# Experiences of using TTCN-3 for Testing SIP and OSP

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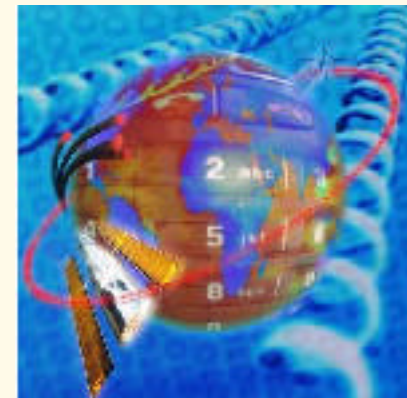
**Protocol and Testing Competence Centre**

**ACATS ATS-CONF 2002, Athens 28th Feb - 1st March 2002**

# About ETSI

❑ **European Telecommunications Standards Institute**

➢ **Develops a wide range of specifications as Europe's contribution to world-wide standardisation of telecommunications and associated domains**

➢ **Over 900 Members, 5000 experts**

❑ **Successful ETSI technologies include**

➢ **GSM, 3G UMTS, HiperLan/2, TIPHON (VoIP), DECT, TETRA, IN, ISDN (and B-ISDN) etc.**

❑ **Visit our website**: **http://www.etsi.org**

# Aim of Standardisation

❑ **Ultimate aim of standardisation is (global)** interoperability

❑ **Likelihood of interoperability is increased with**
  ➢ **Well-defined, accurate and unambiguous standards**
  ➢ **Validated standards**
  ➢ **Systematic testing of products**

❑ **Means standards of high technical quality**
  ➢ **Through the pragmatic use of modern specification and testing techniques**

# Unique ETSI Resources

- **TC MTS (Methods for Testing and Specification)**
  - **Development of specification methodologies [techniques, languages]**
  - **http://portal.etsi.org**
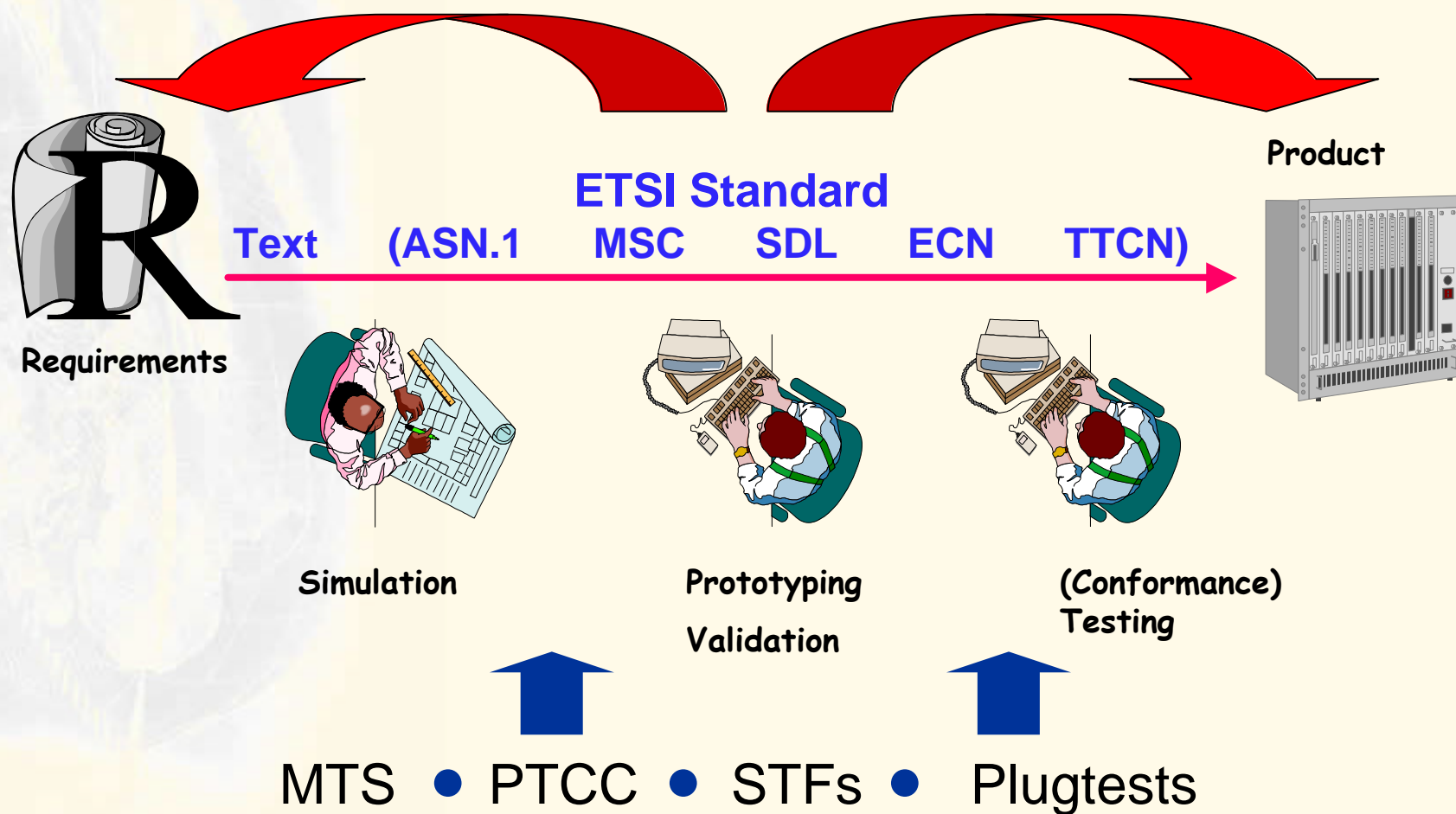- **ETSI PTCC (Protocol and Testing Competence Centre)**

  

  - **Supports ETSI TBs on the use of formal techniques in standards**
  - **Development of test specifications (conformance and interop)**
  - **http://www.etsi.org/ptcc**
- **ETSI Plugtests Service**
  - **Validation of standards and prototypes through interoperability events**
  - **http://www.etsi.plugtests**
- **All three entities are highly complementary - not competitive**

# Key Activities in the Evolution of an ETSI Standard

**Product**

**ETSI Standard**

**Text** **(ASN.1** **MSC** **SDL** **ECN** **TTCN)**

**Requirements**

**Simulation**

**Prototyping**

**Validation**

**(Conformance) Testing**

MTS ● PTCC ● STFs ● Plugtests

# ETSI and Testing

❑ **ETSI produces test specifications**

  ➢ **Developed by Specialist Task Forces (STFs)**

  ➢ **Does not do actual testing or certification**

❑ **Is a strong demand for test suites**

  ➢ **Radio and other physical aspects are regulatory**

  ➢ **Increased self-testing done by ETSI members**

  ➢ **Test Suites are integral to development processes**

❑ **Conformance Testing for Interoperability**

  ➢ **Controlled One-to-One interoperability test**

  ➢ **Critical behaviour, basic interconnection**

  ➢ **Options, combinations of options**

  ➢ **Error recovery behaviour**

  ➢ **Good basis for further (e.g., IOP) testing**

# Testing Methodology
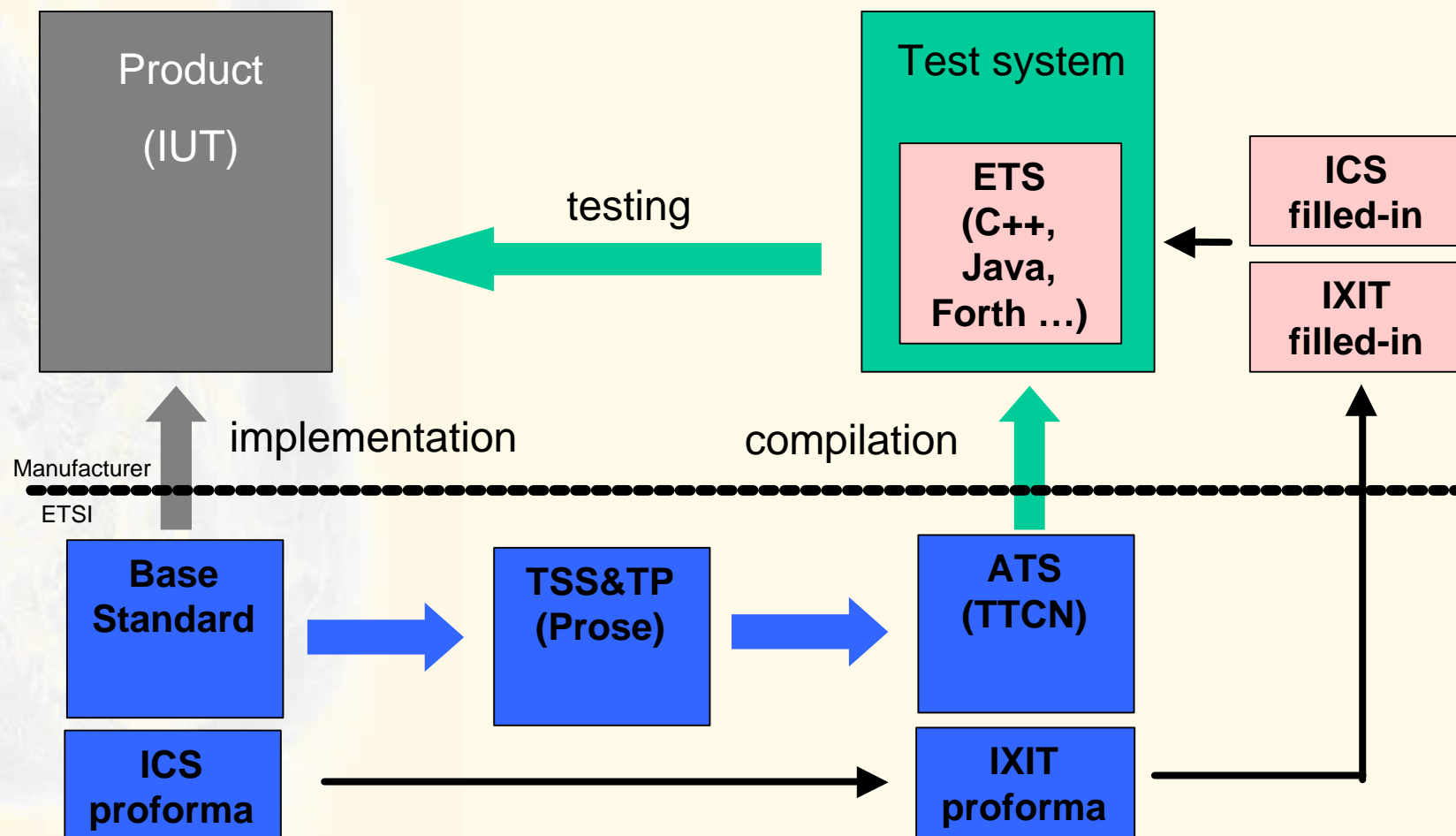
# PTCC Testing Activities (2002)

- **3GPP (and GSM)**
  - 3G terminal tests
  - Inter-system (2G-3G) tests
- **EP BRAN**
  - Hiperlan/2 (RLC, DLC,Convergence layers)
  - HiperAccess
- **TC AT**
  - FSK, SMS
  - IP-CableCom
  - DSL Splitters
- **TC SPAN 12, 13**
  - DSS1/DSS2 (ISDN, B-ISDN) maintenance
  - OSA (Parlay-API, IDL)

# PTCC Testing Activities (2002) for TIPHON

❑ **EP TIPHON™**
  ➢ **Telecommunications and Internet protocol Harmonization Over networks**

❑ **EP TIPHON WG6 Testing and Validation**

❑ **STF196: Test specs based on TIPHON™ profiles for:**
  ➢ **H.225**
  ➢ **H.245**
  ➢ **H.248**
  ➢ **SIP**
  ➢ **OSP**
  ➢ **BICC**
  ➢ **Security**

Today we will look at SIP and OSP test specifications

❑ **Interoperability scenarios for H.323-SIP interworking**

# What is SIP?

- ❑ **Session Initiation Protocol, draft RFC2543**
- ❑ **IETF Internet control protocol for**
  - ➢ **establishing, changing and tearing down voice and multimedia calls**
- ❑ **Like http (sip:anthony.wiles@etsi.fr)**
  - ➢ **Can build services like web pages**
- ❑ **Client-Server behaviour (simple)**
- ❑ **SIP Components**
  - ➢ **Use Agents**
  - ➢ **SIP Servers (proxy server, redirect server)**
- ❑ **SIP messages are text based**
  - ➢ **Defined by a quite complex BNF**
  - ➢ **Loose syntax**

# Status of TIPHON<sup>TM</sup> SIP Conformance Test Specifications

- ❑ **IETF SIP draft RFC 2543 bis4**

- ❑ **437 Test Purposes (TSS&TP)**

- ❑ **Complete TTCN-3 ATS April 2002 (pure SIP)**

- ❑ **Currently validating ATS on experimental test platform**

- ❑ **Will be input to Spring SIPit April 2002**

- ❑ **Fully validated test suite May/June 2002**

- ❑ **Later in 2002 will upgrade to ETSI profile based on finalized RFC (July - Dec 2002)**

# SIP Test Suite Structure and Test Purposes (TSS&TP)

**Registration**
   **Registrant**
      **Valid**
      **Invalid**
   **Registrar**
      **:**
**Session**
   **Originating Endpoint**
    **Call Establishment**
    **:**
    **Call Release**
    **:**
   **Terminating Endpoint**
   **Proxy**
   **Redirect Server**
    **:**

The **TSS&TP** are derived from the relevant base standards. They provide an informal, easy-to-read description of each test, concentrating on the meaning of the test rather than detailing how it may be achieved.

Test Purposes are grouped into a logical Test Suite Structure according to suitable criteria (e.g., basic interconnection, error handling, functionality etc.).

# Typical SIP Test Purpose

**TPId:**          **SIP_SS _PR_CE _V_012**
**Selection:**     Mandatory
**SUT:**           A stateful Proxy
**Precondition:**  Registration of both simulated UA to the IUT and an initiated session
**Ref:**           5.1.1 [1], 17.3.6 [1], 17.4 [1] , 10.46.6 [1]
**Purpose:**       Ensure that the IUT on receipt of a Server Internal Error (500 Server Internal Error) server failure response, sends an ACK request, with the same field Via and branch parameter as in the previous INVITE, to the UAS and forwards it to the UAC.

# SIP Abstract Test Suite (ATS) in TTCN-3

❑ **ES 201 873-1** (Z.140)

  ➢ **TTCN-3 Core Language**

❑ **Analysis on the suitability of TTCN-3 for SIP and OSP**

  ➢ **TR 102 026**

```
testcase SIP_UA_REC_V_028() runs on SipTestComponent
{    activate (Default_1); // Default activation
     // the CSeg number in the request header is not correct
     SIP_PCO.send(Invite_s_1);
     T1.start;
     // the CSeq value has not been understood
     SIP_PCO.receive(Response_r_1);
     verdict.set(pass);
     T1.stop;
     stop;
} // end testcase SIP_UA_REC_V_028
```

**TTCN-3**

# Issues with testing SIP (1)

❑ **Behaviour relatively straightforward**

  ➢ **TTCN-3 address type and map function are useful**

❑ **SIP Messages are unstructured (ASCII text)**

  ➢ **Pure text => many messages perhaps with only small differences**

  ➢ **Can send as pure text …**

  ➢ **… but on receive how to match?**

❑ **Control vs Readability**

  ➢ **Should we structure (sub-structure) each message**

  ➢ **Or rely on pattern-matching?**

  ➢ **…. Or compromise?**

# Issues with testing SIP (2)

□ **Where to place PCO**
  - ➢ **Directly over TCP/UDP …**
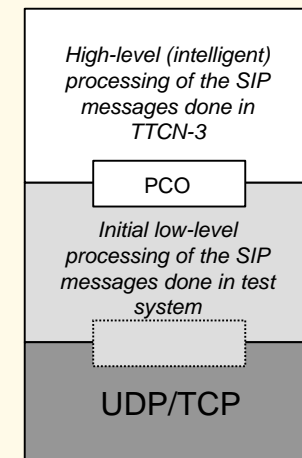  - ➢ **… or allow some processing by test system**

□ **Need some form of test adapter**
  - ➢ **Does some form of preprocessing**
  - ➢ **E.g., remove duplicate spaces and CRLF**
  - ➢ **Breaks message into SIP headers (To, From, Via …)**
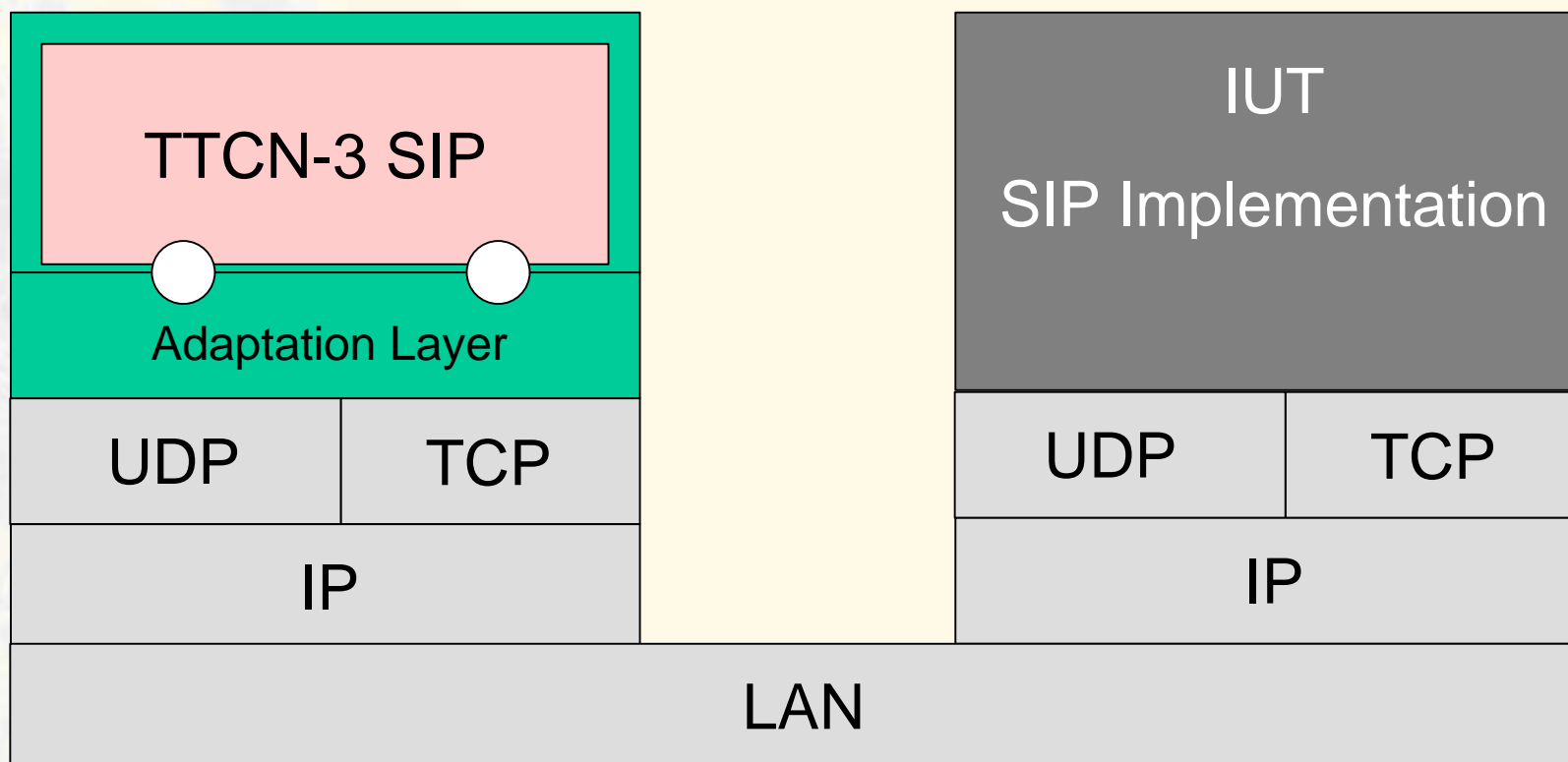  - ➢ **Converts to TTCN-3 types (and vice versa)**

□ **Mapping is defined as part of the ATS**
  - ➢ **TTCN-3 module**

□ **Sending of invalid or 'unusual' SIP messages done as pure text**

| |
|---|
| *High-level (intelligent) processing of the SIP messages done in TTCN-3* |
| PCO |
| *Initial low-level processing of the SIP messages done in test system* |
| UDP/TCP |

# Conceptual SIP Test Architecture

| TTCN-3 SIP | | IUT |
|---|---|---|
| Adaptation Layer | | SIP Implementation |
| UDP | TCP | UDP | TCP |
| IP | | IP |
| LAN | | |

# General Structure of a TTCN-3 test System

**Test System User**

**Test Management (TM)**

TCI

**TTCN-3 Execution (TE)**

TRI

**SUT Adapter (SA)**　　　**Platform Adapter (PA)**

**System Under Test (SUT)**

# Decomposition of the TE

**Test System User**

**Test Management (TM)**

TCI

**TTCN-3 Execution (TE)**

**Codec**

TRI

**SUT Adapter (SA)**

**Platform Adapter (PA)**

**System Under Test (SUT)**
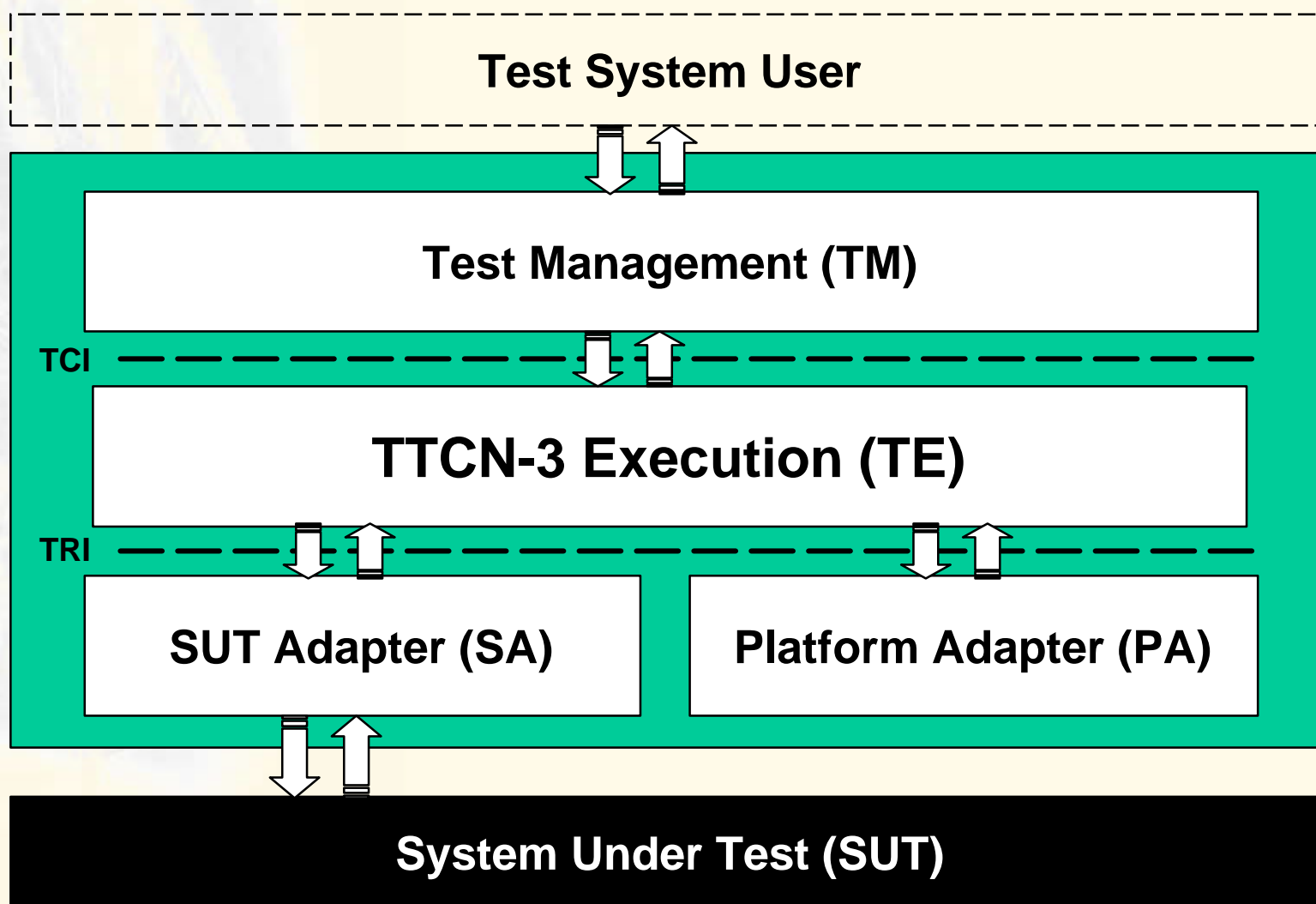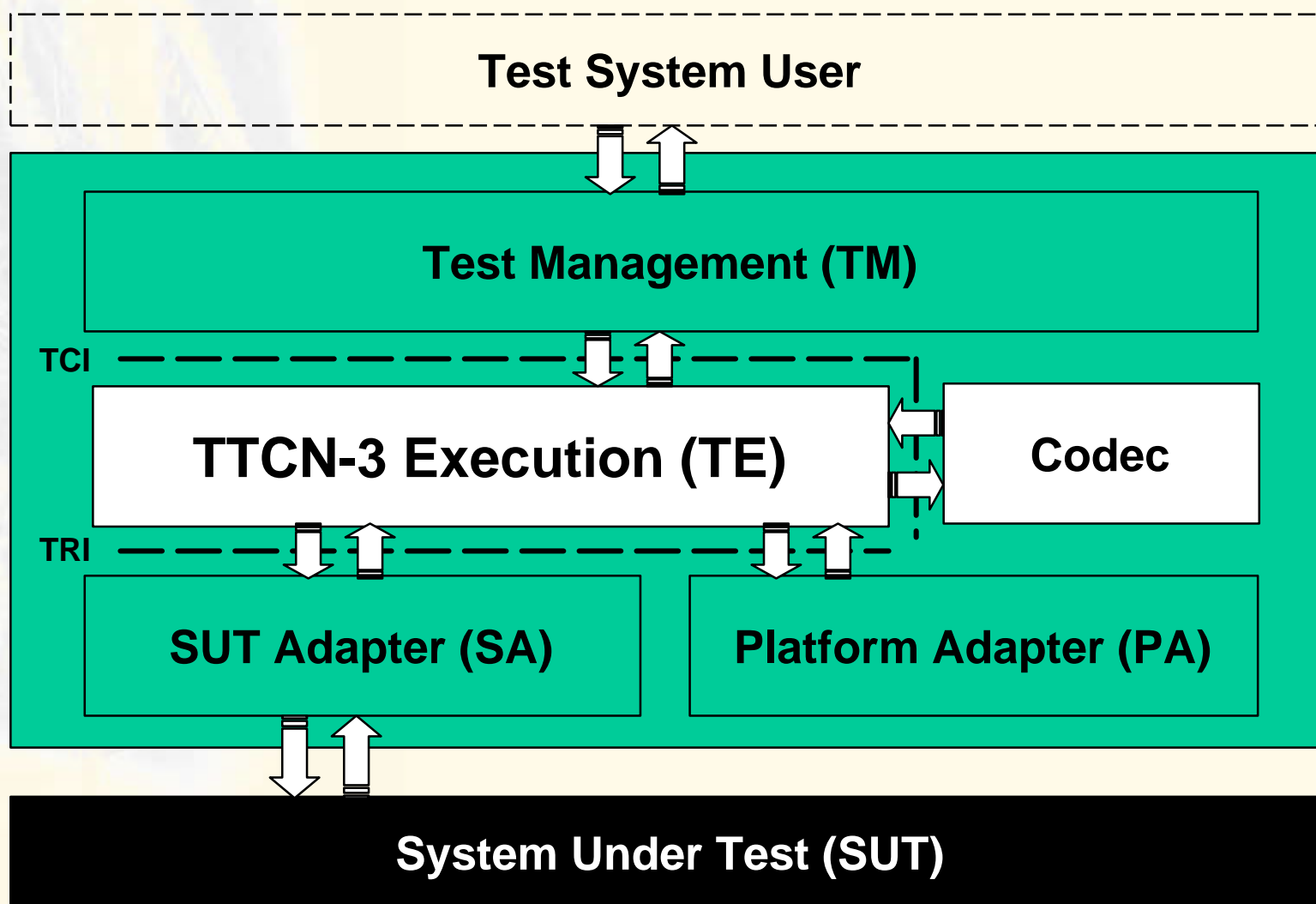
# A Typical SIP Message (Simplified)

```
SIP/2 200 OK

From: userB<sip:xxx@yyy.zzz>

To: userA<sip:aaa@bbb.ccc>

CSeq: 1 INVITE

Content-Length: 0
```

# SIP Message in TTCN-3
## (Readability vs Contr~~ol~~)

**Parameterisation**

```
template SIP_RESPONSE MyResponse (charstring StatusCode) :=
    {   SIP_Version        := "SIP/2.0",
        Status_Code        := StatusCode, // use
        Reason_Phrase      := "OK",
        Message_Headers    := ResponseHeaders, //
        Message_Body       := omit // SDP info.
    }


template SIP_ HEADERS ResponseHeaders // setof
    {   "From: userB<sip:xxx@yyy.zzz>",
        "To: userA<sip:aaa@bbb.ccc>",
        "CSeq: 1 INVITE",
        "Content-Length: " & int2char(MBLength),
        *   // All other headers are ignored
    }
```

**Substructure**

**Setof type**

**Could use regexps**

**Function call**

**Wild cards**

# What is OSP?

❑ **Open Settlement Protocol, TS 101 321 V.2.1.1**
❑ **Facilitates the exchange of inter-domain …**
  ➢ **Pricing**
  ➢ **Authorization**
  ➢ **and Settlement Information**
❑ **… between Internet telephony operators.**
❑ **Works between multiple administrative domains in a secure manner**
  ➢ **XML- based**
  ➢ **ASN.1 for authorization**
❑ **Can be used with SIP or H.323**

# Status of TIPHON™ OSP Conformance Test Specifications

❑ **TS 101 321 V.2.1.1 will upgrade to v2 during 2002**

❑ **30 Test Purposes (TSS&TP)**

  ➢ **Protocol is very open**

  ➢ **TIPHON profile => more TPs**

  ➢ **No authorization tests yet => more TPs**

❑ **TTCN-3 ATS is complete**

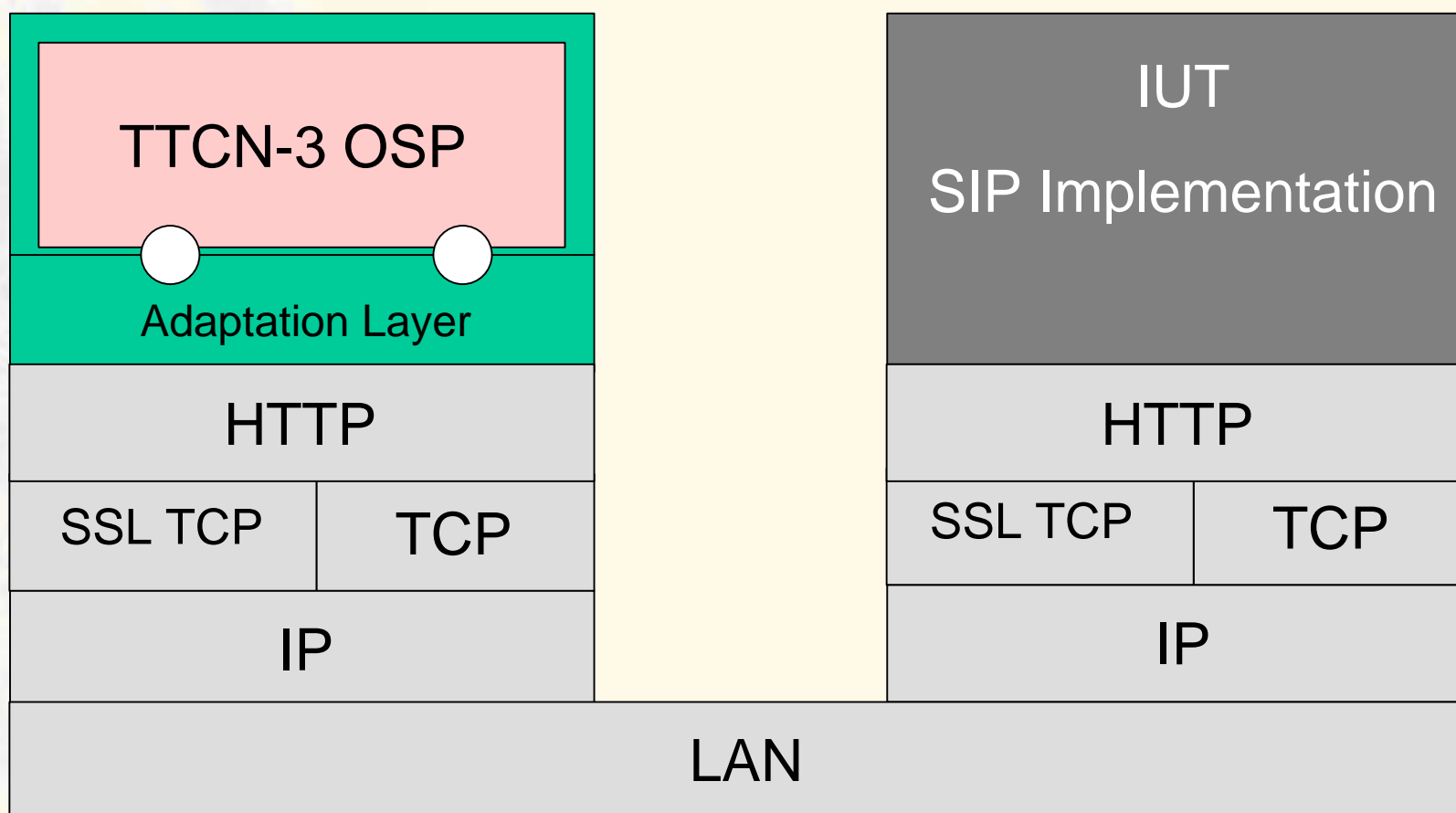❑ **Currently validating ATS on experimental test platform**

# Issues with testing OSP (1)

❑ **Also simple Client - Server behaviour**

  ➤ **No problem for TTCN-3**

  ➤ **Interleaved behaviour useful (easily handles permutations of expected behaviour)**

❑ **OSP messages defined in XML**

  ➤ **Need to map OSP XML DTD to TTCN-3**

  ➤ **Not particularly difficult**

  ➤ **A generic mapping would be useful**

❑ **Security and Authorization (optionally) uses ASN.1**

  ➤ **Not a problem for ATS**

  ➤ **More complex test system as it has to switch between XML and ASN.1 encoding**

  ➤ **Not included in this first version of ATS**

# Issues with testing OSP (2)

❑ **Where to place PCO**
  - ➢ **Directly over TCP or UDP…**
  - ➢ **… or allow some processing by test system?**

❑ **Need some form of test adapter**
  - ➢ **Does some form of preprocessing**
  - ➢ **Converts XML message to TTCN-3 types (and vice versa)**

❑ **Mapping is defined as part of the ATS**

❑ **Sending of invalid or 'unusual' OSP messages done as pure XML (ASCII)**

# Conceptual OSP Test Architecture



TTCN-3 OSP

Adaptation Layer

HTTP

| SSL TCP | TCP |
| --- | --- |

IP

IUT

SIP Implementation

HTTP

| SSL TCP | TCP |
| --- | --- |

IP

LAN

# A Typical OSP Message in XML

```
<!ELEMENT PricingIndication ( Timestamp, SourceInfo, DestinationInfo,
Currency, Amount, Increment, Unit, Service, ValidAfter, ValidUntil )>
<!ATTLIST PricingIndication componentId ID #REQUIRED>


<!ELEMENT Timestamp (#PCDATA)>
<!ATTLIST Timestamp critical (true | false) "true">


:


:
```

# OSP Message in TTCN-3
# (Mapping to XML)

```
type record PricingIndication
{    ID_DTD           msgIdField,
     CDATA_DTD        randField,
     ID_DTD           compIdField,
     Timestamp        timestamp,
     SourceInfo       sourceInfo,
     DestinationInfo  destinationInfo,
     Currency         currency,
     Amount           amount,
     Increment        increment,
     Unit             unit,
     Service          service,
     ValidAfter       validAfter,
     ValidUntil       validUntil
} with {encode (msgIdField, randField, compIdField) "XML_ATTRIBUTE"};


type record Timestamp
{    ENUM_DTD         criticalField ("true","false"),
     PCDATA_DTD       valueField
} with {encode (criticalField) "XML_ATTRIBUTE"};
```

Experiences of using TTCN-3 for Testing SIP and OSP. Copyright ETSI 2002

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# Validation

- ❑ **Have implemented experimental testing platforms for SIP and OSP**
  - ➢ **Main task is the implementation of the adaptation layers**
- ❑ **Validation of SIP test cases**
  - ➢ **As of Dec. 2001 could execute approx. 50 test cases (of a total of 437) against real implementations**
  - ➢ **Demonstrated at IMTC Winterop**
  - ➢ **Expect to be able to execute most test cases by April 2002**
  - ➢ **Will provide conformance testing 'service' at Spring SIPit**
- ❑ **Validation of OSP test cases**
  - ➢ **Achieved initial connection to remote IUT (Transnexus OSP server)**
  - ➢ **Full validation will start in March/April**
  - ➢ **Finish in June 2002**

# Conclusions

❑ **Specific problems when dealing with text-based protocols**

 ➢ **How to represent messages**

❑ **TTCN-3 has several advantages (over TTCN-2)**

 ➢ **Trigger**

 ➢ **Address type**

 ➢ **Map operations**

 ➢ **Interleaved behaviour**

 ➢ **Data types such as set and set of (no need to use ASN.1)**

 ➢ **Regular expressions**

 ➢ **Programming paradigm closer to datacom community**

❑ **Have implemented and executed the test suites**

 ➢ **So we know it works!**

❑ **Learning curve TTCN-2 -> TTCN-3 not too high**

❑ **ETSI TBs will use TTCN-3 if there is tool (test system) support**

 ➢ **TIPHON, 3GPP**

# Acknowledgements

❑ **EP TIPHON™**

- ➤ **Chairman Mr. Hans Van Der Veer**
- ➤ **WG6 Chairman Mr. Klaus Sambor**

❑ **STF 176 SIP/OSP team**

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- ➤ **Jean-Claude Wattelet, Wattelet Telecoms (OSP)**

❑ **Background support**

- ➤ **Nokia, NetTest, Alcatel, Nortel**

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❑ Website **www.etsi.org/ptcc**
  ➢ **Includes TTCN-3 info, drafts, presentations, downloads etc.**
  ➢ **How to join TTCN-3 mailing list**

# Experiences of using TTCN-3 for Testing SIP and OSP

**Thank you!**

# Motivation for Producing TTCN-3

❑ **Modernization**

  ➢ **Language technology and the technology being tested has changed since TTCN was first developed**

❑ **Wider scope of application**

  ➢ **TTCN should be applicable to many kinds of test applications not just conformance**

❑ **Harmonization**

  ➢ **should be the first choice for test specifiers, implementors and users both for standardized test suites ...**

  **… and as a generic solution in product development**

# Scope of TTCN-3
# for Product and Development testing
(List courtesy of Nortel Networks)

- ❑ **Conformance**
- ❑ **Interoperability**
- ❑ **Configuration**
- ❑ **Performance**
- ❑ **Stress**
- ❑ **Robustness (torture)**
- ❑ **Integration**
- ❑ **Functional**
- ❑ **Load**
- ❑ **Interface**
- ❑ **System**
- ❑ **Unit**

> **If you can write a test you can probably write it in TTCN-3**

# Benefits

❑ **Specifically designed for testing**

❑ **Concentrates on the test not the test system**

❑ **Commonly understood syntax and operational semantics**

   ➢ **not related to a particular programming language**

❑ **Constantly maintained and developed**

❑ **Off the shelf tools and TTCN-based test systems are readily available**

❑ **Single language for many testing activities**

   ➢ **Education and training costs can be rationalized**

   ➢ **Maintenance of test suites (and products) is easier**

❑ **Allows the application of a common methodology and style, both on a corporate level and within standardization.**

# Main Capabilities of TTCN-3

❑ **Dynamic** concurrent testing **configurations**

❑ **Various** communication mechanisms **(synch and asynch)**

❑ **Data and signature** templates **with powerful** matching mechanisms (including regular expressions)

❑ **Specification of** encoding information

❑ **Display and user-defined** attributes

❑ **Test suite** parameterization

❑ **Test case** control and selection **mechanisms**

❑ **Assignment and handling of** test verdicts

❑ **Harmonized with** ASN.1 (IDL coming)

❑ **Different** presentation formats

❑ **Well-defined** syntax, static - and operational semantics