IMS Test Challenges

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What is IMS?

- Reference architecture
- Growing collection of protocols and standards
- Evolution of NGN
- Convergence enabler
- Billion $ market
- Universal network platform of the future
IMS Challenges

- **Enormous Complexity**
  - Lots of standards: 3GPP, 3GPP2, TISPAN, Packet Cable, etc.
  - Lots of functions: CSCF, HSS, MRF, PDF, A-BGF, etc.
  - Lots of protocols: SIP, COPS, Diameter, H.248, SS7, etc.
  - Lots of interfaces: Cx, Dx, Mm, Mw, Sh, Si, etc.

- **Standards Ambiguity**
  - Extensible standards are not complete
  - Compliance is a moving target

- **Multi-vendor Interoperability and Network Interworking**
  - The days of single-vendor deployments are numbered
  - How do you agree on how to interoperate with standards in flux?

- **Increasing Customer Expectations**
  - Subscribers don’t care about IMS
  - Voice quality is more important than ever
IMS Test Challenges

Verify interoperability
- Modular IMS architecture encourages use of best-of-breed elements
  - Vendor- and device-specific protocol implementations
- Differentiation and legacy concerns result in service-specific call flows
  - Signaling and media interoperability across service domains

Verify features
- Emulate end-users interaction against the feature set
- Regression test features against new software loads
  - Verify added feature/functionality
  - Ensure that current features function as they did before

Ensure end-user Quality of Experience – Media Quality
- Load testing adds background load to emulate the subscriber base
  - Delayed responses
  - Incorrect responses
  - Call disconnects

Troubleshoot complex, distributed systems
IMS Test Challenges
Interoperability

- **Evolving standards**
  - Protocol extensions
  - Growing ecosystem of versions and drafts

- **Custom implementations**
  - When standards don’t solve problems, custom protocol extensions will…

- **Vendor-specific protocol variants**
  - Protocol extensions support differentiation
  - Third-party stacks limit flexibility

- **Legacy integration**
  - Each legacy interface adds complexity
Interoperability
Product Implementations

Source: TISPAN-3GPP Workshop

- IMS functions
- ETSI TISPAN extensions
- SIP
- H.248
- DIAMETER
- Other

IP transport (access and core)

Other IP networks

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Interoperability
No VoIP Protocol Stacks == Flexibility
Interoperability
Example: Media Redirect

Initial call setup
Interoperability
Example: Media Redirect

Media redirected using re-INVITE
Non-standard header – Remote-Party-ID

- Remote-Party-ID was defined in an Internet-Draft
- Draft was later obsoleted and disappeared from SIP specs

```
INVITE sip:4005@Carrier7288.com;user=phone;maddr=60.163.227.38;cic=9014 SIP/2.0
Via: SIP/2.0/UDP 10.77.99.10:51056
From: <sip:9135427298@Carrier7288.com;user=phone>;tag=10000000-0-774939698
To: <sip:4005@Carrier7288.com;user=phone>
CSeq: 1 INVITE
Contact: <sip:9135427298@10.77.99.10:51056>
Call-ID: 16842F-56@10.77.99.10
Remote-Party-ID: <sip:9135427298@Carrier7288.com;user=phone>;party=calling;id-type=
Max-Forwards: 70
Content-Type: application/sdp
Content-Length: 190

v=0
o=- 3327239644 3327239644 IN IP4 10.77.99.10
s=-
c=IN IP4 10.77.99.69
t=0 0
m=audio 18854 RTP/AVP 0 101
```
Interoperability
Example: De-Registration

Normal registration process

1. Register
2. Register
3. Cx-Query/Cx-Select-Pull
4. Cx-Query Resp/Cx-Select-Pull Resp
5. Register
6. Cx-put/Cx-Pull
7. Cx-Put Resp/Cx-Pull Resp
8. Service Control
9. 200 OK
10. 200 OK
11. 200 OK

Visited Network
UE  P-CSCF

Home Network
I-CSCF  HSS  S-CSCF
De-registration process if the endpoint device is no longer responding
IMS Test Challenges
Verify Features

IMS Lifecycle Testing

- Many Networks
- Many Vendors
- Many Devices
- Single Network
- Many Vendors
- Many Devices
- Single Network
- Single Vendor
- Many Devices
- Single Network
- Single Vendor
- Single Device

- Service Providers
  - Interconnection and Roaming
- Interoperability
- Network Monitoring
- Load & Stress
  - Functional
  - Conformance
  - Prototyping
- Network Equipment Manufacturers

- R&D
- QA
- Production
- Trial
- Deployment
- Maintenance

Lifecycle Phase
Verify Features
Example: Media Server

**Development**
- Unit Test / Feature Test
- Interoperability w/vendor devices
  - Application servers etc.
  - Endpoint devices
- Conformance Test
  - Interoperability w/standards

**QA**
- System Test
- Load Test
- Regression Test

**PoC / Vendor Qualification**
- Feature Test
  - Interoperability w/service implementations
- Analysis and troubleshooting
  - Media and signaling

**Acceptance/Installation**
- Analysis and troubleshooting
- Optimization

**Post-Deployment**
- Monitoring

**Key Test Issues**

- Interoperability
  - Standards
    - Some are in flux
    - SIP extensions
  - AS vendors
  - MGW vendors
  - SIP endpoint vendors
  - Carrier services implementations
    - Vary, often due to legacy

- Media performance
  - Media quality
  - Scalability and performance
  - Functionality (DTMF etc.)
  - Compatibility (e.g. MGW VAD)
Verify Features
Example: Media Server Test Plan

**SIP CALL SIGNALING TESTS**
- Softswitch to Media Server – Normal, Abnormal
- App Server to Media Server – Normal, Abnormal
- RFC3261 Conformance

**ANNOUNCEMENT SERVER TESTS**
- Simple Announcement – NFS-based, HTTP-based
- Simple Announcement – Audio Formats, Endpoint Disconnects, Large Files
- Sequenced Announcement – Variable Duration, Music-on-Hold
- Announcement – Newly Loaded Prompts, Customized Prompt Creation

**IVR SERVER TESTS**
- IVR Prompt Play & Record
- IVR Prompt Play & Collect Digits
- IVR Prompt Play & Collect – Escape/Return, Barge
- IVR Prompt Play & Collect – Music-on-Hold
- Voicemail – Interactions

**CONFERENCE BRIDGE TESTS**
- Simple Conference – Session Open, Session Close, Multi-CODEC
- Advanced Conference – Session Open, Session Close, Multi-CODEC
- Advanced Conference – Play Announcement, Record Session
- Advanced Conference – Mute Leg, Active Talker Event

**VXML-BASED APPLICATION TESTS**
- VoiceXML Announcement
- VoiceXML Transfer
- VoiceXML Conformance – Normal Flows, Abnormal Flows
- SIP-unaware VoiceXML App Servers

**3RD PARTY APPLICATION INTEROP TESTS**
- SIP Proxy Servers
- Application Servers
- IVR Application Servers
- Voicemail /UM Application Servers
- Conferencing Application Servers
- IP Centrex Application Servers

**3RD PARTY GATEWAY/SOFTSWITCH INTEROP**
- Wireline – PSTN
- Cable – PSTN Interworking
- Mobile - IMS Sub-System

**ADVANCED TESTING**
- 10 CPS Load Test – Announcements
- 25 CPS Load Test – Announcements
- 50 CPS Load Test – Announcements
- 100 CPS Load Test – Announcements
- Var Play-Hold Load Test – Announcements
- Var CPS/CODEC Load Test – Announcements
- Load Test – Conferencing
- Load Test – Mixed Applications
- Heterogeneous Endpoints
IMS Test Challenges

**Voice Quality**

- **Latency**
  - End-end transmission, processing delays

- **Jitter**
  - Network congestion causes variable delays

- **Packet loss**
  - Buffer overflow, errors
  - Packet loss concealment

- **Echo**
  - Reflections from analog loop interfaces

- **Compression**
  - Media quality vs. bandwidth tradeoff

- **Devices**
  - IP PBXs
  - IP Phones & VoIP Endpoints
  - Media Gateways
  - IVR / Voice portals
  - SBCs (Session Border Controllers)
  - Media Servers
  - Firewalls/ALGs
  - Messaging Servers
  - Conference Bridges
Voice Quality
Alternative Testing Approaches

- **Passive E-Model via packet inspection**
  - Non-intrusive, minimal MIPS
  - Ignores VQ problems outside the IP network (e.g. gateways, TDM)

- **Active end-to-end VQ measurement via PESQ**
  - Accurately reflects media quality problems from all sources
  - Live test calls required, media processing requires MIPS
IMS Test Challenges
End-to-End VQ Testing

Evaluate quality all the way to the phone’s internal “VoIP gateway”
- Automatic Gain Control (AGC)
- Voice Activity Detection (VAD)
- Comfort Noise Generation (CNG)
- Echo cancellation
- Codecs
- Jitter buffer management
- Packet loss concealment algorithms
- etc…

Evaluate under expected LAN/WAN impairment conditions
- Packet loss, jitter, latency
- Effective bandwidth of IP connection (broadband vs. dialup)

Don’t forget interoperability testing against other VoIP devices
- Verify VQ against other expected manufacturer’s devices
IMS Test Challenges
*Troubleshooting Complexity*

- **End to End**
  - Element Interactions
- **Session Behavior**
  - Discrete Media
    - Stream level inspection
    - Visualization of the Experience
- **Network topology**
  - Multi-Protocol
  - Multi-Carrier
  - Multi-Vendor

**Signaling**
**Gateway**
**Softswitch**
**Media Gateway**
**Application Server**
**Media Server**
**Visualization of the Experience**
IMS Test Solutions
Testing Throughout the Lifecycle

Service

Network

Device

Application

Functionality
Performance

Visualization of the Experience

Multi-Protocol
Multi-Carrier
Multi-Vendor

Distributed Architecture
Multiple Elements

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IMS Test Solutions
Device and Network Emulation

Access Network

IP Network Emulation

Non-IMS IP PDN

Device Emulation

TDM Emulation

Legacy PLMN

IP PDN

Non-IMS

Device

Network

Endpoint

Emulation

Emulation

Emulation

Emulation

Emulation

Emulation

Emulation

Emulation
IMS Test Solutions
Empirix and IMS

- **Verify interoperability**
  - Sig Editor / state machines for flexible device emulation

- **Verify features**
  - HVB for programmable endpoint / user emulation
  - Installed base of Hammer scripts, expertise

- **Ensure end-user Quality of Experience**
  - Best in Class media testing
  - Scalable IP media

- **Troubleshoot complex, distributed systems**
  - Hammer Call Analyzer
  - Integrated Hammer call gen/analysis solutions

- **Confidence, Experience, Predictability**
  - Market share leadership, brand
  - Relationships with Best of Breed NEMs
  - Breadth of coverage from our product line
Empowering Your customers and employees with speech technologies

SpeechTEKI 2006 Empower
The Voice Solutions Showcase

Thank You