Analyzing resilient deployment of DNS hierarchy in India

Presentation For:

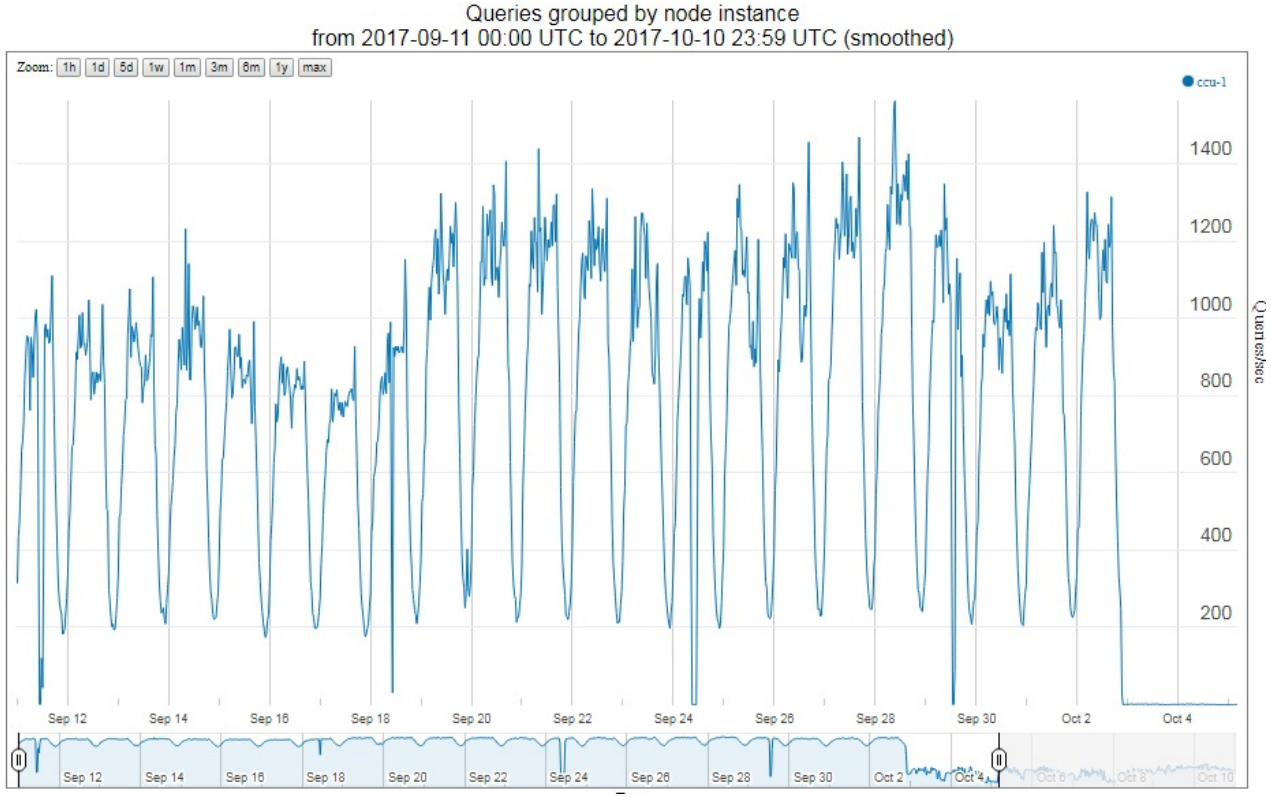
Some initial studies | 2014

In 2014, after deploying the L Root instance in Kolkata, India it started serving **1000+ queries per second**, which otherwise was getting served from instances with higher latency.

Observations:

Most of the queries are from the adjacent AS (TATA Tele) as the preferred choice.

Routing Configurations play a vital role in the overall availability of Root instances. We worked with other ISPs as well for more eyeballs.



The Key Pointers

- The RSSAC suggests exposure to 8 root servers out of 13 for a resilient DNS resolution.

- It's very important to have an optimum deployment of Root Server Anycast instances in the region for a robust and resilient Internet infrastructure for all stakeholders.

Current Status of DNS Root Server Deployments in India

Root Servers	India	Globe	USA	China	Japan	Singapore
A	0	56	30	1	4	3
B	0	6	3	0	0	1
C	0	12	4	0	1	1
D	3	194	39	1	1	1
E	6	328	73	0	3	2
F	15	342	61	4	5	2
G	0	6	3	0	1	0
H	0	12	4	0	1	0
I	1	76	7	3	1	1
J	4	157	43	4	4	3
K	4	102	7	3	1	0
L	6	191	18	13	0	1
M	0	13	1	0	2	1
Total Deployments	39	1495	293	29	24	16
Out of 13	7	13	13	7	11	10

As of Date: 19th June 2023

SL	Site	Instances
1	Ahmedabad	1
2	Bengaluru	3
3	Bhubaneswar	1
4	Chandigarh	1
5	Chennai	4
6	Delhi	2
7	Guwahati	1
8	Hyderabad	3
9	Jaipur	1
10	Kanpur	1
11	Kochi	1
12	Kolkata	3
13	Mohali	1
14	Mumbai	9
15	Nagpur	2
16	New Delhi	4
17	Patna	1
		39

Location wise Root Server instances deployment in India

- As of Date: 19th June 2023

Comparing the performances of DNS Query Latency

Root Server	Range Oscillation	Min	Max	Average DNS Query Latency in each Range					
				Range 1	Sites	Range 2	Sites	Range 3	Sites
A	30	104	291	120.75	3	148.64	17	179.75	4
B	60	43	302	89.45	11	180.16	6	280.25	8
C	20	130	282	136.33	6	160.14	14	177.8	5
D	50	42	485	73	9	109.45	11	182.8	5
E	40	7	178	22.22	9	67.36	11	97.75	4
F	20	7	68	15.44	9	41.41	12	62.2	5
G	-	-	-	-	-	-	-	-	-
H	25	41	172	98.54	11	125.8	10	162	4
I	50	48	260	70.33	3	154.53	15	190.33	6
J	20	8	69	16.33	12	36.75	4	56.4	10
K	60	19	330	59.71	7	150.9	10	210.42	7
L	17	5	72	28	6	46.71	7	63.45	11
M	30	128	278	144.78	16	167.5	16	269.5	2

As of Date: 19th June 2023

Observations from experiments

- F root server with maximum deployments performance is lower than J root which has one-fourth of its deployments.
- Only 6 out of 13 root servers are responding with a DNS query latency of less than 100 milliseconds and out of 6 (J, F, L,E, B, H) root servers that respond to DNS queries in less than 100 milliseconds, only 4 (J, F, L, E) are hosted in India.
- It has been observed that B and H Root Servers which are not hosted in India take part in the lowest resolutions in most of the sites.
- Only a few locations in India where more than 2 root servers are responding query below 100 ms.

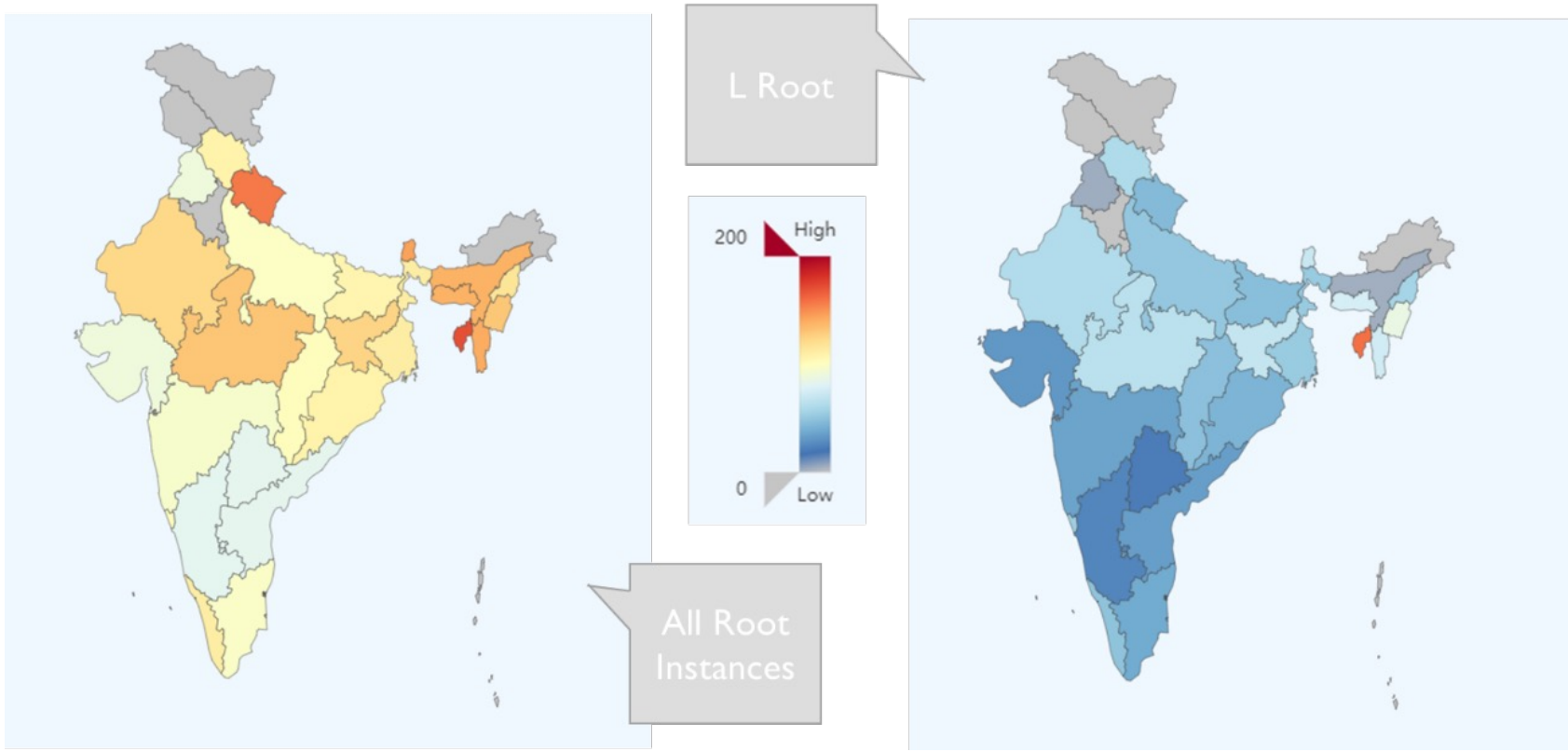
Observations from experiments

- The RSSAC suggests exposure to 8 root servers out of 13 for a resilient root server resolution, with higher latency it meets the criteria. However, the stability of root server resolution remains a question.
- Most of the root server deployments show higher oscillations in latencies which points to non-uniform deployments within the regions.
- The study suggests more anycast root instance deployments in the regions having DNS latency are high i.e. greater than 100 ms.

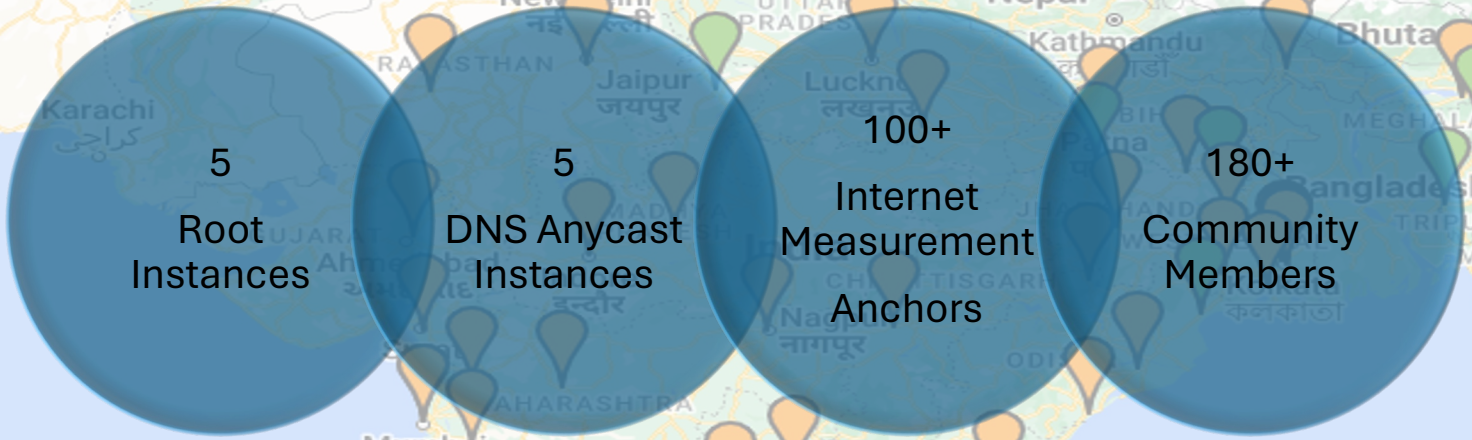
Observations from experiments

- The study suggest DNS Software affinity for a particular root Server (based on the root server discovery algorithm), as the root server queries are not getting distributed to all nearby instances.
- There is a possibility of working on a disaster mitigation plan based on experiment outcomes, provisioning optimum bandwidth to the instances catering to disaster scenarios.

The real-time Root Server health indicator – Tool of AIORI



THE AIORI INITIATIVE | 2019 ONWARDS



Root Instances

4 L Root Instances – GAW, BLR, MOH, MUM at STPI NOC/ DC

1 F Root Instance in KOL at IIFON NOC; M, K & D In Progress

Anchors – 500 by EoP

Community Members – In multiple of 3X of Anchors Deployed.

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Now supported by NIXI.

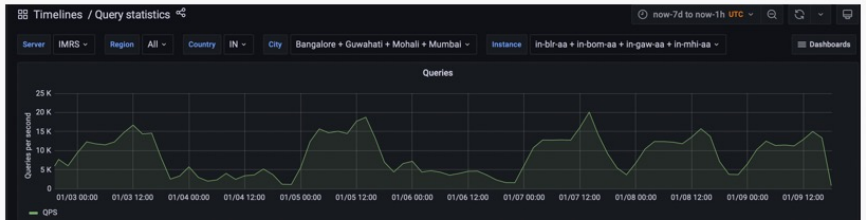
Experiment with L Root | 2021-22

We collaborated with ICANN to deploy four IMRS instances (L root) in 4 different geographic locations of India, namely Mumbai, Bengaluru, Guwahati, and Mohali to understand the traffic patterns of different geographic locations. The 4 L root instances started serving 10% of Global L root traffic.

Observation: Most of the traffic originated from Indian AS networks. Network configs, DNS Software affinity, Routing, Peering what is behind we didn't have any clue.

GLOBAL

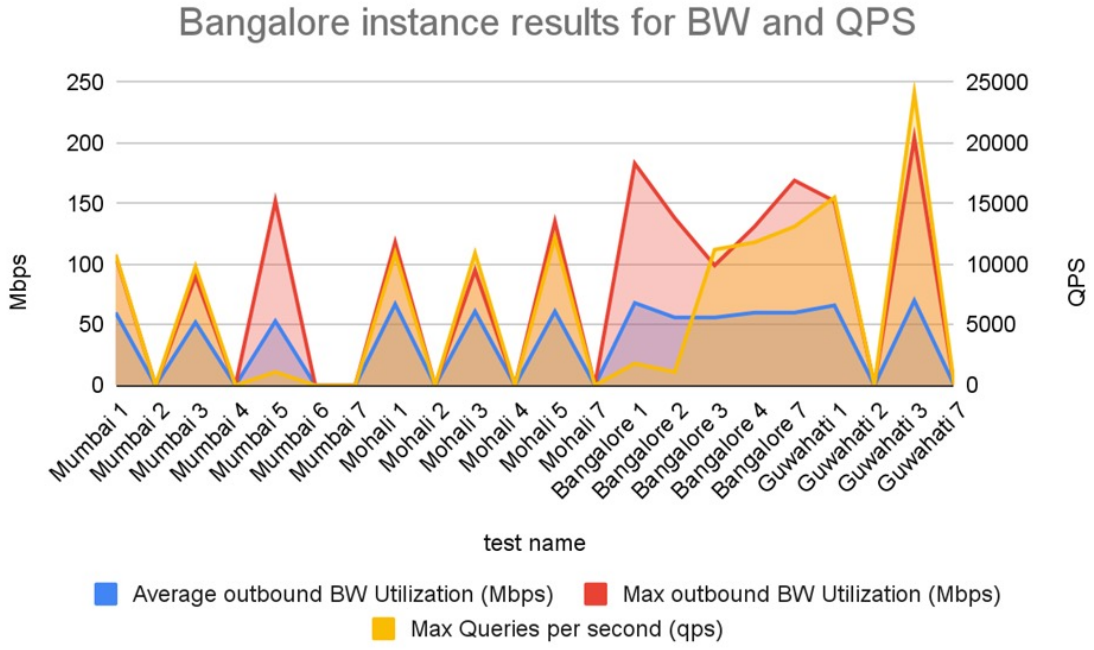
INDIA

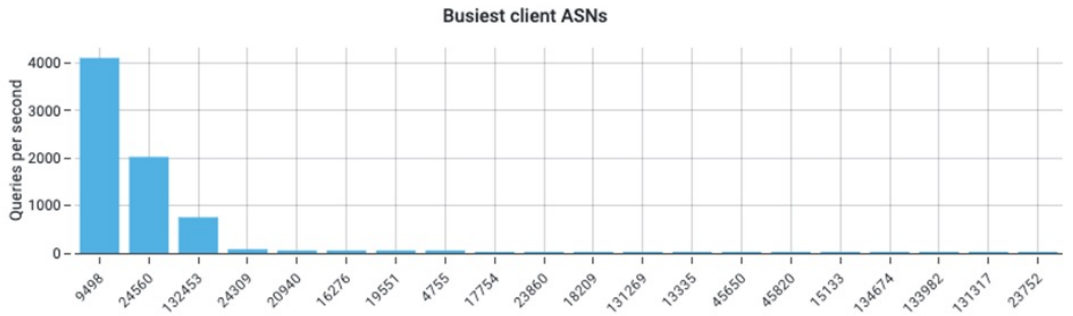


Experiments | Root Server Deployment Models | Bengaluru Instance **Live**

The results from the Bengaluru location wherein when all 3 locations had been shut down for the experiments, the L root traffic suddenly shifted to the Bengaluru location increasing the bandwidth requirements.

The bandwidth utilization in the Bangalore instance had an average of 61 Mbps outbound with a maximum measured at 204Mbps. This is higher than the provisioned bandwidth at that location of 150Mbps. The average queries per second (qps) received by the Bangalore instance was 10,330qps, with a maximum measured at 24,100qps.





Top AS Numbers

The Context of Current Study

Datasets and Measurements are key for bringing resiliency to any system. RSSAC with documents **RSSAC-002**, and **RSSAC-047** are focusing on measurements of Root Server System.

An Internet measurement network has been researched and implemented as part of the AIORI project and 100+ anchors are deployed across various locations in India.

The measurement results are available at https://aiori.in. **As mentioned in RSSAC047, Section 4.9**, Determining the number of RSIs (Root Server Instances) Required for Reliable Operation of the RSO, it says that "**Furthermore, keeping in mind that RSIs have different anycast deployment policies, the requirement of k=8 for reliable operation (of the current system) reflects the number of RSIs reachable by the vantage points, which is different from the number of anycast instances that may be operating.**"

The current study is attempting to measure the availability matrices for RSIs in a region.

Experiments | Root Server Deployment Models

Our team has conducted research experiments with **IMRS instances** to understand the best possible deployment strategy in collaboration with **ICANN** from **November 10, 2021, to January 6, 2022.**

The Idea

The idea in the evaluation was to understand the bandwidth requirements in the situation, if any of the three instances fails, is there a possibility that the traffic moves to another instance? Or to another Root Server?

Observations

We observed that more optimization of networking needs to be done and there is a big scope of anycast L root instance serving as a DR plan for a region, wherein we have seen a shift (more than 80%) in traffic in some experiments. The result here is shown to get some insights about the experiments in the context of continuous efforts towards bringing DNS resilience.

References

1. Raje, Anand, Anupam Agrawal, T. Santhosh, Subodh Sachan, Manjit Nayak, Sushanta Sinha, Indrajit De, Joherul Haq, and Subhasis Maitra. 2023. “The Internet Measurement Network (AIORI-IMN).” Pp. 1–8 in *2023 4th International Conference on Computing and Communication Systems (I3CS)*.
2. Raje, Anand, Anupam Agrawal, T. Santhosh, Indrajit De, Sushanta Sinha, Joherul Haq, Subodh Sachan, and Manjit Nayak. 2023. “An Edge Computing Architecture for Internet Measurement Network to Measure and Analyze Protocol Data.” *SN Computer Science* 4(6). doi: 10.1007/s42979-023-02267-1.

Thanks
Team AIORI @ IIFON

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Network Operators | Academia | Research Institutions