





Migrating NITK Surathkal Campus Network to IPv6: Led by Students and Faculty Members

Centre for Open-source Software and Hardware (COSH)

National Institute of Technology Karnataka, Surathkal

Mangalore, Dakshina Kannada, India

Outline of the presentation

1. Project overview
    - Team
    - Plan of action
    - Current network
2. Project status
    - Advertisement of IPv6 address block
    - Testbed setup at NITK
    - IPv6 deployment workshop at NITK
    - Migration of applications and infrastructure at NITK to IPv6
3. Next steps
    - Performance evaluation of migrated applications
    - Statistics analysis and investigating observations
    - Migrate internal network services and devices to IPv6

Project Overview: Team

1. Faculty members from NITK Surathkal
    - Mohit P. Tahiliani and Saumya Hegde
2. Members from India Internet Engineering Society (IIESoc)
    - Dhruv Dhody
3. Network Engineers from NITK Surathkal
    - Deepa Kumari
4. Students from NITK Surathkal
    - Kavya Bhat, Vanessa Fernandes, Amogh Umesh, Vinayak Vatsalya, M. R. Rishi
5. Advisory Team
    - Nalini Elkins
    - Michael Ackermann
    - Akshay Revankar and Sushanth S. Rao

Project Overview: Plan of action

1. Setup a testbed at NITK and test the basic functionality of IPv6
    - Gain insights into the working of DHCPv6, DNS and IPAM solutions
2. Migrate network services at NITK to IPv6
    - DHCP, DNS and IPAM
3. Dual-stack deployment at NITK
    - Enable dual-stack functionality in routers, firewalls, L3 switches and terminals
4. Update the web services and applications at NITK to support IPv6
    - Custom applications developed at NITK (for example, IRIS)
    - Enable VPNs to work with IPv6
5. Detailed documentation of migrating NITK campus to IPv6
    - Capture the process of migrating NITK to IPv6

Project Overview: Current Network

1. Current Status:
   - 45,000+ terminals connected to the Internet
   - Upcoming campus expansion within 40 km
2. Infrastructure Overview:
   - 350+ switches
   - 1,200+ indoor/outdoor WiFi access points
   - Dedicated data center hosting:
     - Firewalls
     - Core switches
     - Web and application servers
     - Servers for DHCP, DNS, IPAM and NAT
     - Network management and monitoring

Project Status: Advertisement of IPv6 block

1. NITK Surathkal has its own IPv6 address block leased from IRINN (NIXI)
    - 2400:4F20::/32
2. NITK's Internet Service Provider is: Bharat Sanchar Nigam Limited (BSNL)
    - Supports IPv6
3. Step 1: Requested BSNL to use their ASN and advertise our IPv6 block
    - BSNL agreed to advertise our IPv6 block
4. Step 2: Requested IRINN to add a ROA
    - IRINN agreed and added the ROA
5. Step 3: Provided the ROA details to BSNL to advertise the IPv6 address block
    - BSNL now advertises our IPv6 block. Advertised IPv6 block is: 2400:4F20::/36
6. Summary
    - Chose to use ISP's ASN instead of running our own BGP instance

Project Status: Advertisement of IPv6 block

2400:4f20::/36

Originated by AS9829
AS Name: **BSNL (Bharat Sanchar Nigam Ltd)**

Overview | Connectivity | Whois | Validation

Registered on
18 Jan 2022 (18 months old)

Registered to
A923DA91 (APNIC)

Prefix status
Active, Allocated under APNIC

Size of prefix
4096 /48's

Upstreams

- AS6453 - TATA COMMUNICATIONS (AMERICA) INC
- AS9498 - BHARTI Airtel Ltd.
- AS3257 - GTT Communications Inc.

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Home

Welcome to the Hurricane Electric BGP Toolkit.

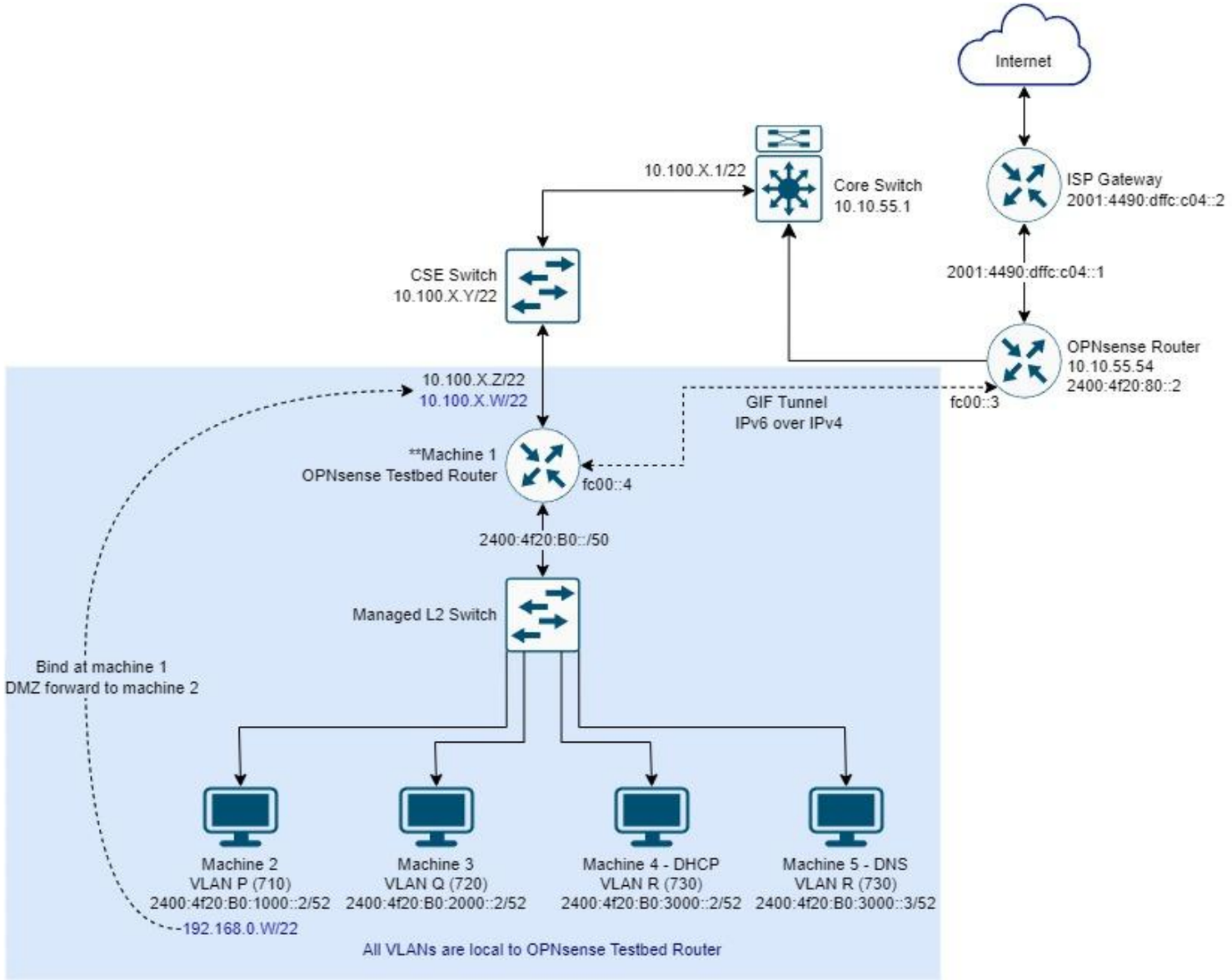
You are visiting from **2400:4f20:70:1000:10:200:200:20**

Announced as **2400:4f20::/36** (NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA)

Your ISP is **AS9829** (BSNL (Bharat Sanchar Nigam Ltd))

Updated 04 Aug 2023 14:17 PST © 2023 Hurricane Electric

Project Status: Testbed Setup at NITK



Project Status: Testbed Experiments

1. phpIPAM: IP Address Management software
   - Installed phpIPAM on the testbed for management and tracking.
   - Enabled DHCPv6 tracking to understand how IP addresses can be managed at the production level.
2. DHCPv6 Kea Server
   - Understand the working of DHCPv6 with different OPNsense router advertisement modes.
   - Explore configuration options to make decisions based on requirements of the campus network.
3. Neighbor Discovery (ND) Snooping on intermediate switch
   - Used to protect against ND attacks by constructing a table of trusted IPv6-MAC bindings.
   - Issue: Observed that table entries were generated only on machine reboots.
   - Analysis: Entries might be generated only when the system first joins the network and advertises its IP.
   - Debugging: In process

Project Status: IPv6 deployment workshop at NITK

92 participants attended the workshop from March 20-22, 2023

- Participants belonged to industries, Government organizations, students and faculty members





Project Status: Migration of applications to IPv6

1. Integrated Resource and Information Sharing (IRIS): most widely used at NITK
   - It is a MIS + ERP of NITK that has automated 40+ processes at NITK Surathkal
   - Most widely used web and mobile application at NITK: 7000+ students and 600+ staff use it everyday!
     - API based integrations with Moodle, BigBlueButton, Jitsi Video Conferencing and others
   - Link: https://iris.nitk.ac.in/
2. What has been achieved so far?
   - Support for IPv6 has been enabled for IRIS!
   - IPv6 support for integrated applications, such as Moodle, BigBlueButton and others is pending
   - Total hits from IPv6 on IRIS: 12,584,565
   - Total hits from IPv6 after adding AAAA record for https://iris.nitk.ac.in/: 3773200
   - Majority of IPv6 requests are from mobile devices, with the maximum coming from IRIS app: 1200956
   - Total number of unique IPv6 addresses accessed (after addition of AAAA record): 210533
   - Ongoing work: performance evaluation and testing in terms of latency and resiliency (IPv4 vs IPv6)

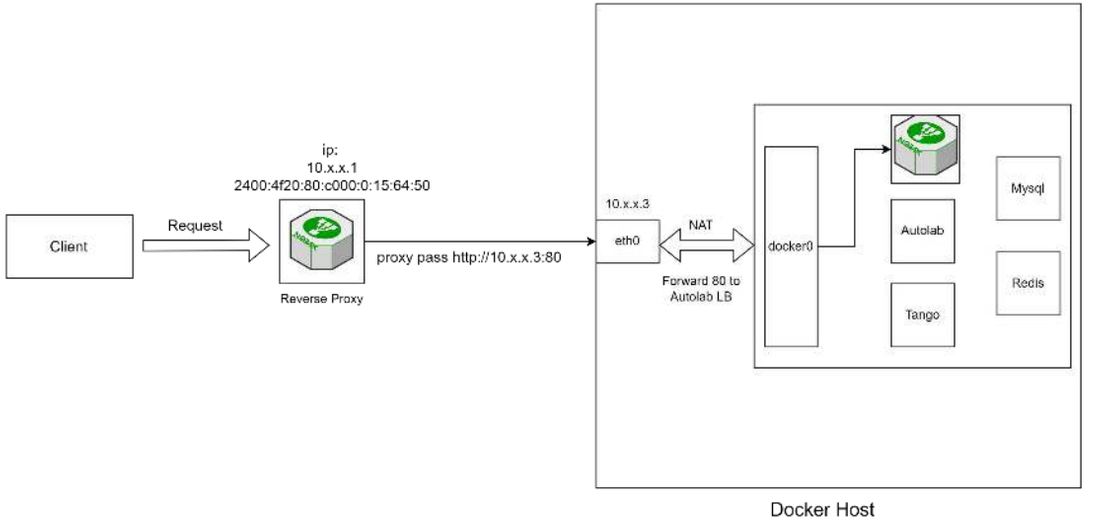
Project Status: Migration of applications to IPv6

1. IRIS NGINX Reverse Proxy/Load Balancer IPv6 Migration
    - Configured IPv6 on NGINX reverse proxies.
    - Added AAAA records for iris.nitk.ac.in for IPv6 load balancing via DNS.
    - Setup reverse DNS for LBs and serving HTTP(S) traffic on IPv6.
2. IRIS Rails App Migration
    - Configured IPv6 on hosts, NFS server, and database.
    - Updated main reverse proxies to proxy to Rails app over IPv6.
    - All services, including NGINX, MariaDB, and NFS, are IPv6 capable.
3. IRIS VPN Migration
    - Enabled IPv6 on OpenVPN servers and Pritunl.
    - Created routed subnet for VPN on IPv6.
    - Implemented ip6tables forwarding and Proxy NDP for IPv6 support.

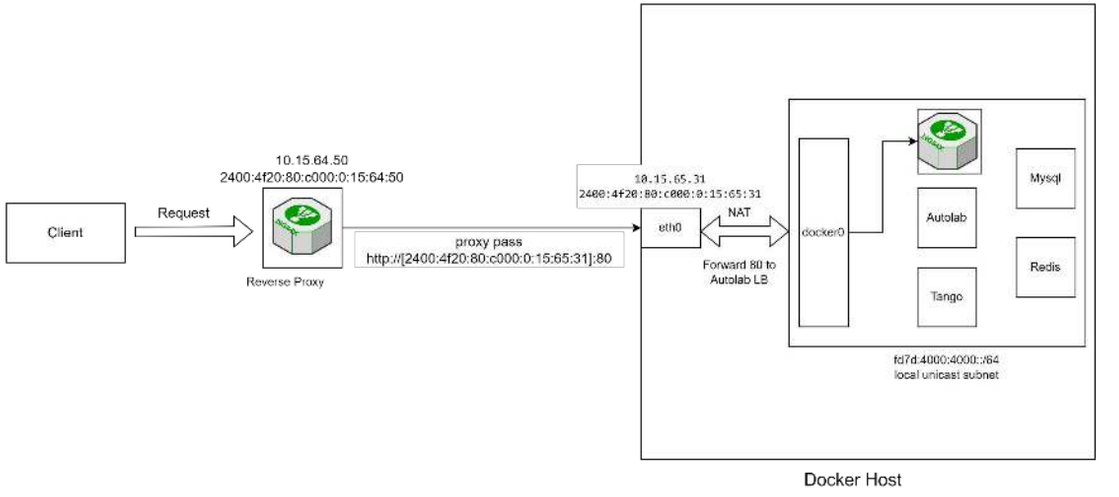
Project Status: Migration of applications to IPv6

4. Docker Network:

- Issue Faced:
  - Containerised services inaccessible via IPv6 due to NAT setup.
  - Preference for server accessibility through reverse proxies.
- Resolution:
  - Configured Docker to use local IPv6 addresses.
  - Established external connectivity via NAT.
  - Forwarded specific ports to reverse proxies for service access.



Before Migration



After Migration

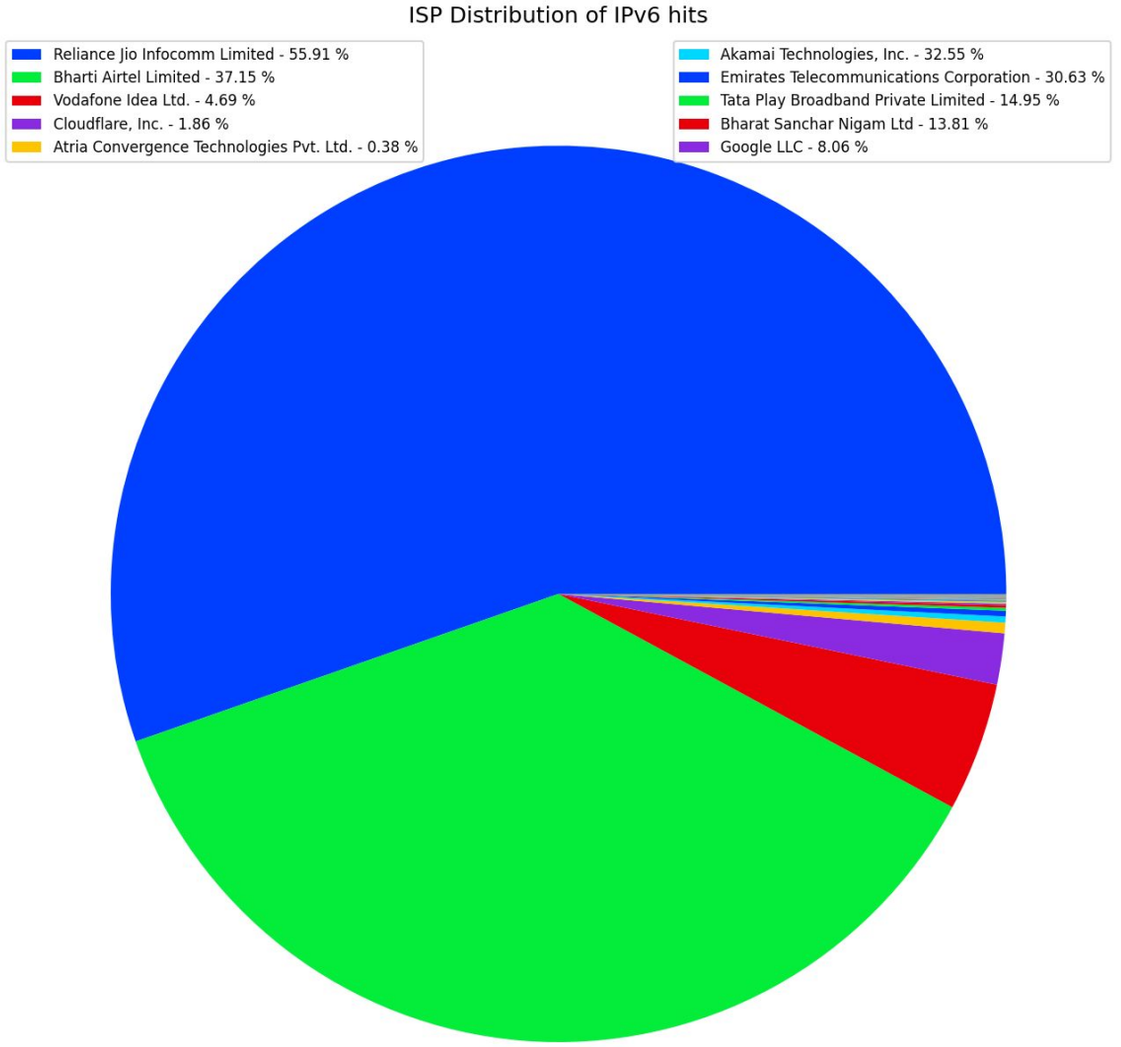
Project Status: Migration of applications to IPv6

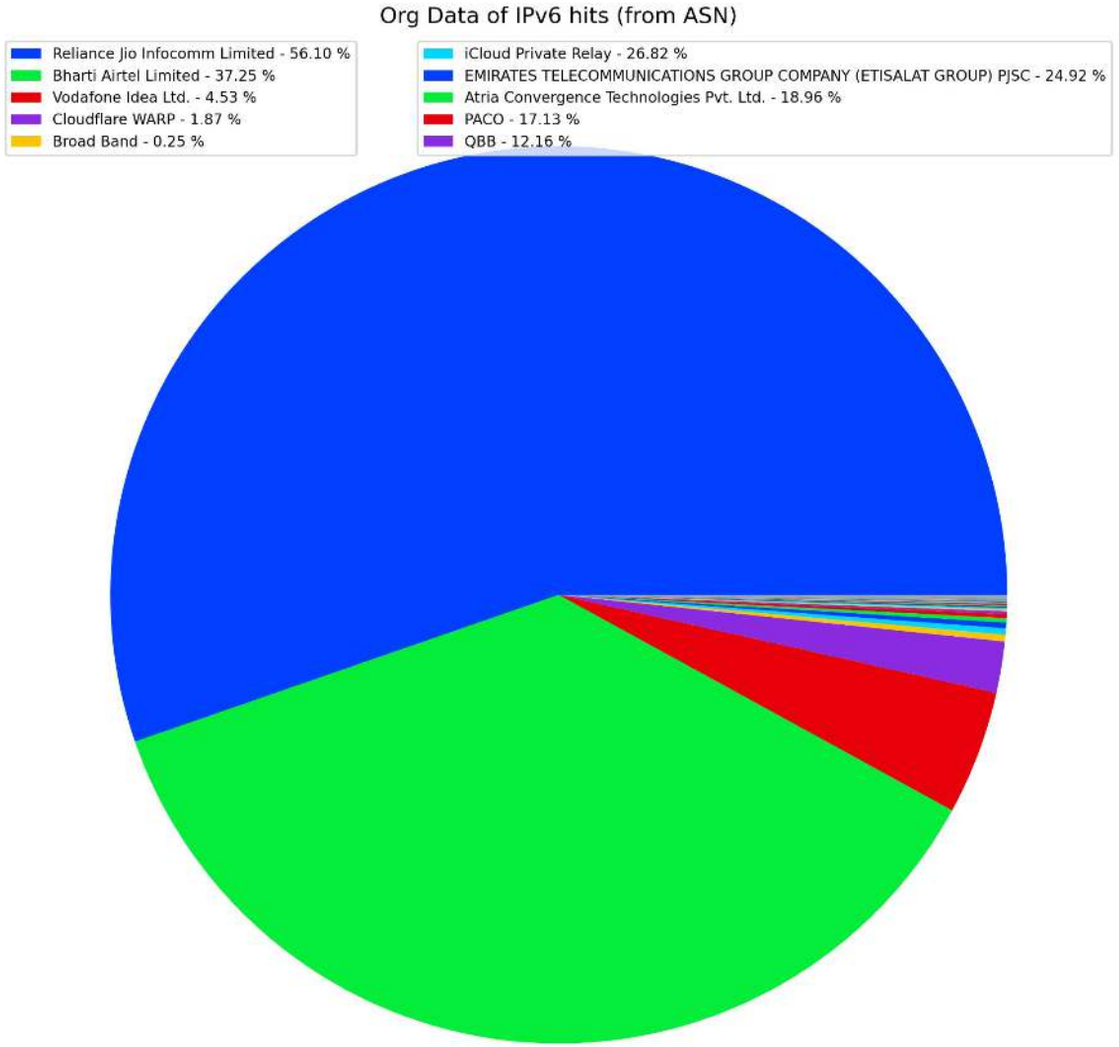
5. IRIS GitLab Migration
    - Enabled IPv6 on GitLab host and configured GitLab to listen over IPv6.
    - Set up ip6tables forwarding and NGINX proxy for GitLab connections on IPv6..

Note:

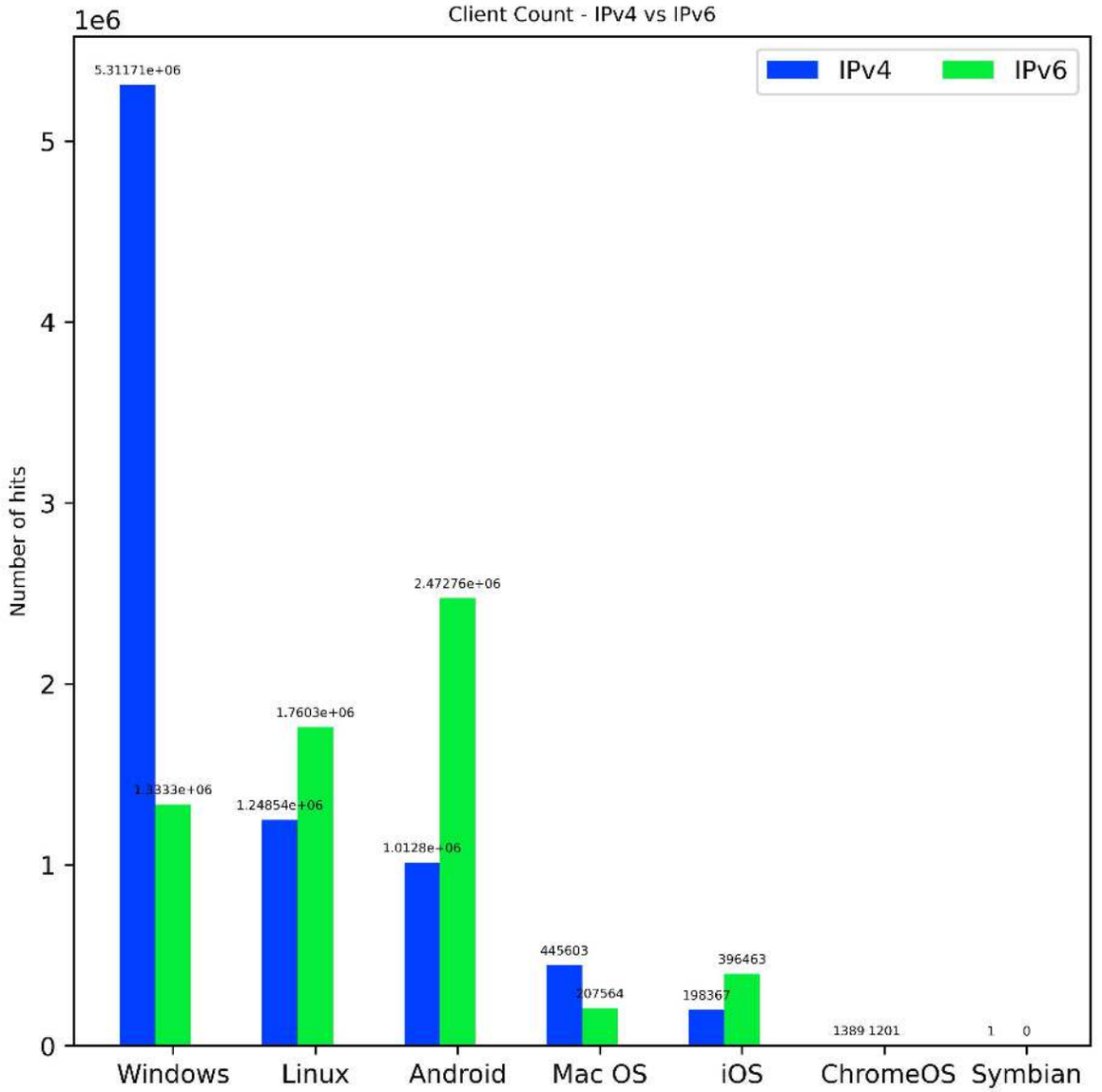
Ongoing migration includes: Moodle Kubernetes Deployment and IRIS Staging Server containerization and migration.

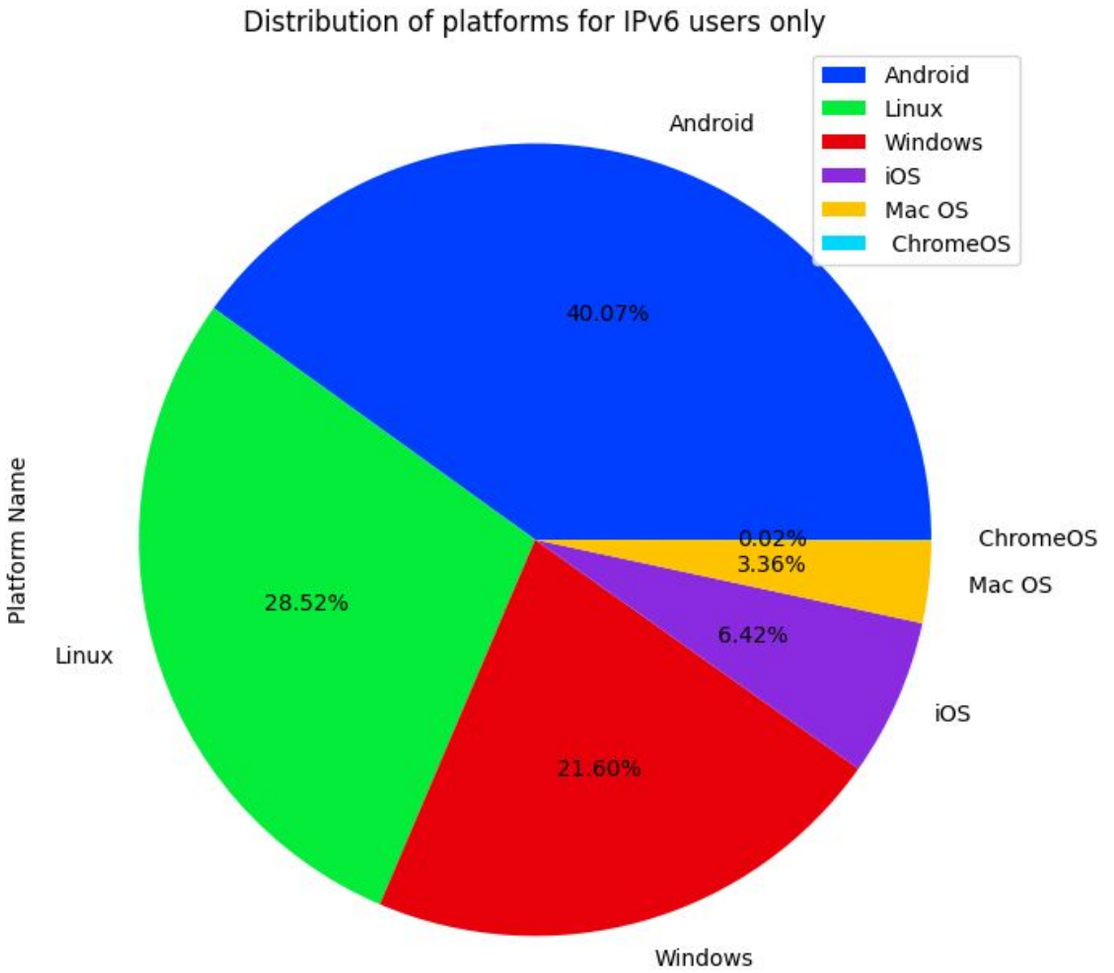
Project Status: IPv6 Statistics from IRIS (6 months)

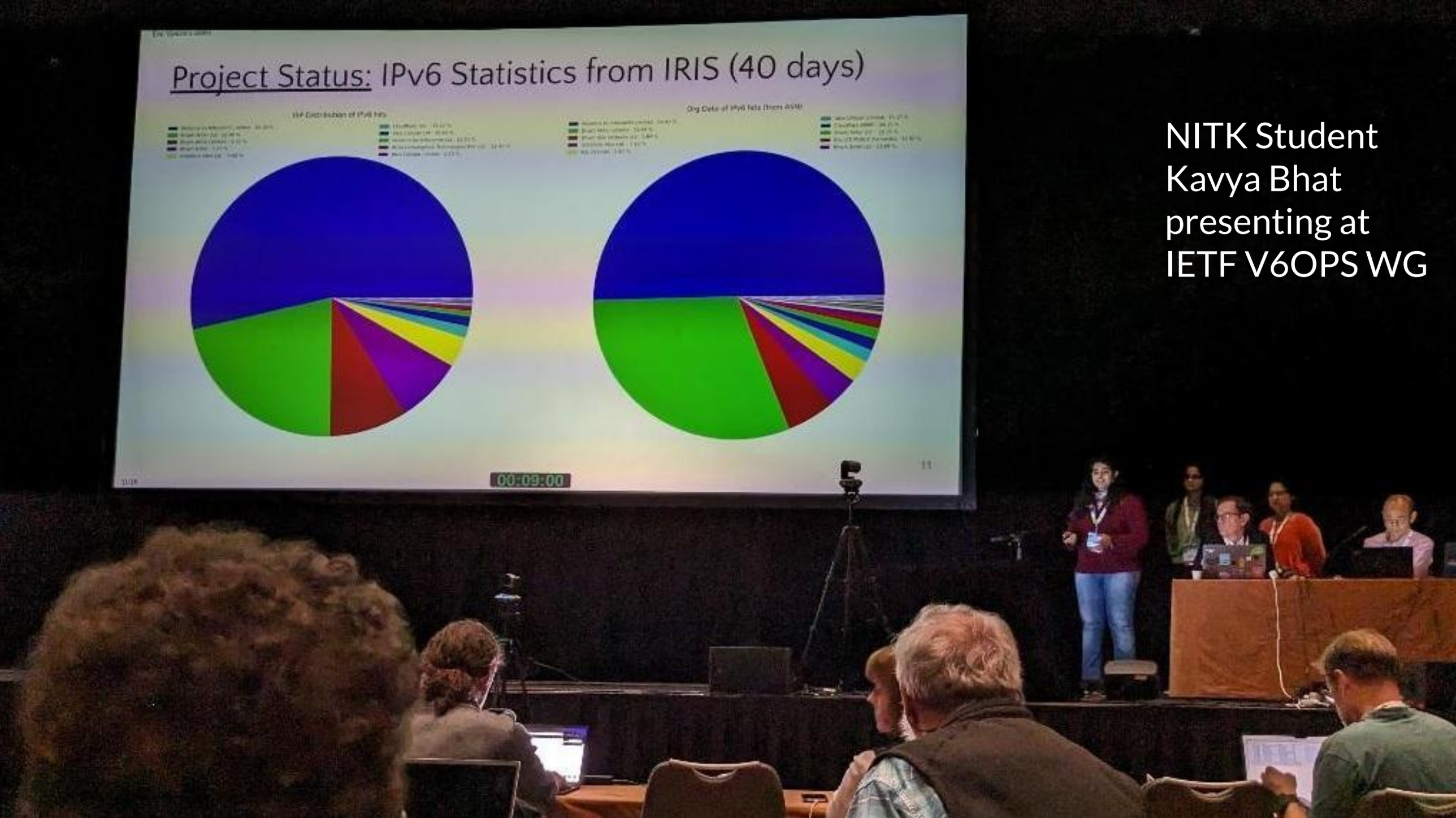




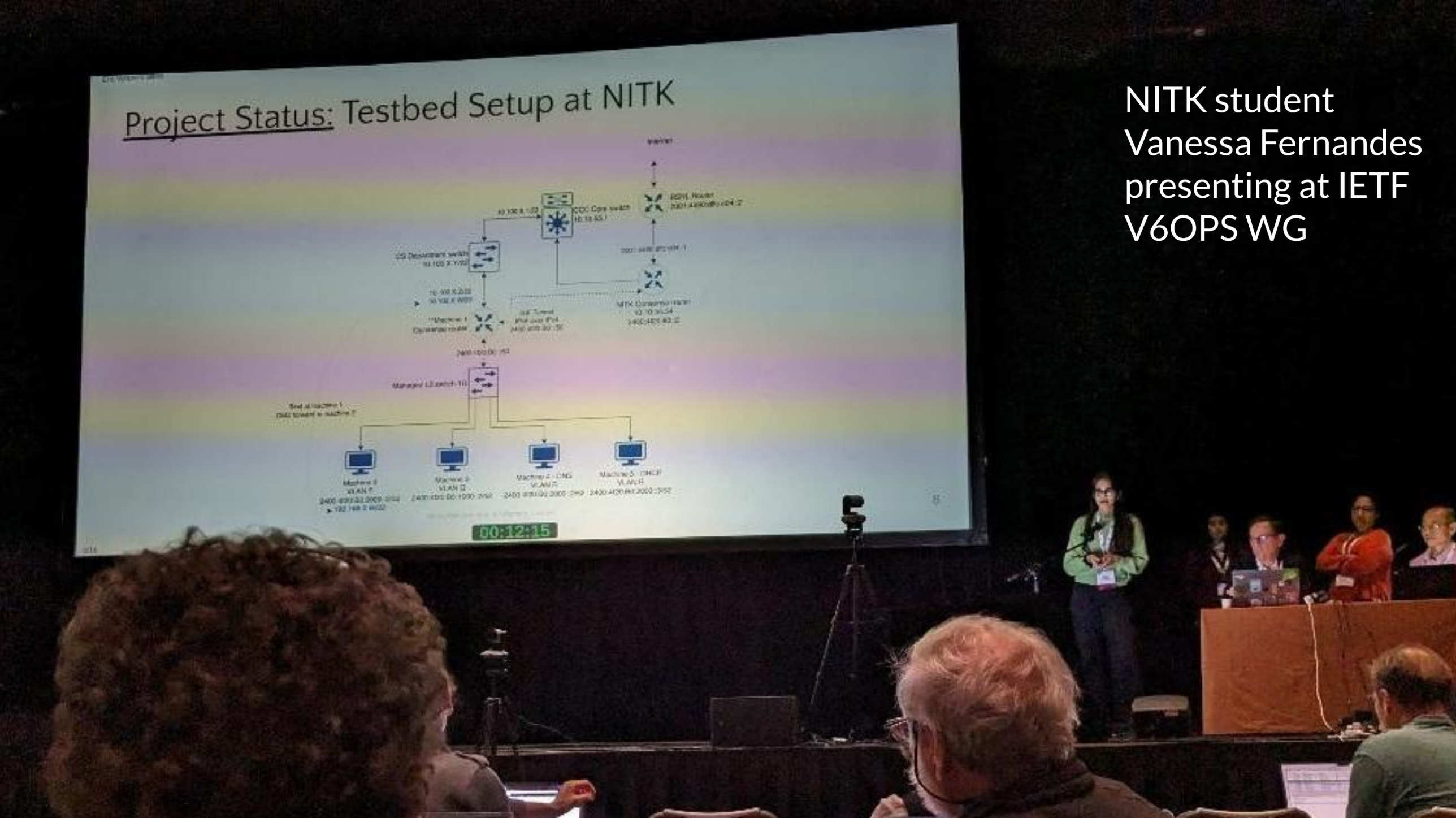
Project Status: IPv6 Statistics from IRIS (6 months)







NITK Student Kavya Bhat presenting at IETF V6OPS WG

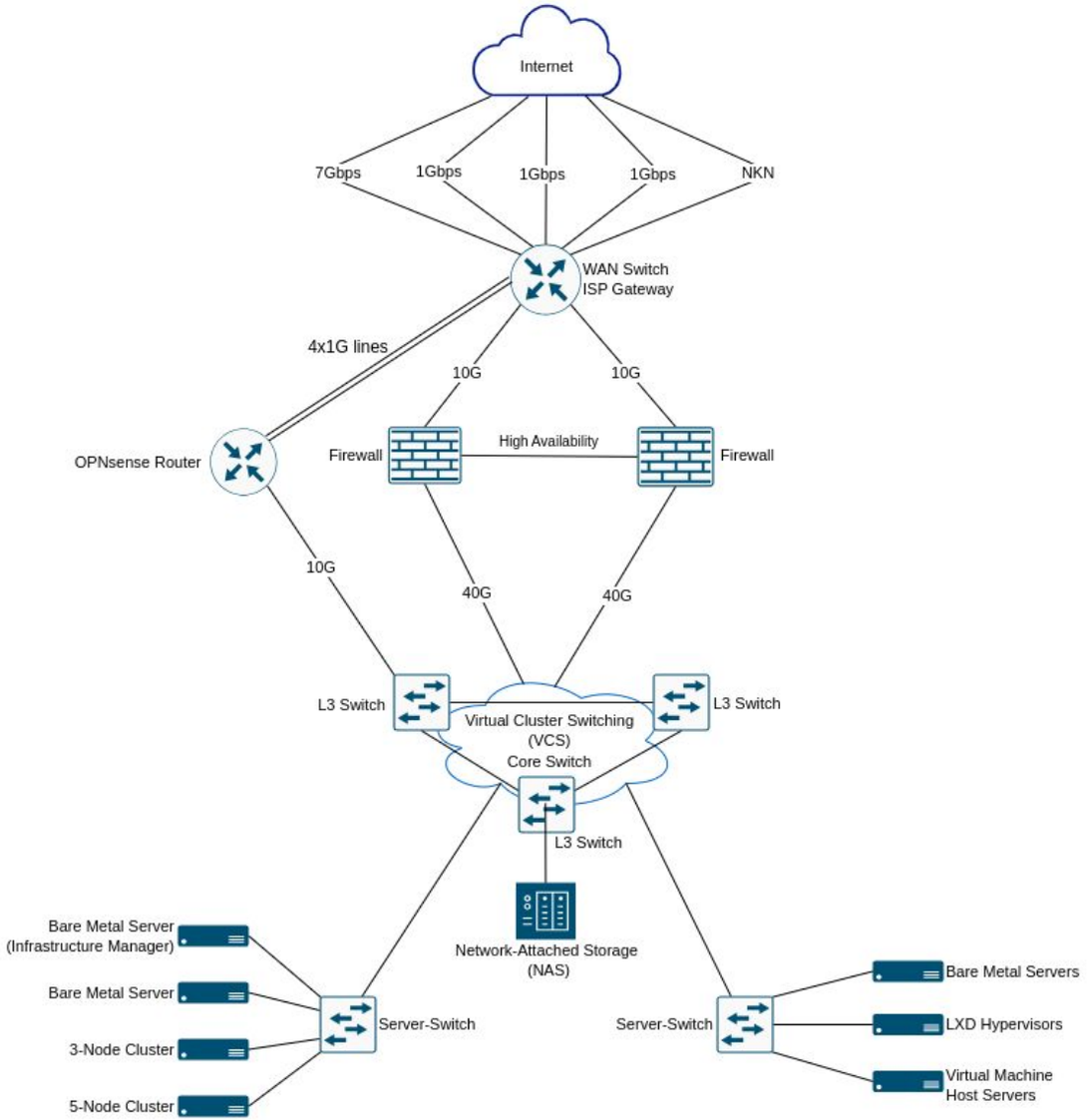


NITK student Vanessa Fernandes presenting at IETF V6OPS WG

Project Status: Migration of Data Center VLAN

1. NITK Surathkal's Data Center contains critical infrastructure:
    - Routers and switches
    - Firewalls
    - Servers and storage systems
2. Status on migrating DC VLAN to IPv6: Completed!
3. IPv6 routing enabled for:
    - Central Computing Center (CCC) Staff VLAN
    - Central Computing Center (CCC) Lab VLAN
4. DHCPv6 server: set up on a container in DC VLAN
    - Currently allocates IPv6 addresses to machines in CCC Staff VLAN and CCC Lab VLAN!

Project Status: Migration of Data Center VLAN



*The OPNsense Router has been set up with 4x1G lines for the purpose of testing IPv6 routing and configurations.

Project Status: Enabling IPv6 support for VPNs

1. NITK Surathkal uses two VPNs:
    - L3 VPNs: OpenVPN, WireGuard
2. Status on migrating VPN services to IPv6
    - L3 VPN service migration: Completed!
3. Ongoing work
    - Performance evaluation and testing with both L3 VPNs
    - Measurement studies
        - Packet losses, latency and other parameters
            - VPNs on IPv4 vs VPNs on IPv6

Next Steps (next 2-3 months):

1. Wrap up testbed experiments
    - Firewall rules to be setup on OPNsense router
    - Profiling functioning of services on IPv4 vs IPv6
2. Migrate all integrated services of IRIS to IPv6
    - Moodle
    - BigBlueButton, Jitsi Video Conferencing, and many others
3. Prepare a thorough documentation of the migration process
    - Documentation of testbed experiments: Completed!
    - Documentation on migration of IRIS is in process
    - Documentation on migration of VPN services is in process
    - Technical and financial report submission to ISIF Asia





Funded by:

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Thank you!