The Internet Measurement, Standards and Research Platform

https://portal.aiori.in

Team AIORI

The story behind AIORI

- **2011** – Outreach and Capacity Building
  - DNS, DNSSEC, IPv6, BGP, Routing Security
- **2014** – Identifying and Addressing Problem Areas
  - L Root Hosting, Kolkata IX, MANRS
- **2019** – Need of Research – Building a Platform
  - AIORI
- **2024** – Engaging Community For Research and Development
  - Workshops, Hackathon, IETF Participation
- **2025** – Delivering Solutions

Advanced Internet Operations Research in India

MEASUREMENT PLATFORM

INTERNET STANDARDS DEVELOPMENT

OPEN-SOURCE PROJECTS

REFERENCE ARCHITECTURE

DATA REPOSITORY FOR ACADEMIC RESEARCH

COMMUNITY ENGAGEMENT FOR CAPACITY BUILDING

The Platform Uses – Measurements by Community

https://aiori.in/

USERS REGISTERED

975

AIORI Services Portal

TOTAL MEASUREMENTS

25463

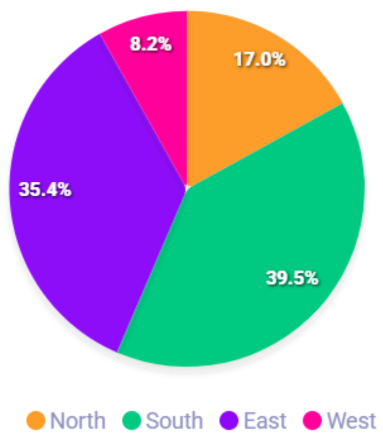
AIORI Services Portal

PUBLIC MEASUREMENTS

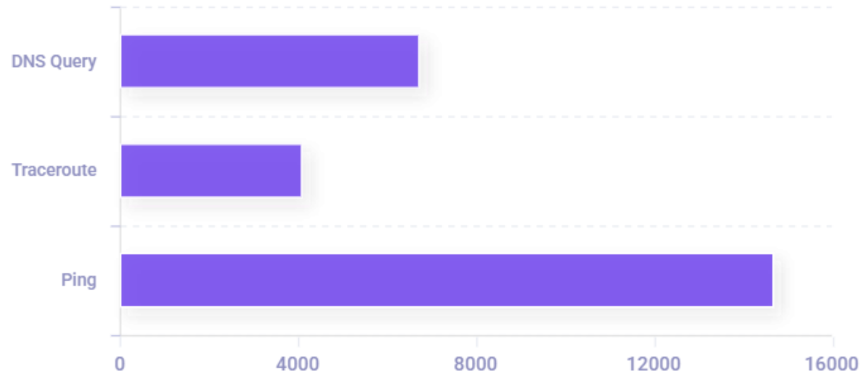
383

AIORI Services Portal

Registered Anchors (Region-wise)



Measurements Executed



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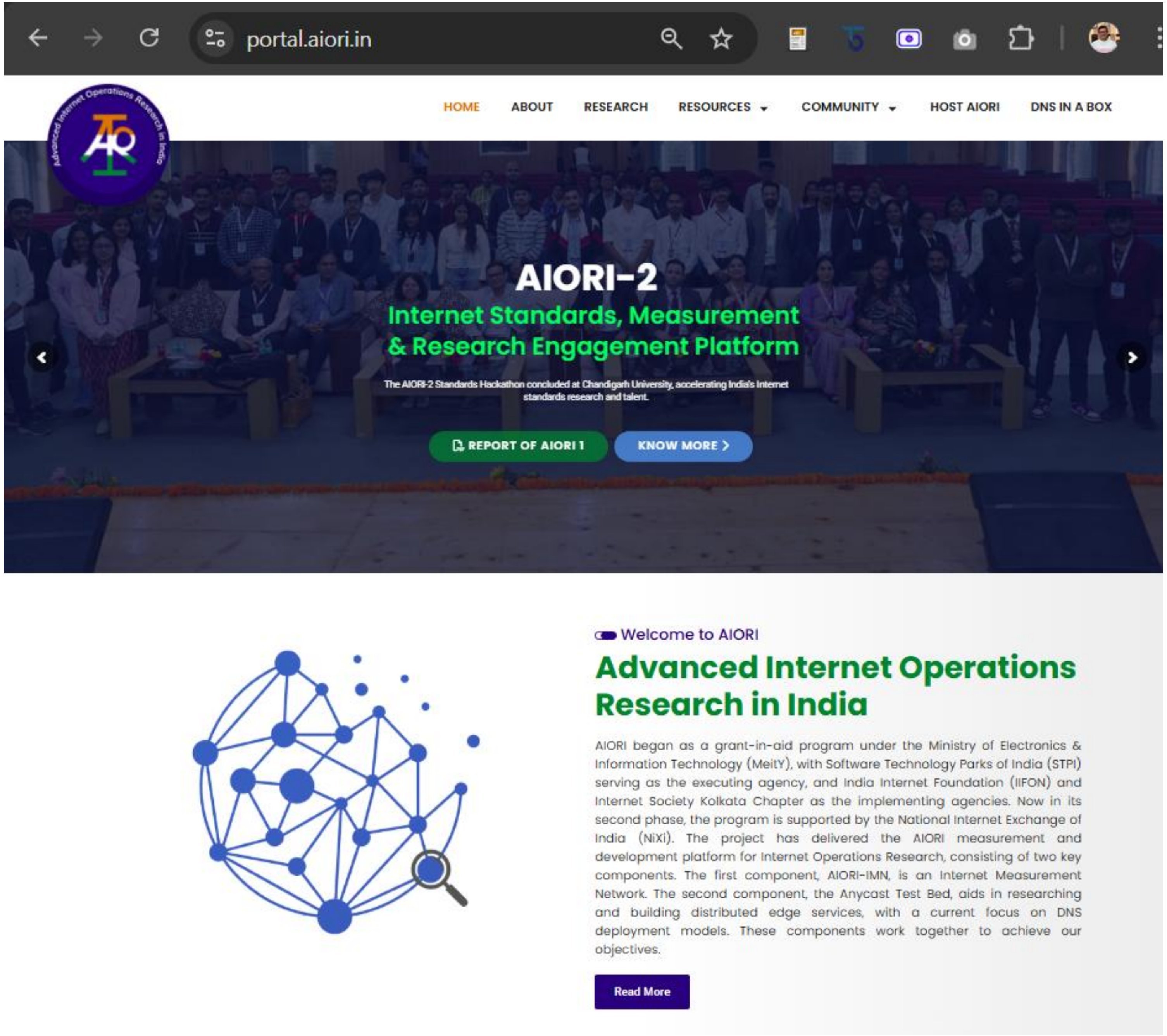

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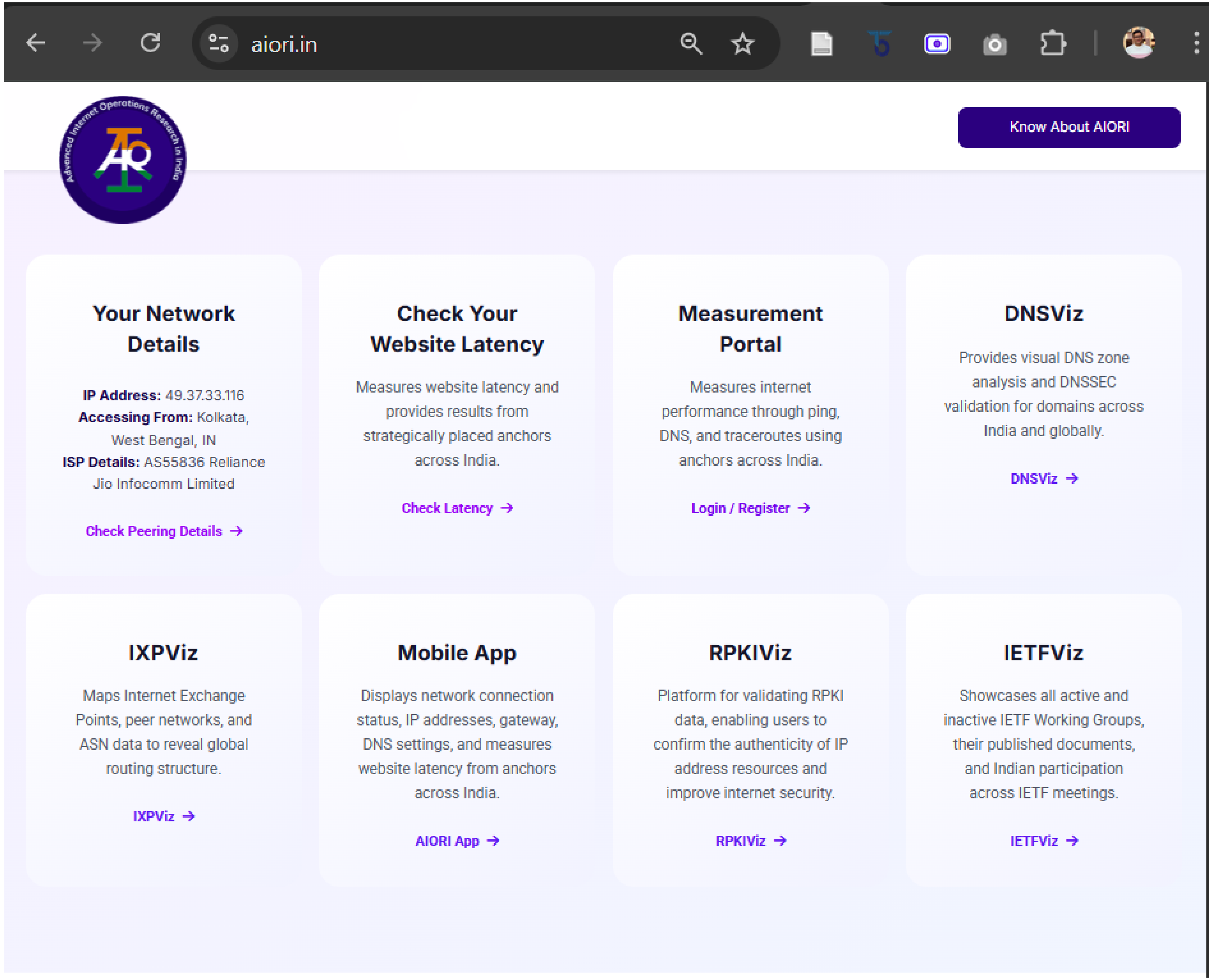
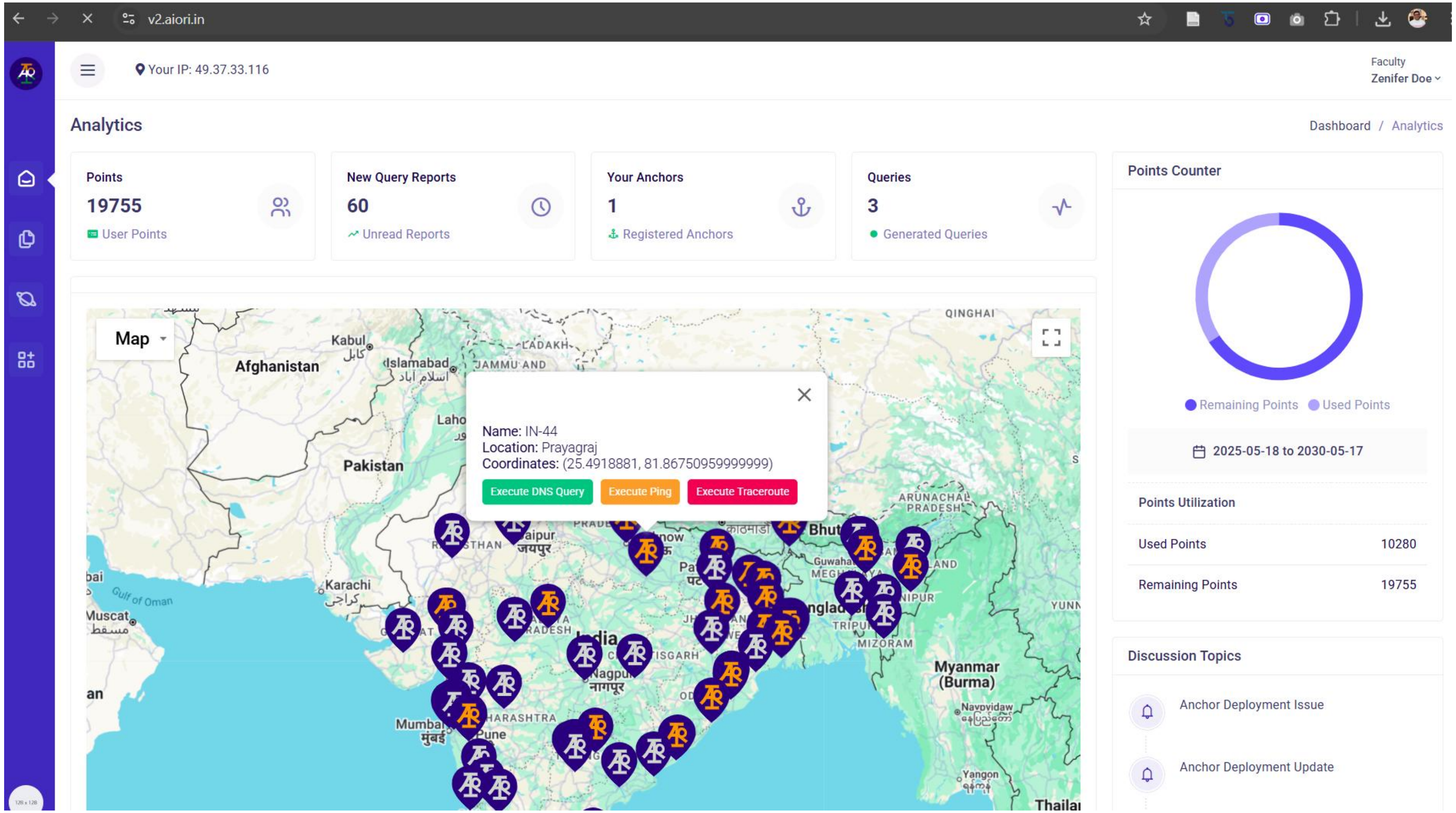


The Measurement Platform



Observing Routes

v2.aiori.in/traceroute_visualizer/?id=16663

AIORI Traceroute Reports

Traceroute / Reports

Query Visibility | Export Result

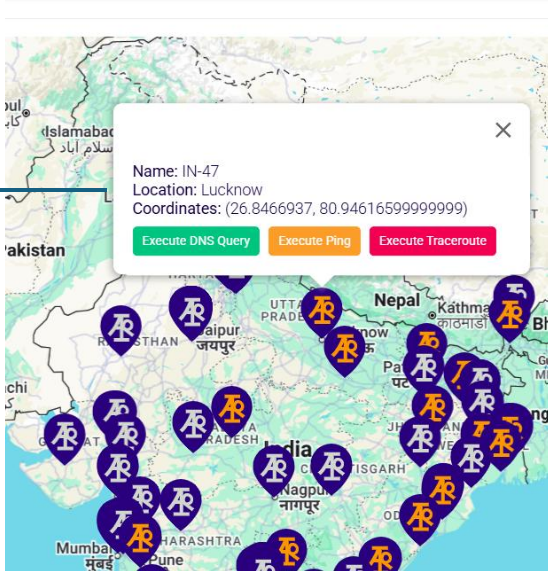
Trace Route For www.facebook.com

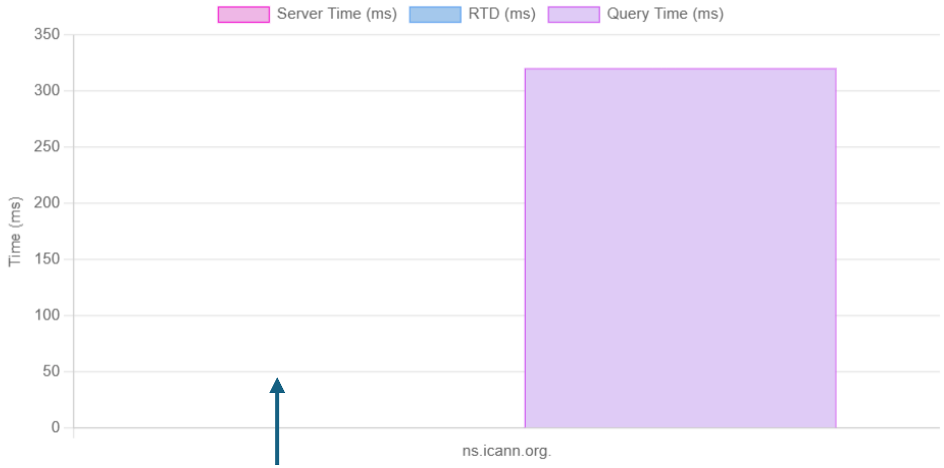
Trace Route For www.facebook.com IN-V2-134:-(Bengaluru)

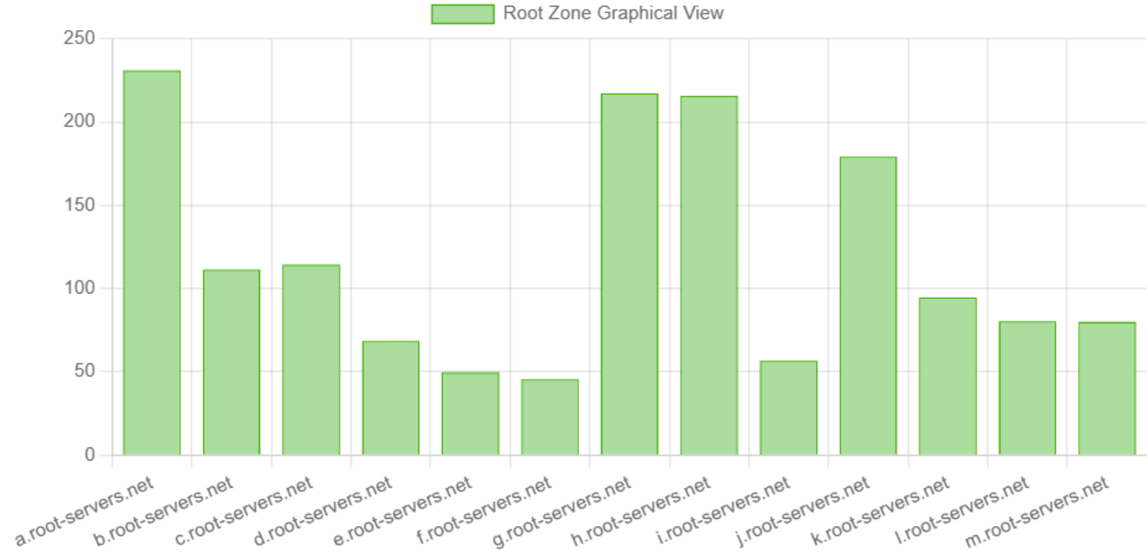
No	Distance	Node	Rtt Max	Rtt Avg	Rtt Min	Latitude	Longitude	Location
1	1	192.168.1.1	0.681	0.634	0.588	12.8630352	77.43797789999999	Bengaluru
2	2	223.178.56.1	5.258	4.996	4.734	28.44324	77.05501	Gurugram

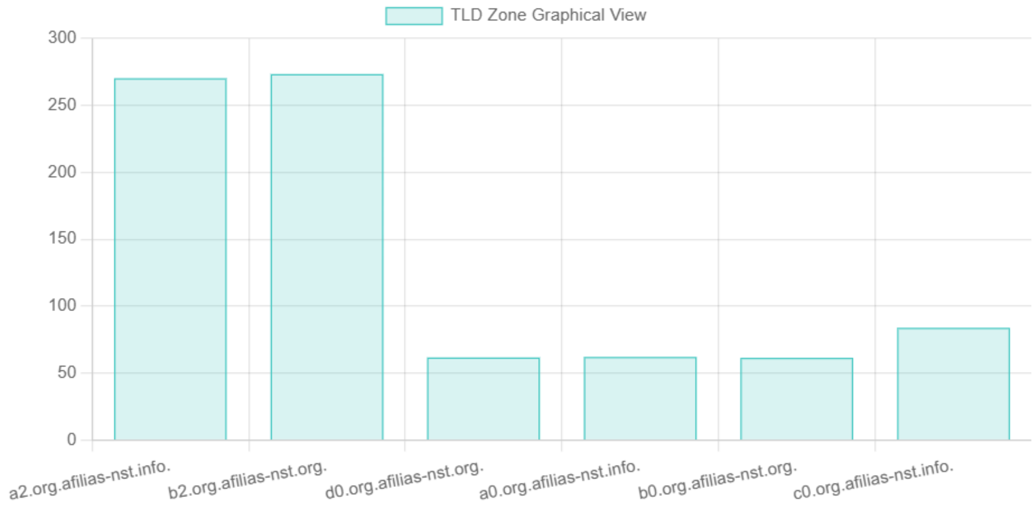
Observing DNS Query Latency from User Locations

icann.org

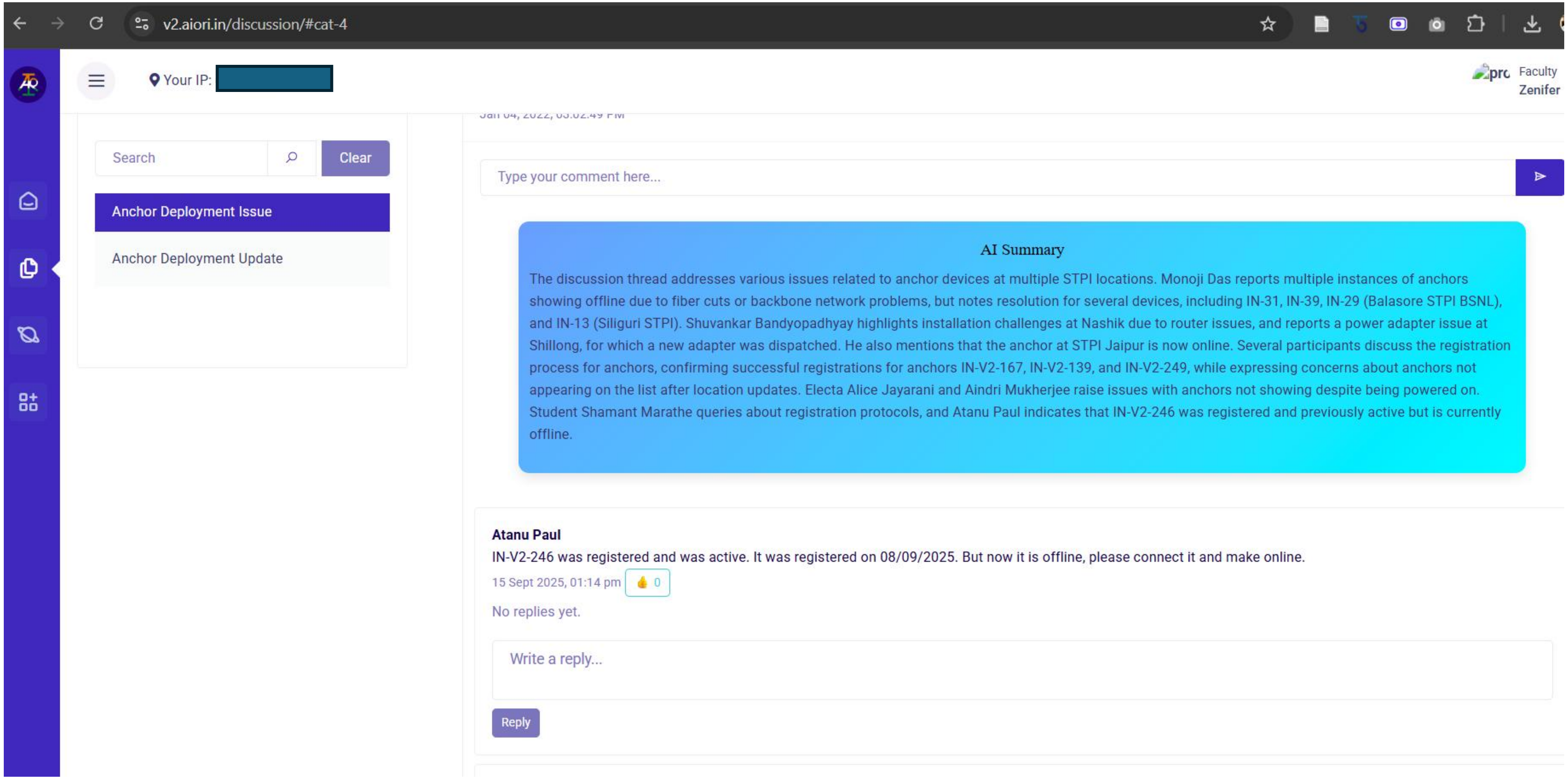








Discussion Forums



Anycast deployments – L Root

Uncovering the regional resilience requirements

AIORI–ICANN L-Root Deployment in India

AIORI collaborated with ICANN to deploy four L-Root IMRS instances in India:

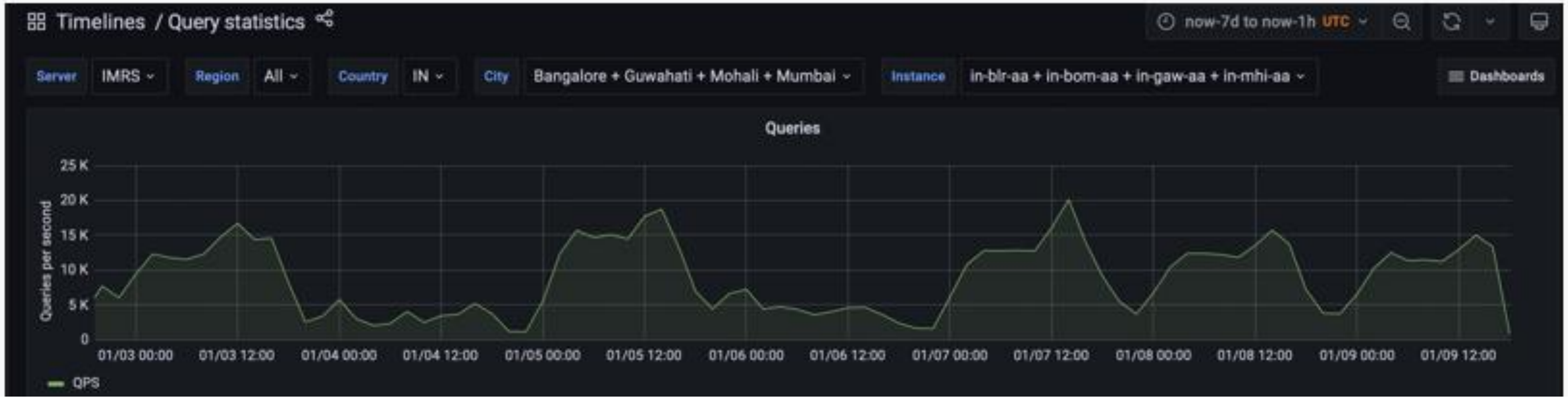
Mumbai, Bengaluru, Guwahati, Mohali

Objectives:

- Measure geographic DNS root traffic patterns
- Study Anycast traffic attraction dynamics
- Evaluate regional load distribution
- Strengthen indigenous Internet measurement capability

L Root – India vs Global

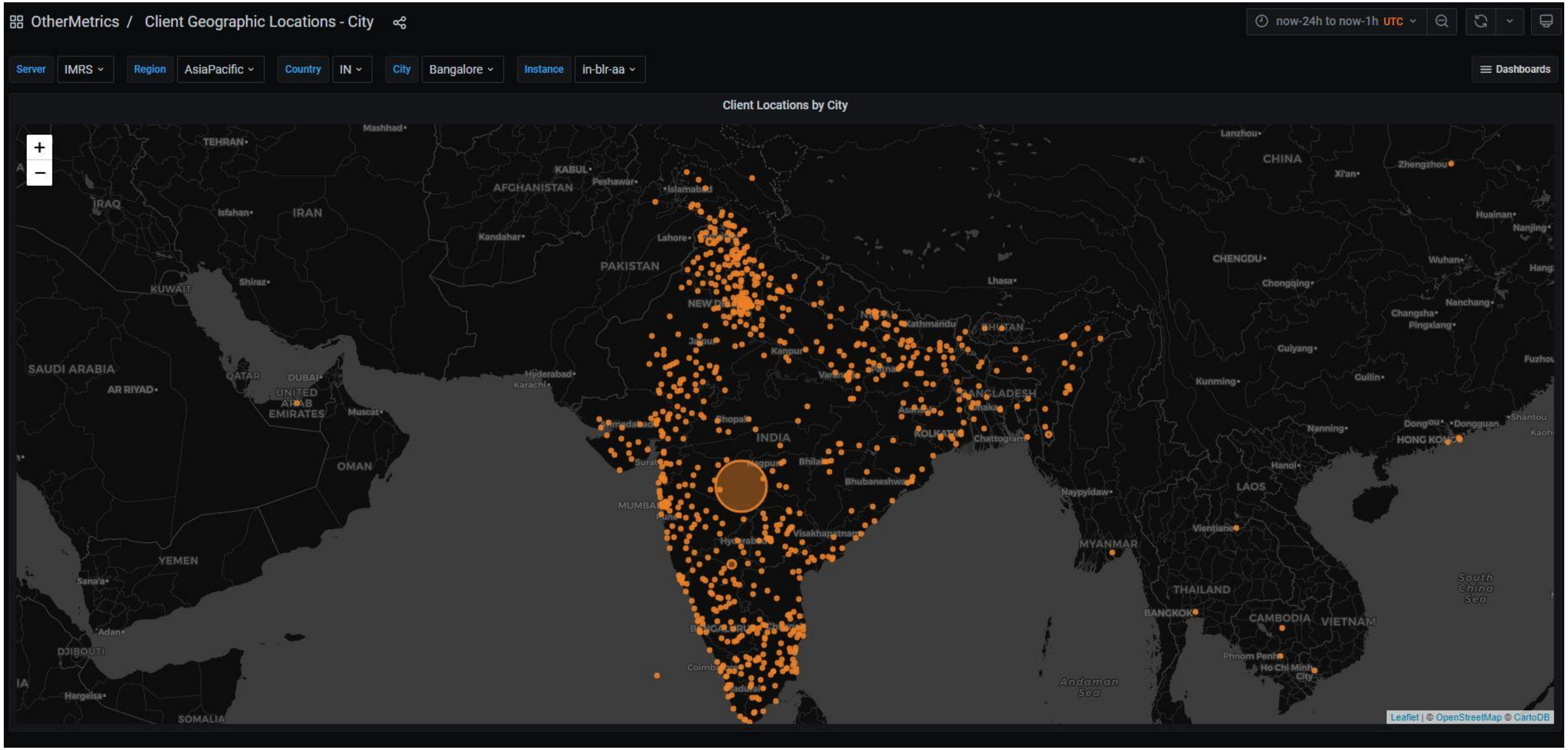
INDIA



GLOBAL

L Root Resilience Experiment

L Root Resilience Experiment



Key Findings & Traffic Distribution

- Four Indian instances began serving ~10% of global L-root traffic
  - These represent ~1% of ~192 global L-root sites
  - Bengaluru & Mumbai attracted majority traffic
  - Mohali & Guwahati observed lower traffic volumes
  - Indicates strong regional DNS demand concentration and routing influence

Research Significance & Strategic Need

- Root server ecosystem operates with limited traffic transparency
  - Anycast placement impact is under-measured globally
  - Traffic concentration affects resilience modeling
  - Need structured measurement of traffic skew and locality bias
  - ~1% deployment serving ~10% traffic highlights disproportionate impact

AIORI L-Root Disaster Stress Test

Objective

Evaluate the resilience and stress-handling capacity of AIORI-deployed L-Root instances during a simulated disaster scenario.

Methodology

- Conducted in coordination with **ICANN**
- Intentionally stopped **3 out of 4 AIORI L-Root instances in India**
- Measured:
  - Traffic rerouting behavior
  - Root zone resolution shifts
  - Bandwidth utilization and saturation

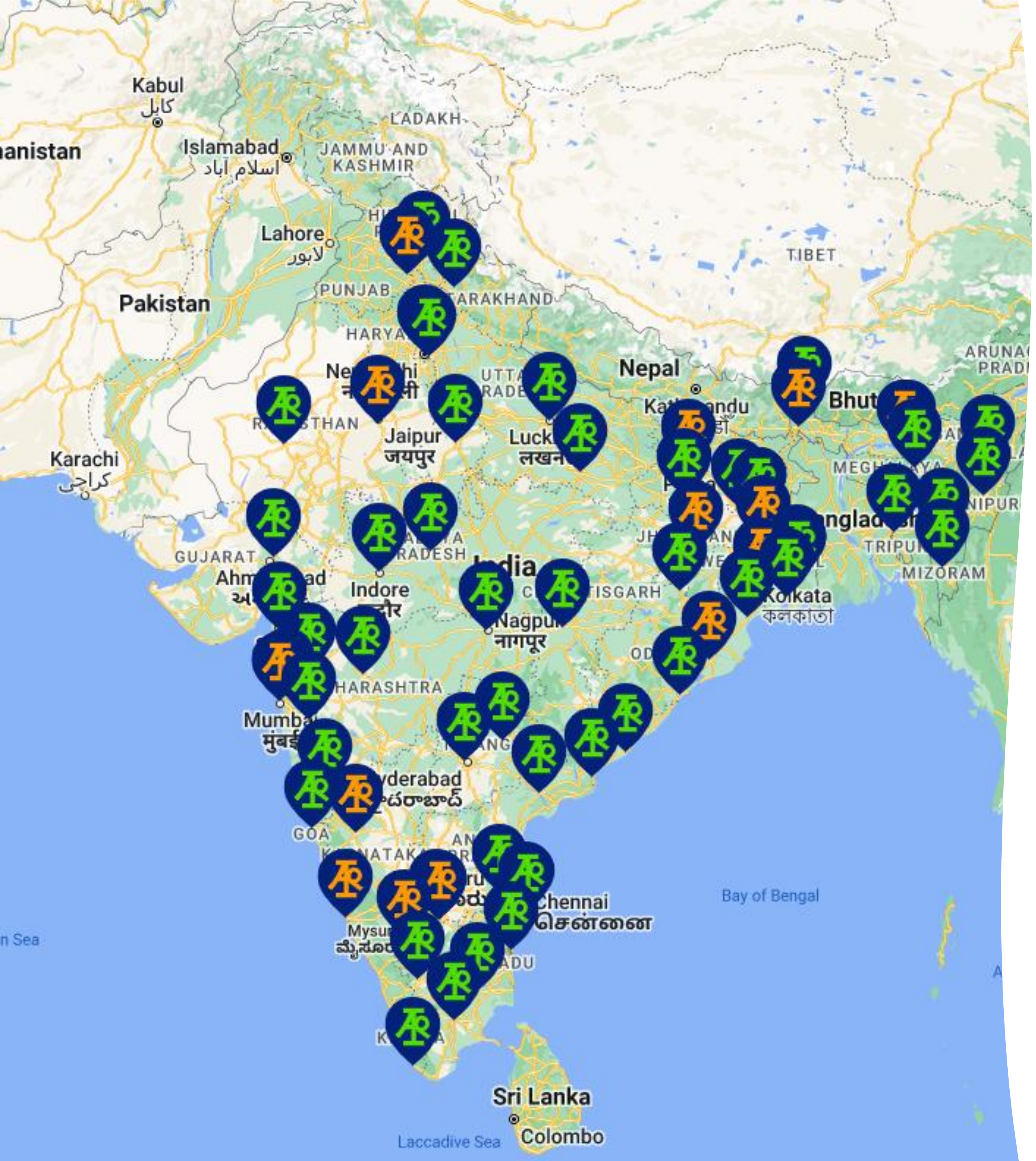
AIORI L-Root Disaster Stress Test

Key Findings

- ~80% of root zone resolution traffic shifted to the remaining active L-Root instance
- Significant bandwidth congestion observed
- Traffic was not evenly absorbed by other locally deployed root instances

Ongoing Technical Analysis

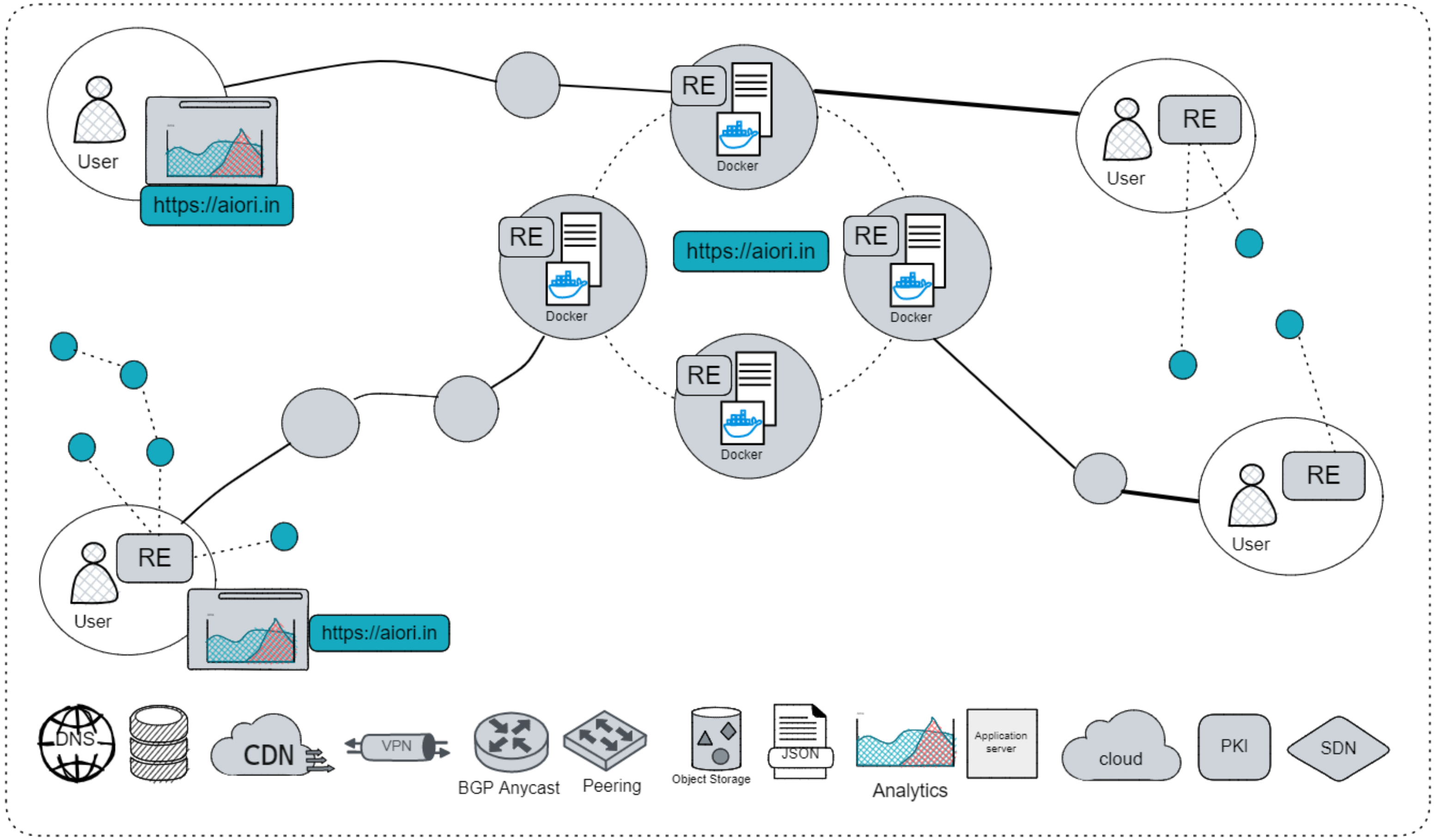
- Recursive resolver bias patterns
- Anycast routing and path selection behavior
- Required bandwidth provisioning for disaster scenarios
- Implementing BGP communities for critical routes



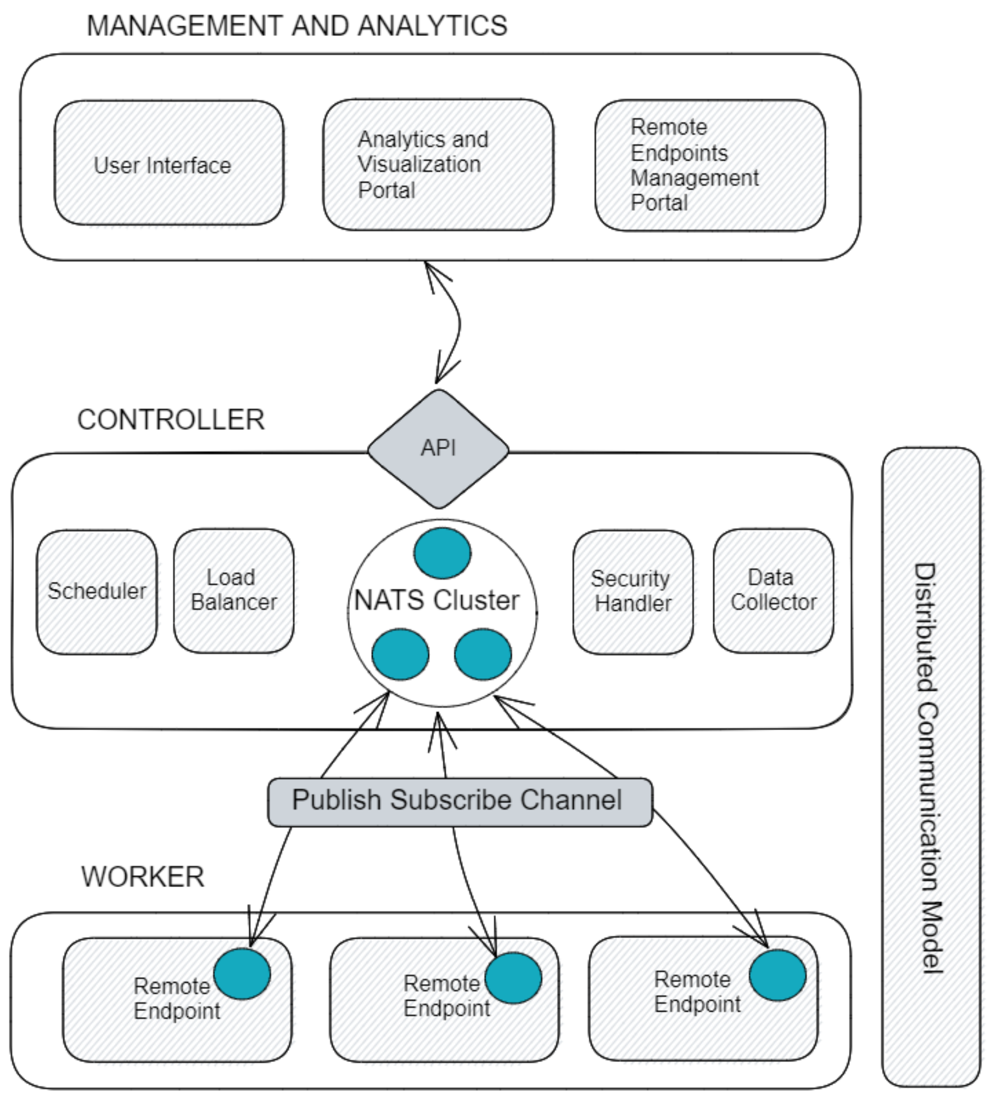
ANCHOR NETWORK

- Edge Measurement Devices
- In 100+ locations across India
- This is helping us measure from user endpoints

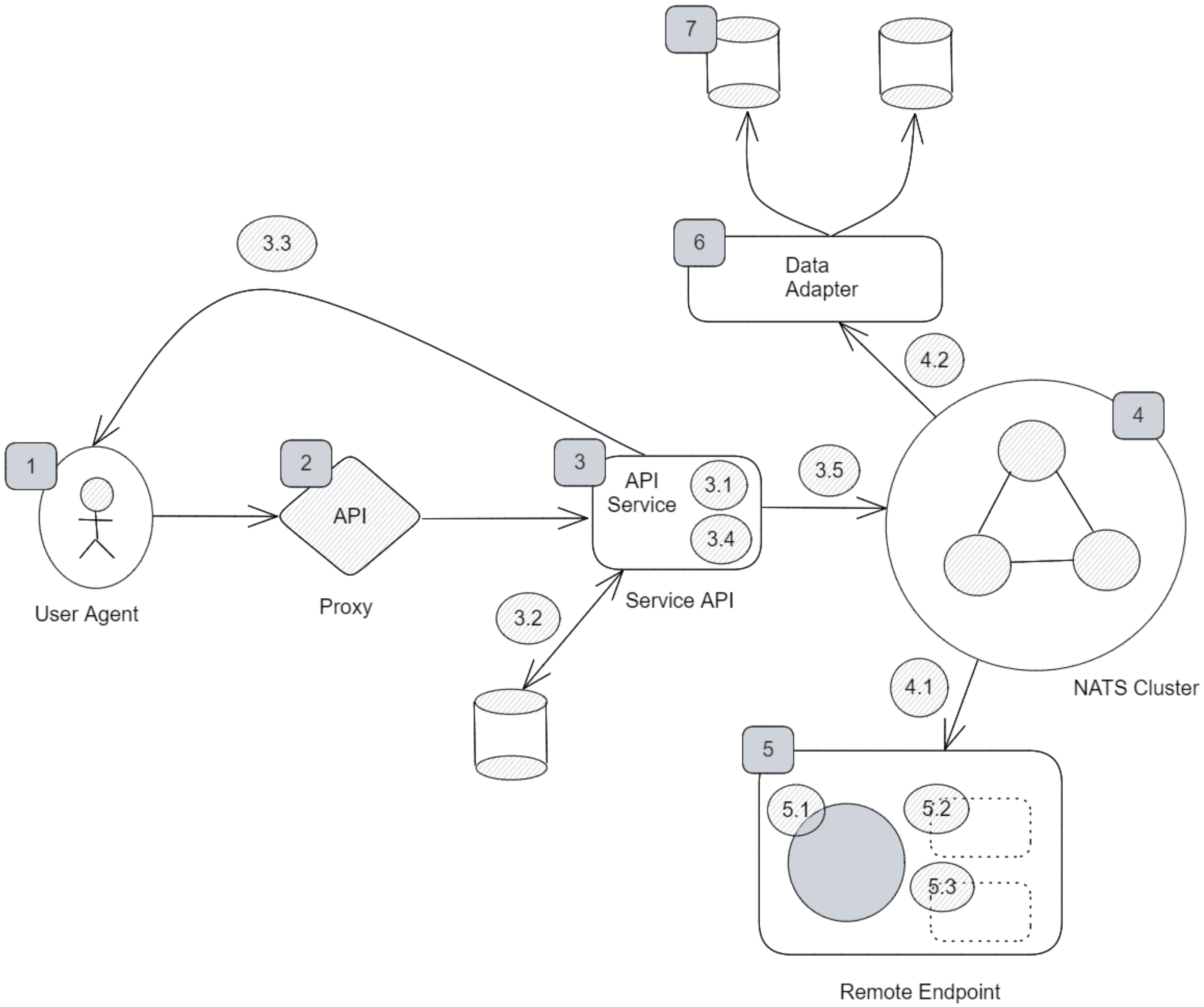
Components of High-Level Architecture



The AIORI-IMN Layered Architecture



Task Execution Flow



Task Execution Flow

(1) The User Agent (API call/Apps): Request to proxy APIs to run measurement using AIORI-IMN REs.

(2) The Proxy APIs: The APIs Validates the User Agent request and acts as a thin API server that exposes a stable interface for service delivery APIs.

(3) The Service Delivery APIs: The Proxy APIs route the Request to Service Delivery APIs; the Service Delivery APIs does the following tasks:

- (3.1) Checks input validation
- (3.2) Store request to Database
- (3.3) Return acknowledgement
- (3.4) Transform payload into message
- (3.5) Publish message to NATS Channel

(4) NATS Cluster:

- (4.1) The NATS distributes/Queue message across NATS leaf nodes implemented in REs
- (4.2) The log and measurement payloads are written to respective data stores.

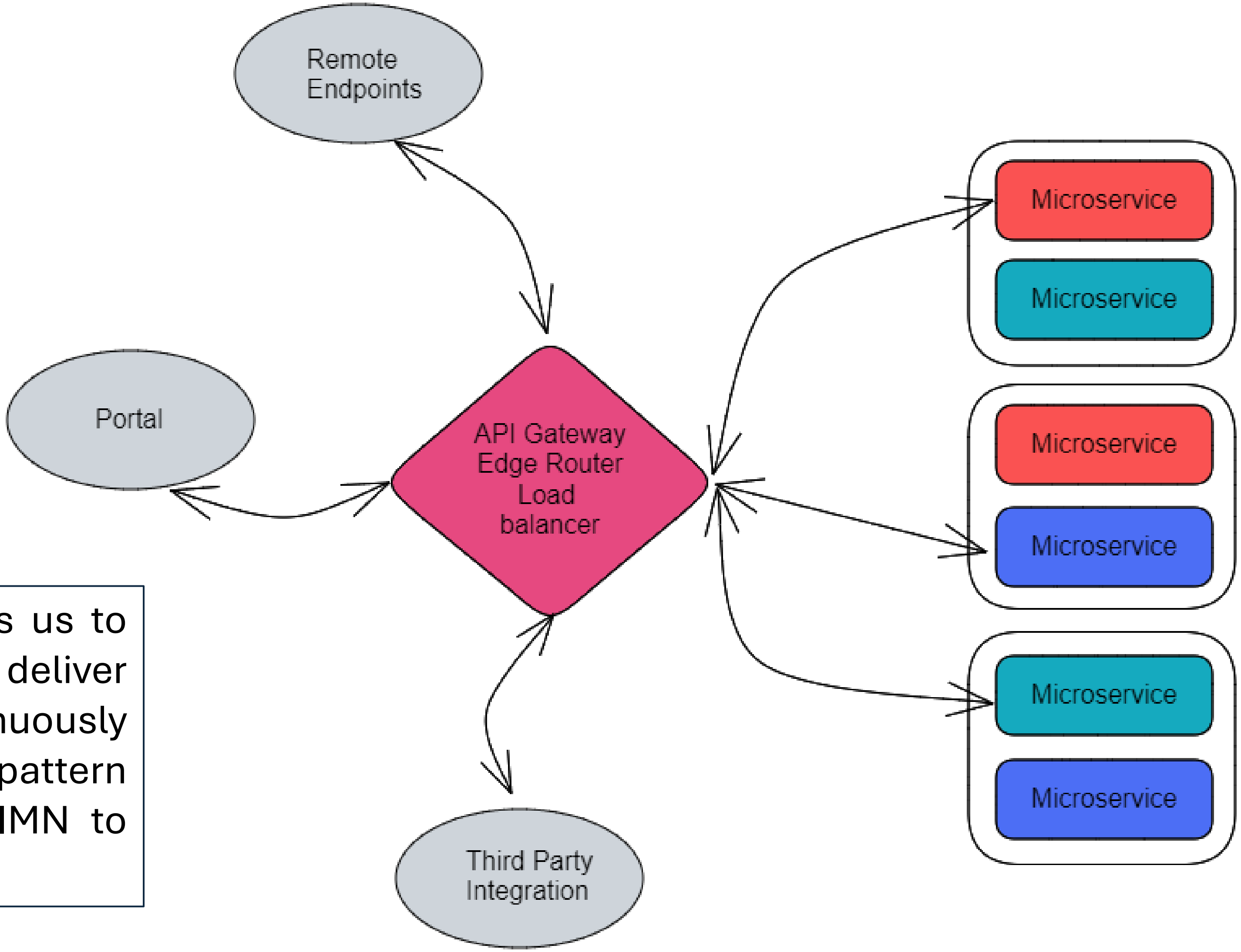
(5) Remote Endpoints(REs):

- (5.1) NATS Leaf node receives/publishes the result into NATS Channel
- (5.2) Application receives message from NATS leaf node[23]
- (5.3) Application decodes and Process the instruction. A scheduler for long run jobs

(6) Data adapter interfacing multiple types of data stores. For e.g., Time Series, RDBMS, Big Data

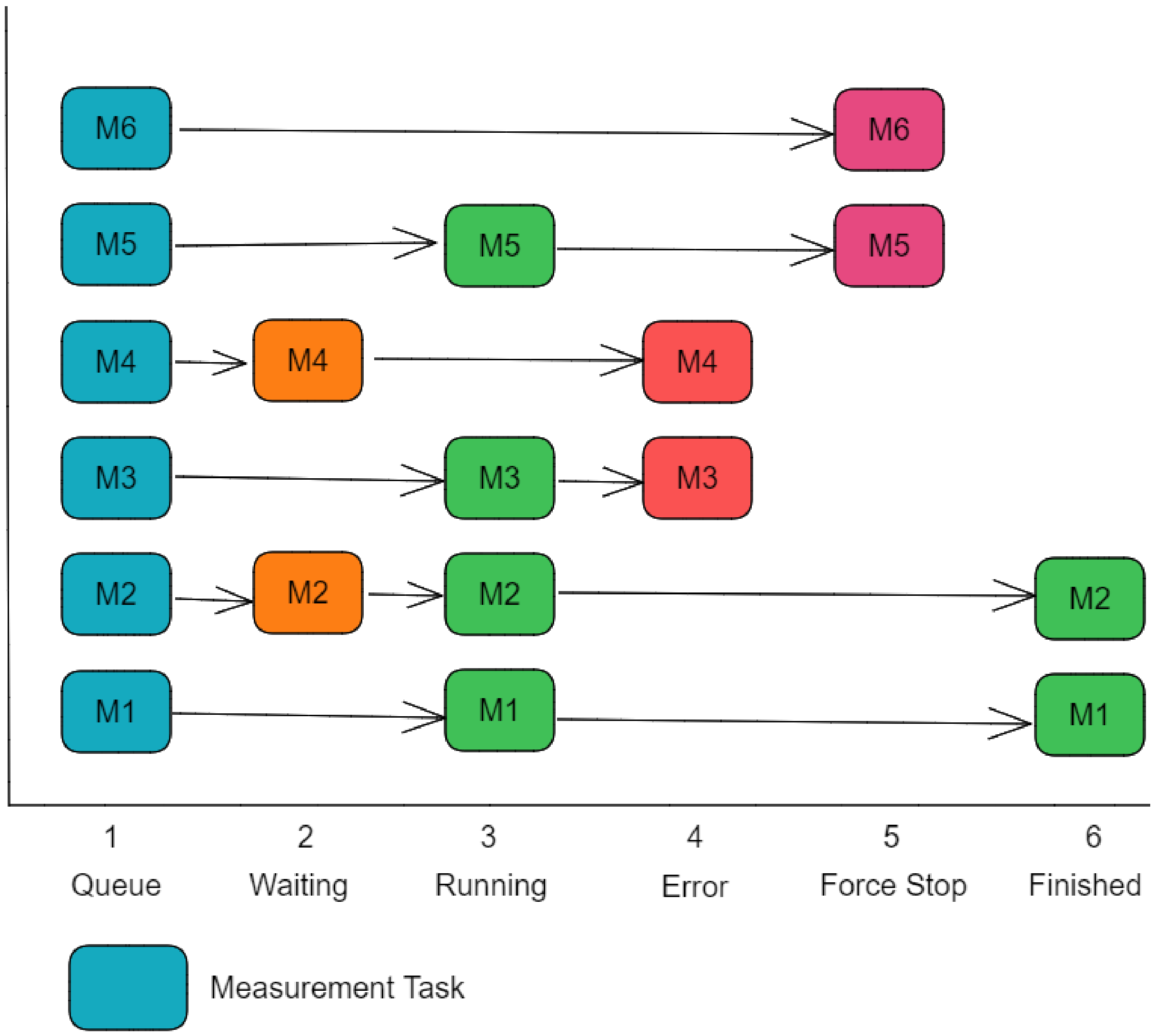
(7) Different Types of data stores

The Microservices



The microservices architecture enables us to handle high traffic volumes, deliver personalized experiences, and continuously evolve its platform. This architectural pattern has given greater flexibility for AIORI-IMN to deliver its core objectives

The task Scheduling Algorithm



Thanks

Team AIORI

A Project By

सत्यमेव जयते
Ministry of Electronics & Information Technology
Government of India

National Internet Exchange of India

Implemented By

India Internet Foundation