Methods and Tools for Testing of Next Generation Networks, VoIP and MMoIP

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Research Group IP-based Comm.-Systems: Technologies / Partners

- Voice over IP, Multimedia over IP
- Session Initiation Protocol (SIP)
- Presence Service

- NGN, IMS (IP Multimedia Subsystems)
- Soft-PBX: Asterisk, SER, Freeswitch, SIPX etc.

- Quality of Service Mechanisms (QoS)
- IntServ, DiffServ, MPLS
- IPv6
- Analysis of "VoIP-Readiness"
- Security in VoIP Systems

- Testing of IP-based Comm.-Systems
- Conformance Tests, TTCN-3
- Interoperability Tests
- Stress Tests

Research project funded by "Niedersächsisches Vorab der VolkswagenStiftung".
In-Vehicle and Tele-Communications ??

- Technology, methods and tools are the same,

- Protocols will become the same ...
Overview

• NGN ... Multiservice Networks

• What to Test ?

• Problems of Testing in the Context of NGN

• First Approach to Systematic Improvement of Test Coverage

• Next Steps
NGN - ITU - Definition

The NGN is characterized by the following fundamental aspects:

- Packet-based transfer
- Separation of control functions among bearer capabilities, call/session, and application/service
- Decoupling of service provision from network, and provision of open interfaces
- Support for a wide range of services, applications and mechanisms based on service building blocks (including real time/streaming/non-real time services and multi-media)
- Broadband capabilities with end-to-end QoS and transparency
- Interworking with legacy networks via open interfaces
- Generalized mobility
- Unrestricted access by users to different service providers
- A variety of identification schemes which can be resolved to IP addresses for the purposes of routing in IP networks
- Unified service characteristics for the same service as perceived by the user
- Converged services between Fixed/Mobile
- Independence of service-related functions from underlying transport technologies
- Compliant with all Regulatory requirements, for example concerning emergency communications and security/privacy, etc.
NGN - Layered Architecture

Service Plane
- AS
- AS

Control Plane
- HSS
- CSCF
- MRF
- SG/MGCF

Transport Plane
- IP with QoS
- PSTN/PLMN
- MGW

Supporting Systems
- Management
- Provisioning
- Charging Mediation
- Number mapping

Number mapping
<table>
<thead>
<tr>
<th>Layer</th>
<th>Terminal</th>
<th>Proxy (e.g. P-CSCF)</th>
<th>Server</th>
<th>Proxy (e.g. P-CSCF)</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Plane</td>
<td>Control Related Terminal Functions</td>
<td></td>
<td>Registrar, Presence Server, Conference Control</td>
<td></td>
<td>Control Related Terminal Functions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Layer</th>
<th>Application</th>
<th>Transport</th>
<th>Internet</th>
<th>Host-to-Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Plane</td>
<td>User Data Related Terminal Functions (e.g. Voice Coding)</td>
<td></td>
<td>TCP, UDP, RTP, RSVP, MPLS, IPv4/IPv6</td>
<td></td>
</tr>
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What to Test?

- **Conformance Test**
  - Test of network elements / protocol entities with respect to conformance with relevant protocol specifications (Standards)
  - Goal: Guarantee interoperability of all network elements having successfully passed a conformance test for the same protocol
  - Problems:
    - Ambiguity/completeness of protocol specifications (Standards)
    - Test coverage

- **Interoperability Test**
  - Analysis of co-operation between networks elements / protocol entities

- **Function Test**
  - Systematic test of specific functions of network elements / protocol entities

- **Stress-Test**
  - Quantitative determination of load limits
  - Analysis of system behaviour when reaching load limits
Interoperability Test ...
Function Test ...

Name: REGISTER

Beschreibung
Mit dem REGISTER meldet sich ein Nutzer mit IP und Adresse am jeweiligen Registranten vor.
Das REGISTERT auch innerhalb einer festgelegten Zeit ab.
Stress-Test ...

Messpunkte / Messgrößen
- Timeouts
- Fehlermeldungen (5xx)

CPU-Load
- Load-Average
- Memory use

"Counter Ticks"
- Rechenaufwands-ermittlung einzelner Quellcodeausschnitte

Timeouts
- Fehlermeldungen (5xx)

Parametrisierung / Lasteinstellung
- Codec
- Rufaufbau (Calls/sec)
- Rufdauer

Testaufbau
- Lastgenerator

SIPp UAC
- Rufaufbau mit verschiedenen Codecs, z.B. G711u, G711a, iLBC, G726, GSM

Testobjekt
- Soft-PBX
  - Rufvermittlung
  - Transcoding

Soft-PBX
  - Annahme von Rufen
  - RTP Echo

Messgrößen

Einstellgrößen

Fachhochschule Braunschweig/Wolfenbüttel
Fachbereich Elektrotechnik
Fachgebiet Telekommunikation

Research project funded by „Niedersächsisches Vorab der VolkswagenStiftung“.
Problems of Testing in the Context of NGN

- Most protocols specified verbally in standard documents
- Lack of independent reference implementations
- Many hybrid network elements operating different external protocols, in particular signalling gateways, media gateways
- Many relevant IETF-Standards still in "Draft" status
Steps of Standardization by IETF

- Standard-Track
  - Standard
  - Draft Standard
  - Proposed Standard
- Non-Standard-Track
  - Experimental
  - Informational
  - Procedures for Experimental and Informational RFCs
- Best Current Practice (BCP)
  - Historic

Course of Development

Internet Draft

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Overview Test Development and Derivation

Protocol Specification

Formal Description Techniques (FDT)

Testcase Derivation, Tools and Methods

Formal Testcase Description

Testcase Compiler

Executable Testcases

- (Verbal) Protocol Specification
- Tabular Testcase Description
- Specification Definition Language (SDL)
- UML, (State Charts)
- Verbal Testcase Description
- UML Testing Profile
- Conformiq Testgenerator
- TTCN-3 Graphical Presentation Format
- TTCN-3 Source Code
- XML Testcases
- Test Script Language (TSL)
- Tau Tester
- OpenTTCN
- TTworkbench
- TK-Testtool (AST_FT)
- Radvision Prolab
- C Programme
- Java Programme
- SIPp Configuration
- Prolab Testagents

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Test Coverage for Conformance Tests

- 100 % test coverage is not realistic

- SOVS - approach to pragmatic optimization is based on idea of numeric variables

- Higher level protocols as in NGN typically have nominal attributes characterizing PDUs exchanged

=> SOVS idea therefore needs to be adapted

  - functional dependencies instead of numeric correlations ...

- Interoperability problems in daily operation need to be analyzed in order to complete conformance test suites.
Approach to Optimization of Test Coverage for Higher Layer Protocols

- **Test Coverage**
- **Conformance Testing**
  - Protocol Specification (verbal)
  - Derivation of Conformance Test Cases
  - Executable Test Cases (TTCN-3)
  - Conformance Testing
- **Development of Network Element**
  - Network Element as SUT
- **Interoperability Monitoring**
  - Network Element in daily Operation
  - PDU Database (AST_PA)
  - Traces of Daily Operation
  - Labeling of Interoperability Problems

**Analysis and Improvement of Test Coverage**

- Test Cases derivated from protocol specification
- Test Cases derivated from rules of SUT’s daily operation
- Test Cases derivated from interoperability problems in SUT’s daily operation

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Thanks for your attention ...

Questions?

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