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SIST-TP TR 102 026 V1.1.1:2004

01-april-2004

Harmonizacija telekomunikacij in internetnega protokola prek omrežij (TIPHON) - Študija uporabe TTCN-3 za preskušalne specifikacije za SIP in OSP

Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Study of the use of TTCN-3 for SIP and for OSP test specifications

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Ta slovenski standard je istoveten z: TR 102 026 Version 1.1.1

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ICS:

33.020	Telekomunikacije na splošno	Telecommunications in general

SIST-TP TR 102 026 V1.1.1:2004 **en**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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ETSI TR 102 026 V1.1.1 (2002-01)

Technical Report

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SIST-TP TR 102 026 V1.1.1:2004

Reference
DTR/TIPHON-06019

Keywords
VoIP, interoperability, IP, testing, TTCN

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

This Technical Report (TR) has been produced by ETSI Project Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON).

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1 Scope

The present document provides an analysis on the suitability of using TTCN-3 as defined in ES 210 873-1 [1] to specify the test specifications for TIPHON protocols, in particular the TIPHON profile of SIP (Session Initiation Protocol) and the TIPHON OSP (Open Settlement Protocol). This study is restricted to the use of the TTCN-3 Core Language.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI ES 201 873-1: "Methods for Testing and Specification (MTS); The Tree and Tabular Combined Notation version 3; Part 1: TTCN-3 Core Language".

[2] ISO/IEC 9646-3: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 3: The Tree and Tabular Combined Notation (TTCN) Edition 2".

[3] ETSI TS 101 321: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Open Settlement Protocol (OSP) for Inter-Domain pricing, authorization, and usage exchange".

[4] ITU-T Recommendation Z.140: "The tree and tabular combined notation version 3 (TTCN-3): Core language".

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3 Abbreviations

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ASN.1	Abstract Syntax Notation One
ATS	Abstract Test Suite
DTD	Document Type Definition
IUT	Implementation Under Test
MTC	Master Test Component
OSP	Open Settlement Protocol
(P)ICS	(Protocol) Implementation Conformance Statement
(P)IXIT	(Protocol) Implementation eXtra Information for Testing
PDU	Protocol Data Unit
SIP	Session Initiation Protocol
SUT	System Under Test
TCP	Transfert Control Protocol
TTCN-2	Tree and Tabular Combined Notation version 2
TTCN-3	Testing and Test Control Notation version 3
UDP	User Datagram Protocol
XML	eXtensible Markup Language
PCO	Point of Control and Observation
DE	Development Environment

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4 Background

The detailed code for nearly all ETSI (conformance) Abstract Test Suites (ATS) is written in TTCN. There are two versions of TTCN, version 2 (TTCN-2) as defined in ISO/IEC-9646-3 [2] and the recently published ETSI version 3 ES 201 873-1 [1].

NOTE: Version 1 of TTCN is not now used by ETSI.

Version 2 is oriented towards conformance testing and has been widely applied in testing telecommunications protocols and services for over 10 years. TTCN-3 is a modernization of TTCN-2. It has been developed to apply to a wide range of testing applications (i.e. it is not limited to conformance testing) and the syntax of the language has been brought into line with that of other modern programming languages.

While it is not anticipated that TTCN-2 will immediately replace TTCN-3 (from ETSI's point of view the transition to TTCN-3 is expected to occur over several years) there are good reasons to consider using TTCN-3 for "new" protocols such as SIP or OSP.

EP TIPHON is writing test specifications for H.225, H.245, H.248, SIP and OSP. The tests for the first three protocols are being written in TTCN-2. This is mainly due to timing (the work was started several months prior to the publication of TTCN-3) and the fact that they are "traditional" protocols (for example H.225 is very close to Q.931). It is also more likely that, in the short-term, the actual test systems for these protocols will be based on TTCN-2.

However, the nature of SIP and OSP (e.g., text-based, datacom-oriented) makes them an ideal candidate for TTCN-3. The present document makes an initial analysis on the suitability of using TTCN-3 to for SIP and OSP test specifications.

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5 Suitability of TTCN-3 for SIP testing

In order to understand the suitability of TTCN-3 for testing SIP it is necessary to consider three main aspects:

- the basic testing architecture, i.e. the location of the test interfaces;
- the expression of dynamic behaviour (i.e. SIP message exchanges);
- the representation of data (i.e. SIP messages).

These aspects are described in clauses 5.1, 5.2 and 5.3 respectively.

5.1 Architectural considerations for testing SIP

Two conceptual SIP test systems are illustrated in figure 1. The TTCN-3 parts of the test system are represented by the white boxes, which in the present document we refer to as the "TTCN-3 Tester". The light grey box represents sub-structured parts of the test system. The dark grey boxes indicate the underlying transport layer, either UDP or TCP.

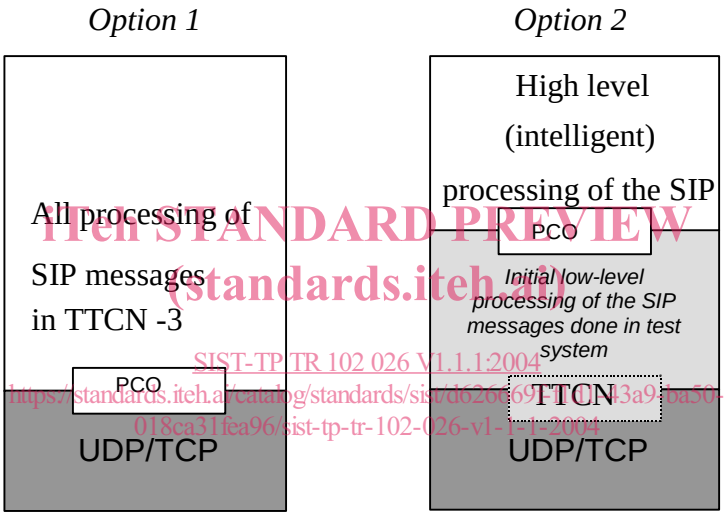

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Figure 1: Basic test system architecture

TTCN-3 behaviour is executed over test ports, sometimes called PCOs (Points of Control and Observation). For SIP testing there are basically two options for the placement of the PCO.

- directly over UDP (or TCP);
- higher than UDP (or TCP), i.e. "embedded" in the test system.

In the first option of figure 1 all processing of the SIP messages is expressed in TTCN-3. For received messages this means that the PCO delivers a SIP message to the TTCN-3 tester as a single text string. The TTCN-3 code must then (somehow) parse this text string and break it down into data structures on which the TTCN-3 matching mechanisms etc. can operate. For send messages the reverse occurs i.e. TTCN-3 data structures representing the SIP message are encoded as a single text string.

It is certainly possible to use TTCN-3 this way but this would probably be inefficient. It would also overload the TTCN-3 test cases (not to mention the test suite writers) with detail not explicitly relevant to the test purposes.

In the second option, the test system receives a SIP message over the UDP (or TCP) port and does the initial parsing *before* passing the structure to the TTCN-3 Tester via the PCO. In its simplest form this parser need only recognize the basic "outline" of the message with no detailed knowledge of individual headers. This structure would be mapped to the corresponding TTCN-3 template on a best possible fit basis. The TTCN-3 Tester then operates directly on this data structure rather than the incoming text string (by pattern matching).

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If the tester is to deliver more complex TTCN-3 structures then the underlying parser will need to be correspondingly complex. As this will effect how a TTCN-3 test case is expressed (i.e. place restrictions on how TTCN-3 is used) it is important that this functionality is defined by EP TIPHON at an early stage.

In conventional protocol testing (especially when using, say, ASN.1) this sub-layer (shaded light grey in figure 1) is often referred to as an encoder-decoder. Here, the incoming data is a bit stream which is decoded by the test system and passed to the TTCN-3 tester in structured form.

Discussions with several tool implementer's indicate that option 2 should be the favoured approach. The present document therefore recommends that EP TIPHON follow option 2 when writing TTCN-3 test cases for SIP.

5.2 Expressing SIP dynamic behaviour in TTCN-3

SIP has very simple dynamic behaviour. The TTCN-3 communication and timer mechanisms etc. are entirely adequate to specify the exchange of SIP messages. The present document recommends that TIPHON SIP tests are expressed using asynchronous communication.

NOTE: Generally, SIP testing would be based on asynchronous message exchanges, however TTCN-3 does have synchronous communication if it is desired to express the test that way.

A typical piece of SIP behaviour could be:

```
testcase SIP_RG_RT_V_001() runs on SipComponent system SipInterfaces
    // Selection: To be defined
    // Status: Mandatory
    // SUT: A UA, a proxy, or a redirect server.
    // Precondition: None
    // Ref: 2.2 [1], 7.1 [1], 10.14 [1]
    // Purpose: Ensure that the IUT, in order to be registered, sends a REGISTER request
    // t to its proxy (Home server, outbound proxy) with the action field set to "proxy"
    // in the Contact header field, without user name in the Request-URI,
    // with a Via header field and with a SIP URL as request-URI.
    {
        var REG_Request V_REGISTER_Request;
        var ContactAddress_List V_ContactList;
        var GenericParam_List V_GenericParamList;
        var integer i,j, nbelement, nbparam;
        var boolean hasBeenFound:=false;

        sut.action ("Please REGISTER");
        TWait.start(PX_TWAIT);
        alt
        {
        [] SIP1.receive (REGISTER_Request_r_2) from rcv_label -> value V_REGISTER_Request
          {
            TWait.stop;
            // Catch and prepare informations to answer
            iutContact :=
      getContactAddr(V_REGISTER_Request.reqHeader.contact.contactBody.contactAddress_List[1]);

            V_CallId := V_REGISTER_Request.reqHeader.callId;
            V_CSeq := V_REGISTER_Request.reqHeader.cSeq;
            V_From := V_REGISTER_Request.reqHeader.fromField;
            V_To := V_REGISTER_Request.reqHeader.toField;
            V_Via := V_REGISTER_Request.reqHeader.via;
            // update sent_label according to received via header field
            getViaReplyAddr(V_Via.viaBody);
            //Add a Tag in the TO field
            V_To.toParams := {{TAG_ID, GetAValueTag()}};

            // Check Contact content
            V_ContactList := V_REGISTER_Request.reqHeader.contact.contactBody.contactAddress_List;
            nbelement := sizeof(V_ContactList);
                for (i:=1;i==nbelement;i:=i+1)
                {
                  hasBeenFound:=false;
                  // Check that parameters are present in the contact
                    if (match(V_ContactList[i], ContactAdress_r_1))
                    {
                        V_GenericParamList := V_ContactList[i].contactParams;
                        nbparam := sizeof(V_GenericParamList);
                        j:=1;
                        //Check that at least one parameter is set to action="proxy"
```

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```
                    do
                    {
                        if (match(V_GenericParamList[j],GenericParam_r_1))
                        {
                            hasBeenFound:=true;
                        }

                        // Check that contact does not include a parameter set to action="redirect"
                        if (match(V_GenericParamList[j],GenericParam_r_2))
                        {
                            hasBeenFound:=false;
                            j:= nbparam;
                        }
                        j:=j+1;
                    }
                    while (j<=nbparam) //end loop on contact parameters
                }

                if(not hasBeenFound)
                {
                  verdict.set(fail);
                  //Answer with a 409 status message
                  SIP1.send (Response_409_s_1(V_CallId, V_CSeq, V_From, V_To,
                  V_Via )) to sent_label; stop
                }
            } //end For on Contact list
            verdict.set(pass);
        //Send a 200OK Answer to the UA with an Expire header field set
        //to PX_DELTA_REGISTRATION and the contact list
        SIP1.send (Response_200_s_2(V_CallId, V_CSeq, V_From, V_To,
         V_Via, V_REGISTER_Request.reqHeader.contact,
          PX_DELTA_REGISTRATION )) to sent_label

    }
  [] SIP1.trigger from rcv_label
  {
      all timer.stop;
      verdict.set(fail);
      stop
  }
  [] Twait.timeout {verdict.set(inconc); stop}
 }

} // end testcase SIP_RG_RT_V_001
```

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5.3 Expressing SIP messages in TTCN-3

Currently many SIP test suites specify one single text string for each instance of a message. Changing one element in a message means that a complete, new message needs to written. The end result is many hundreds of individual SIP messages. No rationalization. No reuse. Worse still, matches on incoming messages have to be exact, where in practice a degree of flexibility is often desirable.

The TTCN-3 approach allows to set and match individual elements of data in complex messages. To give a high degree of controllability and observability. Because SIP messages are text based they have no explicit structure, contrary to conventional telecommunications protocol. For example:

```
INVITE sip:test@sip.com SIP/2.1
From: userB<sip:xxx@yyy.zzz>
To: userA<sip:aaa@bbb.ccc>
CSeq: 1 INVITE
Content-Length: 0
```

In order to test SIP using TTCN-3 it is necessary to give the messages at least some level of structuring. Highly structured SIP data will give a good degree of control but will probably lead to a humanly unreadable test suite. Conversely, little or no structuring will give good readability but very little control. In this clause we present a style of using TTCN-3 that attempts to achieve controllability while retaining a good degree of readability.

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A SIP message has three basic parts, the *Request (or Status) line*, the *headers* and the (optional) message *body*. The components of a Request or Status line appear in a given order. In TTCN-3 this can be represented using a record type, for example:

```
// SIP Message Request
type record SIP_REQUEST
{   charstring      Method          optional, // even mandatory fields are optional
    charstring      Request_URI     optional, // so that we can specify invalid messages
    charstring      SIP_Version     optional,
    :
}
```

Actual messages can be defined using TTCN-3 templates. For example:

```
template SIP_REQUEST MyRequest :=
{   Method      := "INVITE ",
    Request_URI := "sip:test@sip.com ",
    SIP_Version := "SIP/2.1\r\n"  // where \r\n represents %d13%d10 the CR + LF characters
    :
}
```

Explicit spaces could be included in the structure rather than having them as part of the actual string value (see clause 5.3.1).

For the sake of this discussion let us assume that SIP headers are text strings terminated by an end of line character (e.g., CR or LF or CRLF). Generally, SIP messages allow headers to appear in any order. However, for sent messages (i.e. SIP Requests) the TTCN-3 Tester should specify messages with the SIP headers in a given order. In TTCN-3 this can be expressed using the **record of** type.

```
// Unbounded array of character strings (i.e. headers)
type record of charstring REQUEST_HEADERS;

// Unbounded array of character strings (i.e. body elements)
type record of charstring REQUEST_BODY;

// SIP Message = Request Line + Headers + Body
type record SIP_REQUEST
{   charstring      Method          optional, // even mandatory fields are optional
    charstring      Request_URI     optional, // so that we can specify invalid messages
    charstring      SIP_Version     optional,
    REQUEST_HEADERS Message_Headers optional,
    REQUEST_BODY    Message_Body    optional
}
```

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For received messages (i.e. SIP Responses) the TTCN-3 Tester should be prepared to accept messages with the SIP headers appearing in an arbitrary order. In TTCN-3 this can be expressed using the **set of** type.

```
// Unbounded set of character strings (i.e. headers)
type set of charstring RESPONSE_HEADERS;

// Unbounded set of character strings (i.e. body elements)
type set of charstring RESPONSE_BODY;

// SIP Message = Response Line + Headers + Body
type record SIP_RESPONSE
{   charstring          SIP_Version     optional, // even mandatory fields are optional
    charstring          Status_Code     optional, // so that we can specify invalid messages
    charstring          Reason_Phrase   optional,
    RESPONSE_HEADERS    Message_Headers optional,
    RESPONSE_BODY       Message_Body    optional
}
```