JOLATA

Making the Network for you

Objective: Real-Time Network Optimization

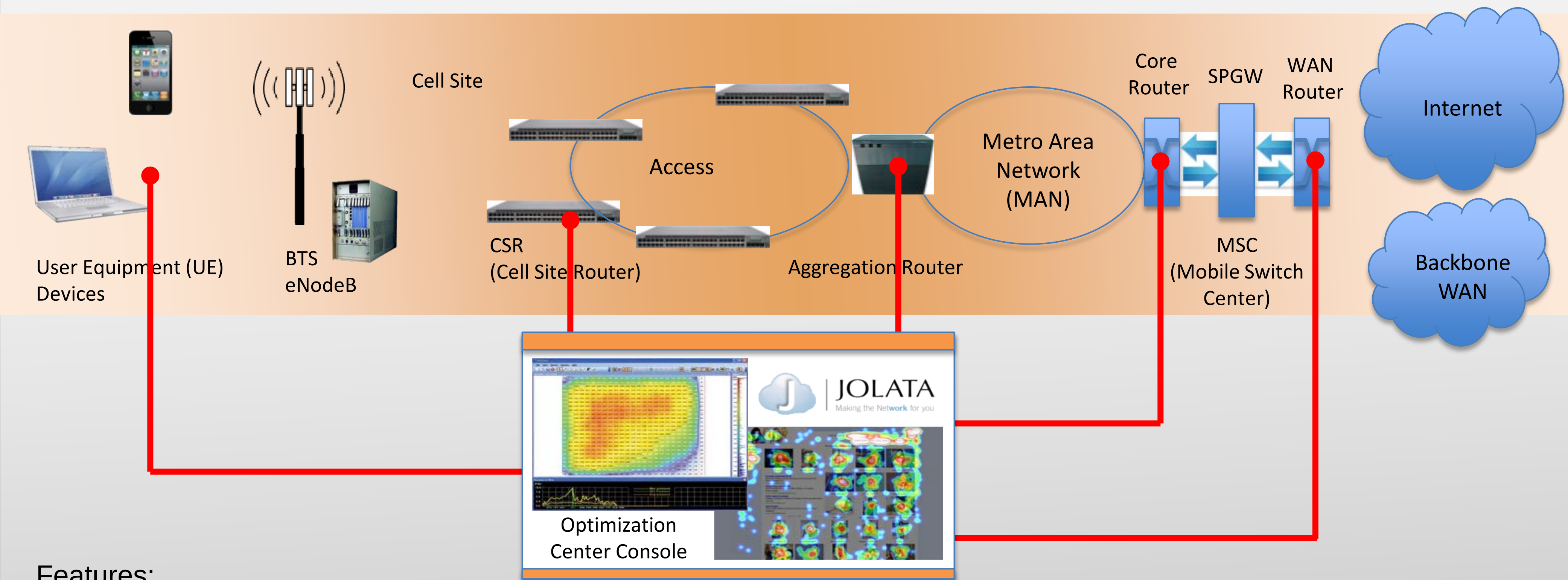
JOLATA
Making the Network for you

- Enable customers to optimally tune their network performance with real time information and proactive recommendations.

Big Data Analytics Technology

- Big data analytics can be to provide a closed loop unified solution for customers, that will:
  - **ingest -- see every node, every packet**
  - **digest -- analyze/report findings, and most importantly**
  - **suggest -- recommend actions to improve performance**

Real-Time Network Performance Monitoring

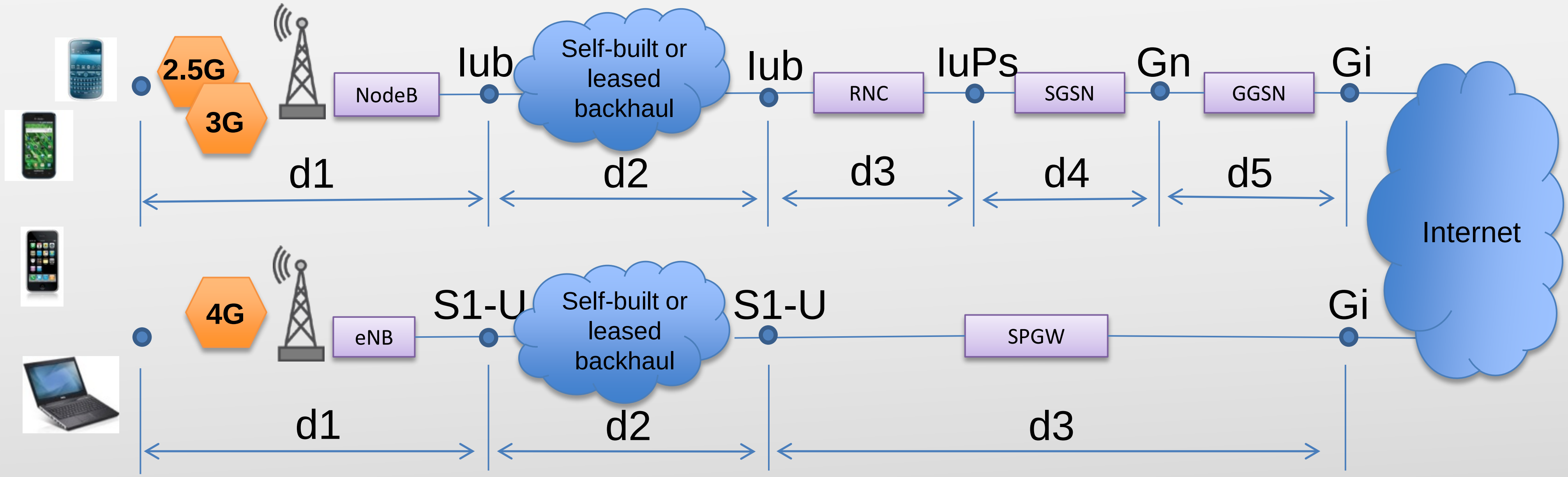


Features:

End-to-end monitoring of delay, jitter, throughput and loss *embedded* into the network elements and user equipment. There is *no need for additional external probes.*

- Metadata creation for up to every packet at every monitoring point, as desired (filtered), and then forwarded to the Analytics engine.
- Metadata aggregated, correlated and analyzed by Jolata appliances at the Master Head End or MSC.
- Wirespeed processing rates of up to 2x100GbE per analytics appliance; effective traffic analysis of 800Gbps.
- Link, Segment and Path statistics from User to Core. Upstream and downstream, one way or roundtrip.
- Heatmap and chart visualizations; Threshold crossing alerts.
- Visibility with zoom window capability to view delays of specific packets or bursts.
- Flexible queries to analyze statistics per node, hop, equipment type, geography, protocol, subscriber, time of day.
- Managed within higher level EMS/NMS, or operator’s OSS
- Synchronized by IEEE1588

Mobile Service Provider Problem Statement



Wireless Service Providers (*and backhaul providers*) need to monitor network performance continually in order to meet required SLAs and to understand Subscriber Quality of Experience (QoE).

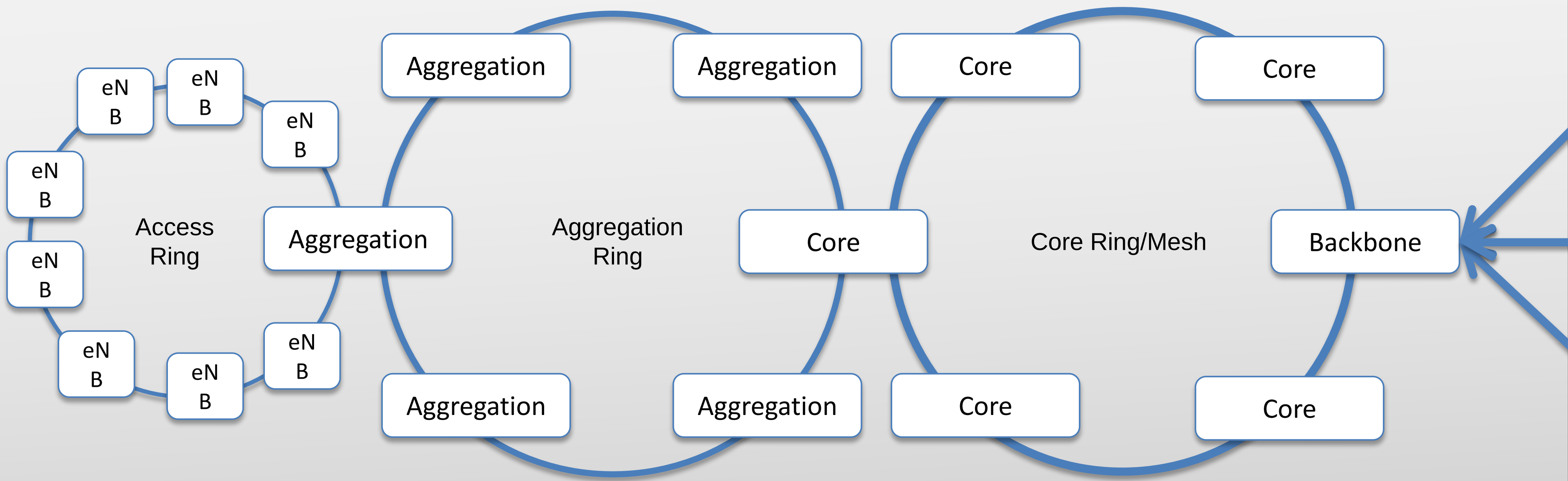
Network delay, jitter throughput and loss are good indicators of network performance. Network delay, jitter and loss occur due to:

- Queuing in network hops
- Varying performance of key elements due to software upgrades, etc.

End-to-end solution embedded in the routers that enables continuous monitoring of delay, jitter, throughput and loss wherever metadata-enabled routers (or external probes) are present.

Analytic-driven actions to improve network are prescribed or taken as per user-defined heuristics.

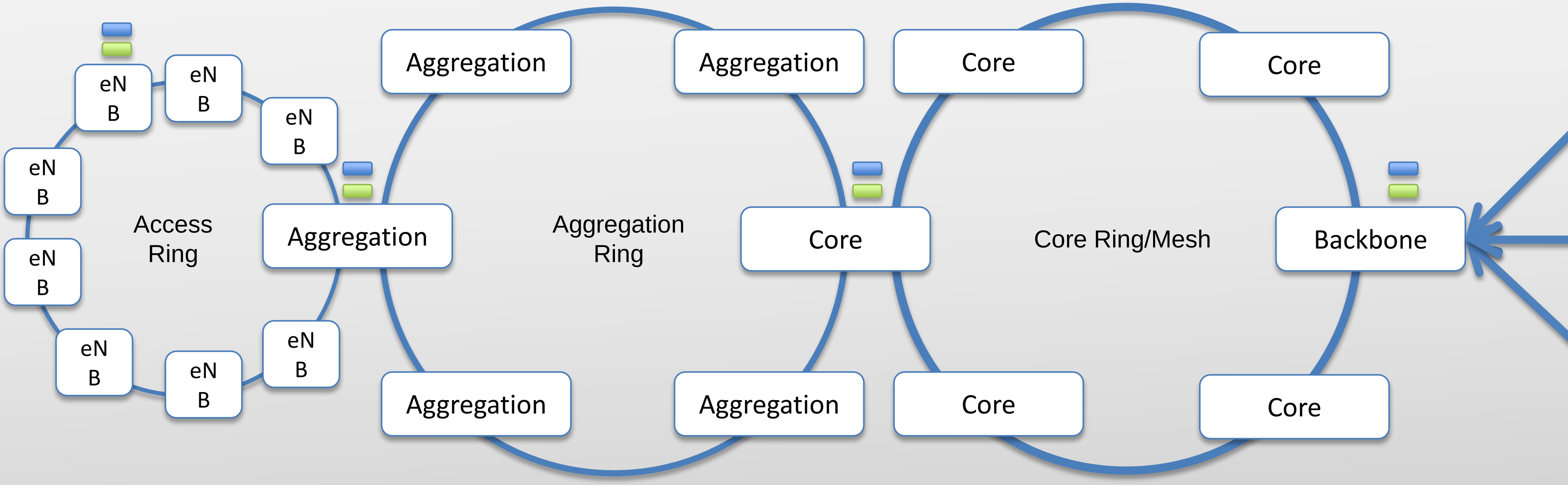
Scale



10 eNB's per Access Ring;
10 Access Rings per Aggregation Ring
8 Aggregation Rings per Core Ring
<u>4 Backbone Nodes (e.g., 4 OMC's)</u>
3556 Observation Points

3200 eNB's
270Mbps sustained, total (upstream + downstream)
5 observation points per packet
<u>40% average sustained load, network-wide</u>
1.73 Tbps!
432Gbps per backbone node (OMC)

Packet and Flow Monitoring



For every Packet at every observation point, key-value metadata is created with a:

- “fingerprint”, e.g., a unique identifier
- time-stamped – when the packet was there
- port-stamped – where the packet was observed
- appended with a user selectable “n-tuple”, e.g., IP SA/DA, Protocol, Source/Dest Port

Metadata is aggregated, compressed and sent to analytics server for processing:

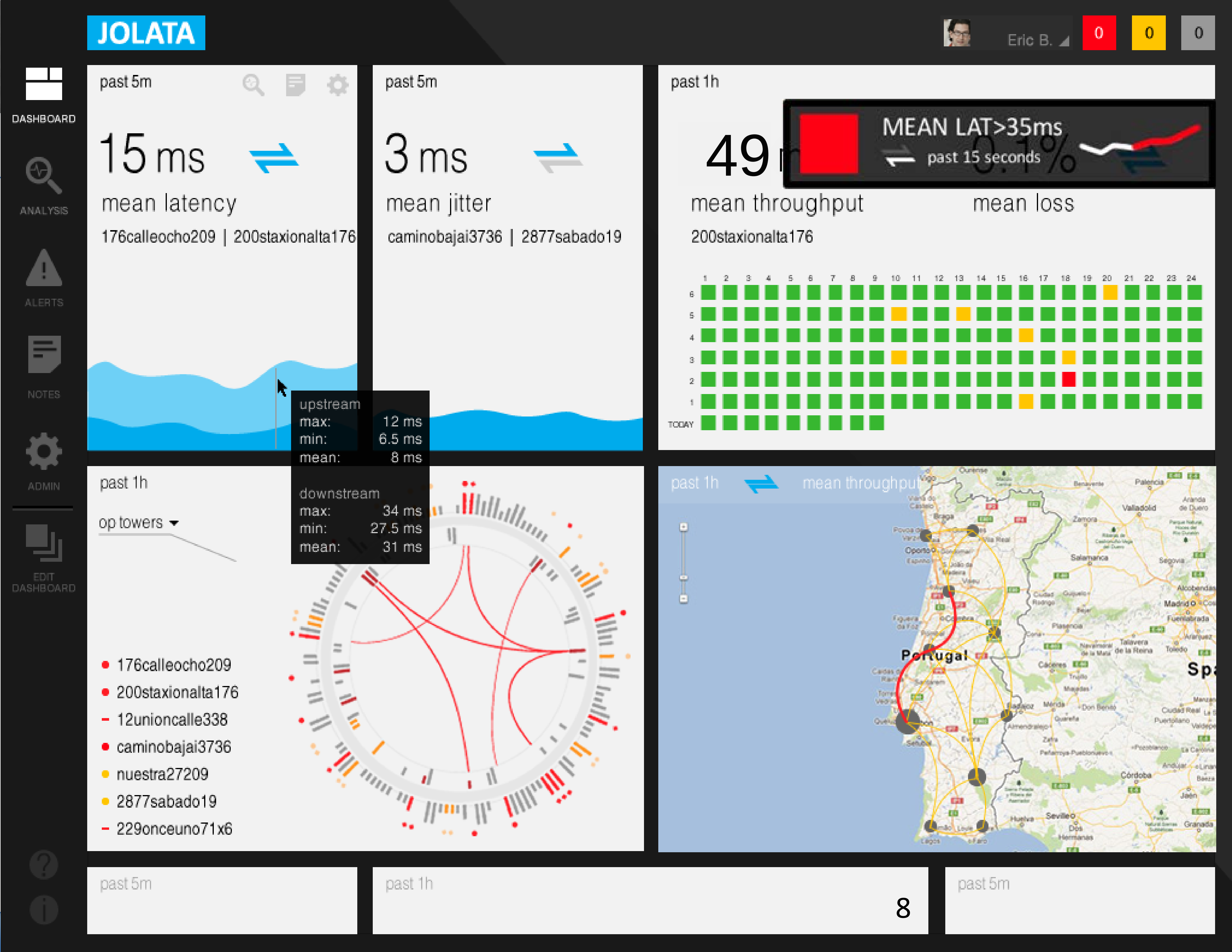
- 1%-2% overhead for metadata

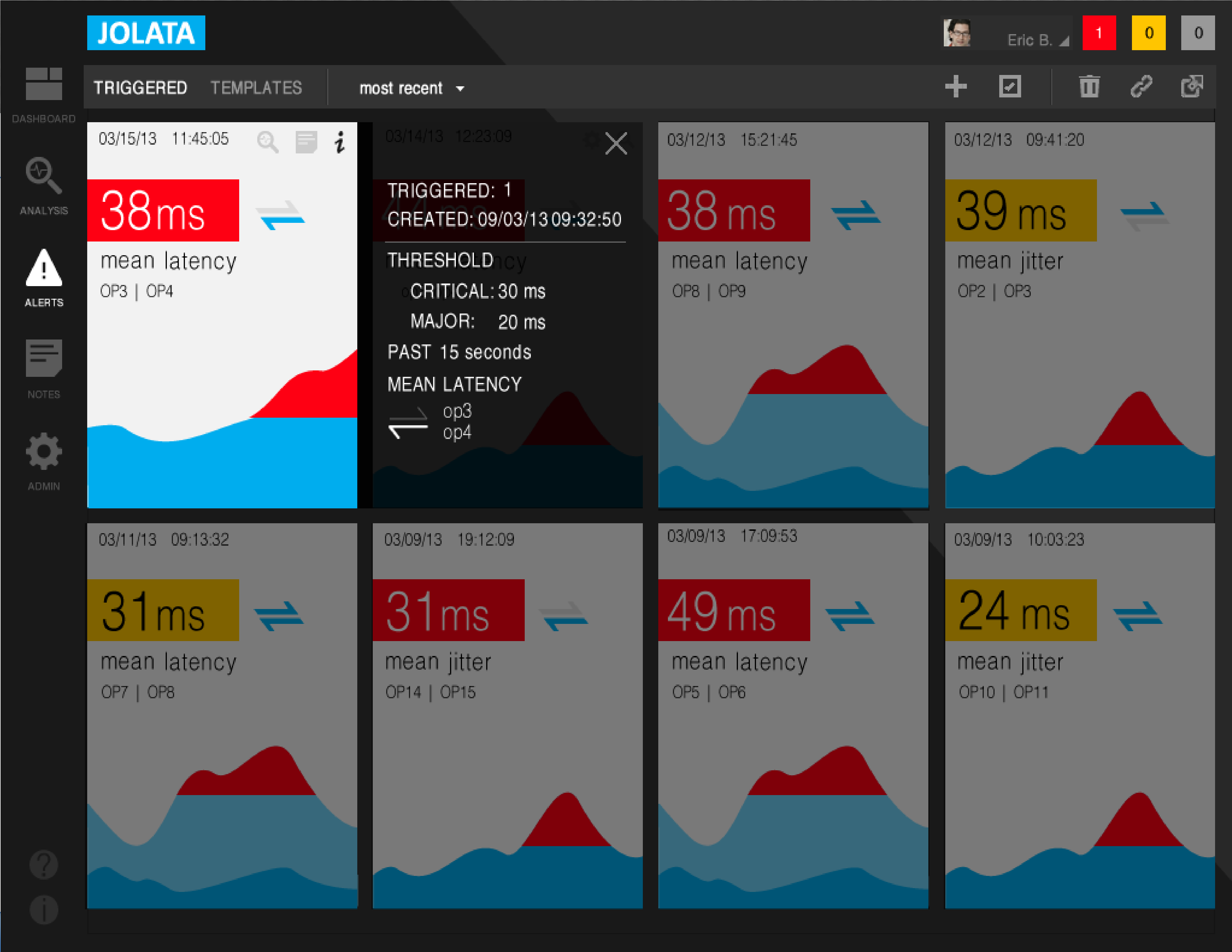
Packet Analysis is performed:

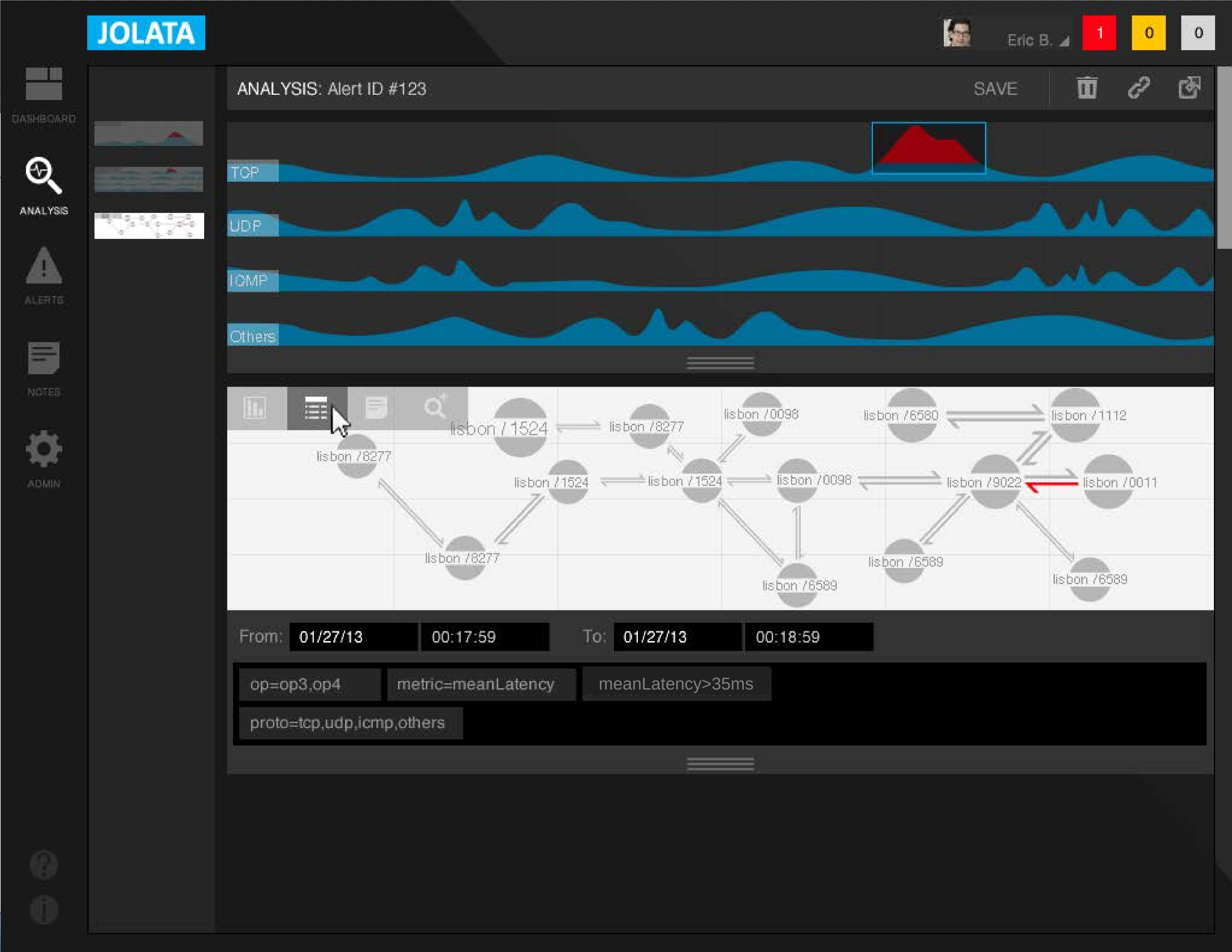
- Fingerprint matching to develop end to end path, throughput, delay, jitter and loss statistics *per packet*

Flow Statistics calculated and stored into the database

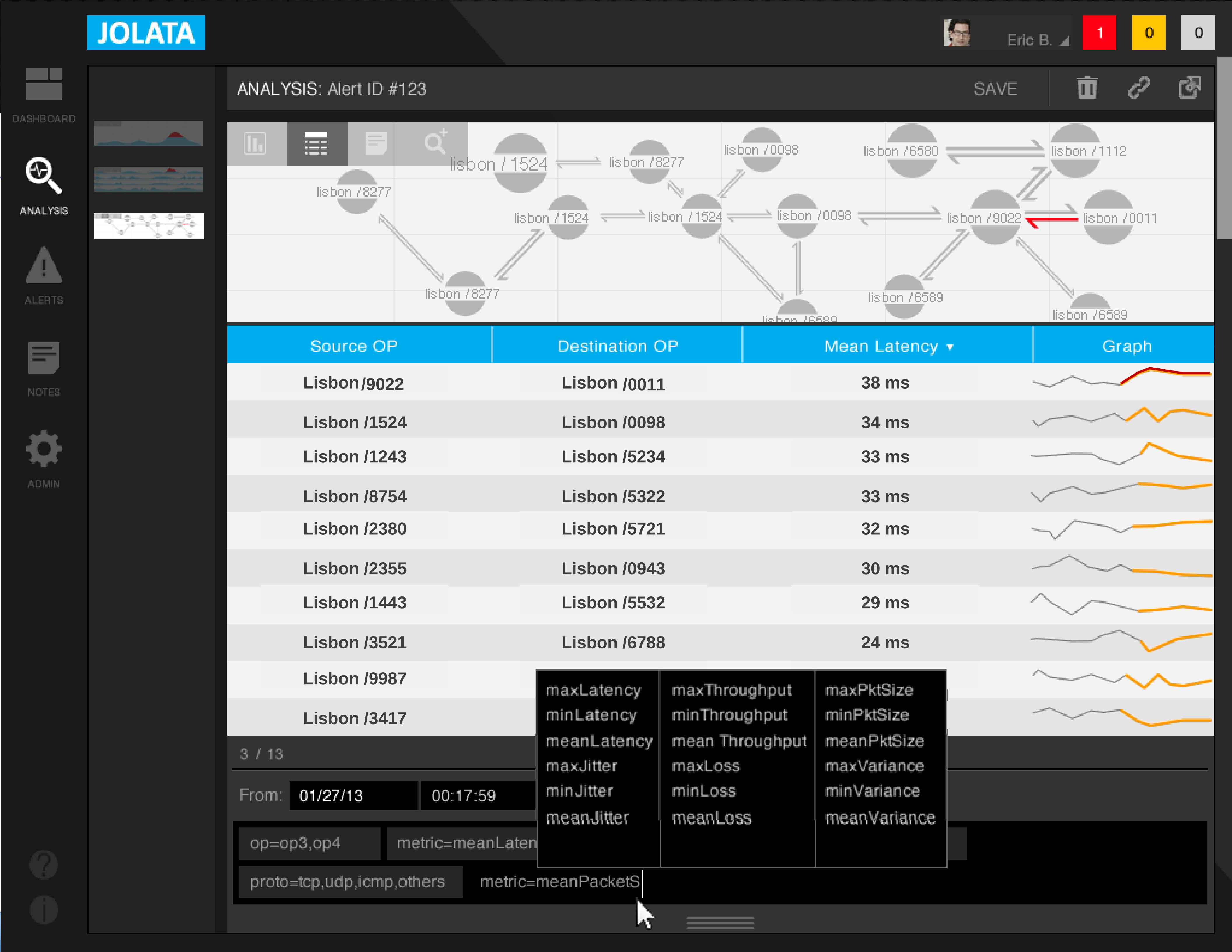
- Per node, traffic type, customer based on n-tuple filters


JOLATA
Eric B.
0
0
0
DASHBOARD
ANALYSIS
ALERTS
NOTES
ADMIN
EDIT DASHBOARD
past 5m
15 ms
mean latency
176calleocho209 | 200staxionalta176
upstream
max: 12 ms
min: 6.5 ms
mean: 8 ms
downstream
max: 34 ms
min: 27.5 ms
mean: 31 ms
past 5m
3 ms
mean jitter
caminobajai3736 | 2877sabado19
past 1h
49
mean throughput
mean loss
200staxionalta176
MEAN LAT>35ms
past 15 seconds
TODAY
past 1h
op towers
176calleocho209
200staxionalta176
12unioncalle338
caminobajai3736
nuestra27209
2877sabado19
229onceuno71x6
past 1h
mean throughput
Portugal
past 5m
past 1h
past 5m

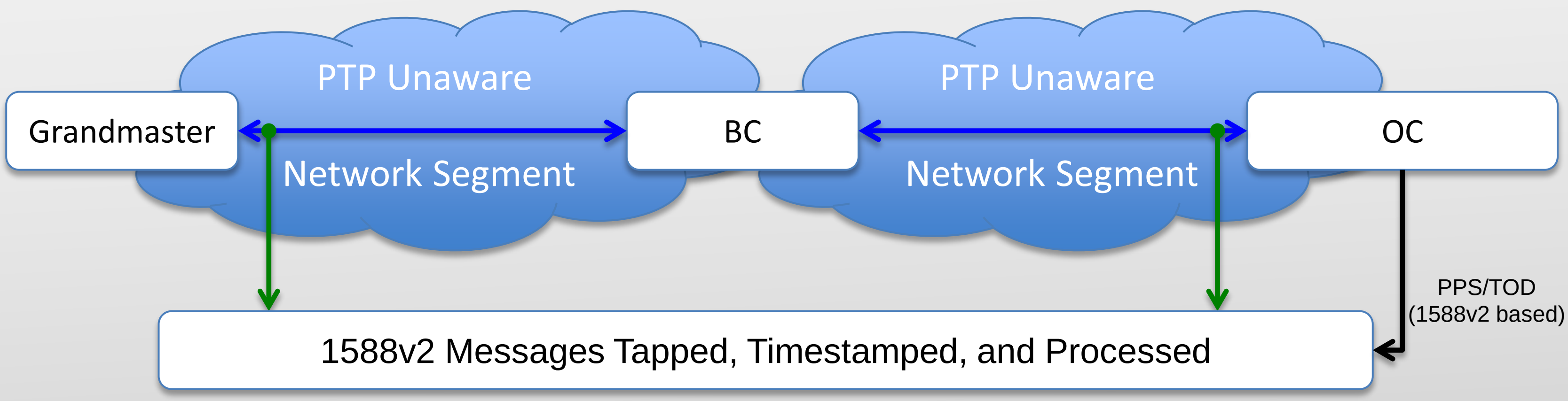

JOLATA
Eric B.
1
0
0
TRIGGERED
TEMPLATES
most recent
DASHBOARD
ANALYSIS
ALERTS
NOTES
ADMIN
03/15/13 11:45:05
38ms
mean latency
OP3 | OP4
03/14/13 12:23:09
TRIGGERED: 1
CREATED: 09/03/13 09:32:50
THRESHOLD
CRITICAL: 30 ms
MAJOR: 20 ms
PAST 15 seconds
MEAN LATENCY
op3
op4
03/12/13 15:21:45
38 ms
mean latency
OP8 | OP9
03/12/13 09:41:20
39 ms
mean jitter
OP2 | OP3
03/11/13 09:13:32
31ms
mean latency
OP7 | OP8
03/09/13 19:12:09
31ms
mean jitter
OP14 | OP15
03/09/13 17:09:53
49 ms
mean latency
OP5 | OP6
03/09/13 10:03:23
24 ms
mean jitter
OP10 | OP11



JOLATA
Eric B.
1
0
0
DASHBOARD
ANALYSIS
ALERTS
NOTES
ADMIN
ANALYSIS: Alert ID #123
SAVE
TCP
UDP
ICMP
Others
lisbon / 1524
lisbon /8277
lisbon /0098
lisbon /6580
lisbon / 1112
lisbon /8277
lisbon / 1524
lisbon / 1524
lisbon /0098
lisbon /9022
lisbon /0011
lisbon /8277
lisbon /6589
lisbon /6589
lisbon /6589
From:
01/27/13
00:17:59
To:
01/27/13
00:18:59
op=op3,op4
metric=meanLatency
meanLatency>35ms
proto=tcp,udp,icmp,others


JOLATA
Eric B.
1
0
0
DASHBOARD
ANALYSIS
ALERTS
NOTES
ADMIN
ANALYSIS: Alert ID #123
SAVE
lisbon / 1524
lisbon /8277
lisbon /0098
lisbon /6580
lisbon /1112
lisbon /8277
lisbon / 1524
lisbon / 1524
lisbon /0098
lisbon /9022
lisbon /0011
lisbon /8277
lisbon /6589
lisbon /6589
Source OP
Destination OP
Mean Latency
Graph
Lisbon /9022 Lisbon /0011 38 ms
Lisbon /1524 Lisbon /0098 34 ms
Lisbon /1243 Lisbon /5234 33 ms
Lisbon /8754 Lisbon /5322 33 ms
Lisbon /2380 Lisbon /5721 32 ms
Lisbon /2355 Lisbon /0943 30 ms
Lisbon /1443 Lisbon /5532 29 ms
Lisbon /3521 Lisbon /6788 24 ms
Lisbon /9987
Lisbon /3417
maxLatency
minLatency
meanLatency
maxJitter
minJitter
meanJitter
maxThroughput
minThroughput
mean Throughput
maxLoss
minLoss
meanLoss
maxPktSize
minPktSize
meanPktSize
maxVariance
minVariance
meanVariance
3 / 13
From: 01/27/13 00:17:59
op=op3,op4
metric=meanLaten
proto=tcp,udp,icmp,others
metric=meanPacketS

Timestamp Accuracy – 1588v2 test architecture



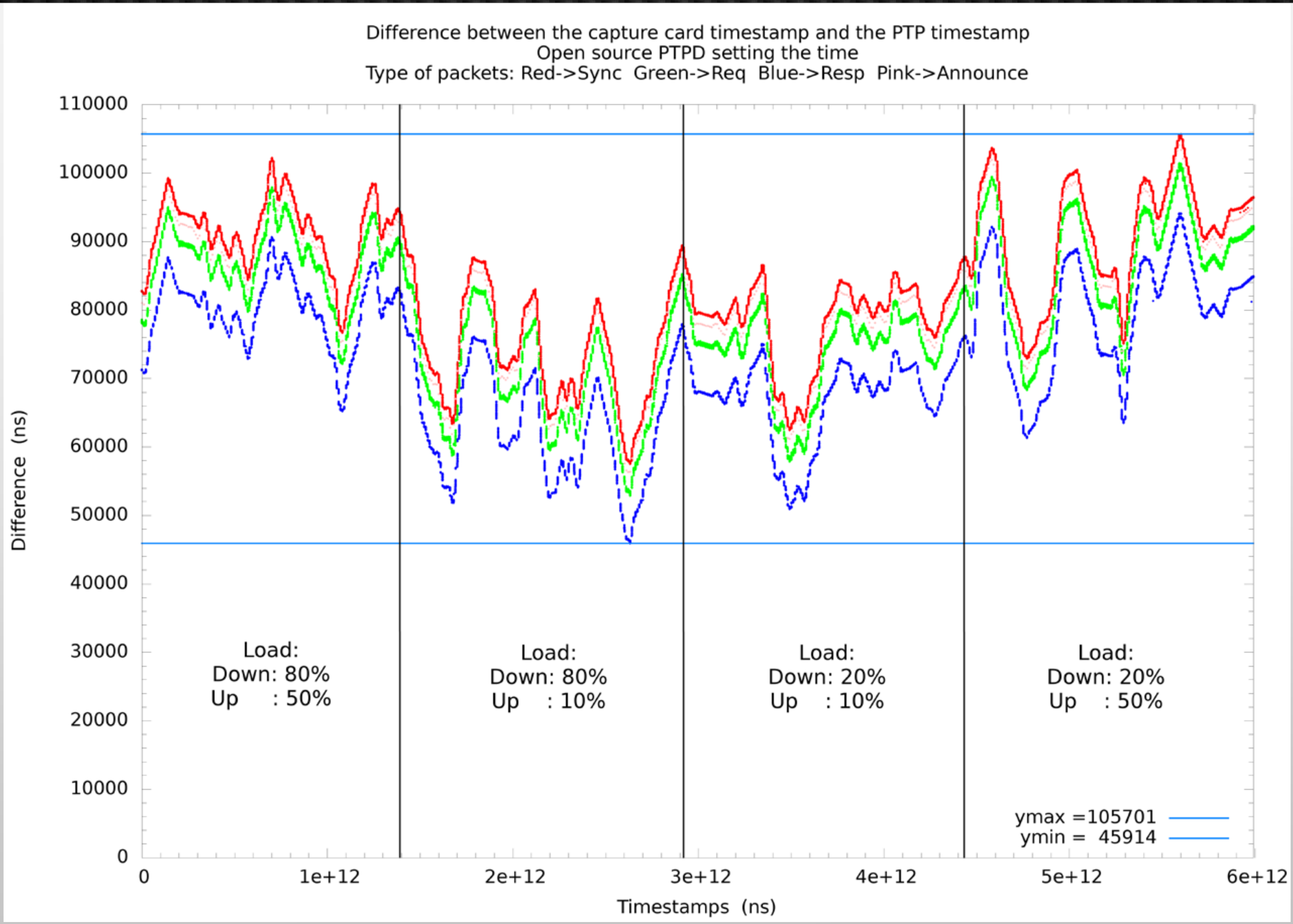
Timestamp accuracy depends upon the 1588v2 distribution network and clock recovery algorithm and especially so when the underlying network is PTP unaware (still, most of the cases today):

- Determine timestamp accuracy using 1588v2 Packets as the probe packets
  - Sync Messages from the GM are referenced directly to GPS with Timestamp accuracy to +/-50ns or better
  - HW-Timestamp Delay Responses have similar accuracy and stability though they are timed upon receipt
  - Delay request packets can also be used when T3 is inserted and where the BC and/or OC clock recovery algorithm is stable & accurate

Desired result:

- Stable floors for each packet type regardless of loading on left or right side network segments

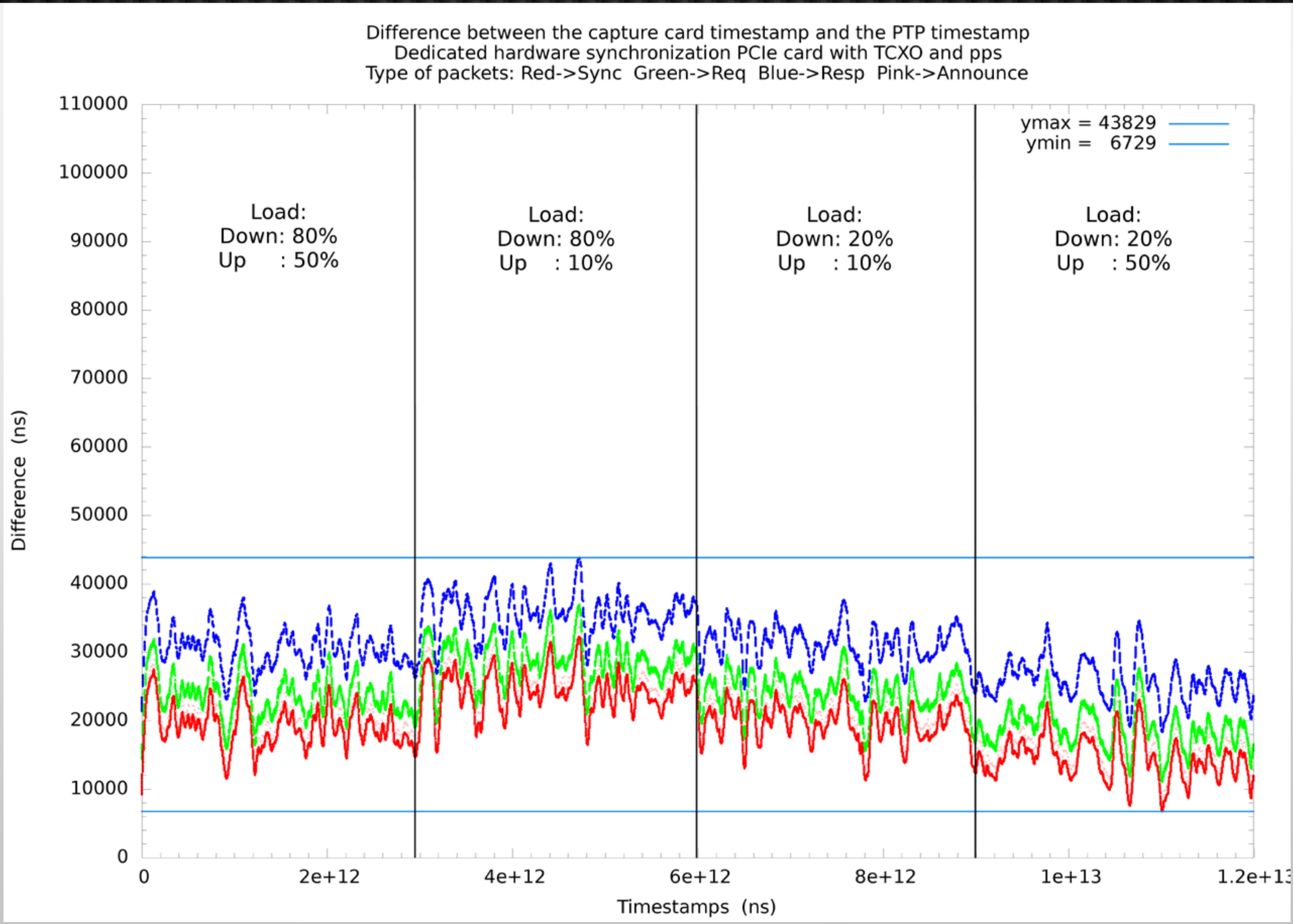
Timestamp Accuracy – 1588v2 Results - I



ITU G.8261 Traffic Model 2; Modified Test Case 13 (10 minute total duration)
Synchronization with open source PTPD software setting linux OS time:

- Timestamp accuracy: 60us wander, jitter is relatively small
  - => Unacceptable for monitoring

Timestamp Accuracy – 1588v2 Results - II

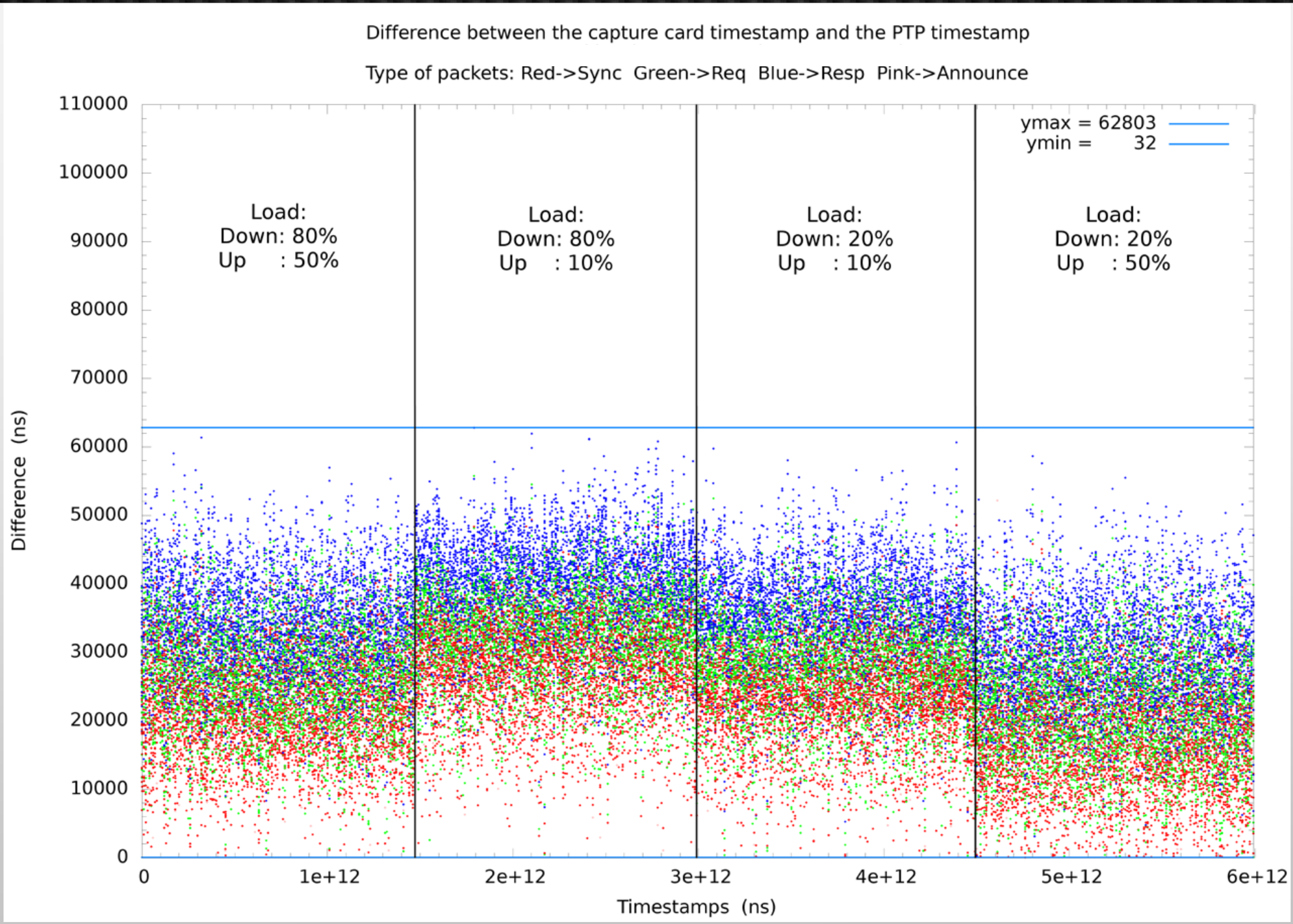


ITU G.8261 Traffic Model 2; Modified Test Case 13 (20 minute total duration)
Synchronization with dedicated HW PCIe Card w/TCXO:

- Timestamp accuracy: 28us wander, jitter is relatively small
  - => Unacceptable for monitoring

Timestamp Accuracy – 1588v2 Results - III

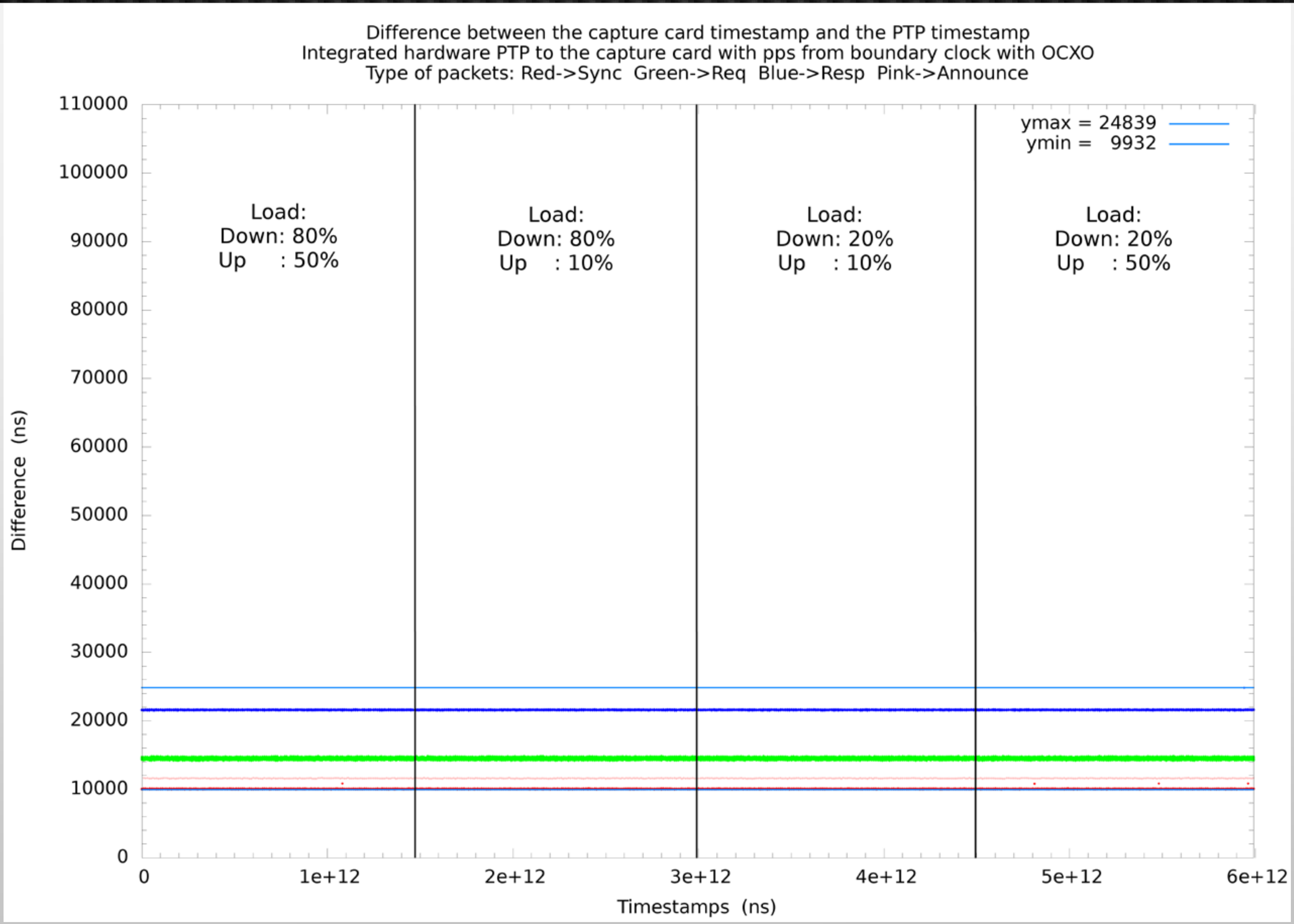
JOLATA
Making the Network for you



ITU G.8261 Traffic Model 2; Modified Test Case 13 (20 minute total duration)
Synchronization with dedicated HW w/TCXO:

- Timestamp accuracy: 25us wander, +/- 30us jitter is very large
  - => Unacceptable for monitoring

Timestamp Accuracy – 1588v2 Results - IV



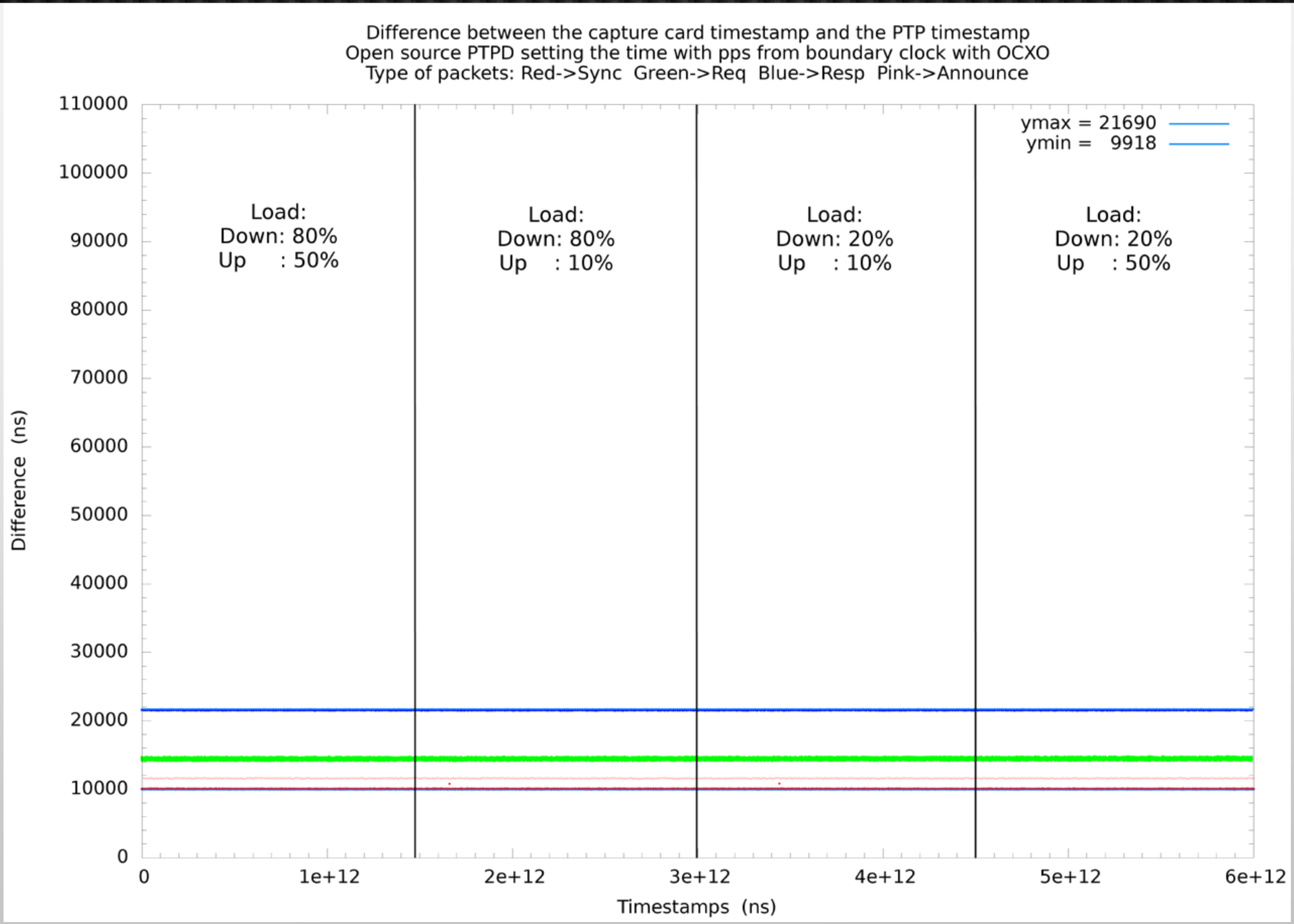
ITU G.8261 Traffic Model 2; Modified Test Case 13 (20 minute total duration)

Synchronization with dedicated Router BC w/OCXO:

Timestamp accuracy: <100ns wander, <500ns jitter

=> Acceptable for monitoring

Timestamp Accuracy – 1588v2 Results - V



ITU G.8261 Traffic Model 2; Modified Test Case 13 (20 minute total duration)
Synchronization with dedicated Router BC w/OCXO:

Timestamp accuracy: <100ns wander, <500ns jitter

=> Acceptable for monitoring

Wrap-Up

Wireless Service Providers, Backhaul Operators and Data Centers are adopting analytics to optimize their network performance and quality of service

- Network scales are thousands of nodes and Terabits per second of data

Sophisticated big data techniques scale to provide real-time network monitoring and analytics of key performance indicators end-to-end and hop-by-hop including:

- Throughput
- Delay
- Jitter
- Loss

Timestamp accuracy depends upon the 1588v2 distribution network and clock recovery algorithm and especially so when the underlying network is PTP unaware:

- PTP packets can be used as the probe packets (GPS-based GM packets preferred)
- Boundary Clocks improve overall performance
- Your results may vary:
  - 1588v2 clock recovery stability is essential to accurate analytics

JOLATA

Making the Network for you