Service Level Agreement (SLA) and Global QoS index for 3G networks

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Outlook

1. UMTS QoS issues and Service level Agreements
2. Parlay for SLA control
3. Global QoS index
4. “Gold-silver-bronze” QoS standard
5. Best practice. New York experience
6. Best practice. LRAIC approach for penalties
7. Conclusion
1.1 Service Level Agreement

1. Service Level Agreement (SLA) - formal agreement between two or more entities with the scope to
   – assess service characteristics,
   – responsibilities and
   – priorities of every part.

2. SLA may include compensations for an unreached level of quality as an economic issue of the contract.
1.2 Introduction on QoS and SLA studies


   - Fault report for access line per year,
   - Unsuccessful call ratio,
   - Call set up time,
   - Supply time for initial network connection,
   - Percentage of orders completed on or before the date confirmed or contracted with the customer,
   - Response time for operator service,
   - Availability of card or coin operated public pay phones,
   - Fault repair time,
   - Service restoration.

3. ETSI TIPHON project for IP telephony. “Gold-silver-bronze” approach:
   - Voice packet loss: < .5% for class 1 = gold,
   - .5% to 1% for class 2 = silver,
   - 1% to 2% for class 3 = bronze.
1.3 3GPP QoS Concept and Architecture
(3GPP TS 23.107 V5.1.0)
1.4 Multimedia Services

- Real Time Communications
- Voice
- Text
- Video
- Non-Real Time Communications
- audio download;
- video download;
- audio streaming;
- video streaming;
- general data files;
- text messaging (e.g. SMS);
- emails;
- general web browsing;
- multi-media messaging
1.5 Value ranges for UMTS Bearer Service Attributes

<table>
<thead>
<tr>
<th>Traffic class</th>
<th>Conversational class</th>
<th>Streaming class</th>
<th>Interactive class</th>
<th>Background class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum bitrate (kbps)</td>
<td>&lt; 2 048</td>
<td>&lt; 2 048</td>
<td>&lt; 2 048</td>
<td>&lt; 2 048</td>
</tr>
<tr>
<td>Delivery order</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Maximum SDU size (octets)</td>
<td>&lt;=1 500 or 1 502</td>
<td>&lt;=1 500 or 1 502</td>
<td>&lt;=1 500 or 1 502</td>
<td>&lt;=1 500 or 1 502</td>
</tr>
<tr>
<td>SDU format information</td>
<td>RCP protocol</td>
<td>RCP protocol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery of erroneous SDUs</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>SDU error ratio</td>
<td>10^{-2}, 7*10^{-3}, 10^{-3}, 10^{-4}, 10^{-5}</td>
<td>10^{-1}, 10^{-2}, 7*10^{-3}, 10^{-3}, 10^{-4}, 10^{-5}</td>
<td>10^{-3}, 10^{-4}, 10^{-6}</td>
<td>10^{-3}, 10^{-4}, 10^{-6}</td>
</tr>
<tr>
<td>Transfer delay (ms)</td>
<td>100 – maximum value</td>
<td>250 – maximum value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guaranteed bit rate (kbps)</td>
<td>&lt; 2 048</td>
<td>&lt; 2 048</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic handling priority</td>
<td></td>
<td></td>
<td>1,2,3</td>
<td></td>
</tr>
<tr>
<td>Allocation/Retention priority</td>
<td>1,2,3</td>
<td>1,2,3</td>
<td>1,2,3</td>
<td>1,2,3</td>
</tr>
</tbody>
</table>
1.6 IETF activities and 3GPP

Quality of Service Enablers

IETF Integrated Services (IntServ) and Resource Reservation Protocol (RSVP)

Differentiated Services (DiffServ)

Multiprotocol Label Switching (MPLS)

QoS Management Enablers

Service Level Agreements (SLAs)

Common Open Policy Service (COPS) protocol

Simple Network Management Protocol (SNMPv3)
1.7 Quality of Service (QoS)

ITU-T: *The collective effort of service performance which determine the degree of satisfaction of a user of the service.*

- **User Domain**
  - Speed
  - Accuracy
  - Dependability
    - Reliability
    - Availability
  - …
- **Provider Domain**
  - Delay
  - Loss
  - Utilization
  - …
1.8 Service Level Agreement

SLA is a result of negotiation between two entities which shows

- service development
- service access & delivery characteristics
- service monitoring and management and
- service economical perspective

**SLA Parts**

- QoA – QoS Agreement
  - QoA Objectives or Service Level Specifications
- TCA Traffic – Conditioning Agreement
- Management and Monitoring
- Reporting and Backup

**QoS: ITU-T:** The degree of conformance of the service delivered to a user by a provider with an agreement between them.
1.9 Service Level Specifications

A SLS is a specific SLA and its SLO's to guarantee quality of service to the user.

- SLS are dependent on network environment but are independent of underlying technology and protocols.
- On the other hand, SLO’s depend on the underlying technology, protocols and implementation schemes.
1.10 SLA and QoS for Wireless Environments

• QoS Support in the 2.5 and 3rd Generation Networks
• QoS Criteria particular to wireless and mobility
  – Accessibility
  – Reliability
  – Connection time
  – Service interruptions or dropout due to scarce network resources
  – Network coverage
  – Roaming and Hand-Over performance
  – Speech quality
  – Data transfer rate
  – Inter-operability between different domains
2.1 The Parlay/OSA API
2.2 The Parlay/OSA Framework

- control of access to the network
- integrity management
- discovery of network functionality

Client Application

Enterprise Operator

Framework

Registered Services

- Application subscription to services
- SCF registration
- support of multi-domain

Call Control
Mobility
etc
2.3 OPIUM Project as UMTS QoS Testbed?
3.1. How to built the global SLA index

1) We use a **linear discriminant function LDF**, in other words, a scalar product of vectors and:

\[ Q = W_1X_1 + W_2X_2 + \ldots + W_nX_n \]

where \( W_1, \ldots, W_n \) are unknown constants, and choose some threshold value \( a \) that the decision rule is as follows:

\[ D_1 \text{ if } Q < a \]
\[ D_2 \text{ if } Q > a \]

2) For "gold-silver-bronze" standard - any service/network provider can be correlated to one of three classes:

- **Gold level** ("Really Great" – expensive) if \( Q < Q_1 \).
- **Silver level** ("Darn Good" – not so expensive) if \( Q_1 < Q < Q_2 \).
- **Bronze level** ("Best Effort" – inexpensive) if \( Q_2 < Q \).
3.2 Geometrical interpretation of classification

for two-dimensional case

Mahalanobis distance

\[ M^2 = (\mu_2 - \mu_1)^T \sum (\mu_2 - \mu_1) \]
3.3 Scheme for SLA conflict resolution

\[
\alpha = 5\%
\]

Density

Acceptable range of SLA values

Complaint zone

\[ z_0 \]

Global SLA index
4.1 Quality optimisation scheme:

a) basic idea, b) penalty scheme
4.2 “Gold-silver-bronze” penalty scheme

- Expenditure
- Quality of service improvement
- Silver penalties/at gold agreed
- Bronze penalties/at gold agreed
- Gold-missed penalties
- Silver-missed penalties

Gold zone
Silver zone
Bronze zone
Q1
Q2

Global SLA index Q
5.1 Best Practice: "New York Telephone" Service Standards

The Telephone Service Standards of New York Telephone Company (Verizon NY now) were adopted by the New York State Public Service Commission in 1973 and revised in 1989 and 1991.

Measurement of service quality in four separate categories:
1) Maintenance Service,
2) Dial-Line Service,
3) Answer Time Performance, and
4) Installation Service.

These measurements are categorised into three levels:
1) **Objective levels** - the level of service that represents good quality service to consumers.
2) **Weakspot levels** to denote a level of service below which immediate analysis and corrective action may be required.
3) Three or more of five consecutive months of weakspot results are usually considered as a **surveillance level failure**
5.2 Illustration to customer trouble report rate CTRR

Relative frequency

Fully acceptable range

Tolerable range

Unusable

Surveillance level = weakspot
3 of 5 months

Objective level = 4.2

Weakspot = 7
### 5.3 NYT service standards

<table>
<thead>
<tr>
<th>Service element</th>
<th>Objective level</th>
<th>Weakspot level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTRR per 100 access lines</td>
<td>0.0 - 4.2</td>
<td>Over 7</td>
</tr>
<tr>
<td>Missed repair appointments (%)</td>
<td>0.0 - 10.0</td>
<td>Over 15</td>
</tr>
<tr>
<td>Out-of-service over 24 hours</td>
<td>0.0 - 20.0</td>
<td>Over 30</td>
</tr>
<tr>
<td>Installation performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installations within 5 days (%)</td>
<td>85 - 100</td>
<td>Below 70</td>
</tr>
<tr>
<td>Installation appointments</td>
<td>0.0 - 3.0</td>
<td>Over 10</td>
</tr>
<tr>
<td>Answering time performance (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business office - within 20 sec</td>
<td>90.0 - 100.0</td>
<td>Below 85</td>
</tr>
<tr>
<td>&quot; ------- &quot; - all positions busy</td>
<td>0.0 - 10.0</td>
<td>Over 15</td>
</tr>
<tr>
<td>Repair service - within 20 sec</td>
<td>90.0 - 100.0</td>
<td>Below 85</td>
</tr>
<tr>
<td>&quot; ------- &quot; - all positions busy</td>
<td>12.0 - 16.0</td>
<td>Over 27</td>
</tr>
</tbody>
</table>
5.4 Rebates to all Manhattan customers relating CTRR

<table>
<thead>
<tr>
<th>Target level</th>
<th>Range of offices without penalties, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>79%</td>
</tr>
<tr>
<td>Rebate (Mill)</td>
<td>1995</td>
</tr>
<tr>
<td>$5.0</td>
<td>78%</td>
</tr>
<tr>
<td>$6.0</td>
<td>77%</td>
</tr>
<tr>
<td>$7.0</td>
<td>76%</td>
</tr>
<tr>
<td>$8.0</td>
<td>75%</td>
</tr>
<tr>
<td>$10.0</td>
<td>74%</td>
</tr>
<tr>
<td>$12.0</td>
<td>73%</td>
</tr>
<tr>
<td>$15.0</td>
<td>72%</td>
</tr>
<tr>
<td>$25.0</td>
<td>&lt;72%</td>
</tr>
</tbody>
</table>
6 Best Practice: LRAIC approach for penalty scheme

Long Run Average Incremental Costs (LRAIC) approach:
1. The interconnection charges reflect the actual production costs (new entrant operators should not pay for inefficiency, mis-investments, etc.)
2. New entrant operators will be stimulated to invest in alternative networks.
3. To create consensus on the cost level among telecom operators.

The SLA as the common target for LRAIC analysis - the border point between bottom-up (new entrant estimate) and top-down (incumbent estimate): the higher LRAIC estimates the higher penalties.
7 Conclusion

1. UMTS QoS issues - a challenge for ITC

2. Parlay for SLA control

3. Revisited OPIUM Project as UMTS QoS and SLA Testbed

4. Global QoS index and “Gold-silver-bronze" standard

5. To develop LRAIC approach for penalties