Multi-domain End-to-end Network Service Level Agreements

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Introduction.

• In the EGEE project, distibuted resources and services are interconected in a multi-domain network environment.

• We implement SLA establishment and monitoring procedures to guarantee the quality of service (QoS) for data transfers across grid resources..

• We use a Grid application, targeted at the remote control and monitoring of instrumentation resources and requiring stringent levels of QoS (e.g. bandwidth, delay) across the interconnecting networks, to test the SLA installation and monitoring procedures.

• In the scenario, we evaluate the SLA installation and monitoring procedures by testing the data transfer, in a DiffServ (Premium IP) enabled multi-domain end-to-end path and in a Best-Effort one.

SLA

Legal Part

Administrative Level Object

- Contact Details, SLA Duration, Service Aavailability, Response Time, Request Lead Time

Service Level Object

- PIP Description (Source IP – Destination IP), Performance (bandwidth, owd, ipdv, packet loss, MTU), Reliability (Allowed Maximum Downtime, Time-To-Repair)

E2e SLA merging rules

- Service duration: intersection of per-domain service duration values
- Service availability: $\min\{ServiceAvailabilty_i\}$
- $Capacity_{e2e} <= \min\{Ci\}$
- $MTU_{e2e} \leq \min\{MTUi\}$
- $OWD_{e2e} \geq \sum\{OWDi\}$
- $IPDV_{e2e}$: we treat IPDV as an RMS value and use its square as an additive parameter.
- $Packet\ loss_{e2e} \geq \sum\{PLi\}$
- The rest fields in the e2e SLA are the union of the per-domain fields.

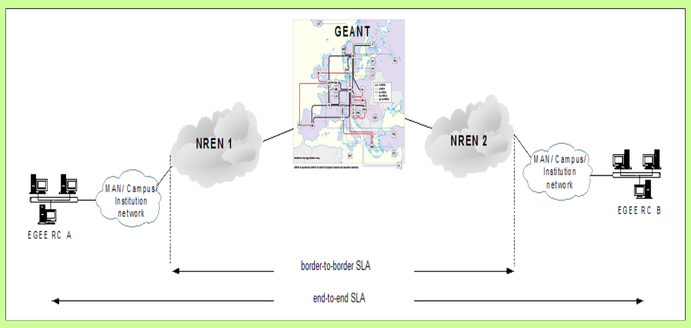


Figure 1: Border-to-border and end-to-end SLA

SLA Installation Procedure: 2 stages

Service Reservation and Service Activation

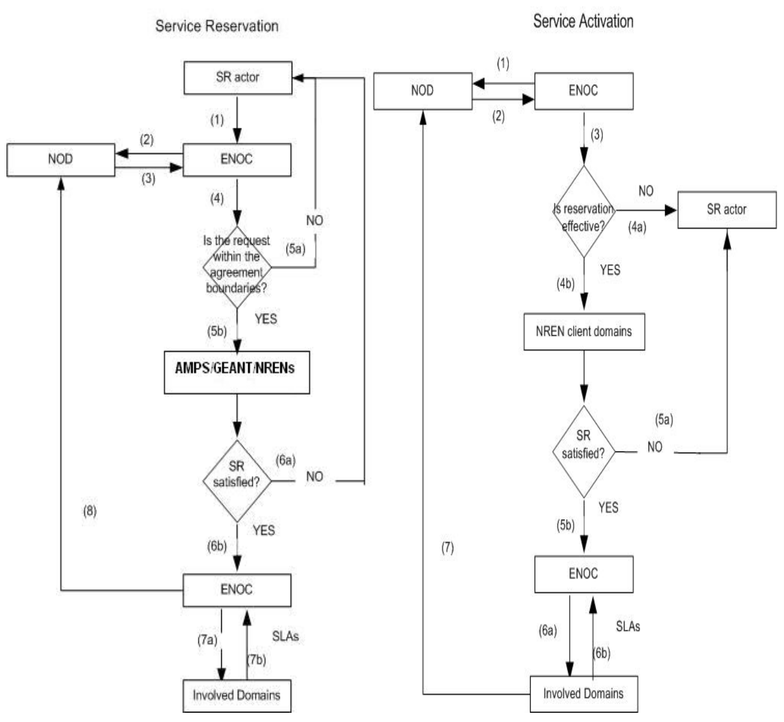


Figure 2: Stage 1 – Service Reservation

Figure 3: Stage 2 – Service Activation

• Service reservation along the QoS extended domain (GÉANT2/NRENs)

• Border-to-border (b2b) SLA established derived from the per-domain SLAs

• Configuration of the routers in the last mile network

• End-to-end SLA produced by extending the pre-established b2b SLA with the SLAs from the site networks.

Monitoring Procedure

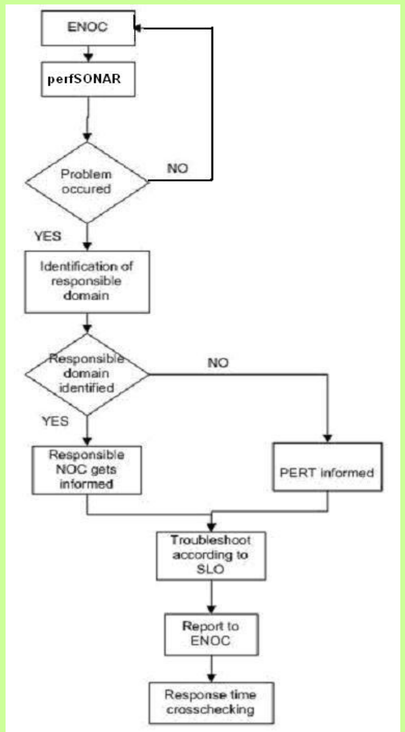


Figure 4:
SLA monitoring and troubleshooting procedure

• ENOC queries perfSONAR monitoring tools (BWCTL, OWAMP) for measurements inside the SLA duration.

• If a problem occurs, the ENOC identifies & notifies the responsible domain

• Not able to isolate the problem ENOC informs GEANT PERT to react-repair according to the e2e SLA.

• ENOC checks the SLA compliance of the troubleshooting procedure and the response times.

Grid Experiment for remote control

• Experiment from GRIDCC project (www.gridcc.org)

• Web Service invocations to remotely control, through an Instrument Element, the instruments distributed across the grid environment

• Transfer of data produced by instruments to grid nodes for further processing.

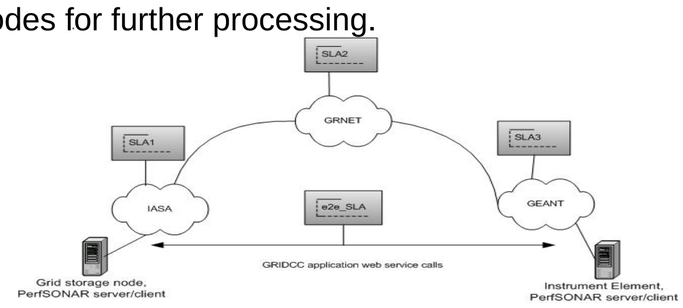
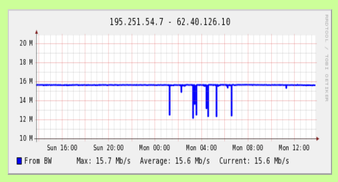


Figure 5: GRIDCC experiment test-bed: *Networked Real Time Environment for accessing a remote Instrument Element (IE).*

Results

In order to monitor the network used for the GRIDCC application testing we deployed some monitoring tools to measure specific network performance metrics such as Bandwidth, Packet Loss, One-Way-Delay (OWD) and jitter.

BEST-EFFORT **PIP**



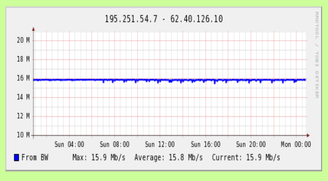
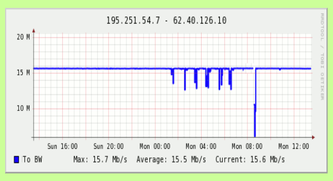


Figure 6,7: Bandwidth (Mbps) representation from IASA to GÉANT2 in B-E and PIP



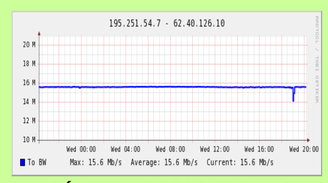
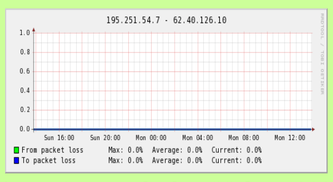


Figure 8, 9: Bandwidth (Mbps) representation from GÉANT2 to IASA in B-E and PIP



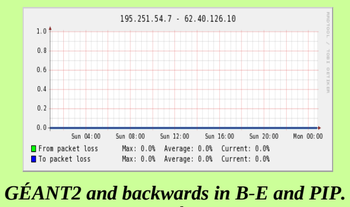
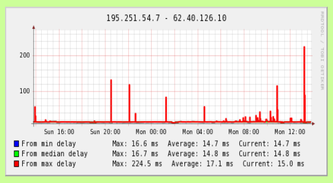


Figure 10, 11: Packet loss (%) from IASA to GÉANT2 and backwards in B-E and PIP.
"From packet loss" direction means from IASA to GÉANT2.
"To packet loss" direction means from GÉANT2 to IASA



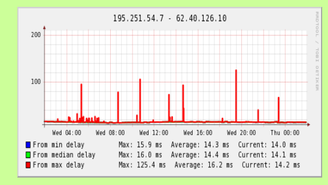
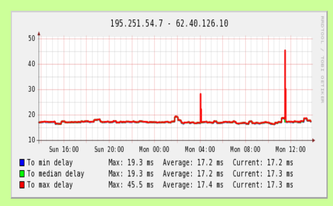


Figure 12, 13: One-Way-Delay (ms) representation from IASA to GÉANT2 in B-E and PIP



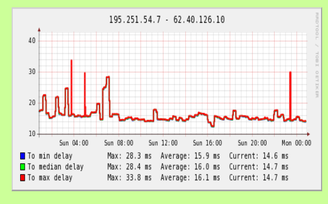
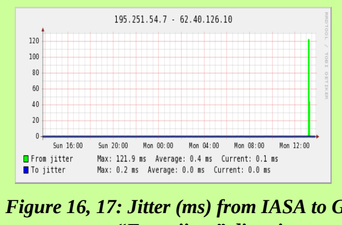


Figure 14, 15: One-Way-Delay (ms) representation from IASA to GÉANT2 in B-E and PIP



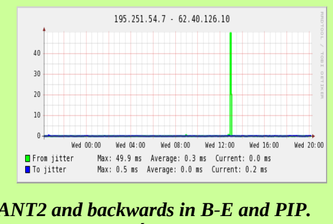


Figure 16, 17: Jitter (ms) from IASA to GÉANT2 and backwards in B-E and PIP.
"From jitter" direction means from IASA to GÉANT2.
"To jitter" direction means from GÉANT2 to IASA

Conclusion

The SLA work for this project was to provide an e2e network service to the end-user and describe the network specifications (e.g. PIP characteristics, monitoring infrastructures and mechanisms, availability guarantees….) in SLAs for each administrative domain involved in the e2e path. The work realized was the complete e2e implementation of an SLA for a real application in a real operational context.

Acknowledgements

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