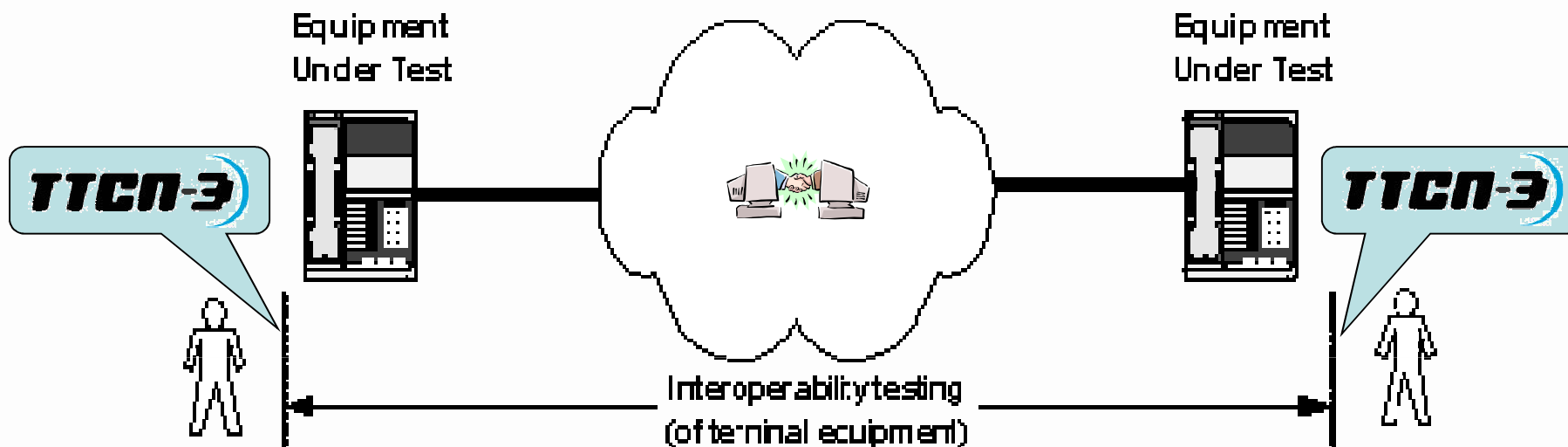
Tests end-to-end functionality between a collection of products

Characteristics of IOP Testing

- **Gives a high-level of confidence that products will interoperate with other products**
- It is <u>system</u> testing
  - Tests a complete product or a collection of products
  - Is functional testing
- Tests can be performed manually
  - Users operate the product via existing interfaces (standard/proprietary)
  - Can also be automated with test drivers
- Testing includes perception of end users
  - Exercises the whole product
- Less thorough than conformance testing but wider in scope

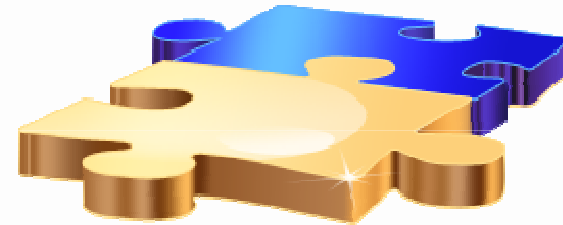# Limitations of IOP Testing

- **Does not prove that a product is conformant**
  - Products may still interoperate even though they are non-conformant
- Requires availability of suitable interfaces
- Limited ability to trigger error behaviour or unusual scenarios
  - Less controllability than in conformance testing
- Interoperability can be elusive!
  - Configuration may be simplified (not a fully operational system, e.g., no billing, no load)
- Does not prove interoperability with other products with which no testing has been done
  - 'A' may interoperate with 'B' and 'B' may interoperate with 'C'. Does not necessarily follow that 'A' will interoperate with 'C'
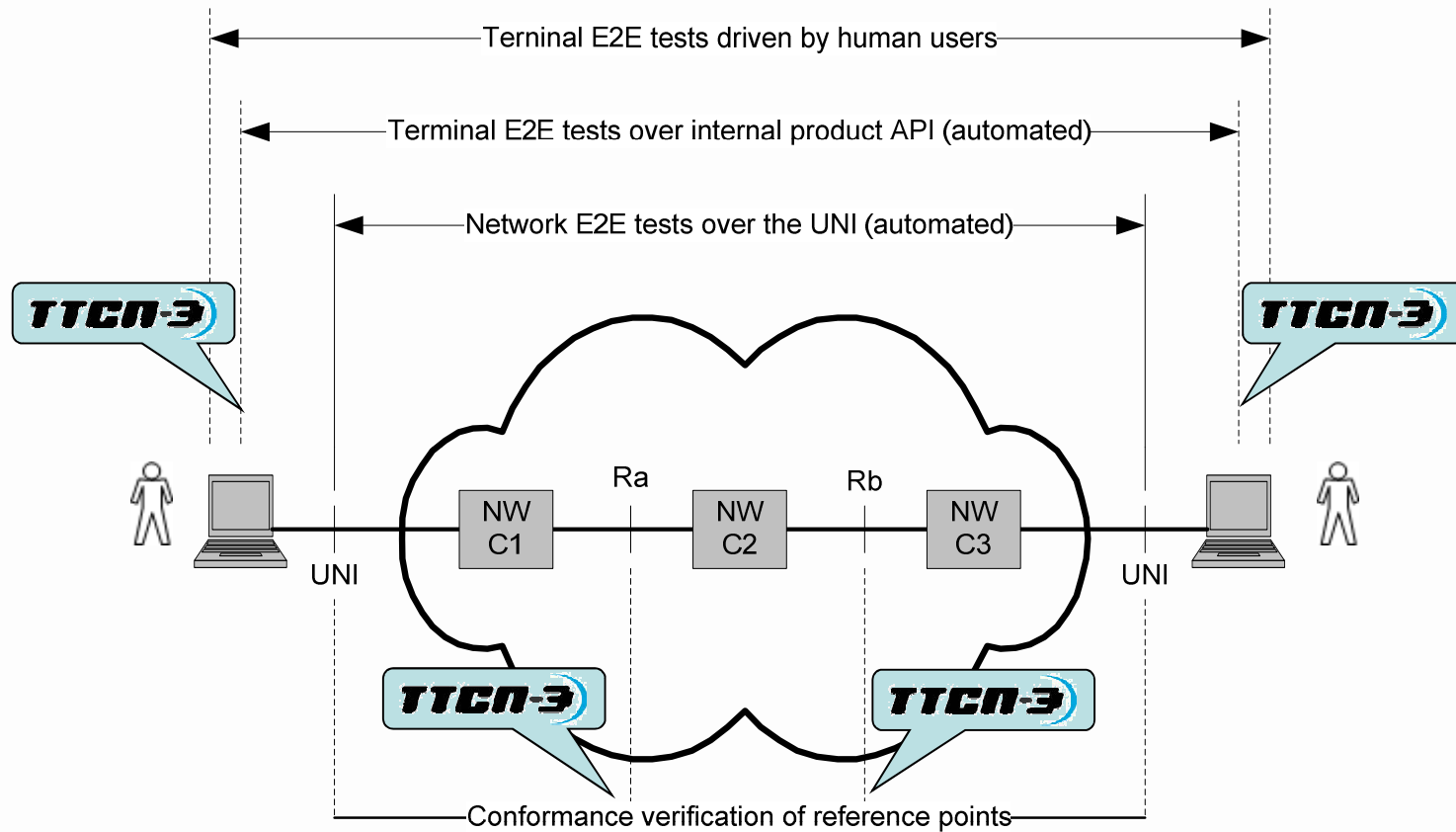
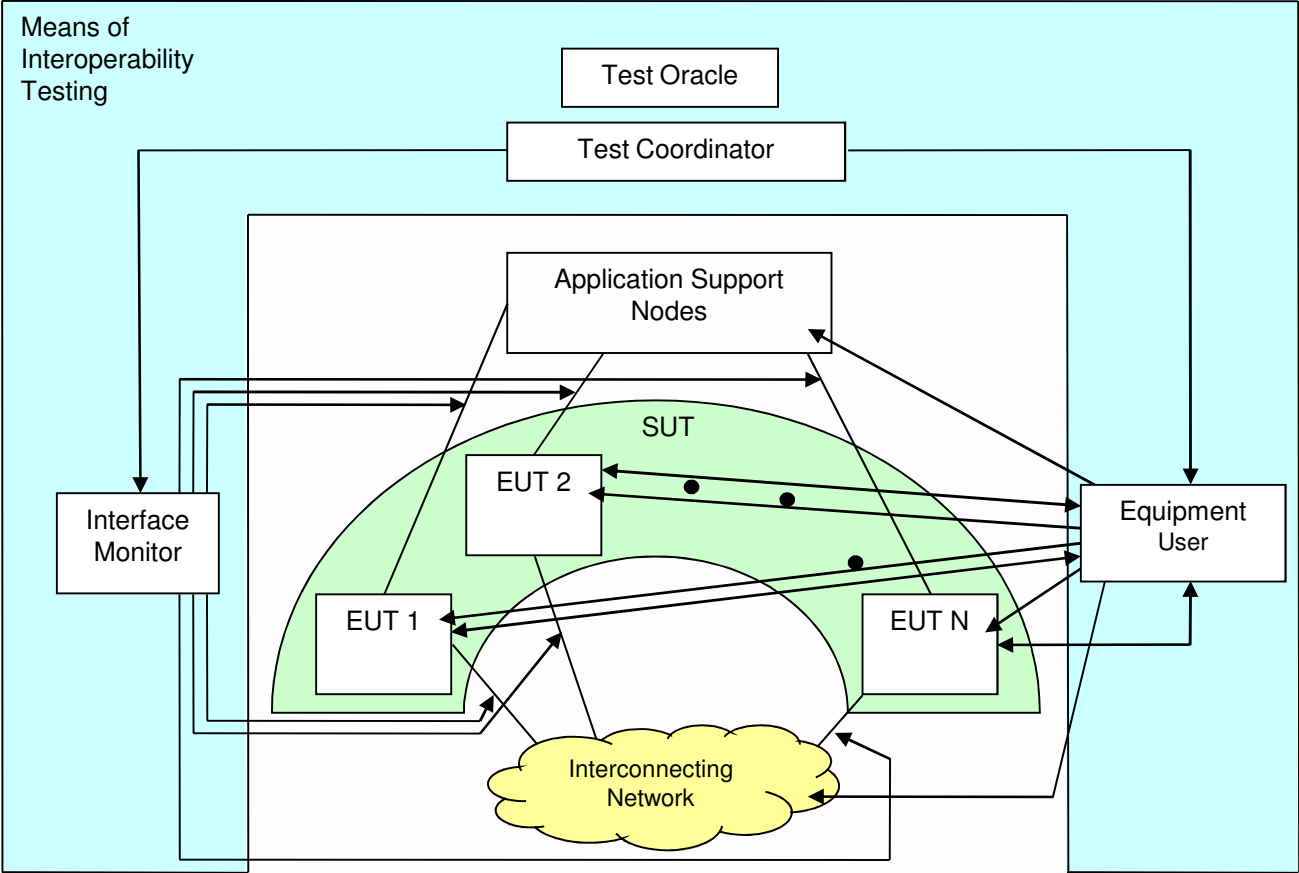# Conformance and IOP Testing are Complementary

- **As you move up a system stack the emphasis should change from conformance to interoperability testing**
- Lower layer protocols
    - Mainly conformance testing
- Middleware, enablers, infrastructure
    - Combination of conformance and interoperability testing
- Services, applications, systems
    - Emphasis on interoperability testing

- **Conformance testing should be a pre-requisite to interoperability testing**
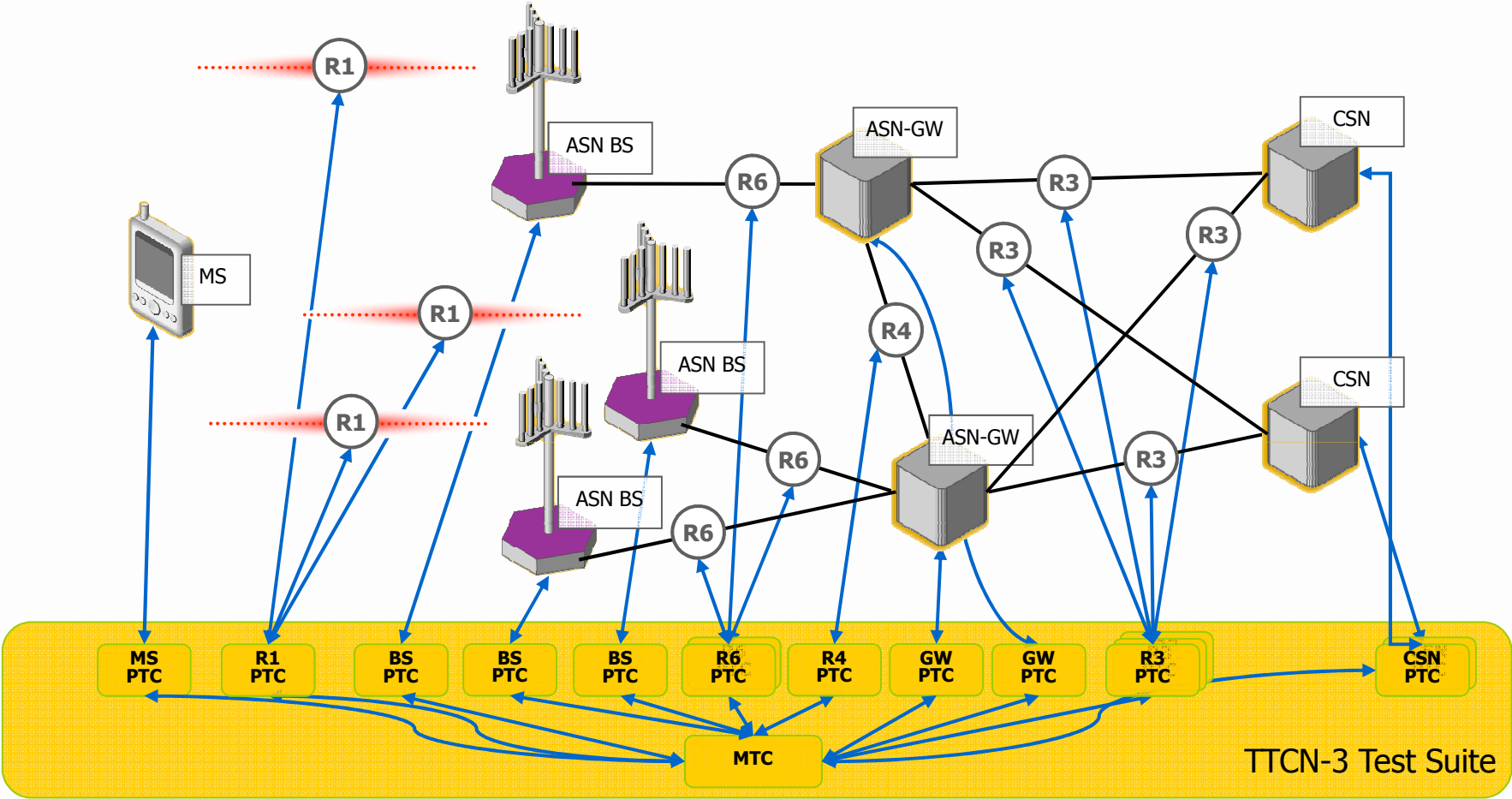
IOT with Conformance Checking

Generic Auto IOT Architecture

Means of Interoperability Testing

Test Oracle

Test Coordinator

Application Support Nodes

SUT

EUT 2

Interface Monitor

EUT 1

EUT N

Equipment User

Interconnecting Network

→ Configuration interface   ↔ Stimulating interface

→ Monitoring interface

WiMAX Interoperability Testbed
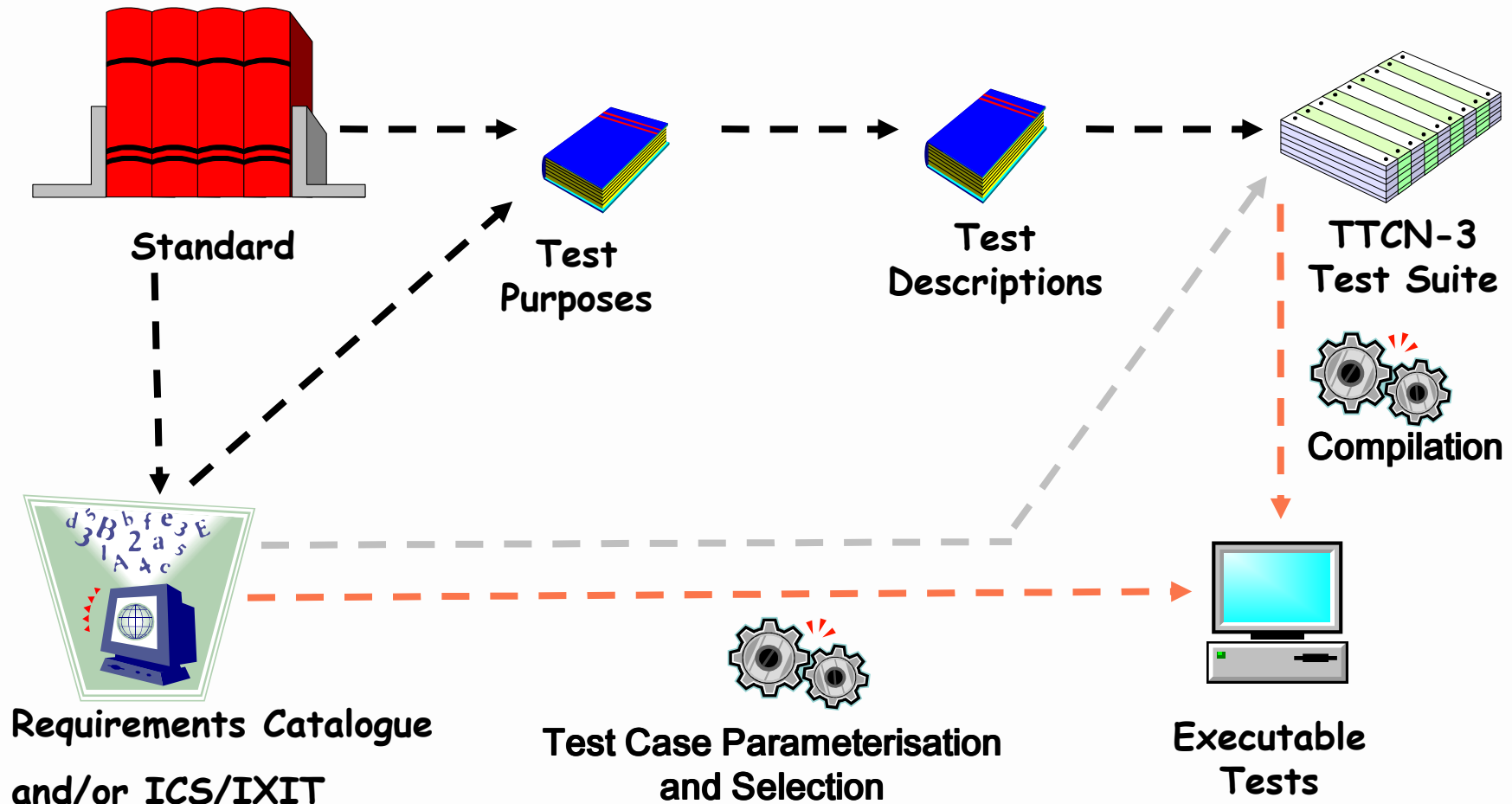
Use of TTCN-3 at ETSI

- All test suite development done in TTCN-3
  - Some maintenance of legacy TTCN-2 test suites

- Test Suites developed by Specialist Task Forces (STF)
  - At the request of the ETSI Technical Committees
  - Experts recruited from the ETSI Membership
  - Mostly under the technical management of CTI
  - 15 to 20 testing STFs per year

Test Specification Development

Successive Levels of Abstraction

Standard → Test Purposes → Test Descriptions → TTCN-3 Test Suite

Requirements Catalogue and/or ICS/IXIT

Test Case Parameterisation and Selection

Compilation

Executable Tests

Validation of Tests

- Where possible ETSI Test Specifications are validated prior to publication
- Minimum requirement is that they compile on at least one tool
  - E.g., UMTS compiles on at least 4 platforms
- In many cases we execute the tests agianst live implementations
  - In co-operation with partners (Test Labs and Vendors)
  - E.g., UMTS tests executed against at least 2 different implementations

Some ETSI TTCN-3 Test Suites

- IPv6 (TC MTS)
  - Core, Security, Mobility, Transitioning
- IMS (TC INT & TC TISPAN)
  - Interoperability, Network Integration, ISDN Interworking, Supplementary Services
- WiMAX (TC BRAN & WiMAX Forum)
  - Conformance (PCT, NCT), Interoperability
- Intelligent transport (TC ITS)
  - Direct Short Range Communication (DSRC)
- LTE (3GPP)
  - UE conformance
- DMR/DPMR (TC ERM)
  - Terminal conformance
- SIP (TC MTS)
  - RFC 3261 UA and Proxy conformance

TTCN-3 Tools Used at ETSI

- 6 different TTCN-3 Development Environments and Compilers

- ETSI TTCN-3 Documentation Tool (T3D)
- ETSI TTCN-3 Code Quality Tool (T3Q)

- ETSI tools will be made available as Open source
  - More information on TTCN-3 tools available at
  - http://www.ttcn-3.org/

ETSI Support for Interoperability

- ## Technical Committee MTS
  - Methods for Testing and Specification
  - Standardised frameworks, methodologies, languages
    - For protocol specification
    - For testing
  - "Making Better Standards" http://portal.etsi.org/mbs

- ## Centre for Testing and Interoperability (CTI)
  - Direct support to ETSI Technical Bodies
  - Application of protocol engineering and best practices
  - Development of test specifications
  - Standards validation, including interoperabilty events (Plugtests™)

Conclusions

- An interconnected world demands interoperability
- Standards enable interoperability
- Validation and Testing are cornerstones in the development of ETSI standards
  - Validated standards mean interoperable standards
  - Interoperable standards facilitate interoperable products
- Plan for validation and testing (early)
  - Right mix of conformance and/or interop
- Synchronise testing activities with the development of the standard
  - Ensure feedback to the base standard
- Perform (regular) interoperability events
  - Synchronise with availability of products
- **For ETSI, TTCN-3 is the future of testing, today!**

THANK YOU!

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