Importance of QoS in communication networks – Net Insight experience from video broadcast markets

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Importance of strong QoS in communication networks

- Trust – The acceptance and wide use of synchrophasors requires low loss communication networks
- Realtime potential – Expectation to use synchrophasor data for real time prevention of outages, oscillations and optimized usage
- Enable Secure communication and GPS independence

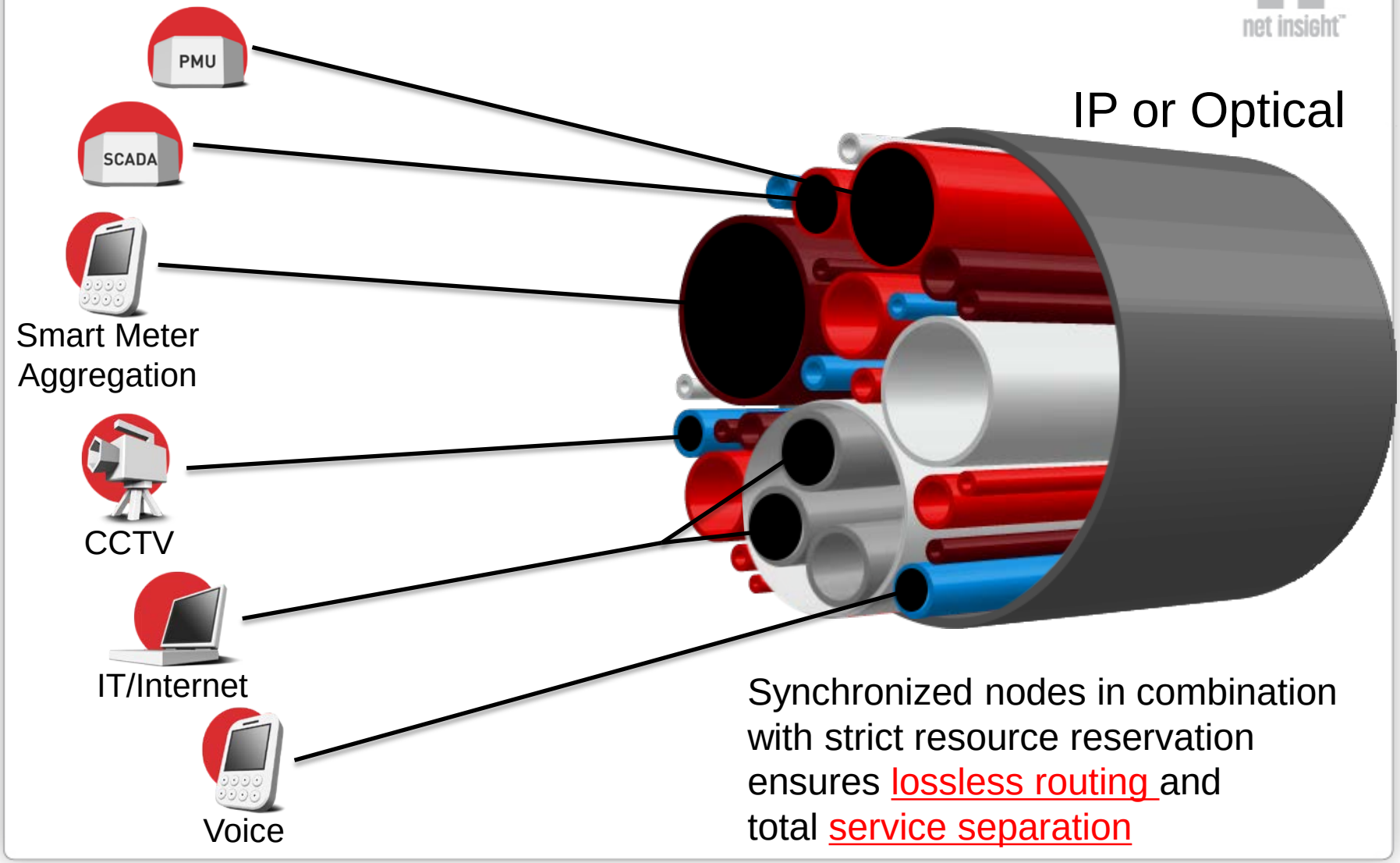
QoS Performance Objectives for packet networks

- There are a set of standards targeting Network Performance Objectives (NPO) for different service classes in packet networks
- Carrier Ethernet 2.0 and its 23.1 Class of Service Phase 2 Implementation Agreement specifies performance objectives for Carrier Ethernet networks
  - 3 Classes of Service (High, Medium, Low) – High is today not good enough for IEEE1588 transport
  - 4 Performance Tiers (Metro, Regional, Continental, Global)
  - Objectives for PLR, PD, PDV for each tier
  - Using Y.1731 for OAM fault and performance monitoring
- ITU-T Y.1541 standard defines QoS objectives for IP networks in terms of
  - Packet Loss Ratio (PLR)
  - Packet Delay (PD)
  - Packet Delay Variation (PDV)
  - (Packet Loss Burst (PLB) which is an important parameter, is missing)
- However, not targeting phase/frequency synchronization applications
- A new standard ITU-T G.8261.1 provides QoS objectives for synchronization
  - A very relevant but different metric compared with the usual “SLA type” spec metrics
  - Hence Operator support for this metric is not expected in the near time horizon

Qos Requirements for Smart grid Communication

Application	Data capacity	Latency allowance	Jitter allowance.	Time sync	Reliability	Security
Smart Metering (PLC/BLP)	Low per feed/ Aggregated high	High (s)	High (>10ms)	(100 ms)	Medium	High
SCADA	Low per feed	Low (100ms)	Low	(1 ms)	High	High
PMU (synchrophasors)	Low per feed	Very low (20 ms)	Very low	(< 5 us)	Very high	Very high
Intersite rapid response (E.g.,Teleprotection)		Very low (10 ms)		(1 ms)		
WAMPAC (closed loop)	Medium	Very low	Very low	(1 us)	Very high	Very high
Distributed Energy mgmt (DER, PEV, storage)	Medium	Low	Low		High	High
Video surveillance	High/medium	Medium	Low	(10 ms)	High	High
Corporate Data	Medium	Medium	Medium	No	Medium	Medium
Corporate voice	Low	Low	Low		High	Medium

Services are separated in end-to-end channels

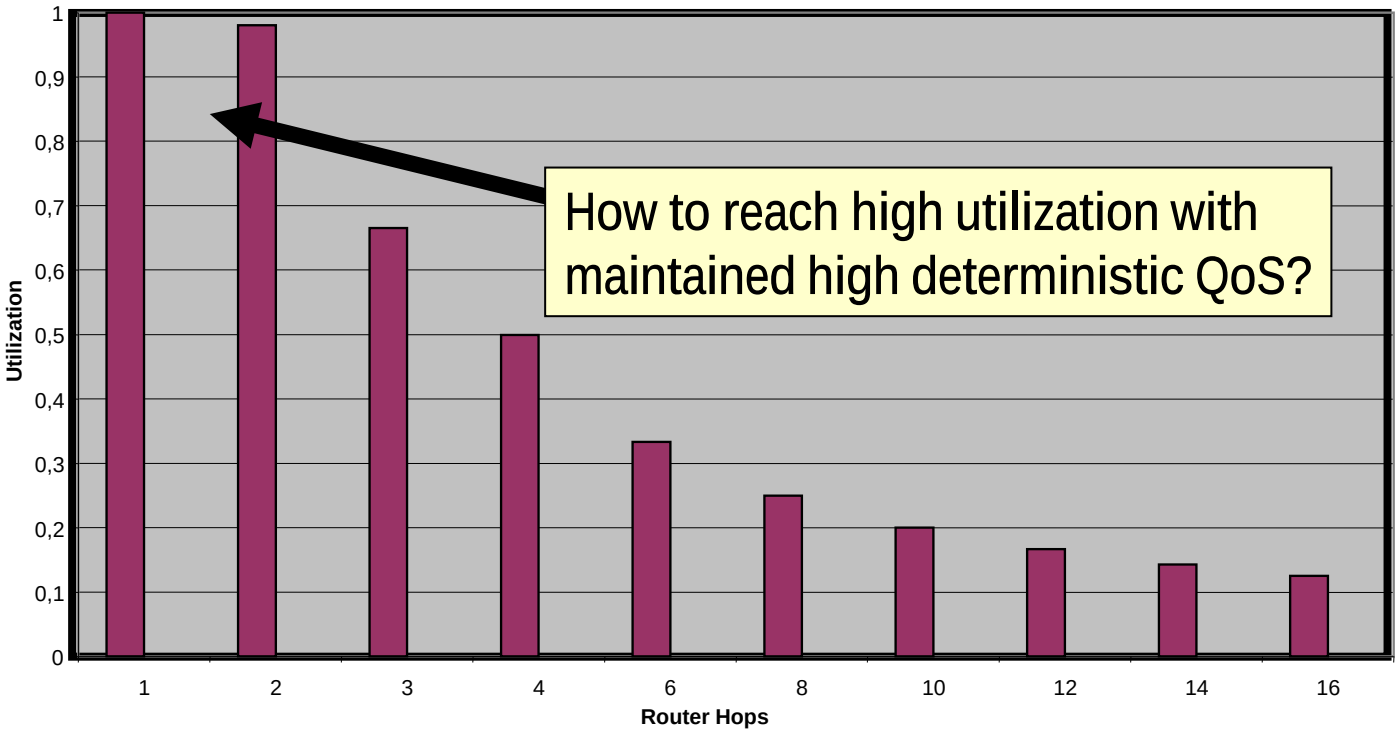


Synchronized nodes in combination with strict resource reservation ensures lossless routing and total service separation

Summary of QoS aspects in SmartGrid

- A truly multi-service environment but with several high-demanding real-time services
- To fully rely on WAPACS, traffic requires bounded delays for stable control loops. Low max delay and lossless transport ensure this (lossless ensures no additional delay because of retransmission)
- Scalability of surveilance video aggregation from many different network points – normally a difficult task as the aggregation points incurs jitter and packet loss
- Reliable sub 1 us resolution time distribution for PMU and event synchrnonization
- Most of the services also requires high security/integrity and very high reliability

Issue - Utilization in packet-switch networks



- Router networks have a trade-off between utilization and packet loss QoS. Complex traffic engineering.
- Networks for SmartGrid normally have many network points
- Scalable QoS solution for SmartGrid IT infrastructure requires a different approach like the Nimbra MSR

Sources:

Bennett, et al, "Delay Jitter Bounds and Packet Scale Rate Guarantee for Expedited Forwarding", INFOCOM 2001.
Charny and Le Boudec, "Delay Bounds in Network with Aggregate Scheduling", QoFIS 2000, Berlin, Germany.
Willinger, et al, "Self-Similarity Through High-Variability: Statistical Analysis of Ethernet LAN Traffic at Source Level", IEEE/ACM Transactions on Networking, Vol.. 5, No. 1, 1997

QoS in Nimbra Networks – Bringing experience from mission-critical TV/video networks

"What is the difference between a network for mission critical TV and SmartGrid? Actually not that much"

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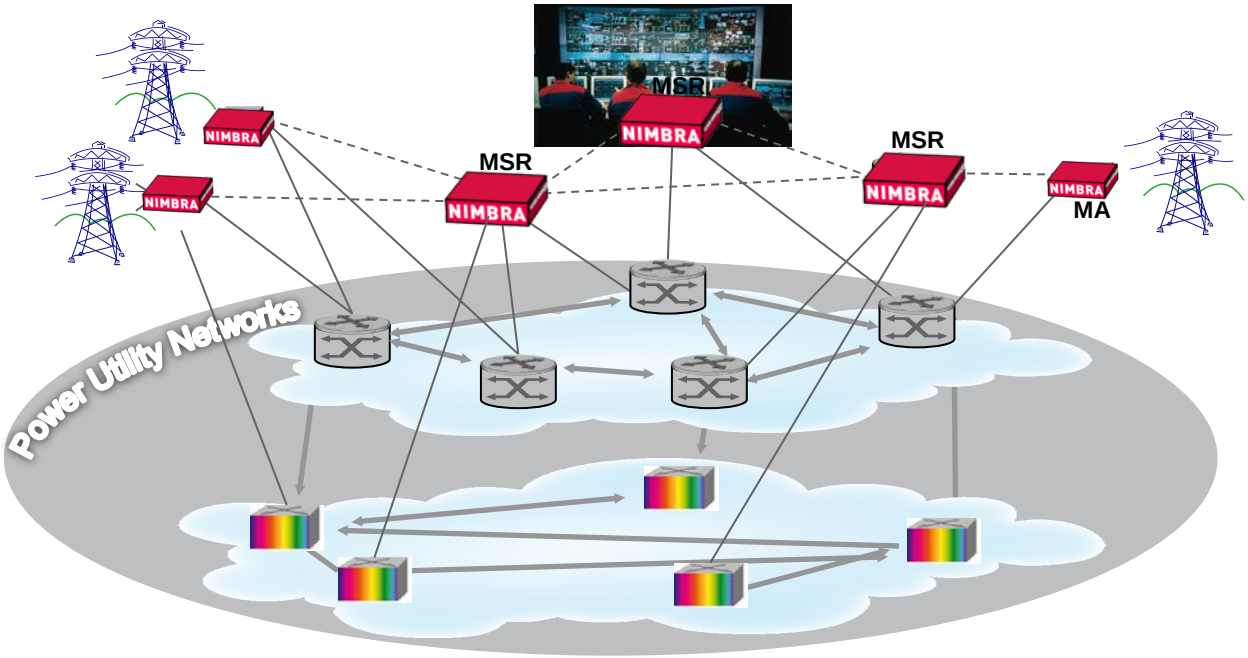
Network architecture for communication for the SmartGrid

- Guaranteed Real-time networking – Lossless and low predictable delay
- Time distribution capabilities for PMU and sensor synchronization – IRIG-B, 10MHz/PPS
- Secure, high integrity separated intrusion free communication
- Multi-service – Handle all communication in one system



SmartGrid Overlay

IP/MPLS Core

Optical Transport

Adding real-time and 100% integrity to IP networking

Service Aware Nimbra Smart Grids

Service-centric network management
Service separation, real-time, BW control, Monitoring Protection

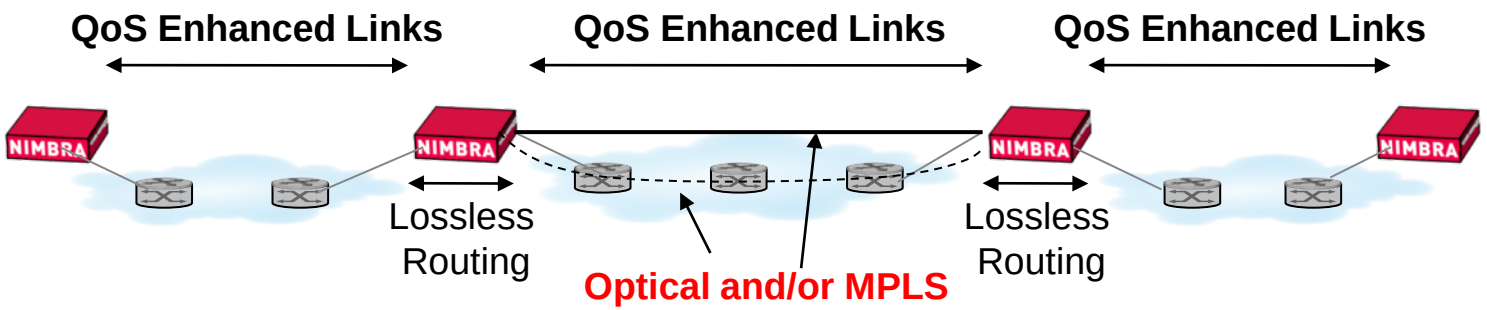
QoS Enhanced Links
FEC
Traffic shaping
Resync

Lossless routing
Zero packet loss through the Nimbra MSR

Net Insight offers MSRs

Full controlled Networking for SmartGrid
IPT QoS Ethernet

Service-Centric Network Management
Provisioning, Monitoring and Protection

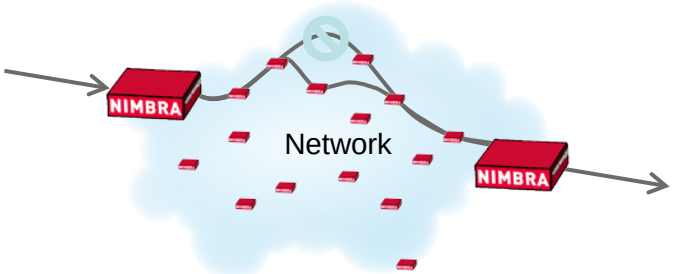


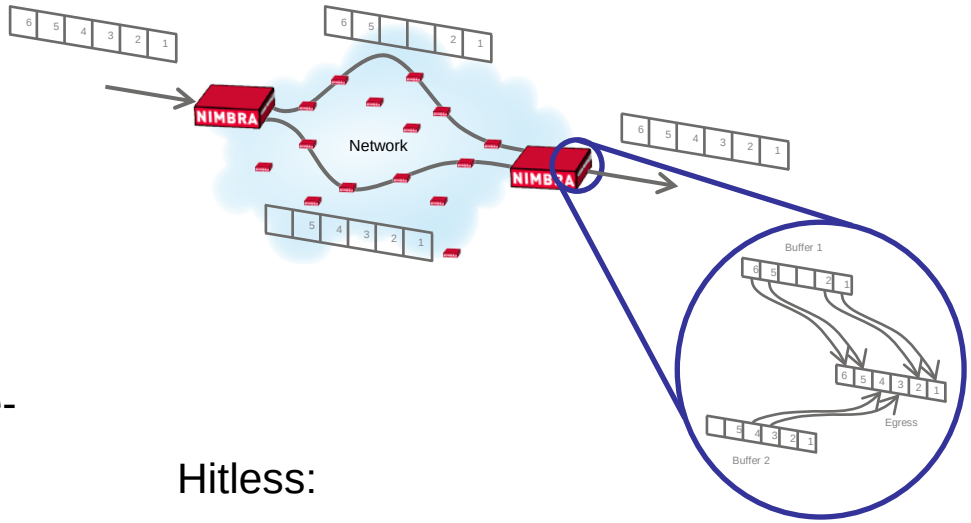
OoS Enhanced Links
Forward-error correction, Traffic Shaping and Resynchronization

Improves the performance of the IP traffic for data transfer, data collections, real-time control system, etc.

Per service Restoration or Hitless switch over

Offers extremely high reliability and flexible design





Restoration:

- In case of failure, the network will re-establish the service
- Re-establishment time depends on network topology and complexity
  - Typical values are between ~100 ms and ~1 s
  - Restoration is resource-aware to not create new congestion
- Use prioritized list of static routes or dynamic routing
  - Strict or loose source routes
  - or a combination thereof; for instance dynamic routing as last option

Hitless:

Packet based services

- For L2 Ethernet transport
- Sequence counters on packages
- Configurable max latency (buffer depth)

Stateless protection mechanism

- Diminishes the notion of primary and secondary path

Completely Hitless Switching

- Frequency + phase + packet sequence remains intact