Service Quality Assessment in All-IP Networks

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2010 Annual CQR Workshop
June 8 - 10, 2010
Agenda

- Background
- A Network Reliability Assessment Framework
- The China Mobile Project
- Summary & Future Work
Trends in Telecom Networks and Services

Network architecture evolution:  
“stovepipe” → unified IP-based

- **New, multiplex services**
  - VoIP, WAP, IPTV, etc.

- **New network technologies and elements**
  - GPON, PTN, LTE and even intelligent terminals.
Key for Addressing Network Reliability Issues

1. To develop a solution for any network-related reliability problems, it's important to have an E2E view on the networks.


An E2E Network Solution’s View

Service-Centered

- Reliability
- QoS/QoE
- Security

Next Generation IP-based Networks Reliability should include reliability, QoS/QoE, & security.
Network Reliability Assessment System Approach

Allocation

Service QoE

Network E2E KPIs/KQIs

KPIs of Each Network Layer

Assessment

- VoIP
- IPTV
- WAP
- ...

- E2E Packet Loss
- E2E Latency
- ...

- Terminal
- Access
- Core Network
- IP bearer
- Transport
- ...
Remaining Challenges

- The connection between network KPIs and service QoE is not transparent.
- An E2E hierarchical framework for All IP network KPIs and service QoE is needed:
  - includes not only internet or IP layer, but all the relevant network layers and NEs.
- Practical monitoring solutions for All IP network KPIs and Service QoE are needed.

Traditional network quality monitoring is only concerned with the KPIs of delay, jitter, packet loss;

**BUT**, good KPIs does not imply good service quality. Network KPIs are insufficient to forecast the decline of service quality and end-users’ QoE.
E2E Hierarchical Framework of All IP Network KPIs & Service QoE

VoIP
- Call completion rate
- Voice quality
- ...

IPTV
- Quality of the pictures (voice & video)
- Zap Time (channel change latency)
- Response time of request

WAP
- Successful connection rate
- Web-browsing speed
- ...

Wireless Access:
- Accessibility, ...
- Resource usage
- Coverage

Wire line Access:
- Coverage
- Cross Talk

IP Bearer:
- Call success Ratio
- Switch success Ratio
- Authentication success Ratio
- Latency
- Jitter
- Packet Loss

Transport:
- Bit Error Rate (BER), Optical Signal To Noise Ratio (OSNR)

Service QoE

Net. KPI

Net. Layer

Terminal
- Mobile
- Telephone
- TV
- STB
- PC

Access Networks

Core Network

Bearer Network

Sustainability, ...

[Diagram showing terminal access networks, core network, and bearer network with various KPIs and QoE metrics for VoIP, IPTV, and WAP.]
Project Overview

**Target**
Understanding the impact of KPI/NPI of individual network layers on the KQI of the end-to-end network. Thereby improve the performance and quality of production network.

- Each network layer has its own KPIs, but operators don’t know which ones are of the most important for service quality and reliability, and what are the relationships between these KPIs and end-user’s QoE;
- The operators need a methodology for the end-to-end network quality assessment based on KPIs of individual network layers.

**Method**
The method consists of identifying the KPIs, studying the correlation between KPIs and QoE by doing tests on production networks, and further testing and validation in the lab.
Identify the Metrics

E2E Service Quality Metrics

Softswitch
- MOS Value
- Delay
- Jitter
- Packet Loss

IP Bearer
- MOS Value
- Delay
- Jitter
- Packet Loss

Optical Transport
- BER
- OSNR
- Errored Second
- Degraded Second

Identify the metrics to monitor at different network layers
Testing Results and Conclusions

The effect of delay on voice quality

- E2E voice quality is insensitive to delay.
- E2E voice quality is sensitive to jitter.
- E2E voice quality is sensitive to packet loss.

The effect of jitter on voice quality

The effect of packet loss on voice quality

Effect of bearer network KPIs on voice quality:
- E2E voice quality is insensitive to delay.
- E2E voice quality is sensitive to jitter.
- E2E voice quality is sensitive to packet loss.
E2E Network Quality Assessment Method

Network Quality =

( Soft switch Network Quality ) + ( IP Bearer network Quality ) + ( Optical Transport Network Quality )

- **Soft switch Network Quality Score** = A interface MOS score + delay score + jitter score + packet loss score
- **IP Bearer Network Quality Score** = Nb interface MOS score + jitter score + packet loss score
- **Optical Transport Network Quality Score** = single-wavelength optical power score + OSNR score + bit error rate score

**Value Ranges for Parameters**

- MOS Value: measured value, from 0 to 5
- Delay score: 5 below 50ms, interpolated linearly above 50ms.
- Jitter score: 5 below 10ms, interpolated linearly above 10ms.
- Packet loss score: 5 below 1%, interpolated linearly above 1%
- Single-wavelength Optical Power score = 5 within threshold, 0 otherwise
- OSNR score = 5 within threshold, 0 otherwise
- BER score = 5 within threshold, 0 otherwise
Summary & Future Work

- Network reliability ideas need to be changed as the network technologies develop. Include not only the outages & failures, but also the E2E service quality.

- A hierarchical reliability assessment methodology for All IP networks should be developed. The key is identifying the correlations between network KPIs and service QoE.

- We have shared early results of an experiment project for China Mobile production network. Several questions are still being explored.
Thank you

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Related Work

- Several “pieces” already in place:
  - Service QoE
    - ITU-T G.107 E-Model and P.800 MOS for voice
    - ITU-T G.1070 for multimedia
  - Network KPI
    - A lot of work has been done by ITU-T SG12 and SG13, and IETF IPPM groups BUT only for IP networks.

Example: Relevant Standards developed by IETF IPPM
- RFC 2330 Framework for IP Performance Metrics
- RFC 2678 IPPM Metrics for Measuring Connectivity
- RFC 2679 A one-way Delay Metric for IPPM
- RFC 2680 A one-way Packet Loss Metric for IPPM
- RFC 2681 A Round-trip Delay Metric for IPPM
- RFC 3148 A Framework for Defining Empirical Bulk Transfer Capacity Metrics
- RFC 3357 One-way Loss Pattern Sample Metrics
- RFC 3393 IP Packet Delay Variation Metric for IP Performance Metrics (IPPM)
- RFC 3432 Network performance measurement with periodic streams Status of this Memo
- RFC 4656 A one-way Active Measurement Protocol (OWAMP)
- RFC 4737 Packet Reordering Metrics
- RFC 5136 Defining Network Capacity
- RFC 5357 A Two-Way Active Measurement Protocol (TWAMP)
- RFC 5560 A One-Way Packet Duplication Metric
- RFC 5644 IP Performance Metrics (IPPM) Spatial and Multicast
Validation Testing in Lab

The measurement were done on the following Reference Paths:

A: E2E MOS value of Um1 - Um2
B: MOS value of Um1-A1
C: MOS value of Um2-A2
D: MOS value of A1-A2
E: MOS value, delay, jitter, and packet loss of Nb1-Nb2

Legend
A: Air interface
MOS: Mean Opinion Score
RP: Reference Point
Um: air interface between the MS and the BTS (GSM standard)