Uncovering IP Traffic Pattern in Saudi Arabia

Latency, Routes, Hop count, . . .

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Motivation

01

Cyber security

03

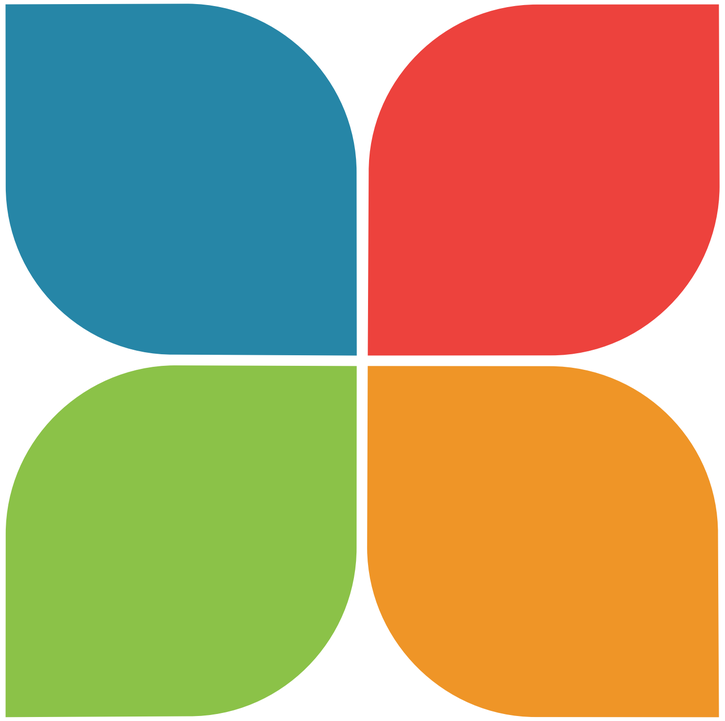
Bandwidth eater applications

Future technology

02

Research Objectives

- Study the pattern and behavior of intra and inter IP traffic in Saudi Arabia
- Measure average packet loss in IP traffic in Saudi Arabia
- Measure average latency within and across the boarder of the kingdom
- Provide recommendation to improve the quality of service (QoS) as well as the quality of experience (QoE) for the existing IP network



RIPE Atlas

Available measurements

- Ping
- Traceroute
- DNS
- SSL
- HTTP
- NTP

Atlas Distribution in Saudi Arabia

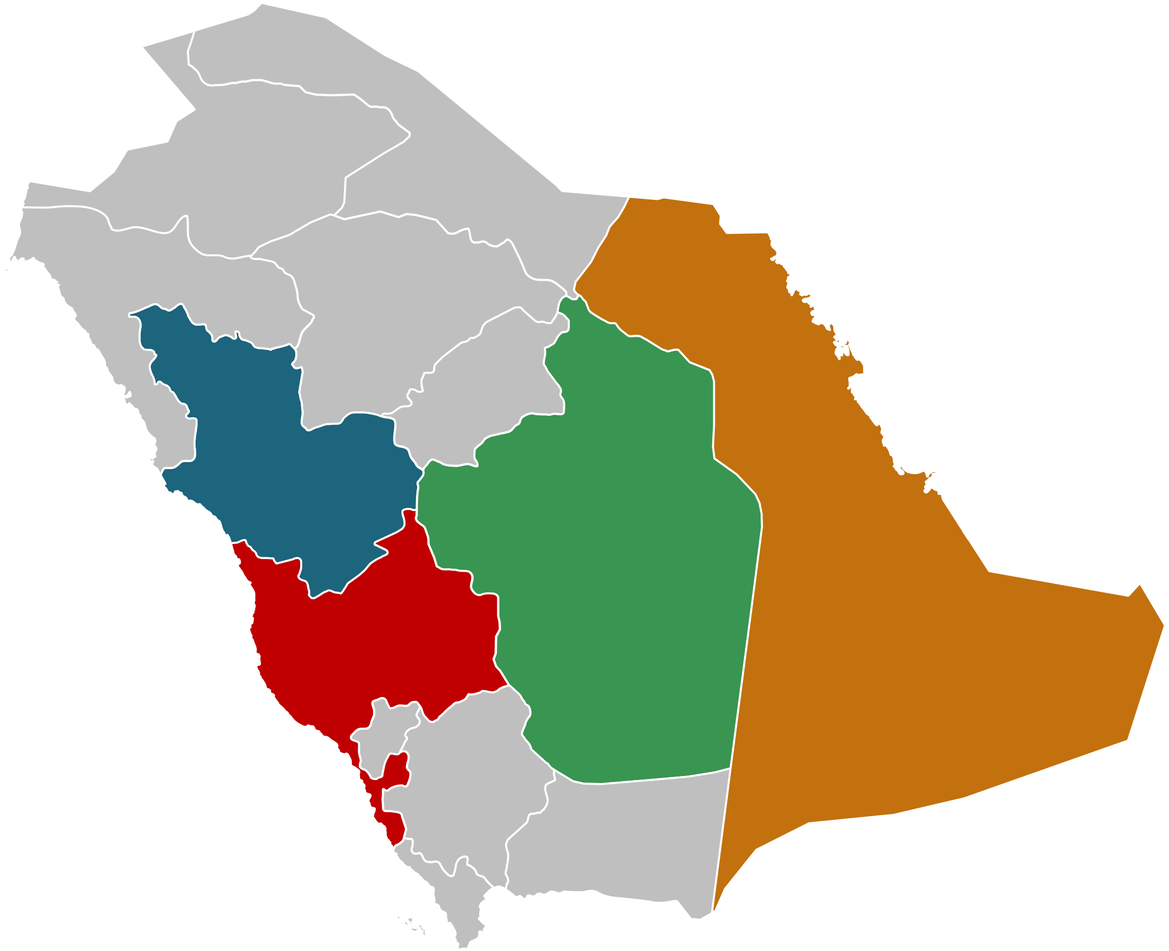
Connected probes are distributed in 4 (out of 13) regions in Saudi Arabia

Region 1
Almadinah Almunawwarah
3 Connected probes

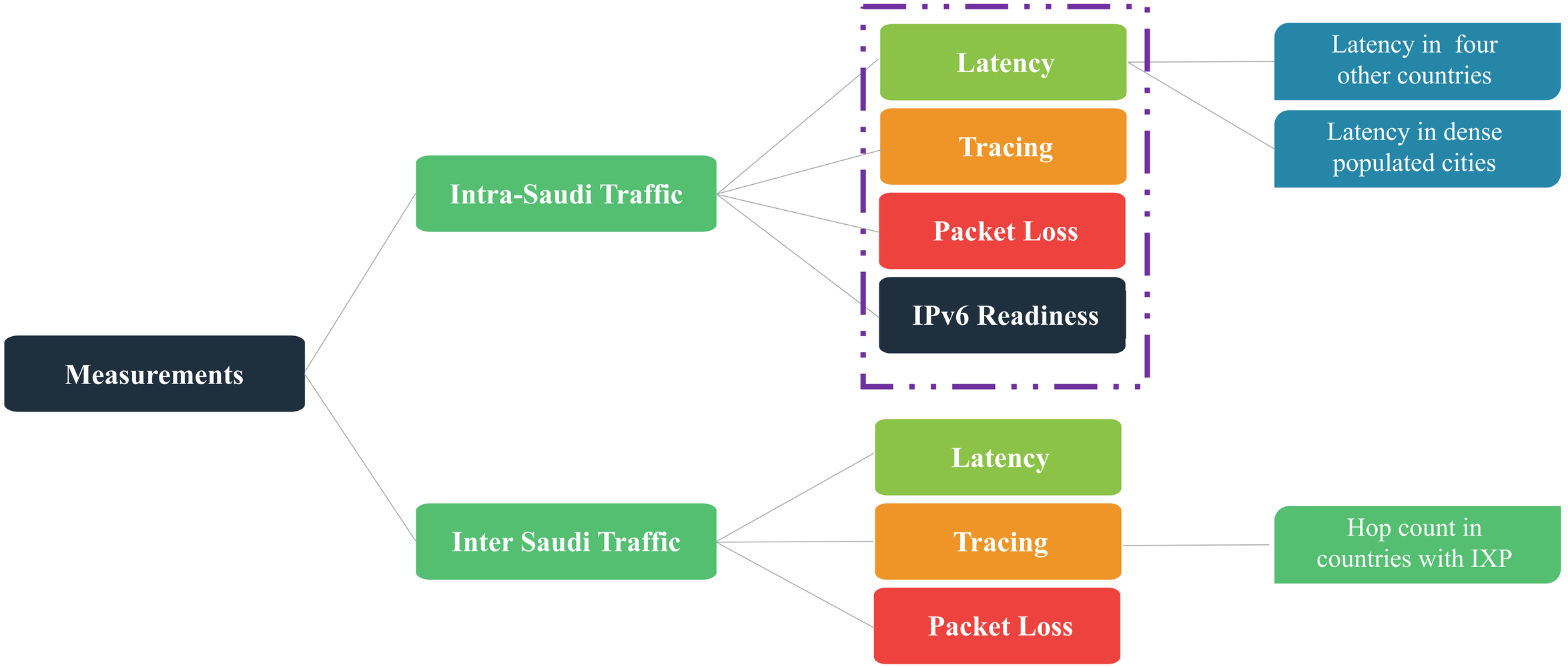
Region 2
Alriyadh
4 Connected Probes

Region 3
Eastern Region
4 Connected Probes

Region 4
Makkah mukarramah
1 Connected Probe



Measurements Setup Outline



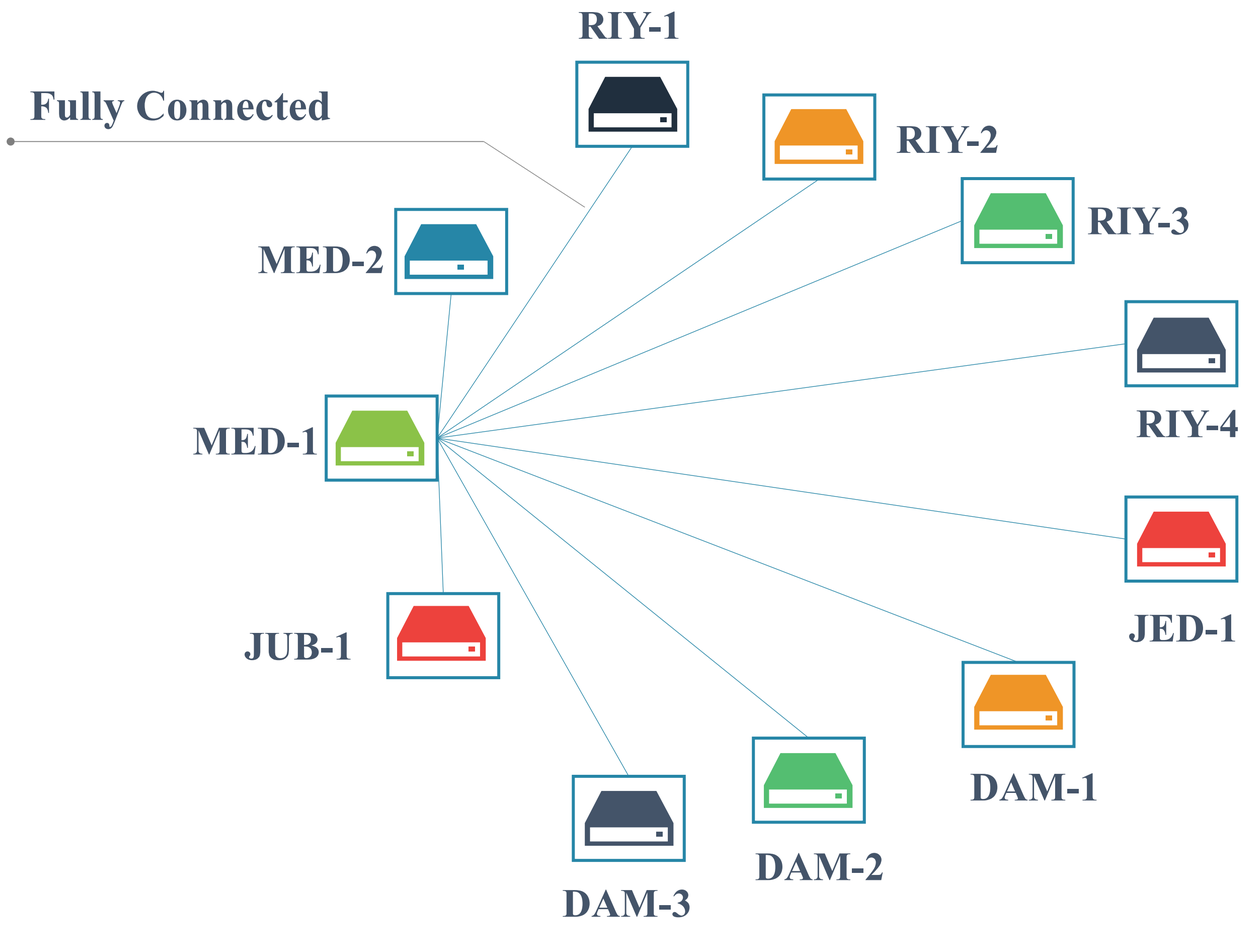
Measurements' Setup 1

Probe-to-probe

- There are 12 connected probes within Saudi Arabia.
- **Probes are used to measure:**
  - **Latency,**
  - **Packet loss, and**
  - **Hop count**

Ping

Traceroute



Measurements' Parameters 1

Ping

Probe-to-Probe (Intra-Saudi)

Number of Packets	4
Packet Size	32 bits
Interval	1,800 seconds (30 minutes)
IP version	IPv4
Start at	July 21, 2017 00:00
End at	July 27, 2017 23:55

Round Trip Time (RTT)

Probe-to-Probe (Intra-Saudi Arabia)

		30918 MED-1	31376 MED-2	3981 RIY-1	26936 RIY-2	25205 RIY-3	3997 RIY-4	25684 JED-1	23624 DAM-1	23601 DAM-2	20923 DAM-3	11068 JUB-1
30918	MED-1		∞	78.17	53.21	72.65	∞	86.33	∞	∞	252.86	448.04
31376	MED-2	∞		109.12	69.39	68.13	∞	89.80	∞	∞	66.99	83.20
3981	RIY-1	∞	∞		19.32	20.83	∞	60.62	∞	∞	18.33	23.53
26936	RIY-2	∞	∞	40.70		30.06	∞	54.48	∞	∞	35.90	39.97
25205	RIY-3	∞	∞	19.21	8.012		∞	50.33	∞	∞	16.11	20.03
3997	RIY-4	∞	∞	22.73	9.98	10.97		36.05	∞	∞	14.85	23.54
25684	JED-1	∞	∞	59.17	32.42	38.18	∞		∞	∞	139.32	36.79
23624	DAM-1	∞	∞	43.22	9.672	13.08	∞	21.53		∞	1.534	7.065
23601	DAM-2	∞	∞	24.68	12.44	16.94	∞	26.39	∞		122.53	8.050
20923	DAM-3	∞	∞	18.10	15.30	16.14	∞	139.36	∞	∞		6.028
11068	JUB-1	∞	∞	21.55	18.19	19.52	∞	36.99	∞	∞	5.72	

≤50 ms ≤100 ms ≤200 ms ≤300 ms >300 ms ∞

Measurements' Parameters 1

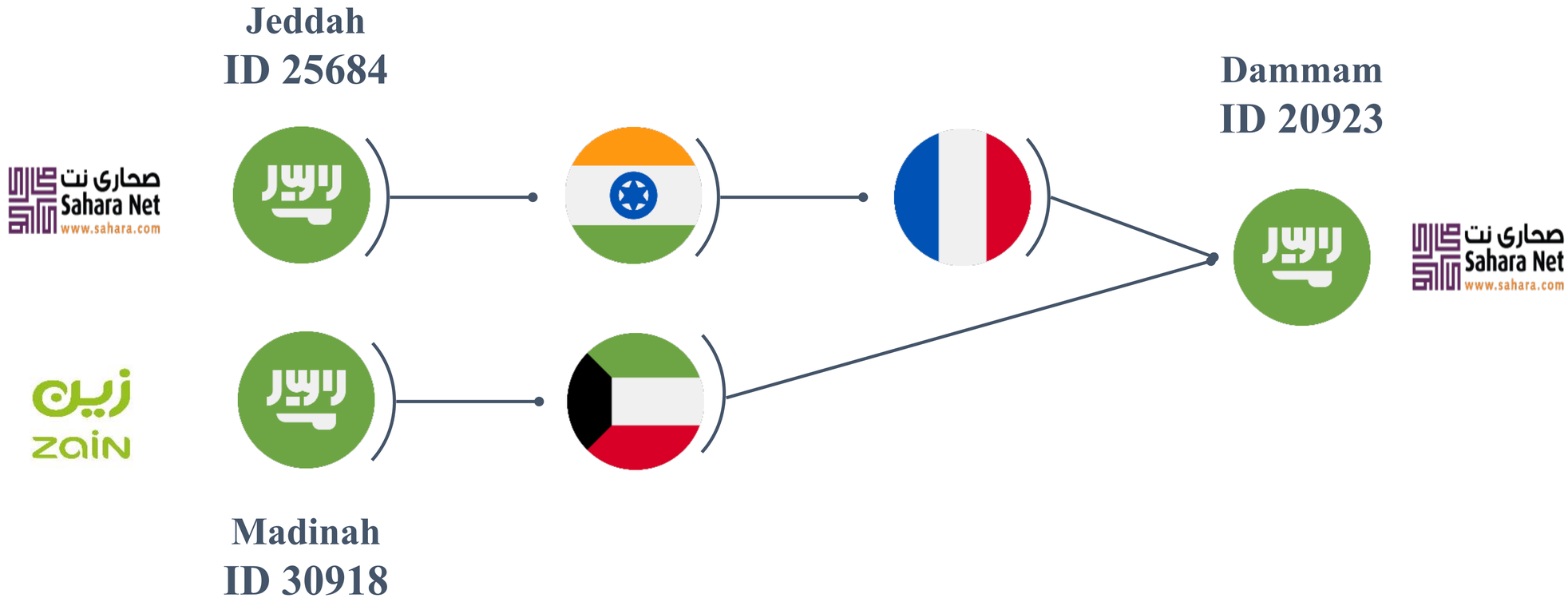
Traceroute

Probe-to-Probe (Intra-Saudi Arabia)

Number of Packets	3
Packet Size	32 bits
Interval	43,200 seconds (12 hours)
IP version	IPv4
Start at	July 22, 2017 00:00
End at	July 28, 2017 23:00
Maximum hops	40
Timeout	4000 (≈1 hours)

Probe-to-Probe Traceroute Remarks - 1

- Some of the intra-Saudi Arabian traffic was routed outside the country



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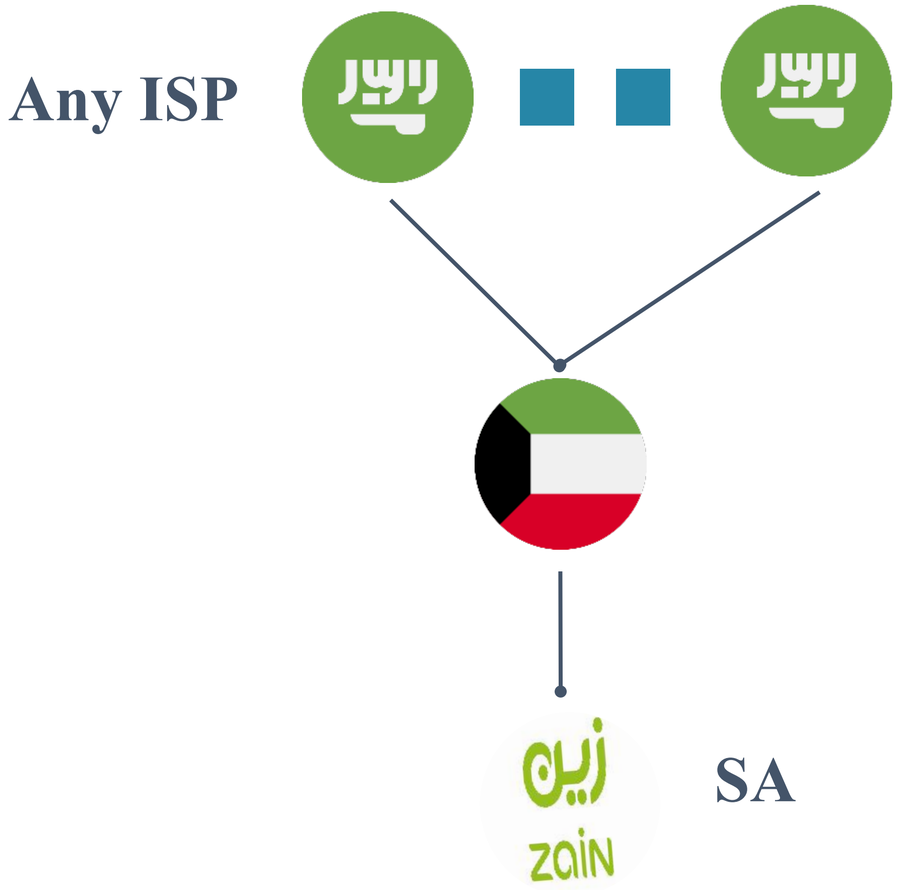
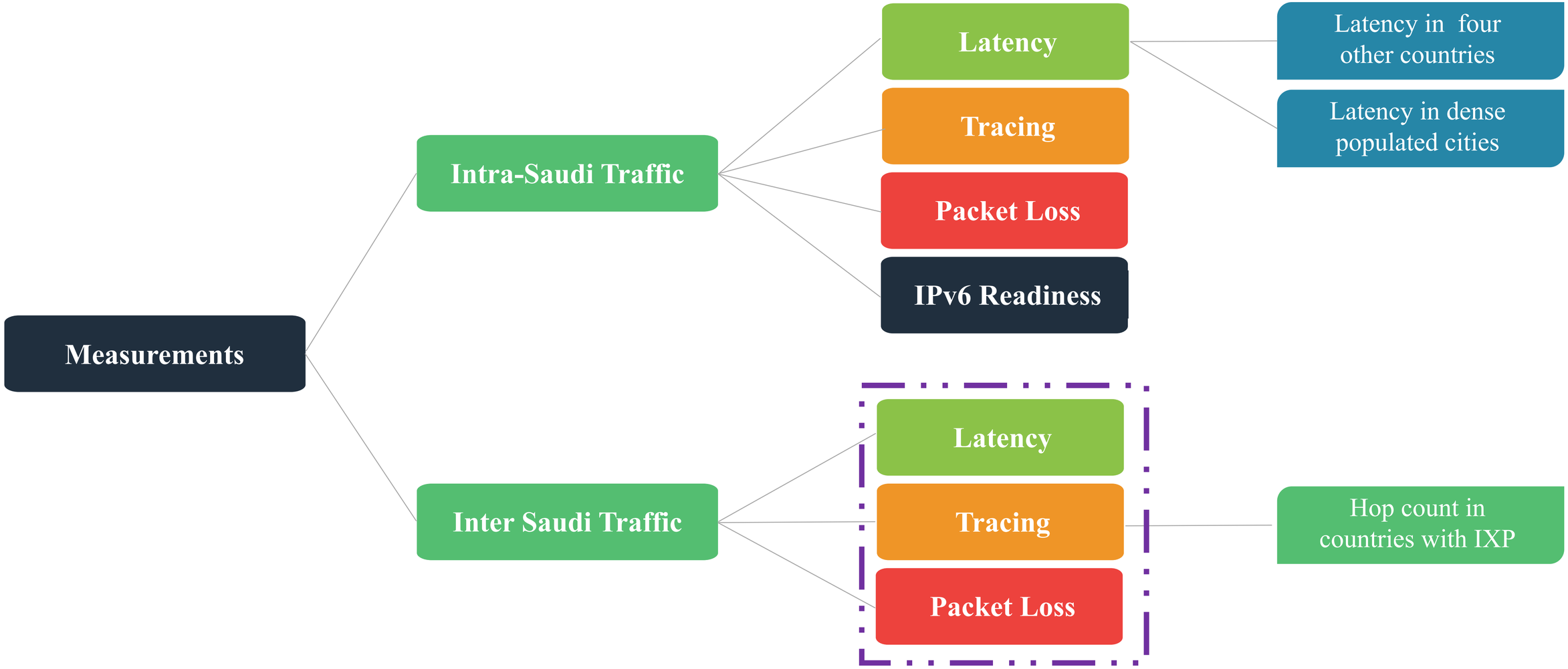
Probe-to-Probe Traceroute Remarks - 2

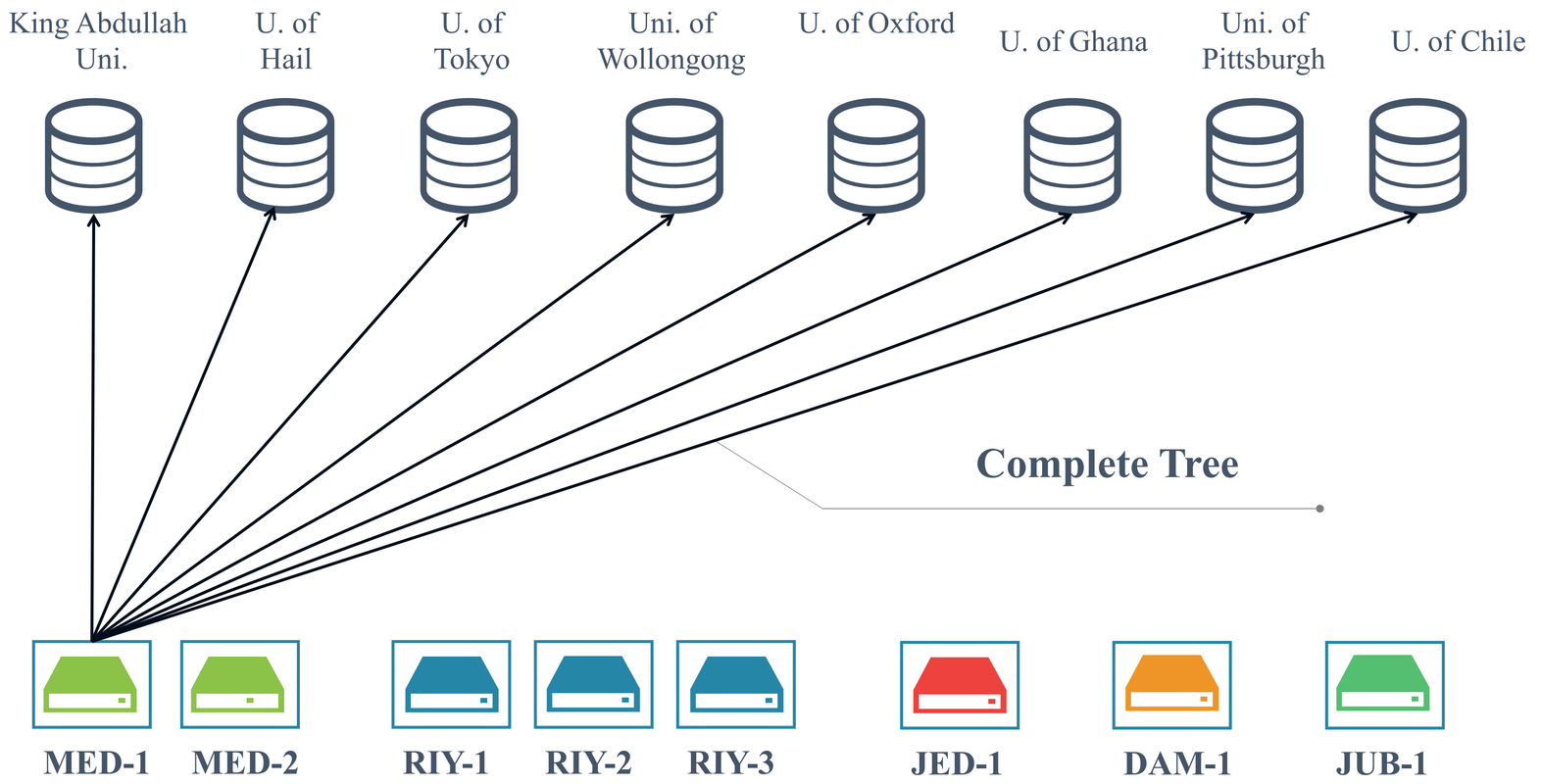
All traffic distained to a any probe that is connected to Zain-SA is always routed to Kuwait regardless of the ISP



Measurements Setup Outline



Measurements Setup 2



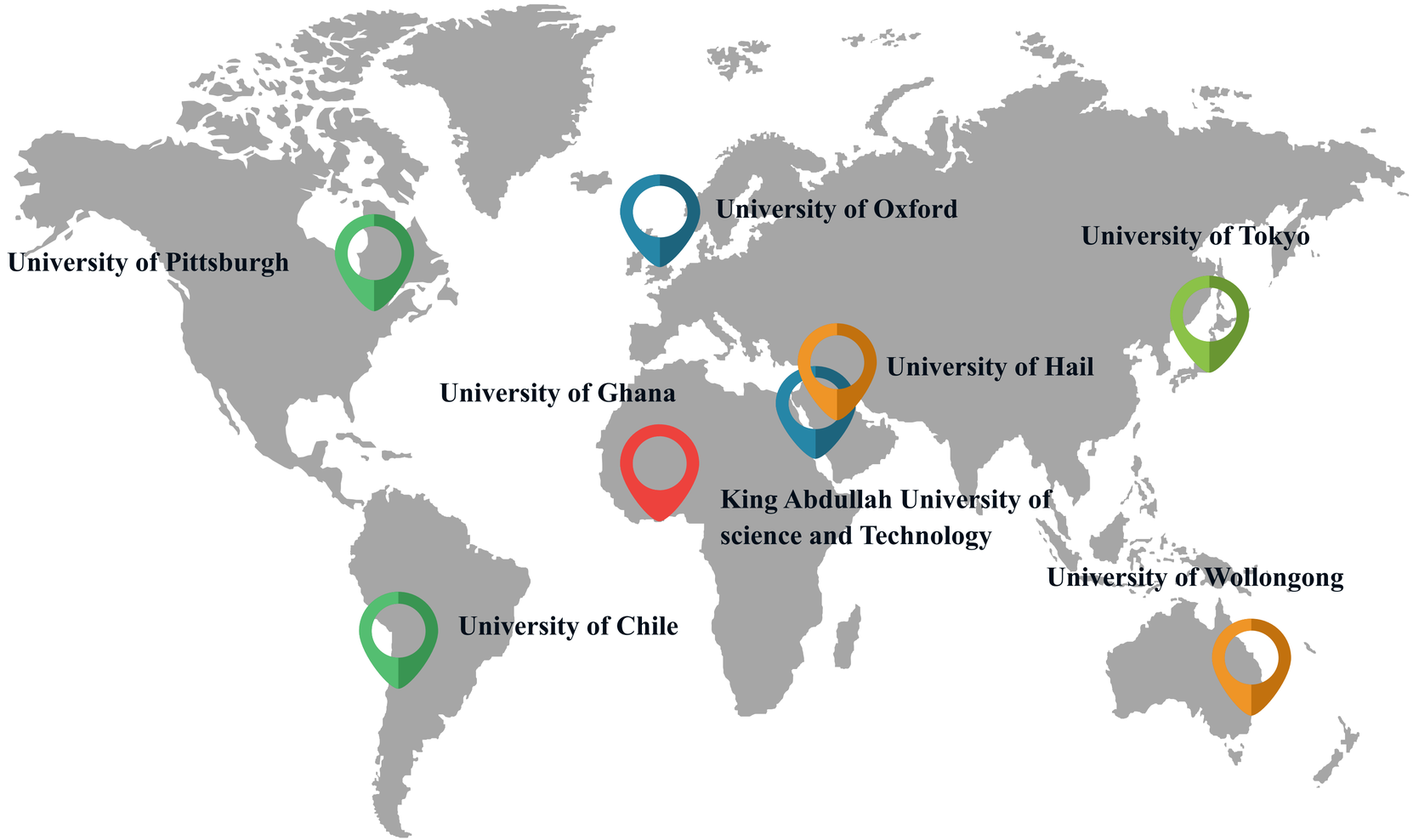
Probe-to-server

We eliminated some of the duplicated probes and ended up with 8 connected probes within Saudi Arabia.

Ping

Traceroute

Servers Used Distribution



United Kingdom

United States

Japan

Australia

Ghana

Saudi Arabia

Chile

Saudi Arabia

Measurement's Parameters

Ping

Probe-to-Server

Number of Packets	4
Packet Size	32 bits
Interval	1,800 seconds (30 minutes)
IP version	IPv4
Start at	July 21, 2017 00:00
End at	July 27, 2017 23:55

Round Trip Time (RTT)

Probe-to-Server

	Japan	Saudi A.	Saudi A.	UK	USA	Chile	Ghana	Aust.
MED-1	353.67	187.06	97.68	116.25	200.66	395.83	240.09	398.58
MED-2	326.48	64.23	74.14	139.77	226.74	581.94	634.24	463.98
RIY-1	255.63	31.25	41.08	121.39	198.28	360.68	359.60	413.19
RIY-2	387.90	128.71	51.79	124.52	185,81	338.96	203.85	412.38
JED-1	240.38	60.27	54.31	131.31	205.21	379.75	277.03	427.85
RIY-3	251.33	104.73	29.80	94.60	166.63	334.76	237.25	393.09
DAM-1	235.84	31.72	34.12	106.01	170.68	334.35	258.44	427.00
JUB-1	259.50	115.28	35.91	123.25	193.00	387.98	222.46	402.58

≤50 ms ≤100 ms ≤200 ms ≤300 ms >300 ms ∞

Measurements' Parameters

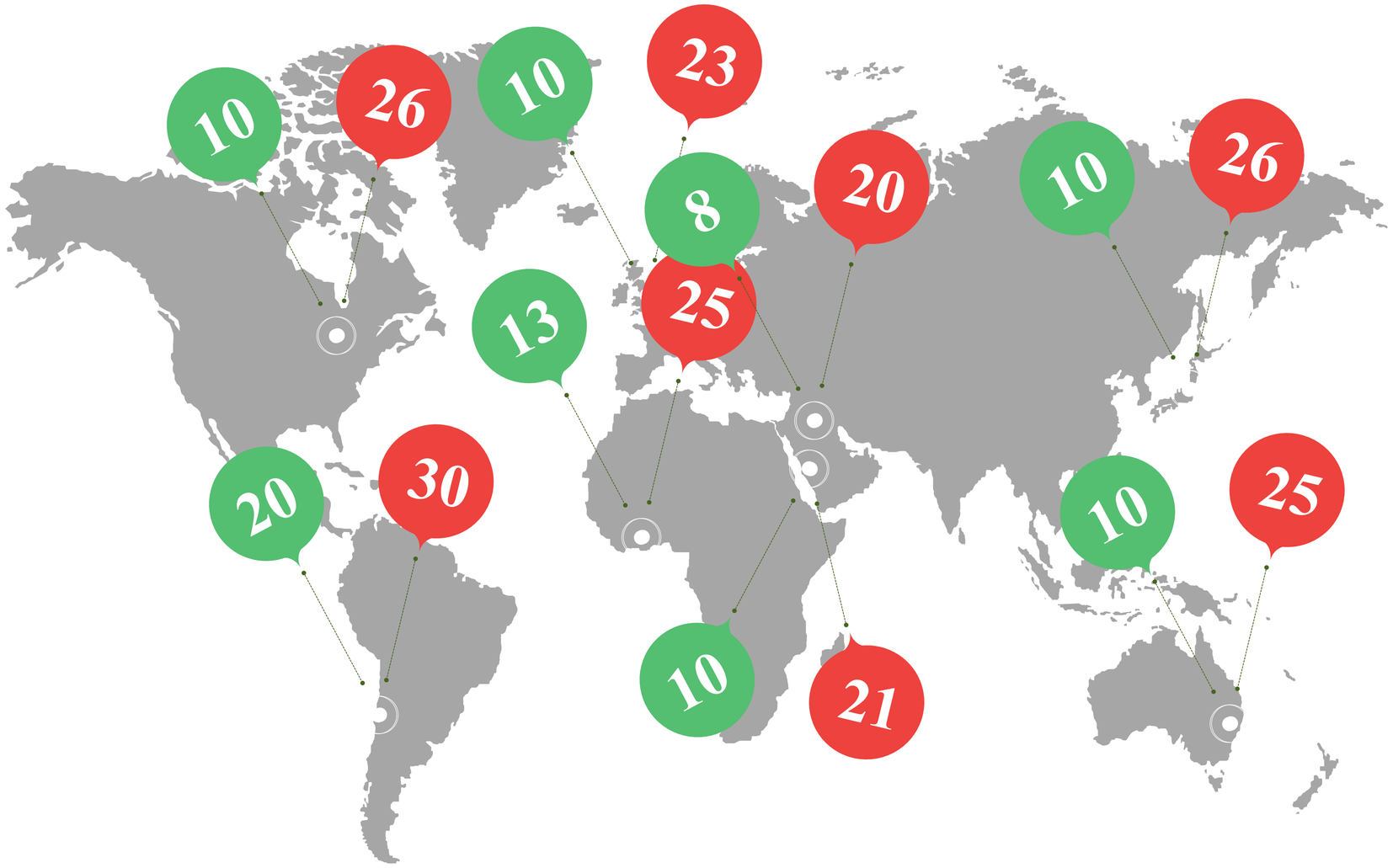
Traceroute

Probe-to-Server

Number of Packets	3
Packet Size	32 bits
Interval	43,200 seconds (12 hours)
IP version	IPv4
Start at	July 21, 2017 13:15
End at	July 27, 2017 12:55
Maximum hops	40
Timeout	4000 (≈1 hours)

Min-Max Hop Count

The minimum and maximum hop count to reach the desired servers from Saudi probes



United Kingdom
University of Oxford

United States
University of Pittsburgh

Japan
University of Tokyo

Australia
University of Wollongong

Ghana
University of Ghana

Saudi Arabia
King Abdullah University of science and Technology

Chili
University of Chile

Saudi Arabia
University of Hail

Remark #1 (Hop Count)

The variance between minimum and maximum hop count for local IP traffic verses a cross ocean servers is not significant

Australia
University of Wollongong

12,700 Km Distance
From Riyadh to Wollongong

10 Hops

25 Hops

Saudi Arabia
University of Hail

600 Km Distance
From Riyadh to Hail

8 Hops

20 Hops

Remark #2 (Traffic Route)

IP traffic from Saudi Arabia to University of Ghana server travels to Europe and never passes an IXP.

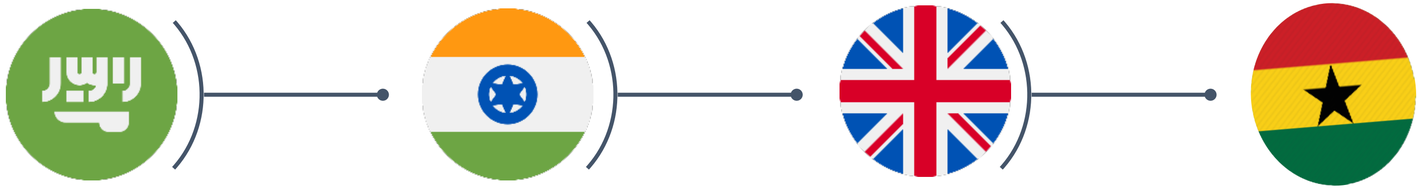
Ghana
University of Ghana

20 hops

7 hops | 3 hops | 2 hops | 3 hops | 5 hops

16 hops

8 hops | 2 hops | 3 hops | 3 hops



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Remarks #3 (IXP)

Sample of IP traffic from Saudi Arabia that pass through IXPs.

Japan
University of Tokyo

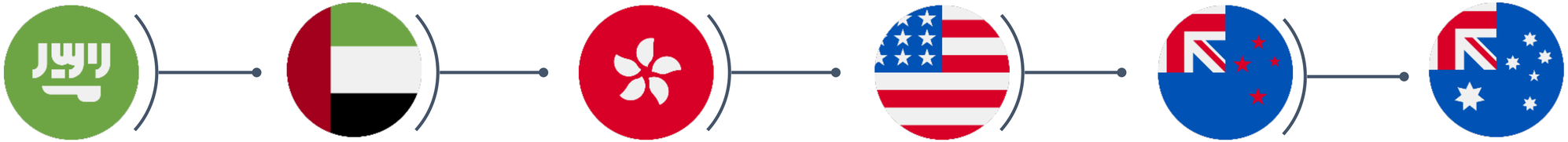
21 hops

7 hops → 3 hops → IXP → 10 hops

Australia
University of Wollongong

16 hops

7 hops → 3 hops → IXP 3 hops → IXP → 2 hops → 5 hops



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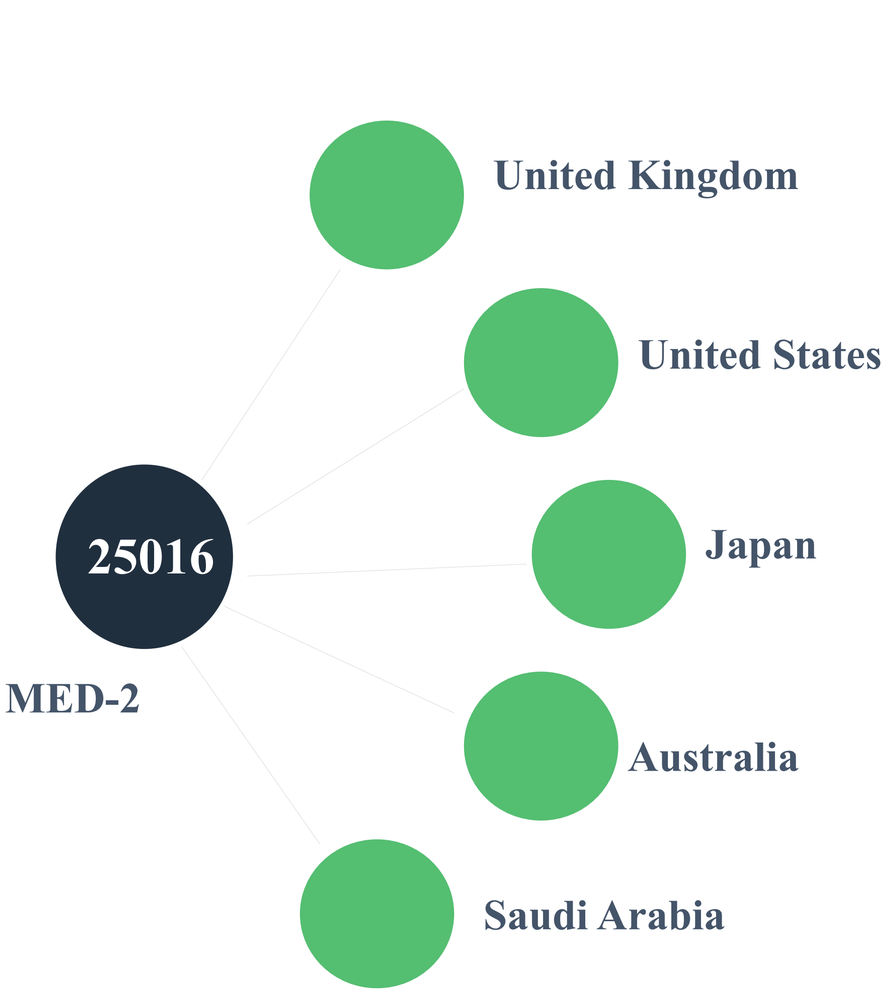
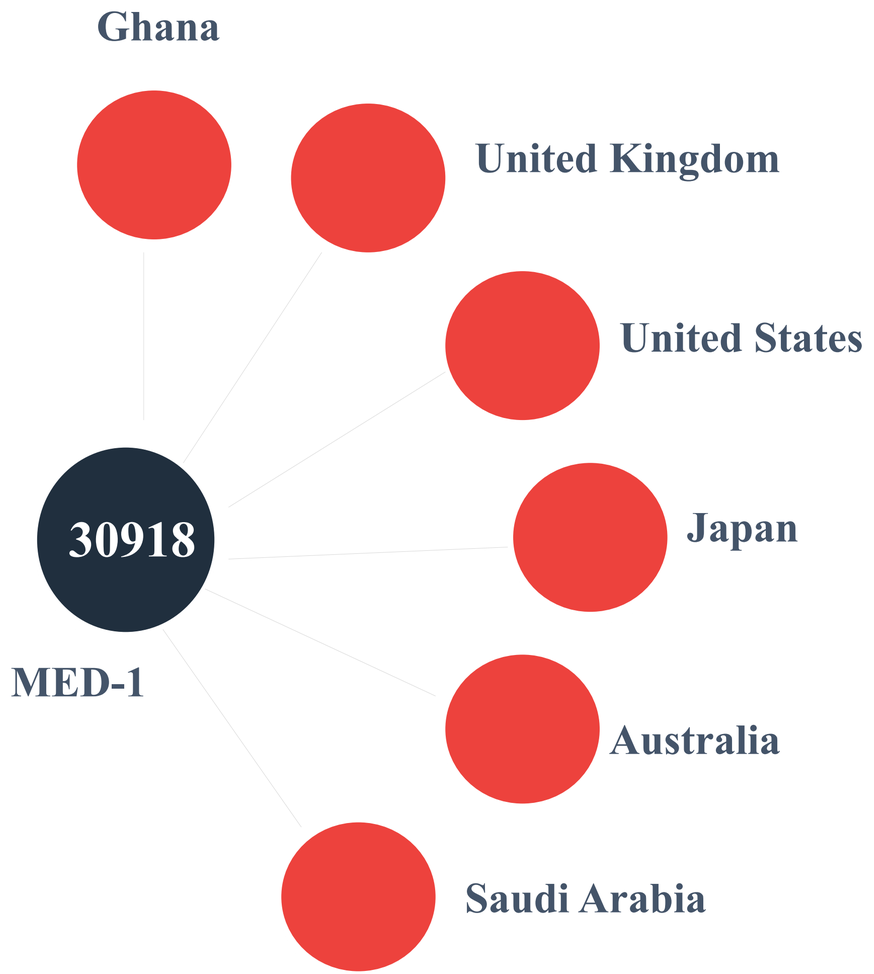
Remark #4 (Min-Max Hop Count)

Probes that resulted on minimum and maximum hop-count

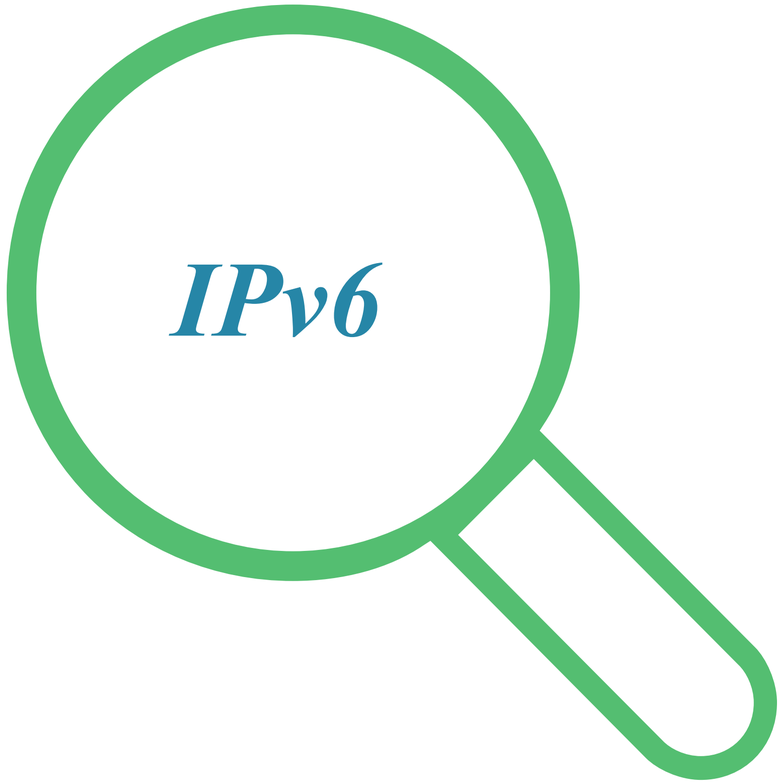




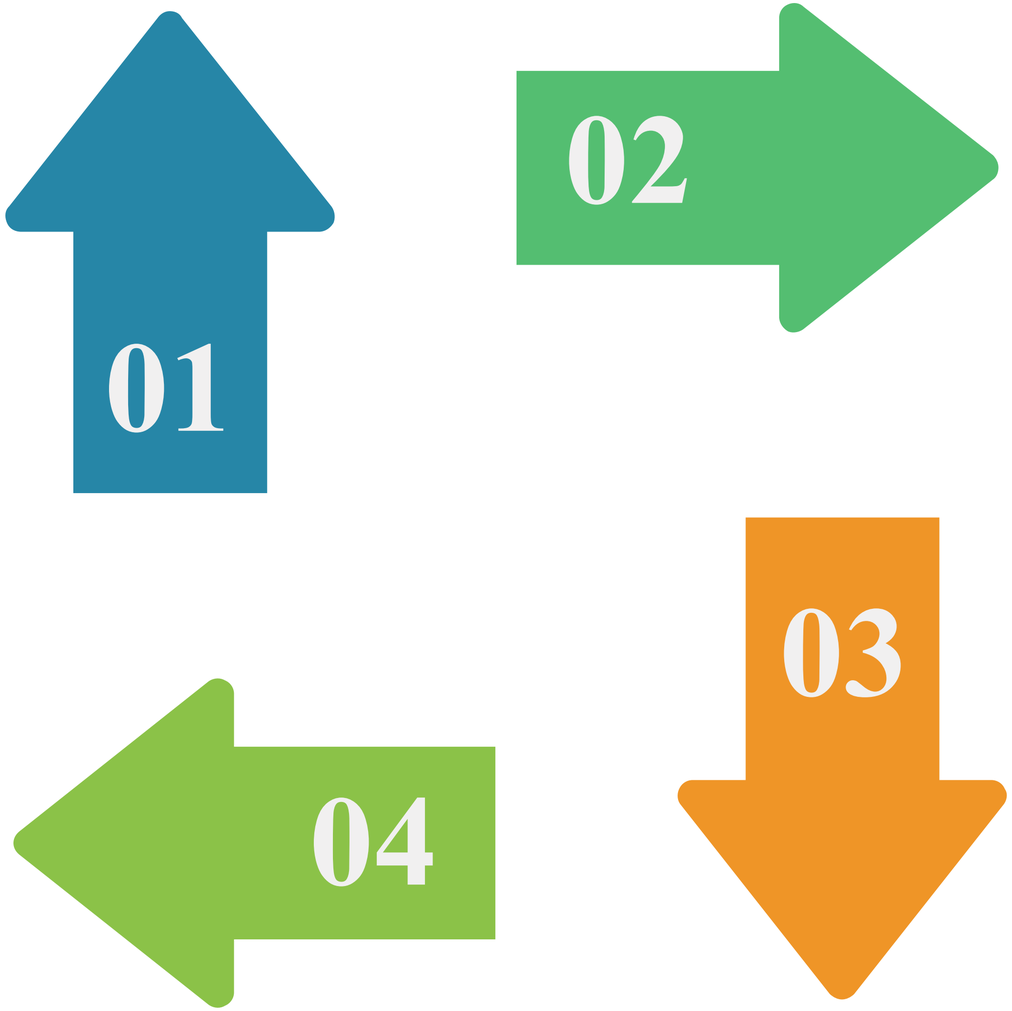
IPv6 Ready ?

Only 1 probe in Saudi Arabia that is IPv6 ready

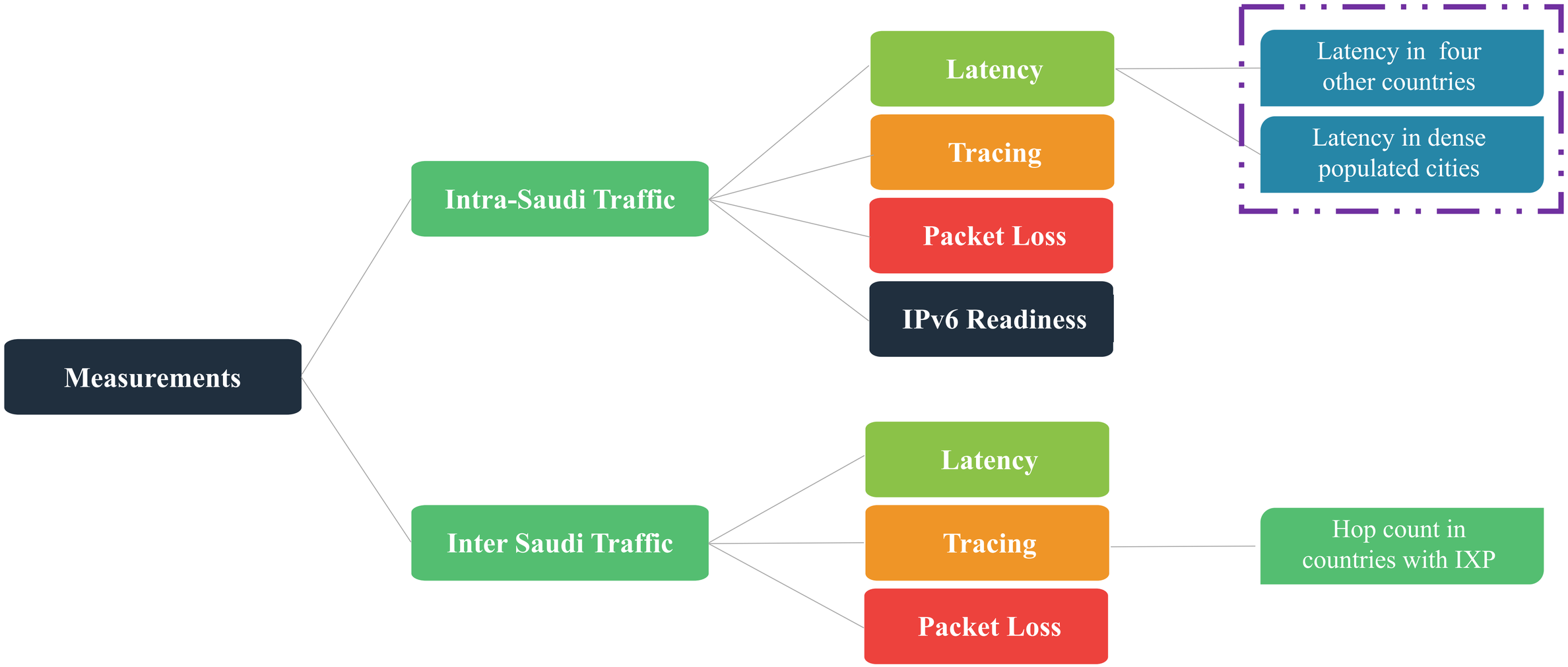
Probe ID 25205
ISP: STC



Unanswered Questions



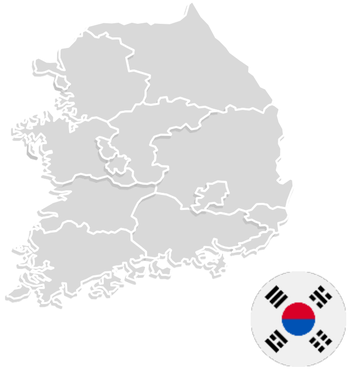
Measurements Setup Outline



Random RTT measurements

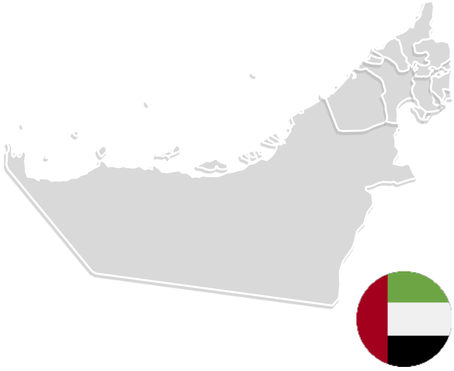
Local Latency in 4 counties that’s been choses randomly

ID 2925	3.1 ms
ID 19512	8.4 ms
ID 20110	2.7 ms
ID 31265	9.6 ms
ID 33108	17 ms



ID 18497	8.3 ms
ID 18499	9.7 ms
ID 18525	7.9 ms
ID 19207	5.9 ms
ID 20820	8 ms

ID 2138	+ 38.7 ms
ID 2380	14.9 ms
ID 13275	+ 22.5 ms
ID 14627	+ 45.2 ms
ID 28414	16.4 ms



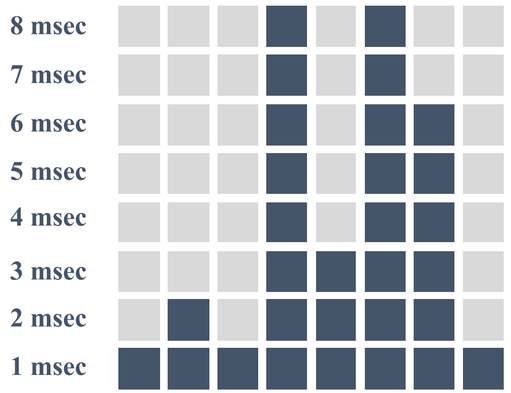
ID 3029	7.2 ms
ID 13151	18.3 ms
ID 13152	+ 34.1 ms
ID 13258	+ 22.3 ms
ID 13914	9.4 ms

5 mseconds

Delay in Dense Pullulated Cities

Local Latency in 4 high dense pullulated cities.

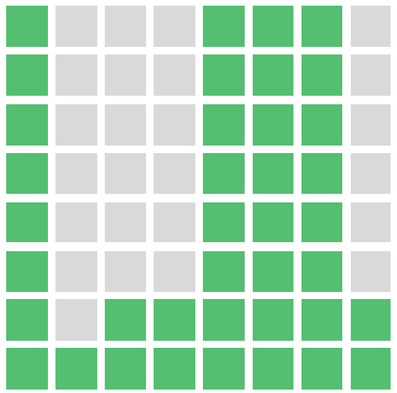
Dhaka



16 M

Density: 114,300
per square mile

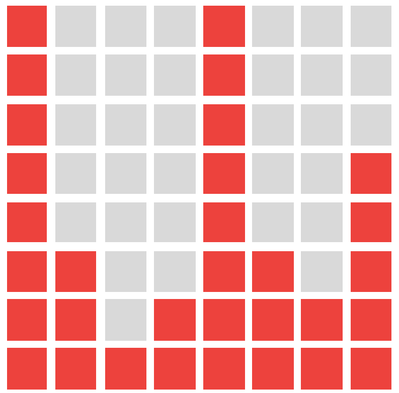
Manila



1.8 M

Density: 110,000
per square mile

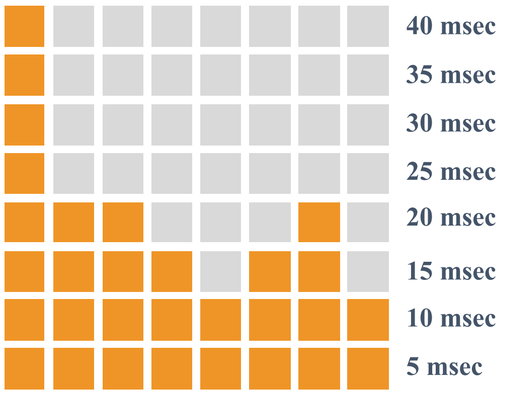
Paris



2.2 M

Density: 54,415
per square mile

São Paulo



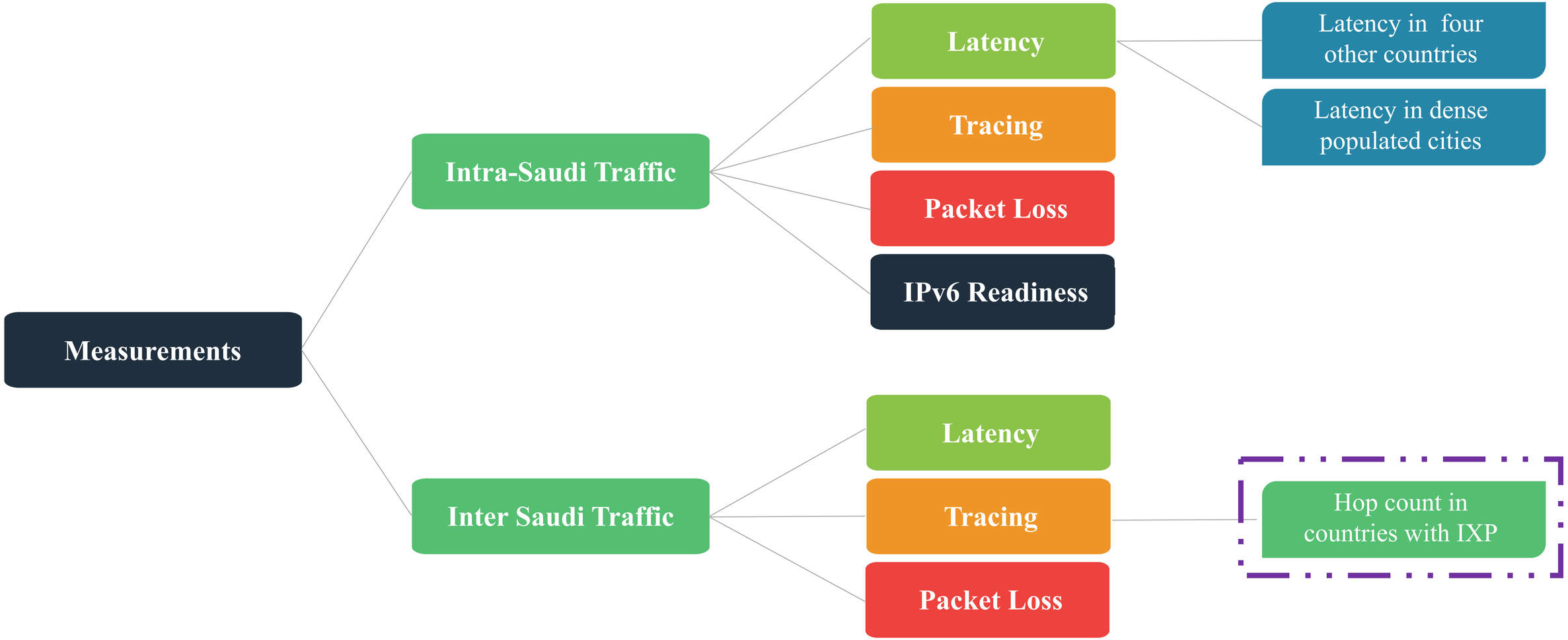
12 M

Density: 20,495.3
per square mile

1 msecond

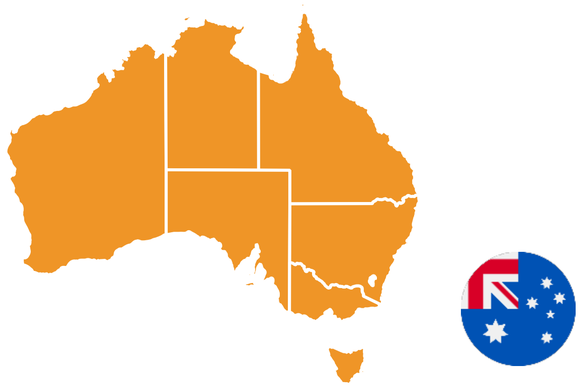
5 msecond

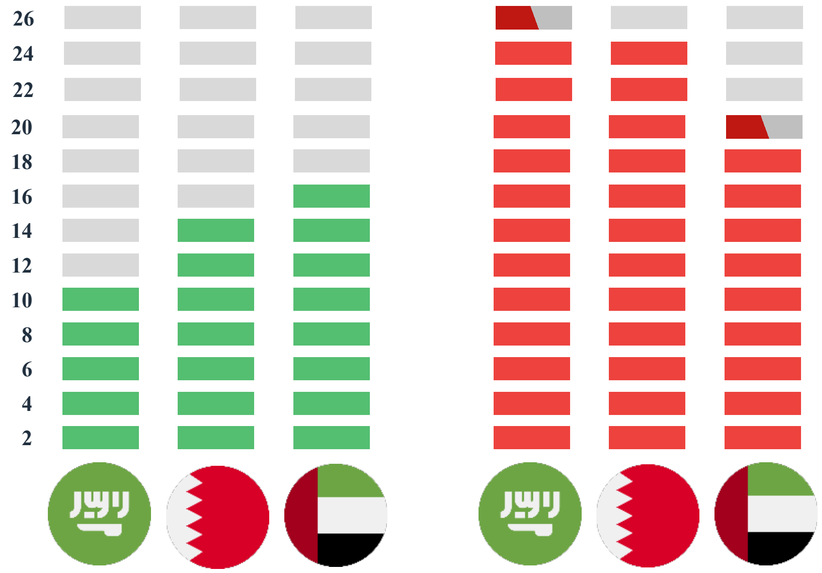
Measurements Setup Outline

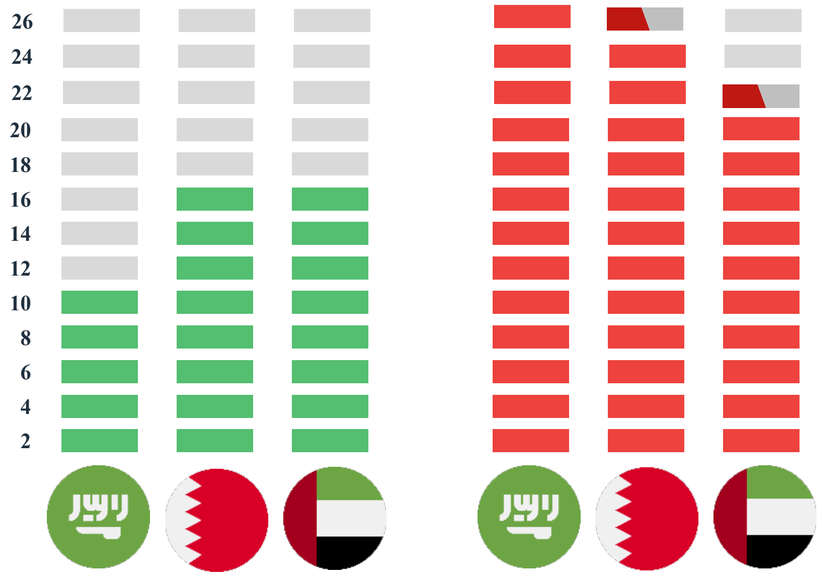


Effect of IXPs on the Hop Count

Hop count between for traffic generated from Saudi Arabia, Bahrain and United Arab Emarat's to University of Wollongong and University of Tokyo.



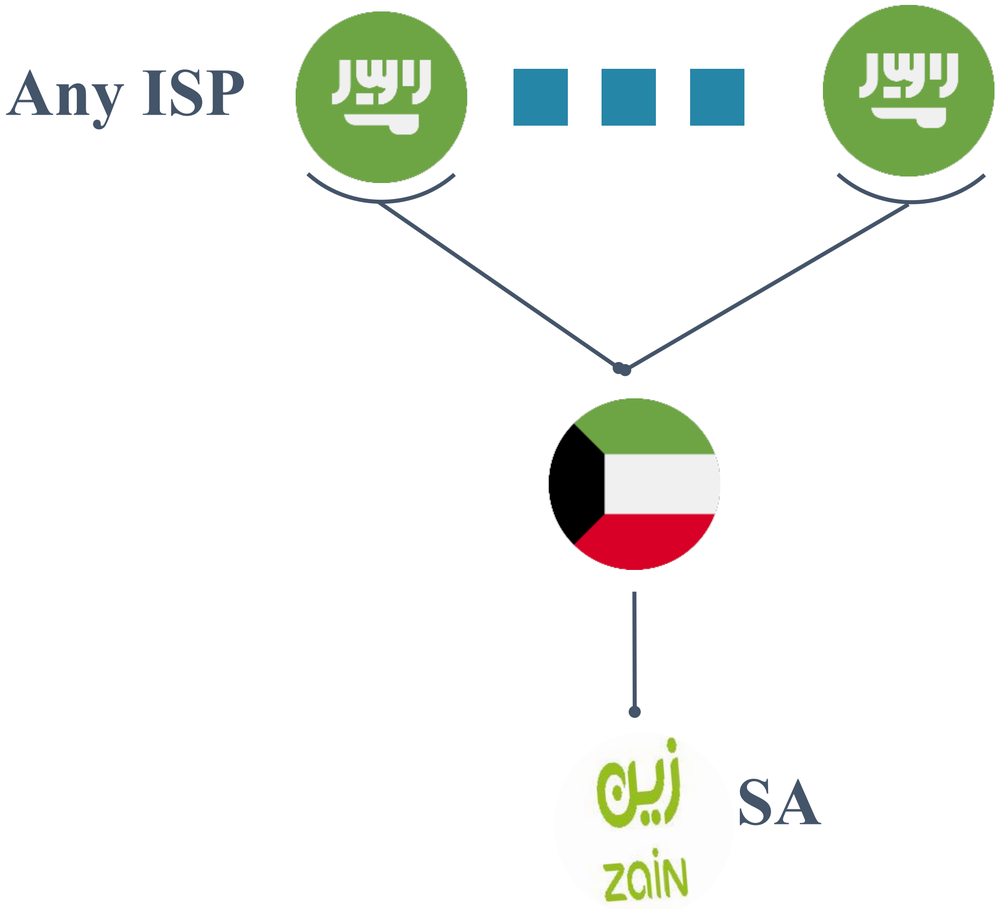


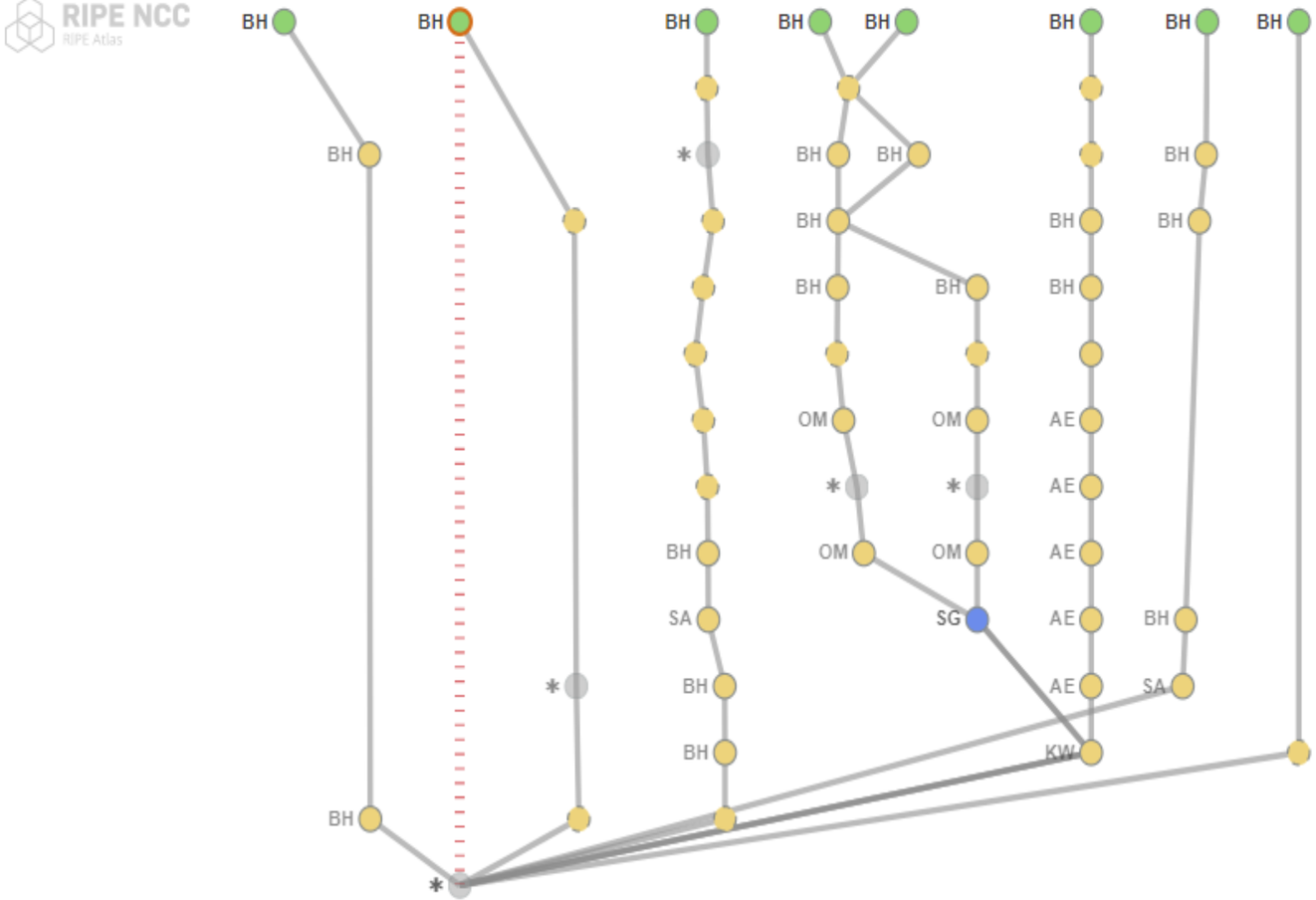


2 hops

Probe.sa to Zain.sa vs Probe.bh to Zain.bh

Although Bahrain has IXP, IP traffic to a probe that is connected to Zain still routed to Kuwait.





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Major Findings

Average RTT

Up to half a second delay across Kingdom severely affects real time applications

Hop Count

Traffic within Kingdom spans large hop count (up to 20 in the worst case)

Traffic Route

Traffic within the same city in Saudi is leaving the country!!

IPv6 readiness

Out of all connected probes in Kingdom, only one is using IPv6 ☹

Packet Loss

Packet loss was always 0% unless the destination is unreachable

Thank you

Questions . . . ?