NetMon a tool for multi-user network service monitoring and fault localization

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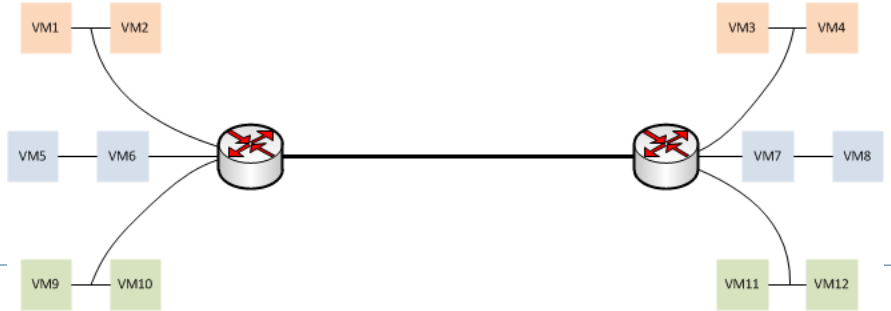
Motivation

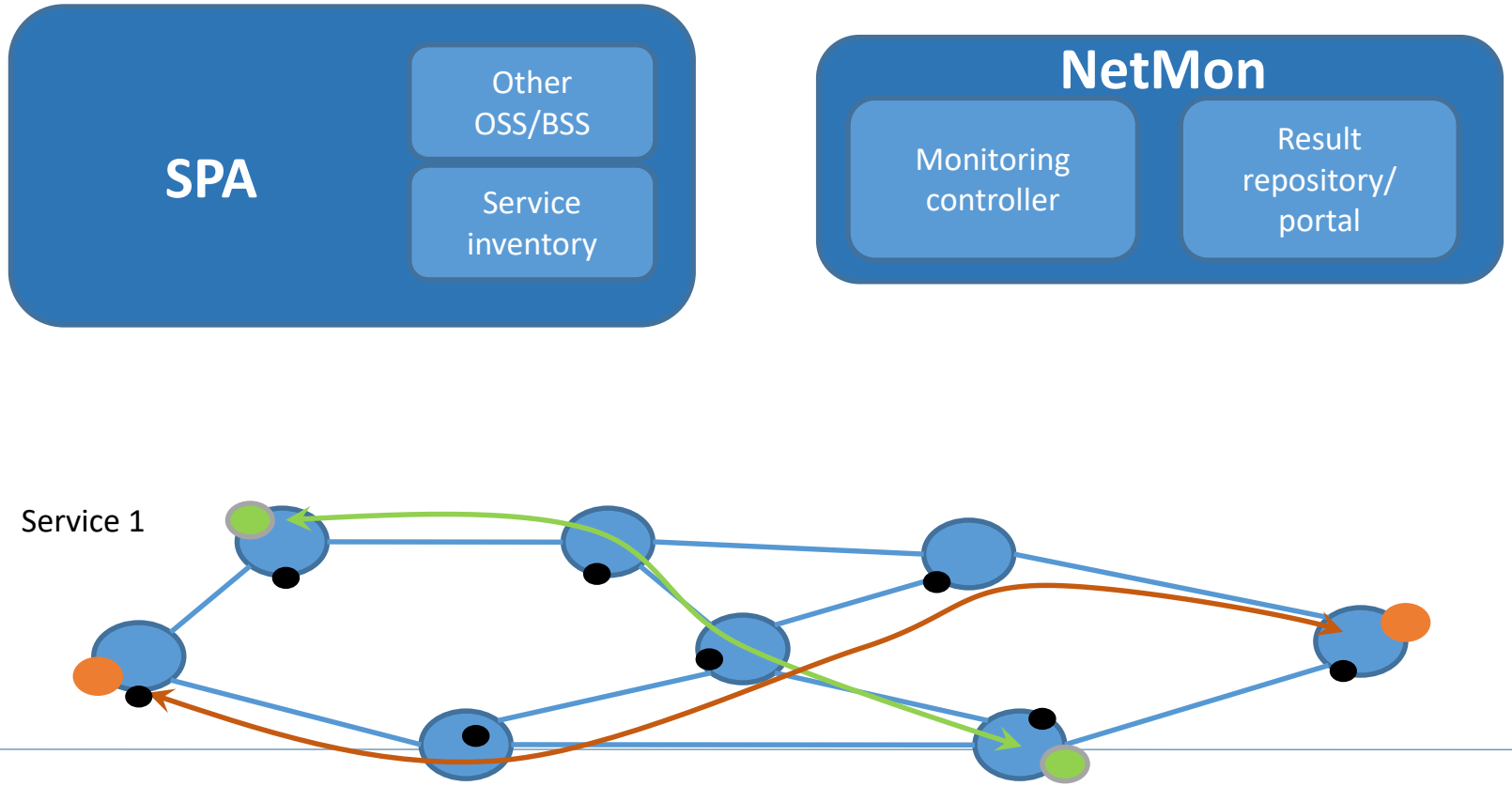
- Virtualized infrastructures – multiple users traffic is multiplexed over the same physical links
- How to estimate the quality of service/experience of each user separately?
- Monitoring physical infrastructure is not sufficient and using separate tools for each virtual network is not scalable
- Various network technologies are used for multiplexing users traffic (different VPN flavours, L2, L3, e-circuits, etc.). Goal: create a single, scalable, vendor independent monitoring platform capable to monitor all these technologies
- Automated monitoring upon network service installation integrated with the provisioning
- Fault localization – where is perfomance degradation on the end-to-end path?



NetMon approach

- NetMon provides:
  - real-time feedback to network operations personnel or users,
  - determines whether services are performing to spec (SLA verification),
  - if not, it initiates an automated analysis to localise the fault, and notify the appropriate agent to take corrective action.
- Key performance indicators:
  - MEF (10.3) and ITU defined metrics: delay, jitter, loss, availability, etc.
- Getting the metrics – hybrid approach (RFC 7799).
- Key components:
  - Monitoring Controller
  - Multihomed Monitoring Agents
  - Monitoring Result Repository and portal
  - (Capturers and Correlators for fault localization)
- 3 modes of operation: active – end-to-end, active+fault localization, full traffic analysis

Workflow integrated with the rest of the OSS/BSS Architecture (Mode 1)



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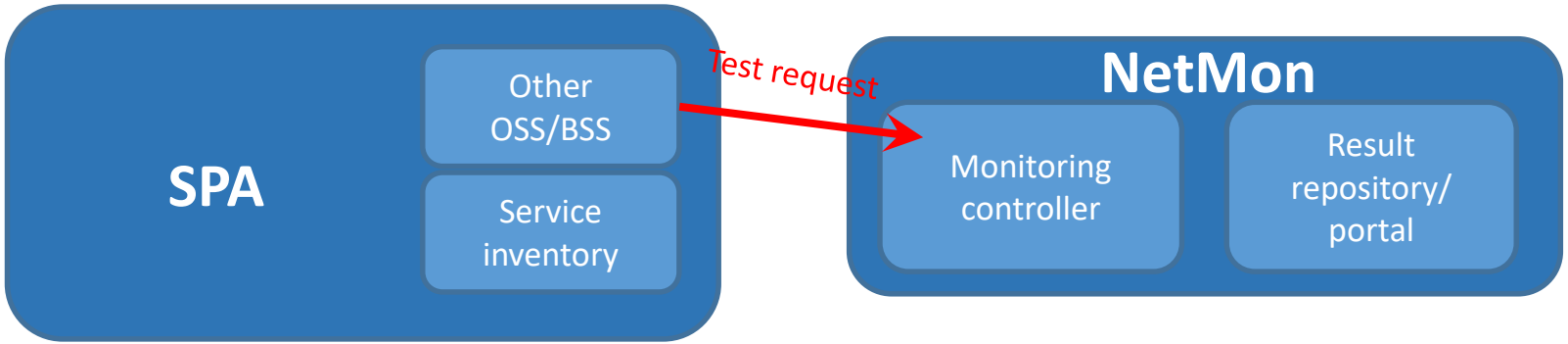

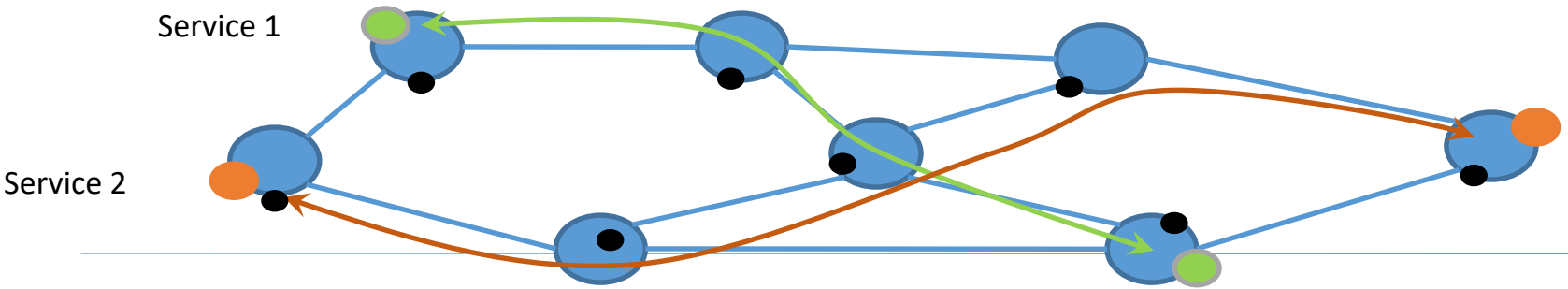

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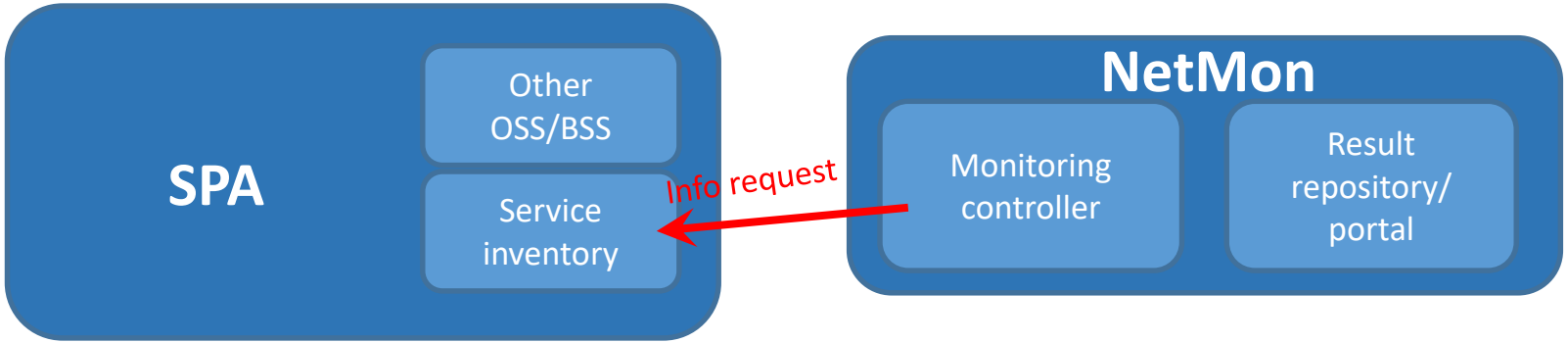

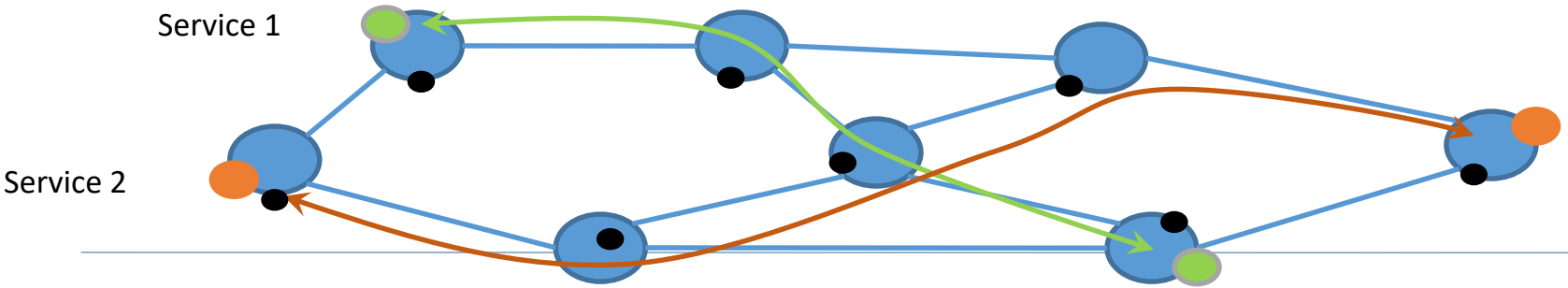

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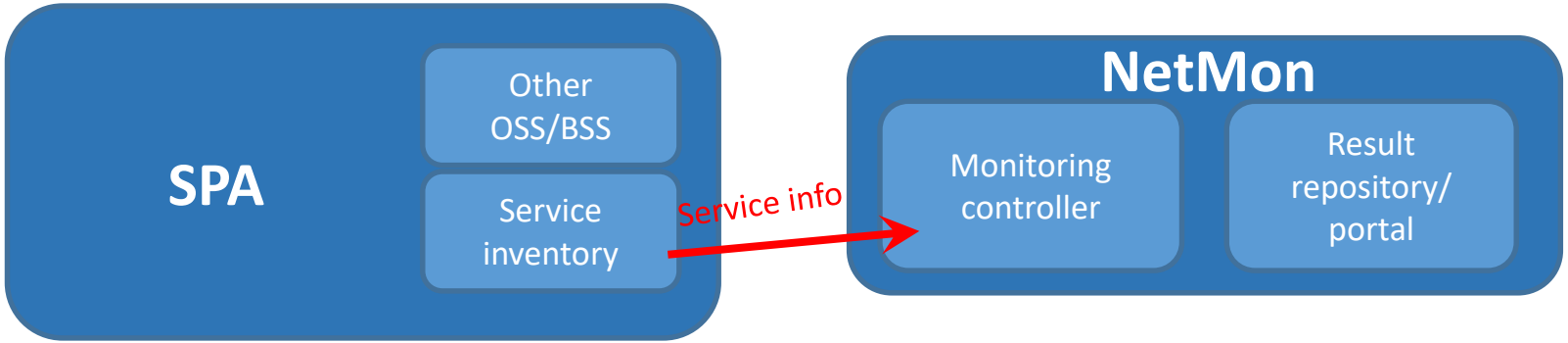

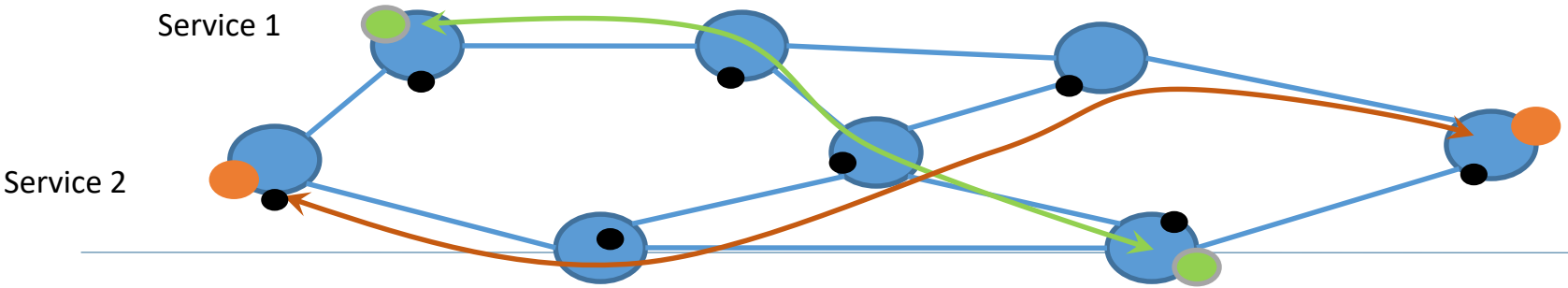

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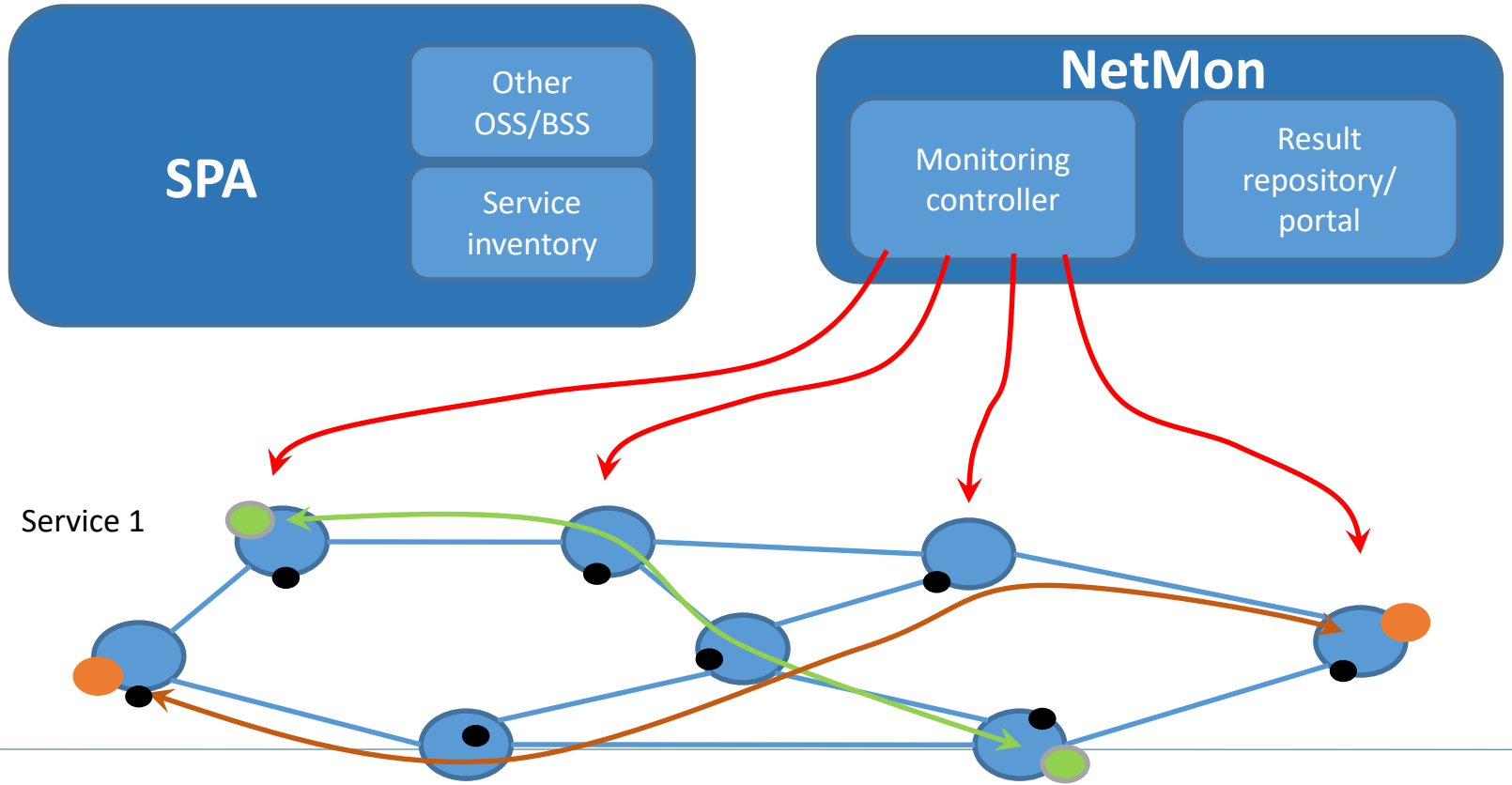

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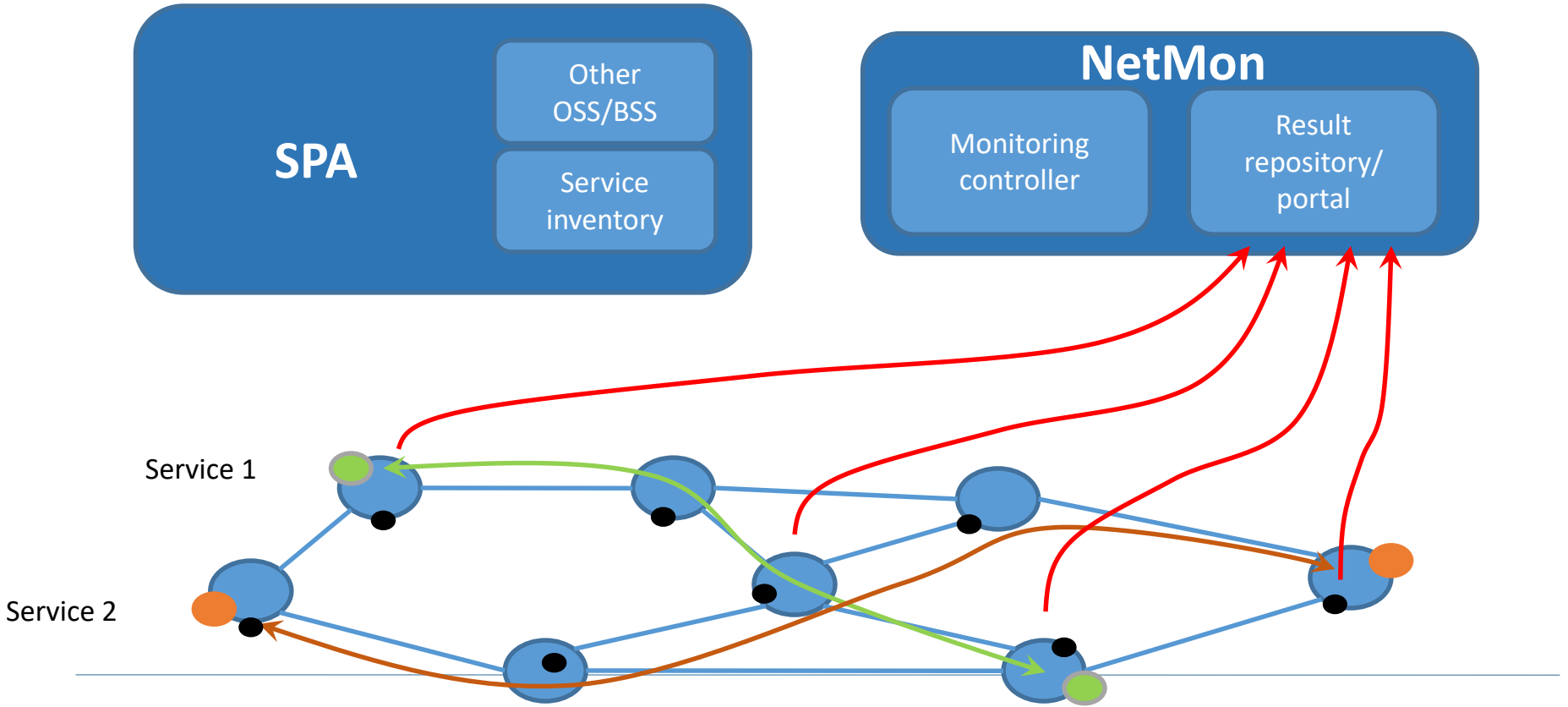

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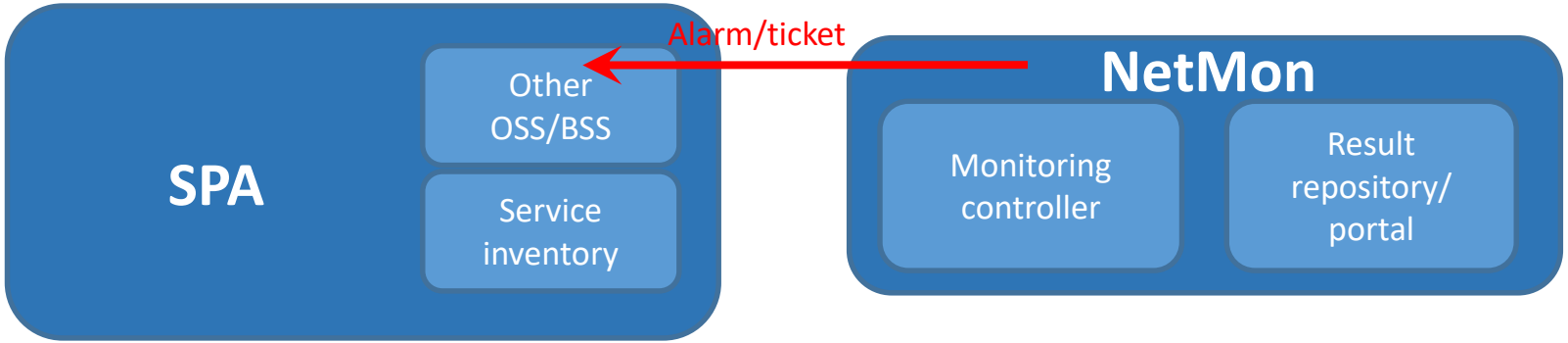
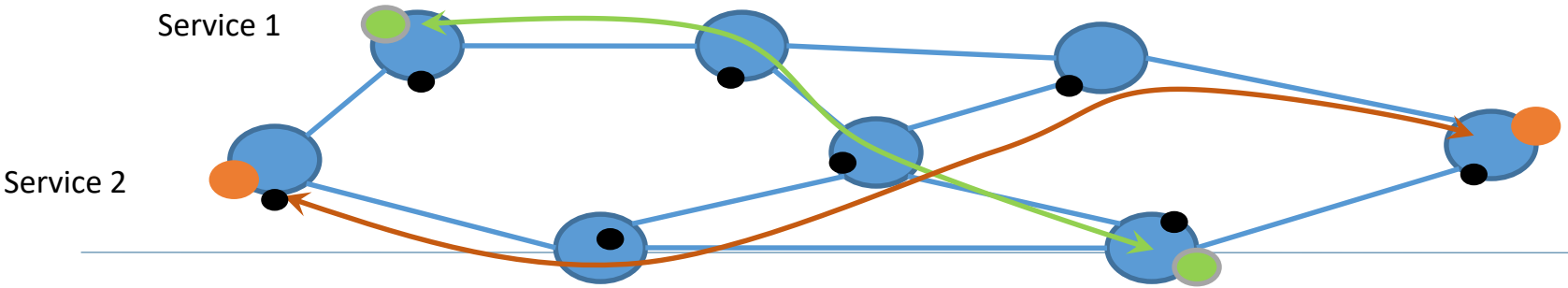
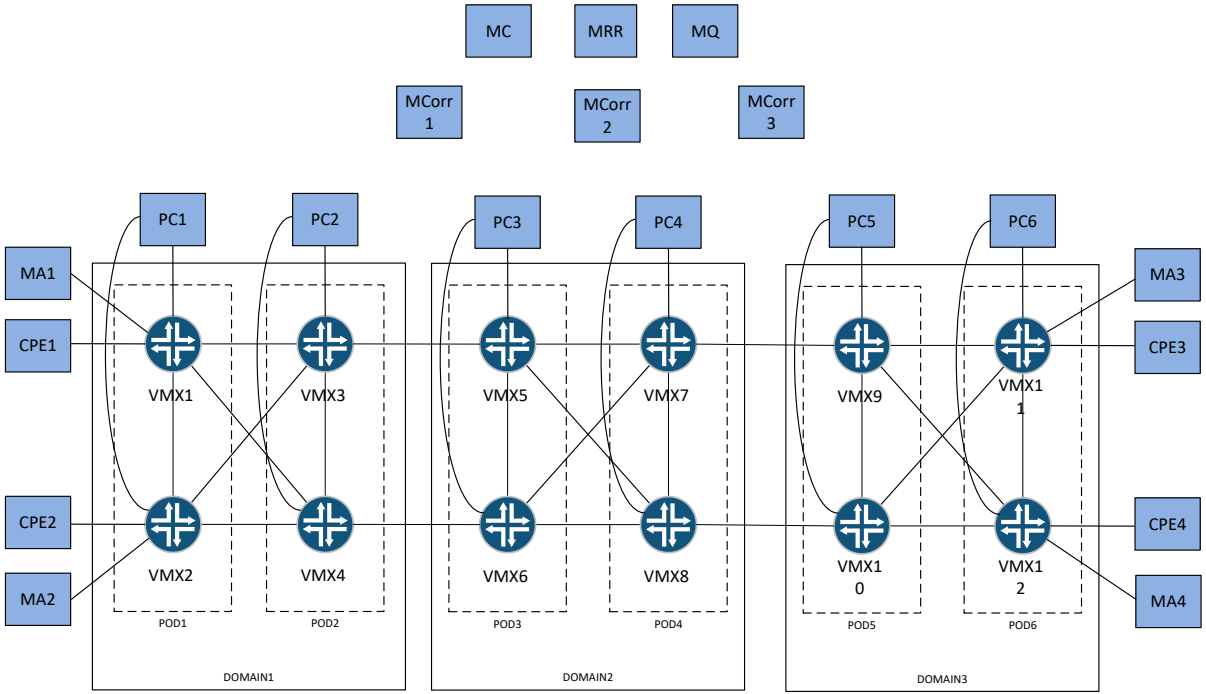


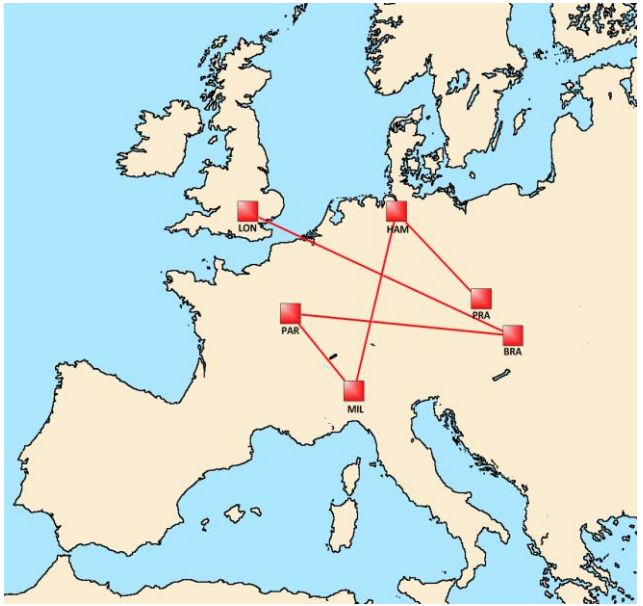


Compatibility and technology

- TMF Service Test API
- TMF Service inventory API
- TMF Trouble ticket API
- Monitoring @100G
- Integrate proven solutions:
  - Active probing - modified
  - Component configuration
  - Inter-component communication
  - Result database
  - Result display

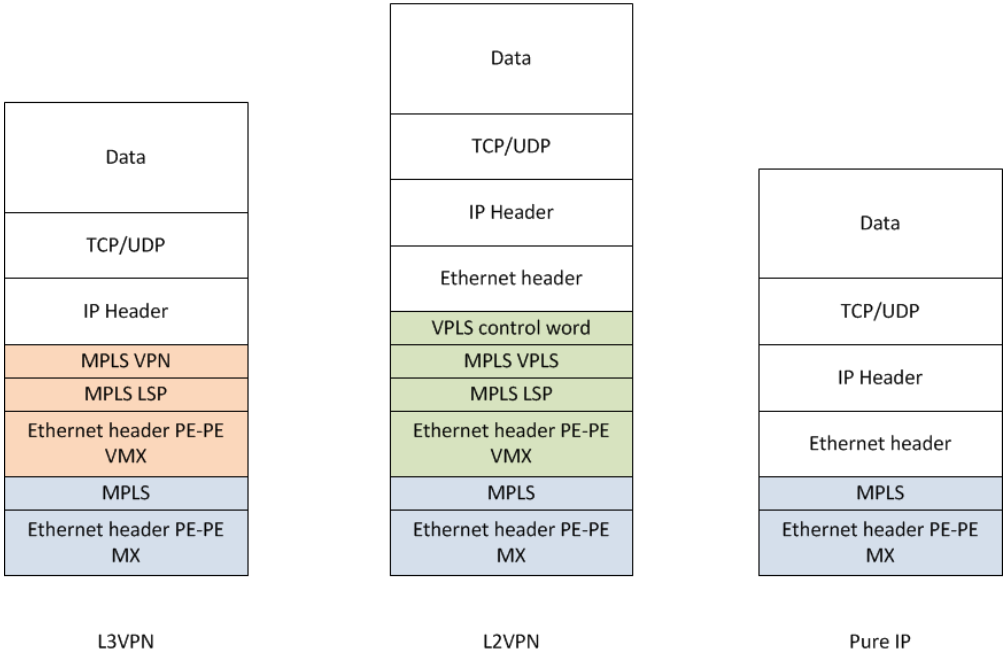
Network setup for the demo





The protocol stack

- Between MX routers (PODs): CCC L2VPN
- Between VMX: native IP, L2VPN, L3VPN
- Total on the wire:



VPNs

- 100 – Multipoint L3VPN
- (200 – p2p L3VPN)
- 300 – Multipoint L2VPN
- 400 – point to point L2 VPN
- Native IP communication between the CPE/MA devices
- In the example, we turn on and off VPN 200 monitoring and change the delay on the selected network path in the network

Initiating Monitoring Session

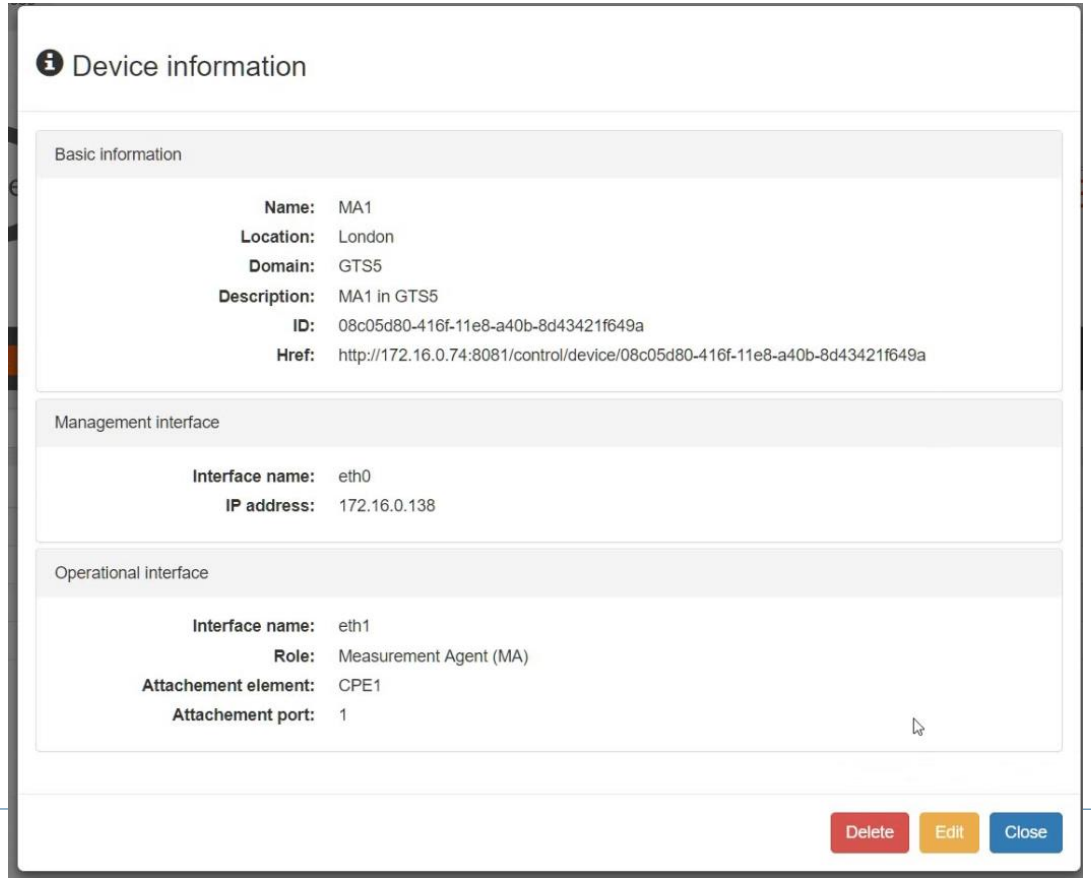
Monitoring Controller

Monitoring devices

Devices 4

Search...

▲Name	Location	Domain	Description
MA1	London	GTS5	MA1 in GTS5
MA2	London	GTS5	MA2 in GTS5
MA3	Prague	GTS5	MA3 in GTS5
MA4	Prague	GTS5	MA4 in GTS5


Device information
Basic information
Name: MA1
Location: London
Domain: GTS5
Description: MA1 in GTS5
ID: 08c05d80-416f-11e8-a40b-8d43421f649a
Href: http://172.16.0.74:8081/control/device/08c05d80-416f-11e8-a40b-8d43421f649a
Management interface
Interface name: eth0
IP address: 172.16.0.138
Operational interface
Interface name: eth1
Role: Measurement Agent (MA)
Attachement element: CPE1
Attachement port: 1
Delete
Edit
Close

Test specifications

Service Test Specifications 3

Search...

▲Name	Description
STS-Inproduction (delay, jitter, loss)	Inproduction performance verification (delay, jitter, loss)
STS-Inproduction (delay, loss)	Inproduction performance verification (delay, loss)
STS-Preproduction	Preproduction test based on ping

Test specifications

a40b-8d43421f649a

Measure definition 1

Name:	E2D Delay
Metric href:	e2e-delay
Metric name:	e2e delay
Metric description:	end to end delay
Unit of measure:	ms
Value type:	
Capture method:	inproduction-test-mode1
Capture frequency:	60s
Threshold rules:	Show

Measure definition 2

Name:	E2E Jitter
Metric href:	e2e-jitter
Metric name:	e2e jitter
Metric description:	end to end jitter
Unit of measure:	ms
Value type:	
Capture method:	inproduction-test-mode1
Capture frequency:	60s
Threshold rules:	Show

Measure definition 3

Name:	E2E Loss
Metric href:	e2e-loss

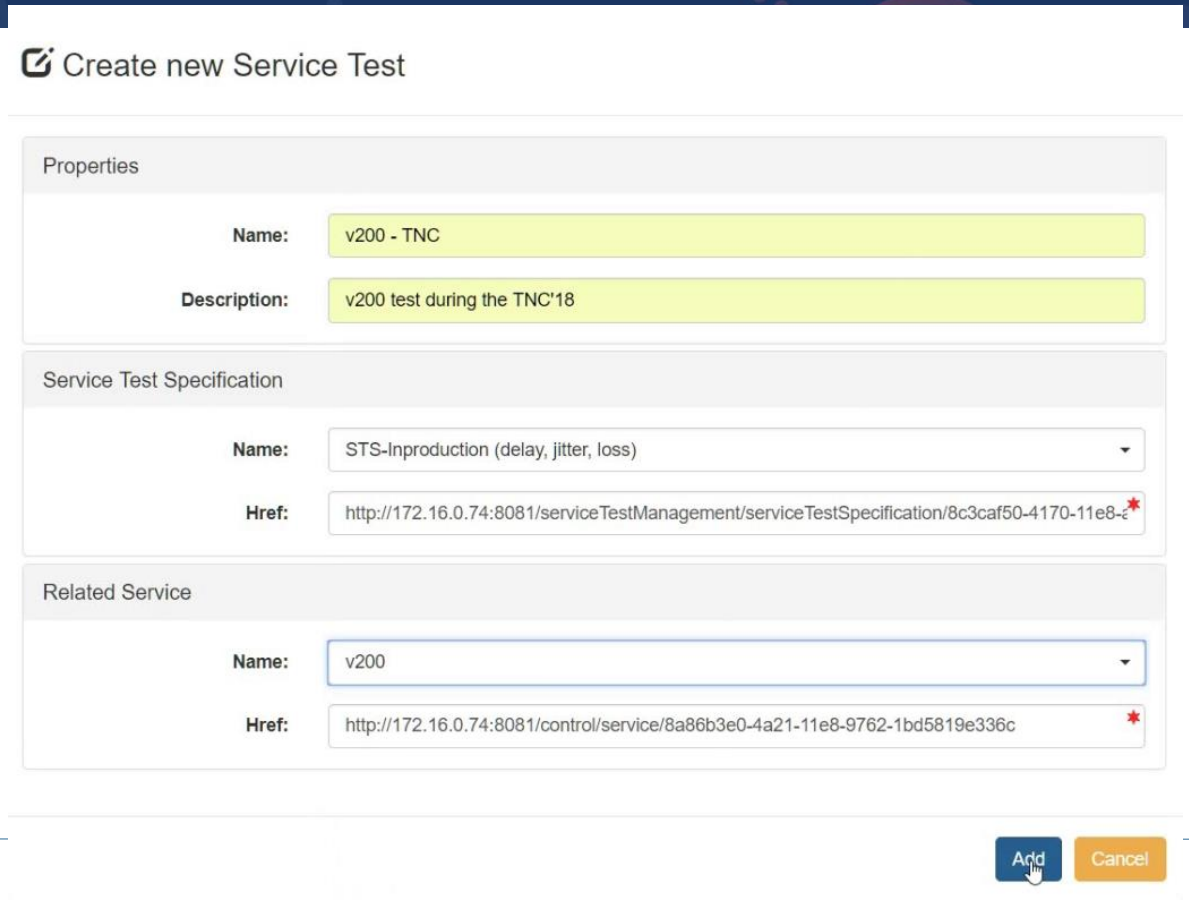
Service Tests 7

Search...

Start Time since: last day

Name	Description	Service	Status	▼Start Time	End Time
v200 - TNC	v200 test during TNC 2018	v200	Completed	2018-06-11T11:44:03.759Z	2018-06-11T11:49:12.044Z
Inproduction test (v200)	Inproduction test on v200	v200	Completed	2018-06-11T07:37:08.692Z	2018-06-11T07:54:52.874Z
Inproduction test (v300)	Inproduction test on v300	v300	In Progress	2018-06-11T07:33:27.807Z	
Inproduction test (v100)	Inproduction test on v100	v100	In Progress	2018-06-10T20:20:42.486Z	
Inproduction test (v100)	Inproduction test on v100	v100	Failed	2018-06-10T20:19:45.084Z	2018-06-10T20:21:28.668Z
Inproduction test (v100)	Inproduction test on v100	v100	Failed	2018-06-10T20:16:20.155Z	2018-06-10T20:18:03.941Z
Inproduction test (v300)	Inproduction test on v300	v300	Completed	2018-06-10T20:11:26.851Z	2018-06-10T20:15:48.652Z

New service test



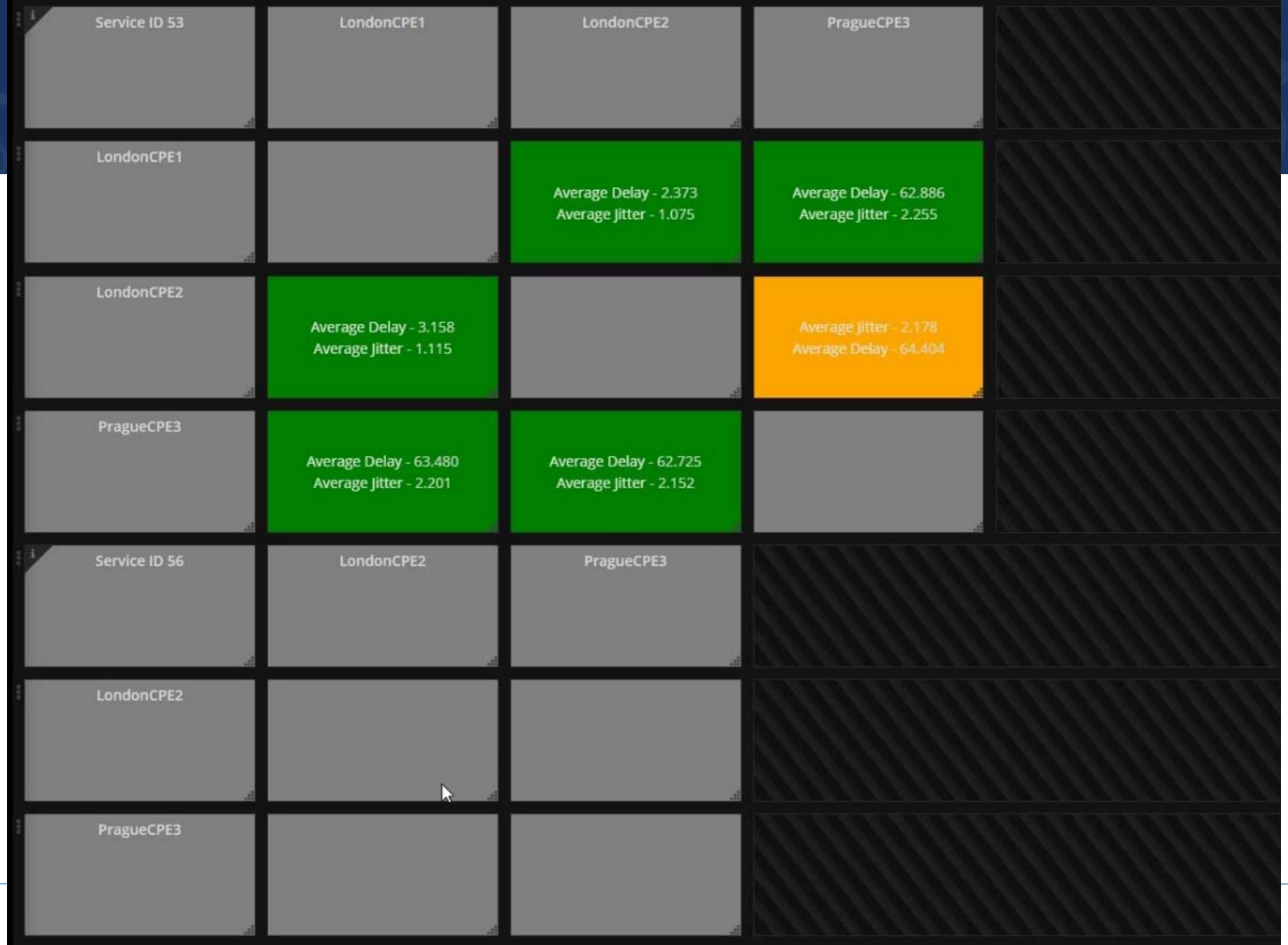
Service Tests 8

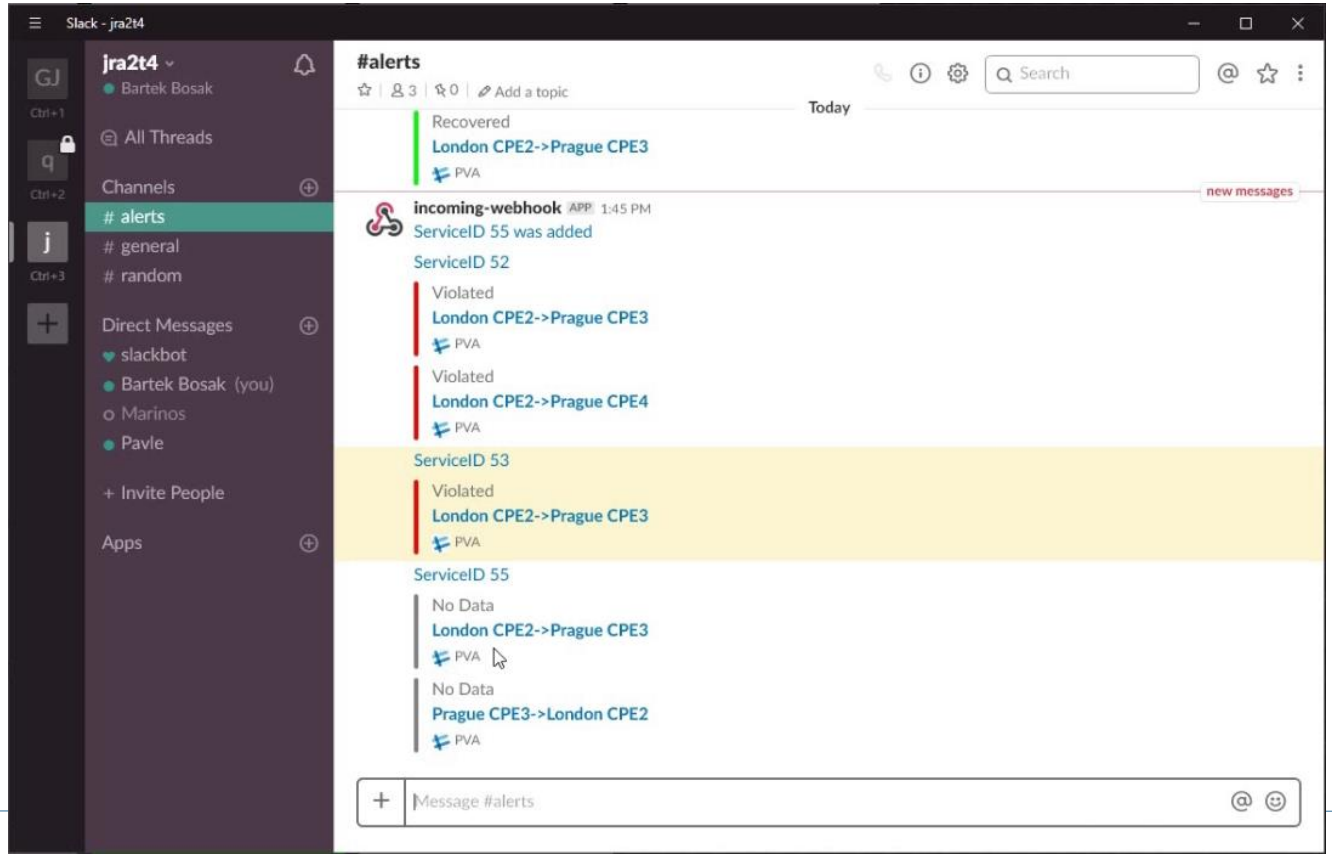
Search...

Start Time since: last day

Name	Description	Service	Status	▼Start Time	End Time
v200 - TNC	v200 test during the TNC'18	v200	In Progress	2018-06-11T11:53:03.530Z	
v200 - TNC	v200 test during TNC 2018	v200	Completed	2018-06-11T11:44:03.759Z	2018-06-11T11:49:12.044Z
Inproduction test (v200)	Inproduction test on v200	v200	Completed	2018-06-11T07:37:08.692Z	2018-06-11T07:54:52.874Z
Inproduction test (v300)	Inproduction test on v300	v300	In Progress	2018-06-11T07:33:27.807Z	
Inproduction test (v100)	Inproduction test on v100	v100	In Progress	2018-06-10T20:20:42.486Z	
Inproduction test (v100)	Inproduction test on v100	v100	Failed	2018-06-10T20:19:45.084Z	2018-06-10T20:21:28.668Z
Inproduction test (v100)	Inproduction test on v100	v100	Failed	2018-06-10T20:16:20.155Z	2018-06-10T20:18:03.941Z
est (v300)	Inproduction test on v300	v300	Completed	2018-06-10T20:11:26.851Z	2018-06-10T20:15:48.652Z

ice Test

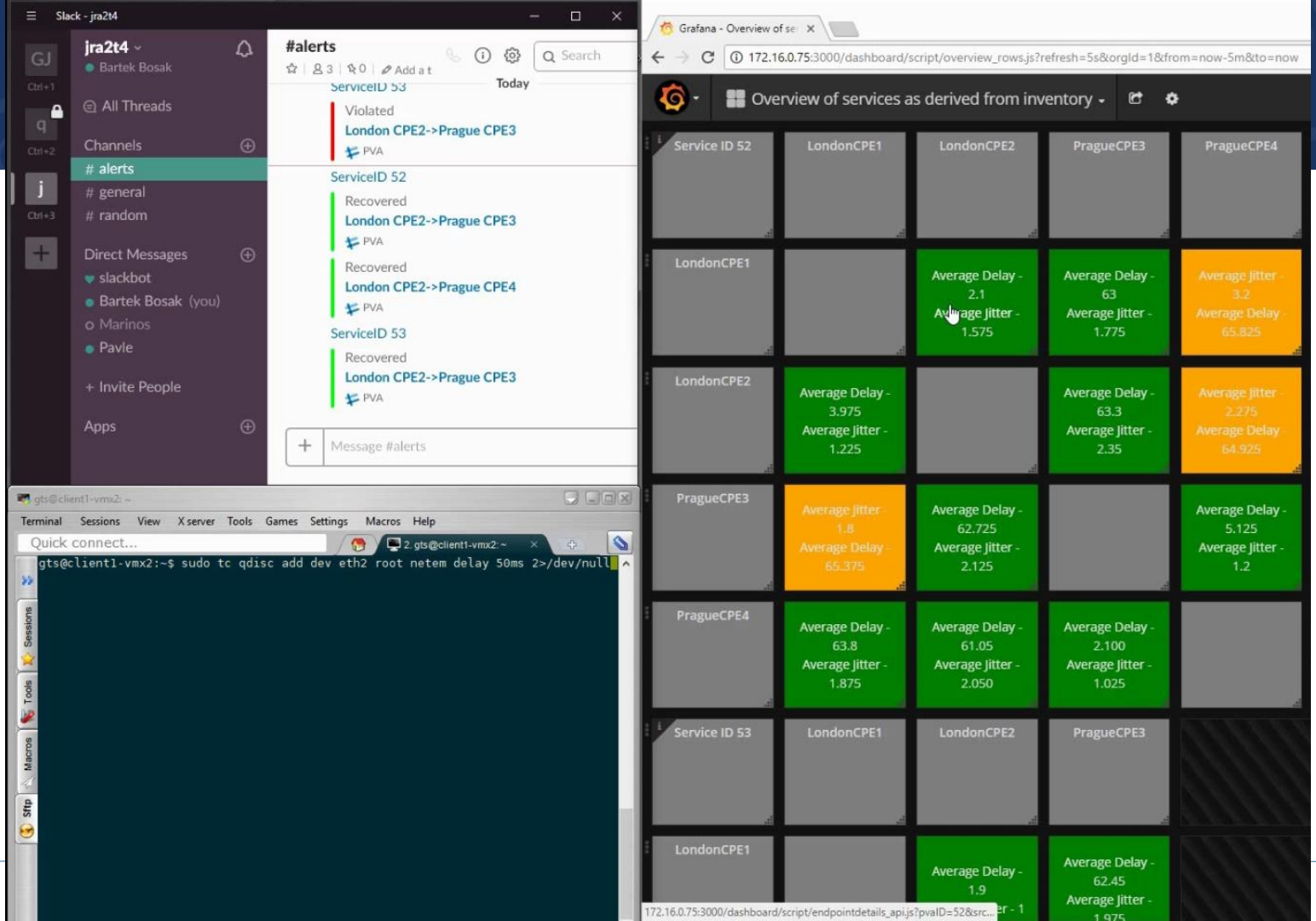

Service ID 53
LondonCPE1
LondonCPE2
PragueCPE3
LondonCPE1
Average Delay - 2.373
Average Jitter - 1.075
Average Delay - 62.886
Average Jitter - 2.255
LondonCPE2
Average Delay - 3.158
Average Jitter - 1.115
Average Jitter - 2.178
Average Delay - 64.404
PragueCPE3
Average Delay - 63.480
Average Jitter - 2.201
Average Delay - 62.725
Average Jitter - 2.152
Service ID 56
LondonCPE2
PragueCPE3
LondonCPE2
PragueCPE3


Slack - jra2t4
jra2t4
Bartek Bosak
All Threads
Channels
alerts
general
random
Direct Messages
slackbot
Bartek Bosak (you)
Marinos
Pavle
+ Invite People
Apps
#alerts
Add a topic
Search
Today
Recovered
London CPE2->Prague CPE3
PVA
new messages
incoming-webhook APP 1:45 PM
ServiceID 55 was added
ServiceID 52
Violated
London CPE2->Prague CPE3
PVA
Violated
London CPE2->Prague CPE4
PVA
ServiceID 53
Violated
London CPE2->Prague CPE3
PVA
ServiceID 55
No Data
London CPE2->Prague CPE3
PVA
No Data
Prague CPE3->London CPE2
PVA
Message #alerts

Service ID 53	LondonCPE1	LondonCPE2	PragueCPE3
LondonCPE1		Average Delay - 2.371 Average Jitter - 1.074	Average Delay - 62.883 Average Jitter - 2.255
LondonCPE2	Average Delay - 3.159 Average Jitter - 1.115		Average Jitter - 2.192 Average Delay - 64.394
PragueCPE3	Average Delay - 63.484 Average Jitter - 2.206	Average Delay - 62.725 Average Jitter - 2.155	

Service ID 56	LondonCPE2	PragueCPE3
LondonCPE2		Average Delay - 63.3 Average Jitter - 3.4
PragueCPE3	Average Delay - 62.5 Average Jitter - 1.6	

End-to-end Monitoring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Search
Today
ServiceID 53
Violated
London CPE2->Prague CPE3
PVA
ServiceID 52
Recovered
London CPE2->Prague CPE3
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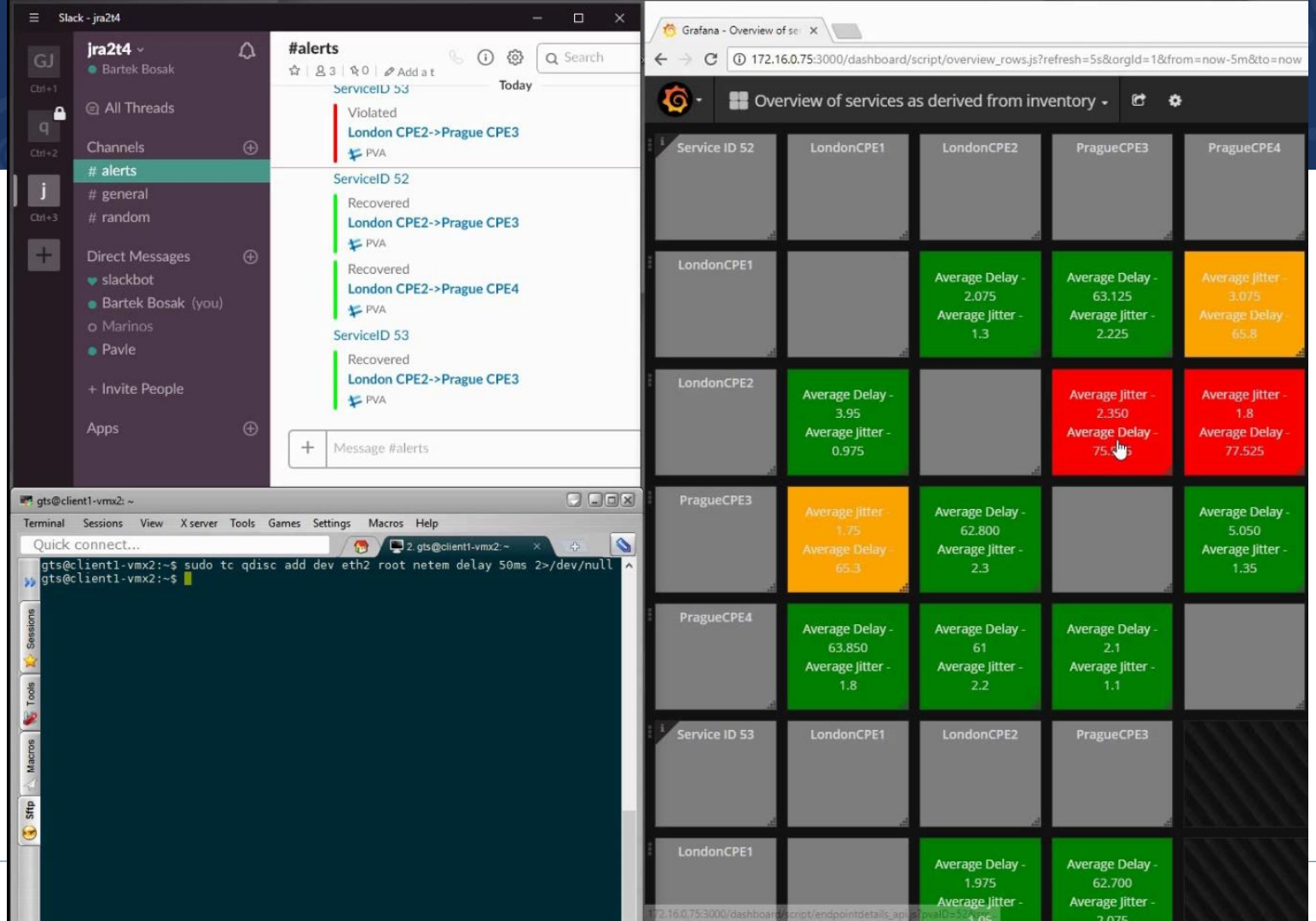
London CPE2->Prague CPE4
PVA
ServiceID 53
Recovered
London CPE2->Prague CPE3
PVA
Message #alerts
Terminal Sessions View X server Tools Games Settings Macros Help
Quick connect...
gts@client1-vmx2:~$ sudo tc qdisc add dev eth2 root netem delay 50ms 2>/dev/null
Grafana - Overview of se
172.16.0.75:3000/dashboard/script/overview_rows.js?refresh=5s&orgId=1&from=now-5m&to=now
Overview of services as derived from inventory
Service ID 52
LondonCPE1
LondonCPE2
PragueCPE3
PragueCPE4
Average Delay - 2.1
Average Jitter - 1.575
Average Delay - 63
Average Jitter - 1.775
Average Jitter - 3.2
Average Delay - 65.825
Average Delay - 3.975
Average Jitter - 1.225
Average Delay - 63.3
Average Jitter - 2.35
Average Jitter - 2.275
Average Delay - 64.925
Average Jitter - 1.8
Average Delay - 65.375
Average Delay - 62.725
Average Jitter - 2.125
Average Delay - 5.125
Average Jitter - 1.2
Average Delay - 63.8
Average Jitter - 1.875
Average Delay - 61.05
Average Jitter - 2.050
Average Delay - 2.100
Average Jitter - 1.025
Service ID 53
Average Delay - 1.9
Average Delay - 62.45
172.16.0.75:3000/dashboard/script/endpointdetails_api.js?pvaID=52&src...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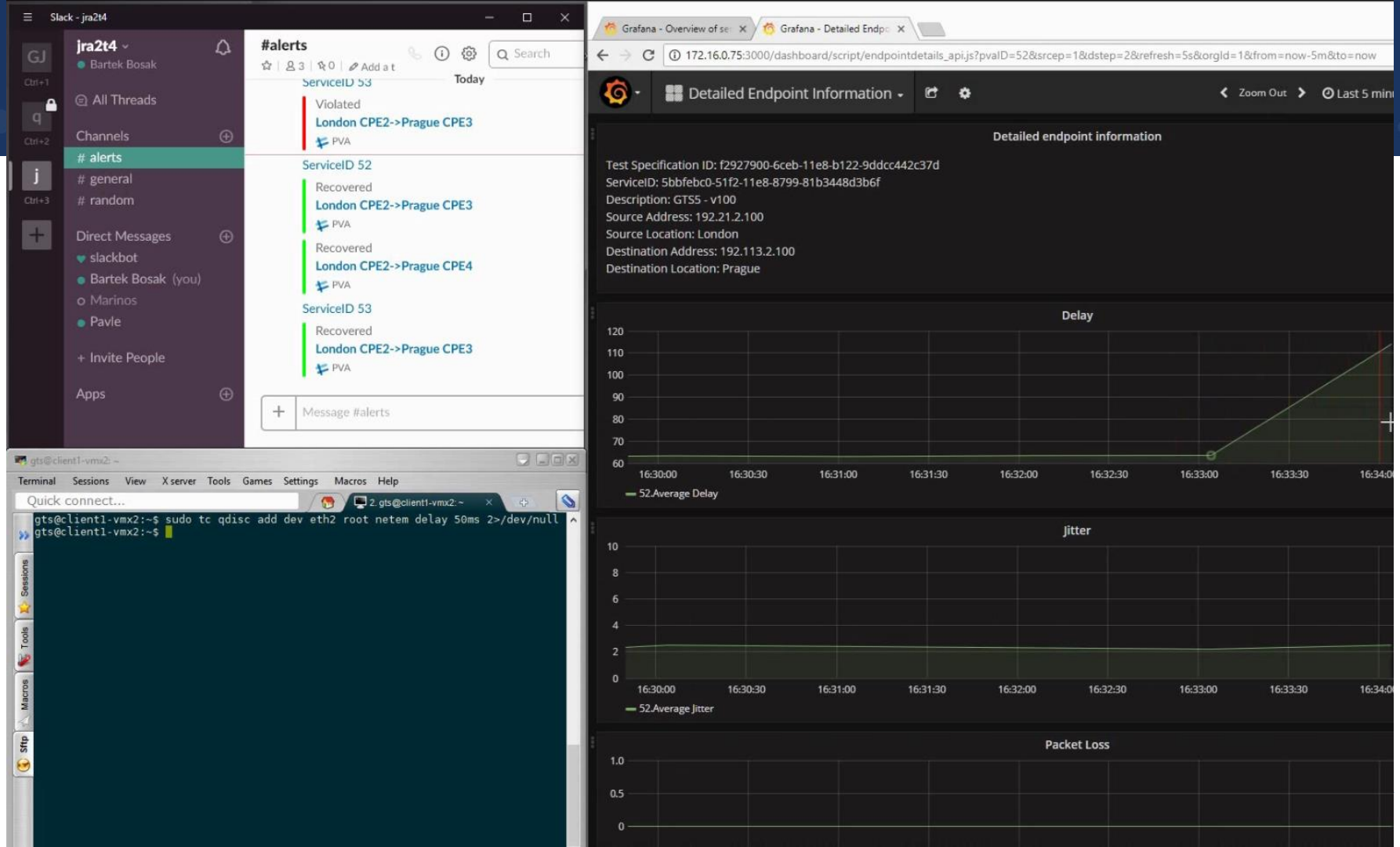
Average Delay - 63.125
Average Jitter - 2.225
Average Jitter - 3.075
Average Delay - 65.8
Average Delay - 3.95
Average Jitter - 0.975
Average Jitter - 2.350
Average Jitter - 1.8
Average Delay - 77.525
Average Jitter - 1.75
Average Delay - 65.3
Average Delay - 62.800
Average Jitter - 2.3
Average Delay - 5.050
Average Jitter - 1.35
Average Delay - 63.850
Average Jitter - 1.8
Average Delay - 61
Average Jitter - 2.2
Average Delay - 2.1
Average Jitter - 1.1
Service ID 53
Average Delay - 1.975
Average Delay - 62.700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Detailed Endpoint Information
Zoom Out
Last 5 min
Detailed endpoint information
Test Specification ID: f2927900-6ceb-11e8-b122-9ddcc442c37d
ServiceID: 5bbfebc0-51f2-11e8-8799-81b3448d3b6f
Description: GTS5 - v100
Source Address: 192.21.2.100
Source Location: London
Destination Address: 192.113.2.100
Destination Location: Prague
Delay
120
110
100
90
80
70
60
16:30:00
16:30:30
16:31:00
16:31:30
16:32:00
16:32:30
16:33:00
16:33:30
52.Average Delay
Jitter
10
8
6
4
2
0
52.Average Jitter
Packet Loss
1.0
0.5
0

Fault localization

Fault localization (Mode 2 and 3)

- It is necessary to get the information from the intermediate points in the network
- Similar approaches:
  - Single technology (CFM) or vendor/proprietary solutions

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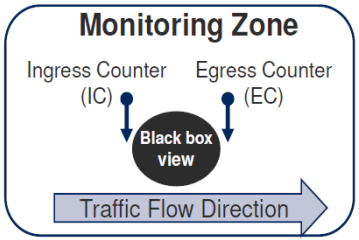

aken from: Ericsson Diamond: https://pdfs.semanticscholar.org/0119/099638d68a0836d55d7de0dfc00891571876.pdf

Fault localization (Mode 2 and 3)

- It is necessary to get the information from the intermediate points in the network
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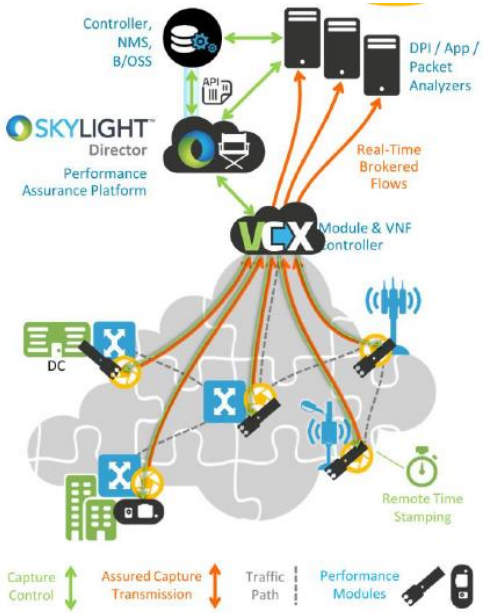

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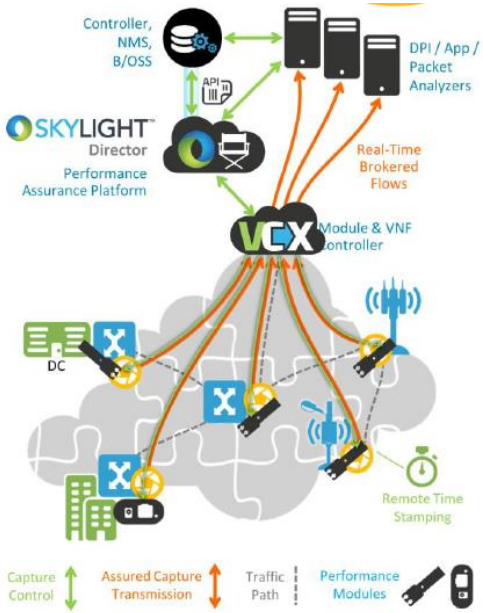
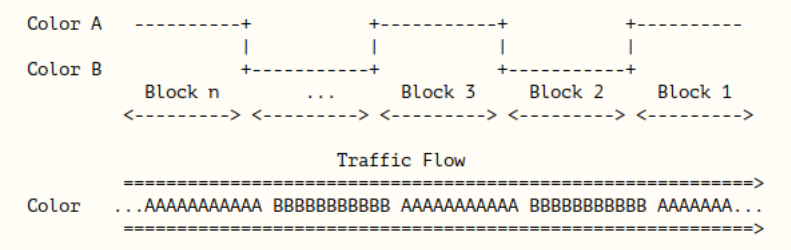
  - IETF RFC 8321 (Jan 2018) – Alternate marking (requires changes in the network elements)



Fault localization (Mode 2 and 3)

- It is necessary to get the information from the intermediate points in the network
- Similar approaches:
  - Single technology (CFM) or vendor/proprietary solutions
  - Concept of the monitoring zone
  - Flow Broker
  - IETF RFC 8321 (Jan 2018) – Alternate marking (requires changes in the network elements)
  - IETF RFC 8372 (May 2018) – MPLS Flow identification



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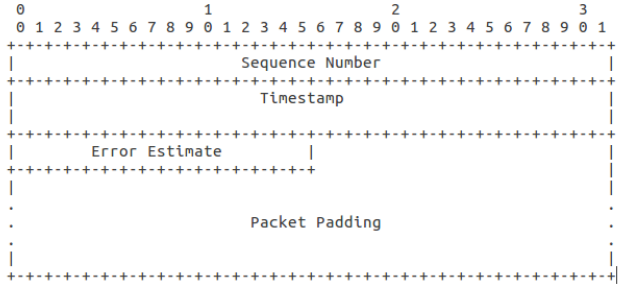
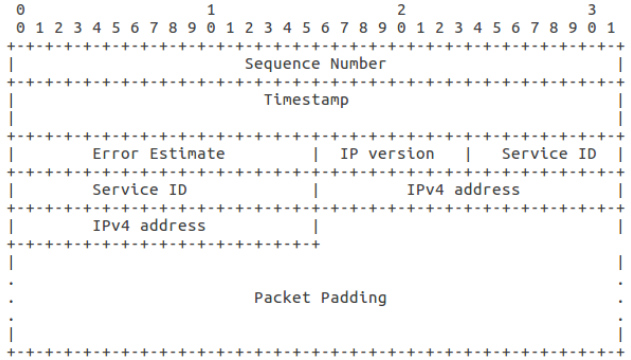
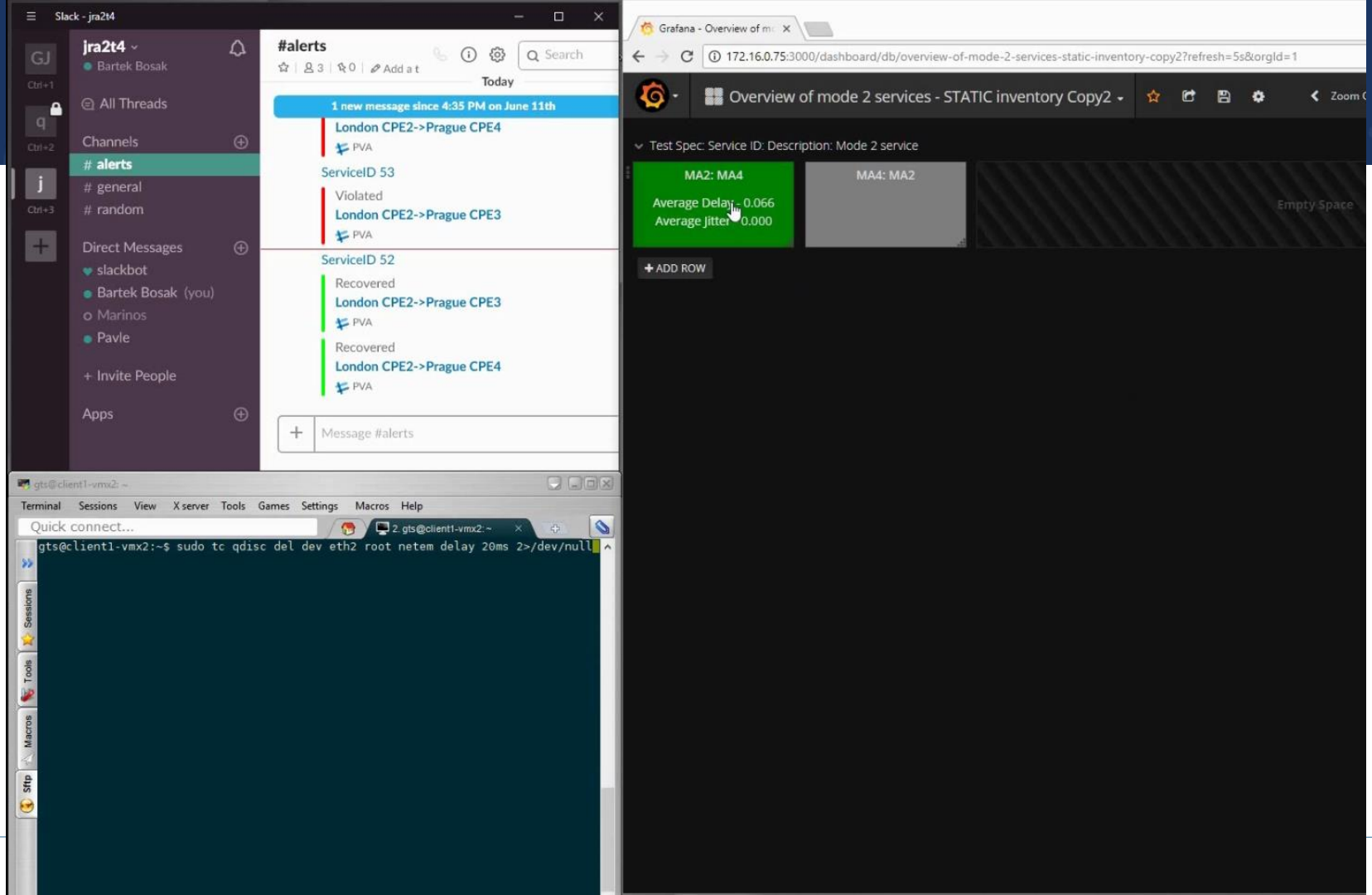
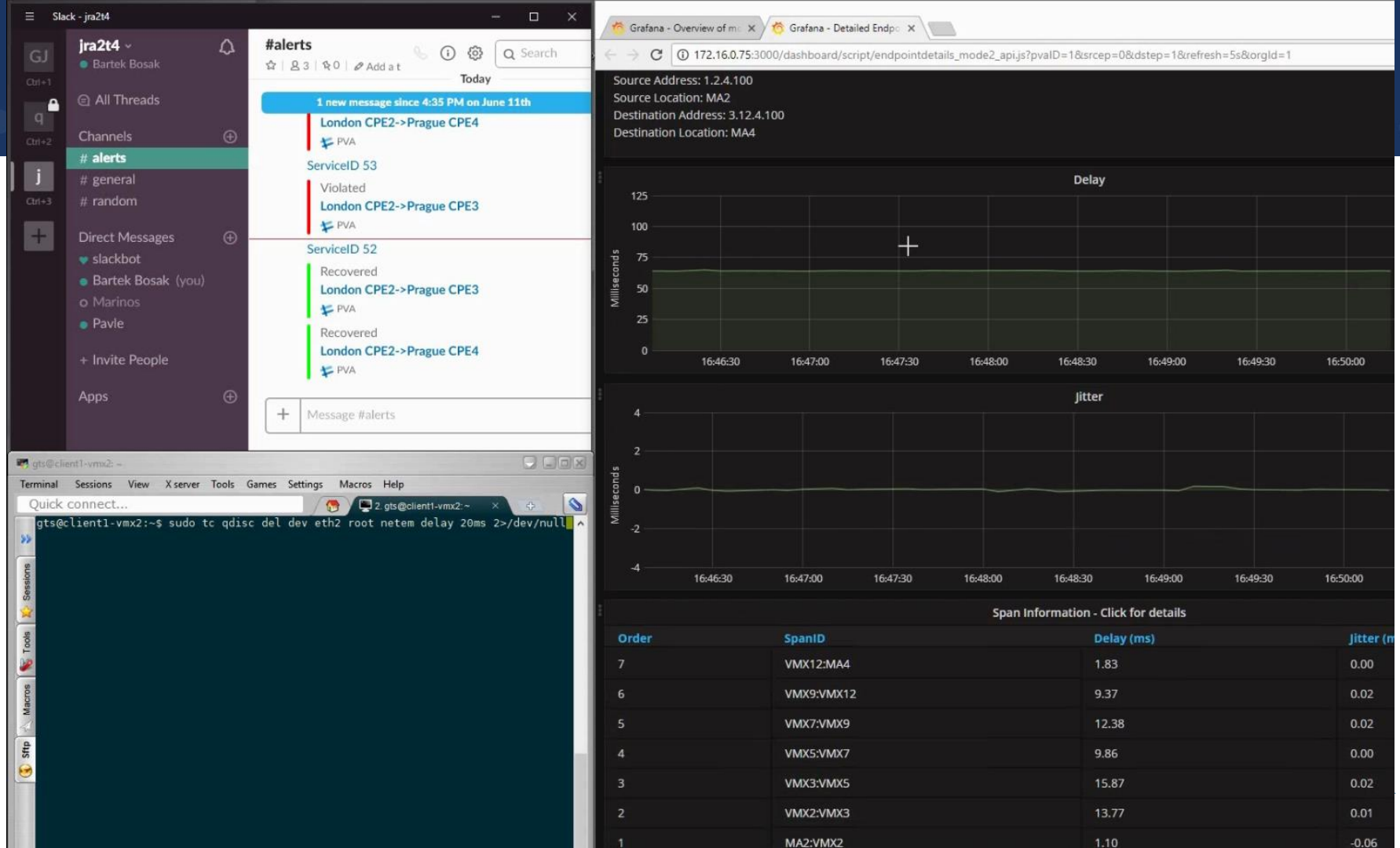
  - IETF RFC 8321 (Jan 2018) – Alternate marking (requires changes in the network elements)
  - IETF RFC 8372 (May 2018) – MPLS Flow identification
- NetMon approach
  - Specially crafted OWAMP packets (serviceID)
  - Captured at various points in the network
  - Matched based on the packet hash and service ID
  - Packet digest sent to the Correlator and from there to the Result reposirory





owping -s 30 -x 04000064AC100016 192.168.100.2:8765


Slack - jra2t4
jra2t4
Bartek Bosak
All Threads
Channels
alerts
general
random
Direct Messages
slackbot
Bartek Bosak (you)
Marinos
Pavle
+ Invite People
Apps
#alerts
Search
Today
1 new message since 4:35 PM on June 11th
London CPE2->Prague CPE4
PVA
ServiceID 53
Violated
London CPE2->Prague CPE3
PVA
ServiceID 52
Recovered
London CPE2->Prague CPE3
PVA
Recovered
London CPE2->Prague CPE4
PVA
Message #alerts
Grafana - Overview of mode 2 services - STATIC inventory Copy2
172.16.0.75:3000/dashboard/db/overview-of-mode-2-services-static-inventory-copy2?refresh=5s&orgId=1
Overview of mode 2 services - STATIC inventory Copy2
Test Spec: Service ID: Description: Mode 2 service
MA2: MA4
Average Delay - 0.066
Average Jitter - 0.000
MA4: MA2
Empty Space
+ ADD ROW
Terminal
Sessions
View
X server
Tools
Games
Settings
Macros
Help
Quick connect...
2. gts@client1-vmx2: ~
gts@client1-vmx2:~$ sudo tc qdisc del dev eth2 root netem delay 20ms 2>/dev/null
Sessions
Tools
Macros
Sftp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PVA
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PVA
Message #alerts
Grafana - Overview of mo
Grafana - Detailed Endpo
172.16.0.75:3000/dashboard/script/endpointdetails_mode2_api.js?pvaID=1&srcep=0&dstep=1&refresh=5s&orgId=1
Source Address: 1.2.4.100
Source Location: MA2
Destination Address: 3.12.4.100
Destination Location: MA4
Delay
Milliseconds
125
100
75
50
25
0
16:46:30
16:47:00
16:47:30
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
Jitter
Milliseconds
4
2
0
-2
-4
16:46:30
16:47:00
16:47:30
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
Span Information - Click for details
Order
SpanID
Delay (ms)
Jitter (m
7
VMX12:MA4
1.83
0.00
6
VMX9:VMX12
9.37
0.02
5
VMX7:VMX9
12.38
0.02
4
VMX5:VMX7
9.86
0.00
3
VMX3:VMX5
15.87
0.02
2
VMX2:VMX3
13.77
0.01
1
MA2:VMX2
1.10
-0.06
Terminal
Sessions
View
X server
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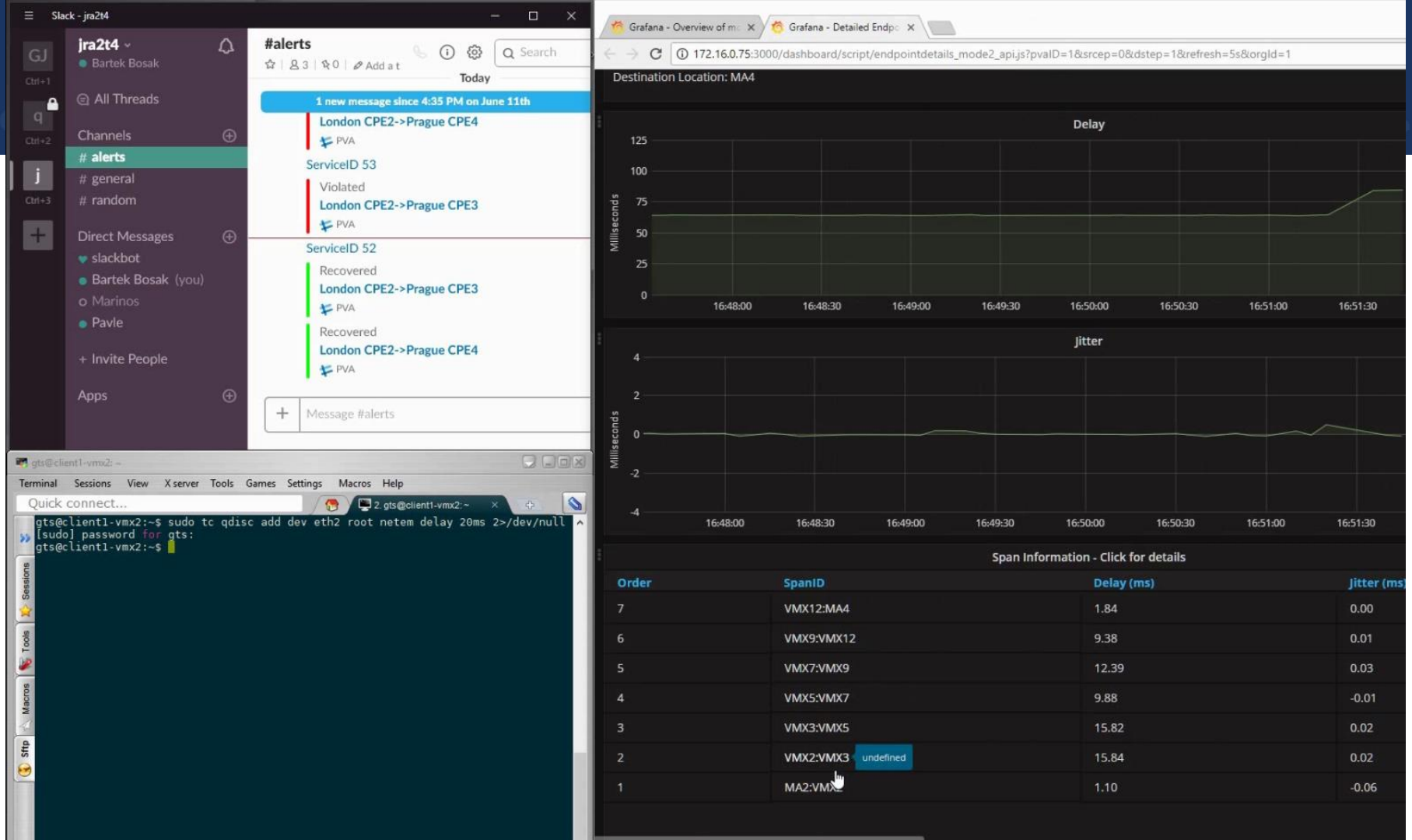
Settings
Macros
Help
Quick connect...
2. gts@client1-vmx2:~
gts@client1-vmx2:~$ sudo tc qdisc del dev eth2 root netem delay 20ms 2>/dev/null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Terminal Sessions View X server Tools Games Settings Macros Help
Quick connect...
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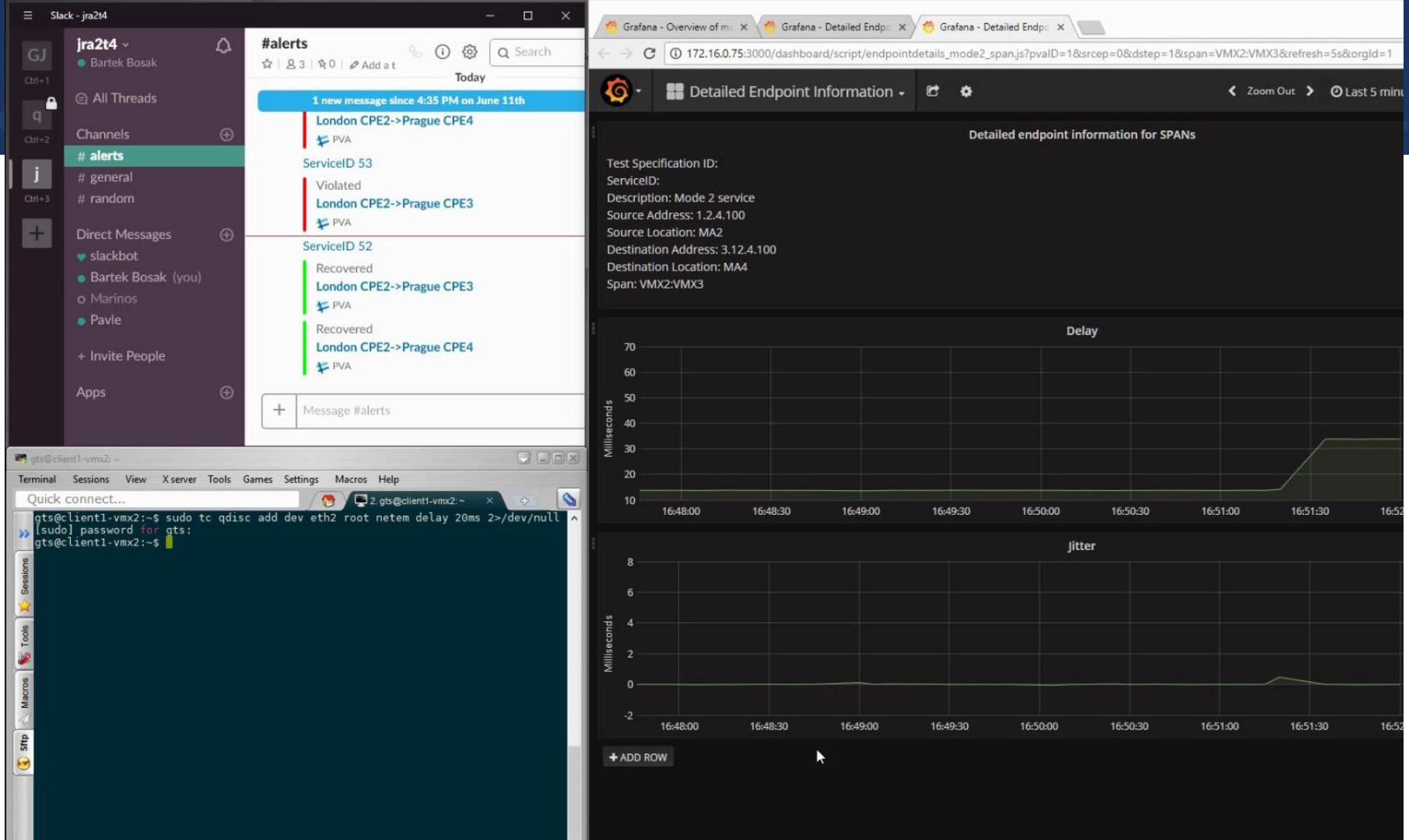
gts@client1-vmx2:~$ sudo tc qdisc add dev eth2 root netem delay 20ms 2>/dev/null
[sudo] password for gts:
gts@client1-vmx2:~$
Grafana - Overview of m
Grafana - Detailed Endpc
172.16.0.75:3000/dashboard/script/endpointdetails_mode2_api.js?pvaID=1&srcep=0&dstep=1&refresh=5s&orgId=1
Destination Location: MA4
Delay
Milliseconds
125
100
75
50
25
0
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
16:50:30
16:51:00
16:51:30
Jitter
Milliseconds
4
2
0
-2
-4
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
16:50:30
16:51:00
16:51:30
Span Information - Click for details
Order
SpanID
Delay (ms)
Jitter (ms)
7
VMX12:MA4
1.84
0.00
6
VMX9:VMX12
9.38
0.01
5
VMX7:VMX9
12.39
0.03
4
VMX5:VMX7
9.88
-0.01
3
VMX3:VMX5
15.82
0.02
2
VMX2:VMX3
undefined
15.84
0.02
1
MA2:VMX
1.10
-0.06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[sudo] password for gts:
gts@client1-vmx2:~$
Grafana - Overview of mc
Grafana - Detailed Endpc
Grafana - Detailed Endpc
172.16.0.75:3000/dashboard/script/endpointdetails_mode2_span.js?pvaID=1&srcep=0&dstep=1&span=VMX2:VMX3&refresh=5s&orgId=1
Detailed Endpoint Information
Zoom Out
Last 5 minu
Detailed endpoint information for SPANs
Test Specification ID:
ServiceID:
Description: Mode 2 service
Source Address: 1.2.4.100
Source Location: MA2
Destination Address: 3.12.4.100
Destination Location: MA4
Span: VMX2:VMX3
Delay
Milliseconds
70
60
50
40
30
20
10
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
16:50:30
16:51:00
16:51:30
Jitter
Milliseconds
8
6
4
2
0
-2
16:48:00
16:48:30
16:49:00
16:49:30
16:50:00
16:50:30
16:51:00
16:51:30
+ ADD ROW

Can NetMon be merged with perfSONAR?

- NetMon uses active monitoring approach (but no BW tests)
- NetMon uses the same key monitoring tool (owamp/twamp)
- perfSONAR recently adopted the work in netnamespaces (multihoming – multi-tenant operation)
- perfSONAR has well organized development process and a long history of successful deployments
- Key gaps:
  - Service awareness (use case: Service X operating between CPE A, B, C over VLANs 100, 200, 300 on interfaces eth2, eth1, eth2 respectively. KPI for Service X: delay, jitter and loss. SLA specification, RAG alarm thresholds, signaling towards other components)
  - Integration with the other OSS/BSS components (extracting the required data from other inventories, receiving monitoring orders, sending alarms)
  - Fault localization
  - perfSONAR plans

Thank you
Any Questions?