Internet Infrastructure

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APNIC

Overview

- Internet Infrastructure
- Visualising the interconnection
- South Asia Internet Infrastructure
- Live Demo
- Looking ahead

Internet Infrastructure

An introduction to Internet numbers

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What do I mean by Infrastructure

Layer		Data unit	Function[3]
Host layers	7. Application	Data	High-level APIs, including resource sharing, remote file access, directory services and virtual terminals
	6. Presentation		Translation of data between a networking service and an application; including character encoding, data compression and encryption/decryption
	5. Session		Managing communication sessions, i.e. continuous exchange of information in the form of multiple back-and-forth transmissions between two nodes
	4. Transport	Segments	Reliable transmission of data segments between points on a network, including segmentation, acknowledgement and multiplexing
Media layers	3. Network	Packet/Datagram	Structuring and managing a multi-node network, including addressing, routing and traffic control
	2. Data link	Bit/Frame	Reliable transmission of data frames between two nodes connected by a physical layer
	1. Physical	Bit	Transmission and reception of raw bit streams over a physical medium

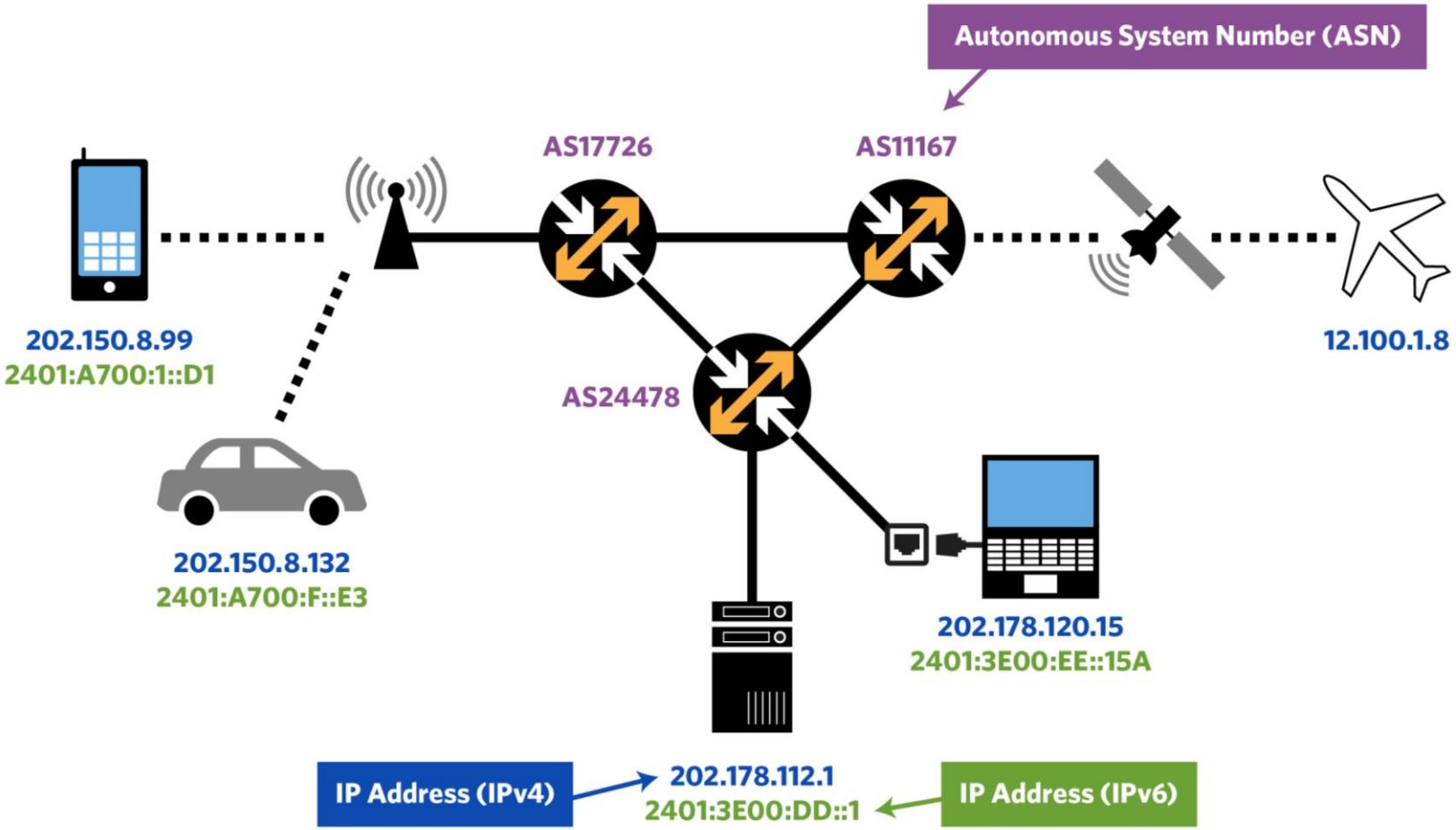
Layer 3 and below

The Open Systems Interconnection (OSI) model

Sending data over the Internet

- Data is sent over the Internet in discrete packets
  - Each packet can be a few bytes or a few hundred bytes, or even larger
- Packets are sent from ‘source’ to ‘destination’
  - When streaming YouTube movie on your mobile phone:
    - YouTube server is mainly the source
    - Your mobile phone is mainly the destination
- Every source and destination in the Internet must have an IP address
  - IPv4 example 203.0.113.15 (32 bit number)
  - IPv6 example 2001:db8:200:ff:1:dc:77:ab (128 bit number)

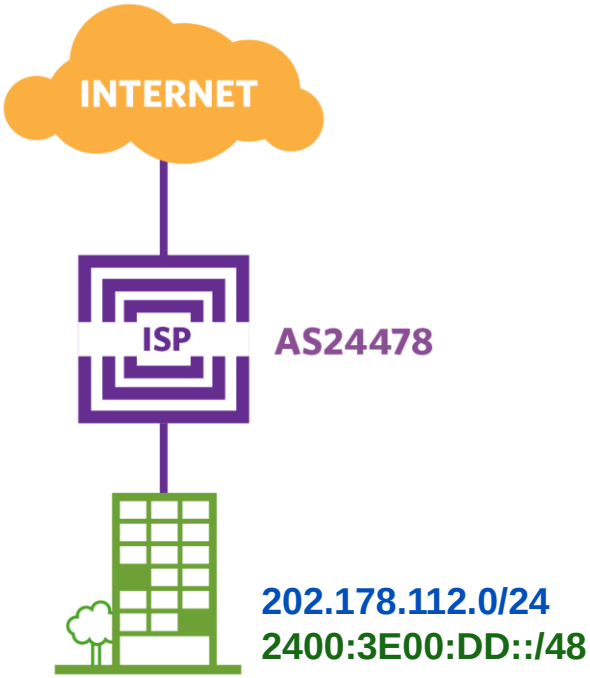
IP addresses and ASNs



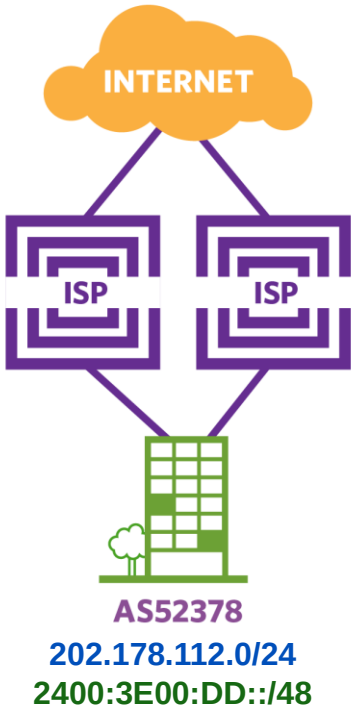
Routing and ASN

- RFC 1930:
  - An AS (Autonomous System) is a connected group of one or more IP prefixes run by one or more network operators that has a SINGLE and CLEARLY DEFINED routing policy.
  - An AS has a globally unique number (sometimes referred to as an ASN, or Autonomous System Number) associated with it. This number is used in both the exchange of exterior routing information (between neighbouring AS's), and as an identifier of the AS itself.

Connecting to the Internet



Single-homed network
No need for public ASN

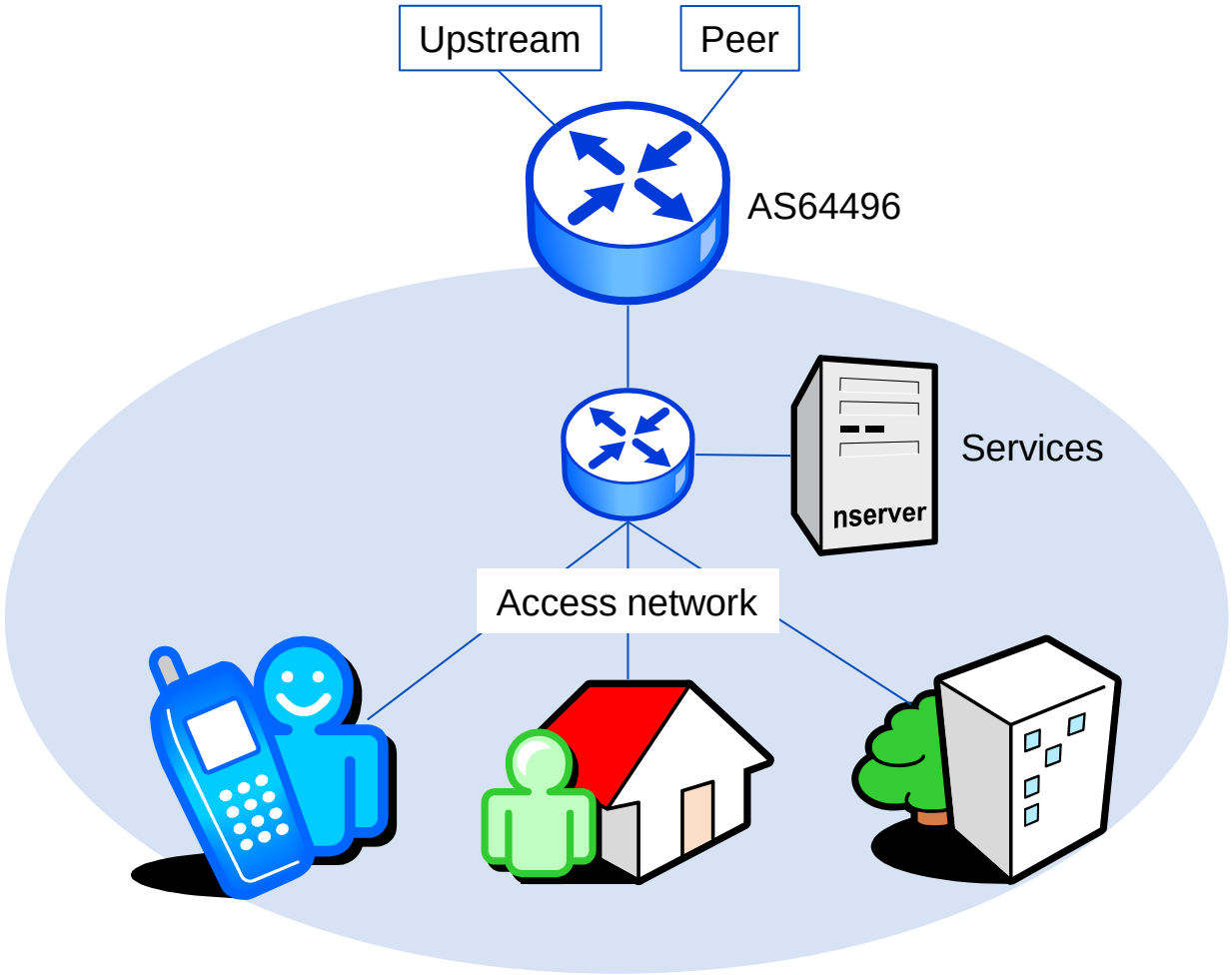


Multi-homed network
MAY have a need for BGP and public ASN

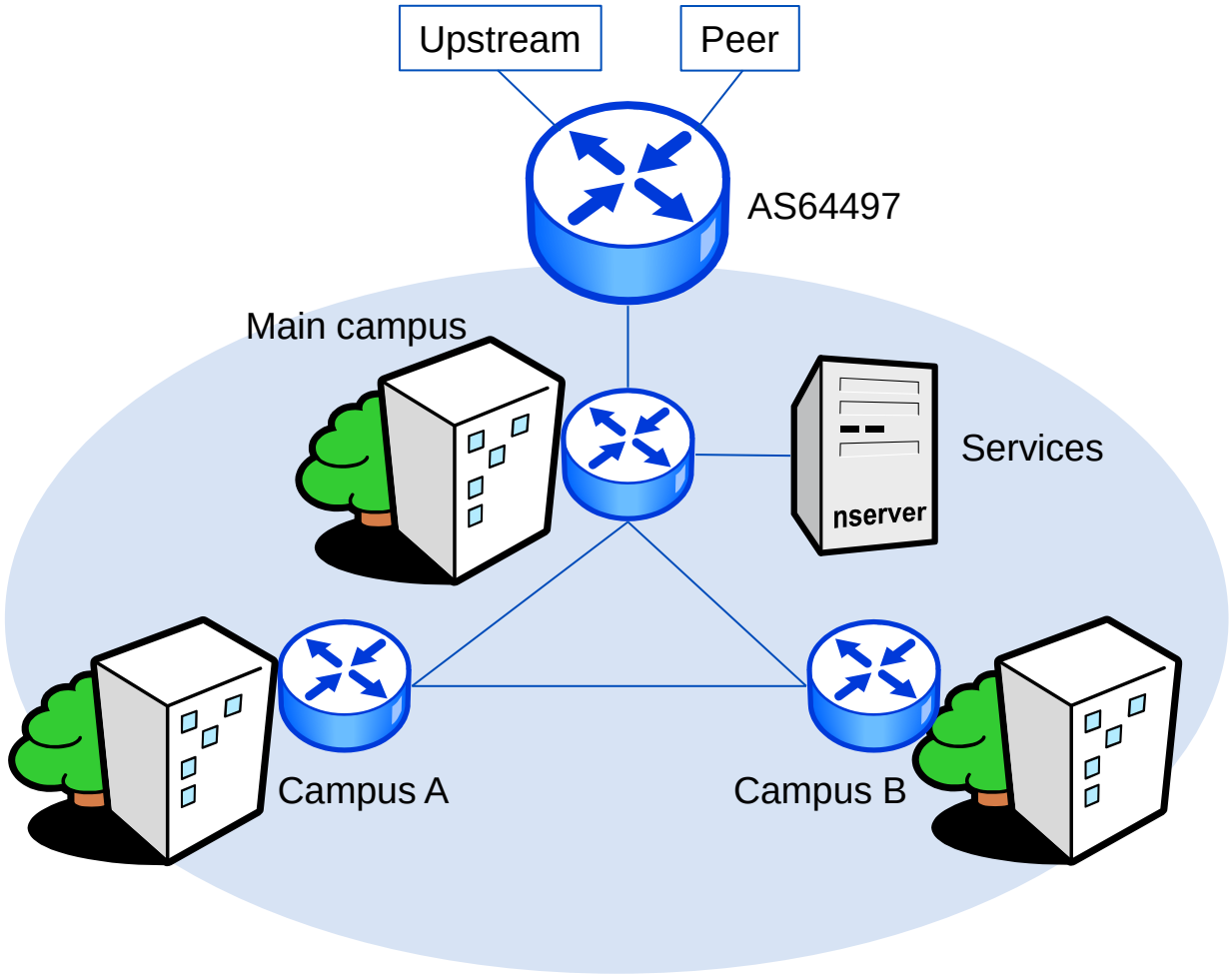
Why multihome with BGP and use a public ASN?

Cost	Good interconnection strategy can lower cost of operation by directing traffic through the most cost effective connections wherever possible
Resilience	Looking further than next hop path diversification allows you to better evaluate interconnection options, which in turn could result in better network resiliency
Performance	Understanding where your network traffic goes and when possible shortening the path to your main customers/suppliers/partners could result in better overall network experience

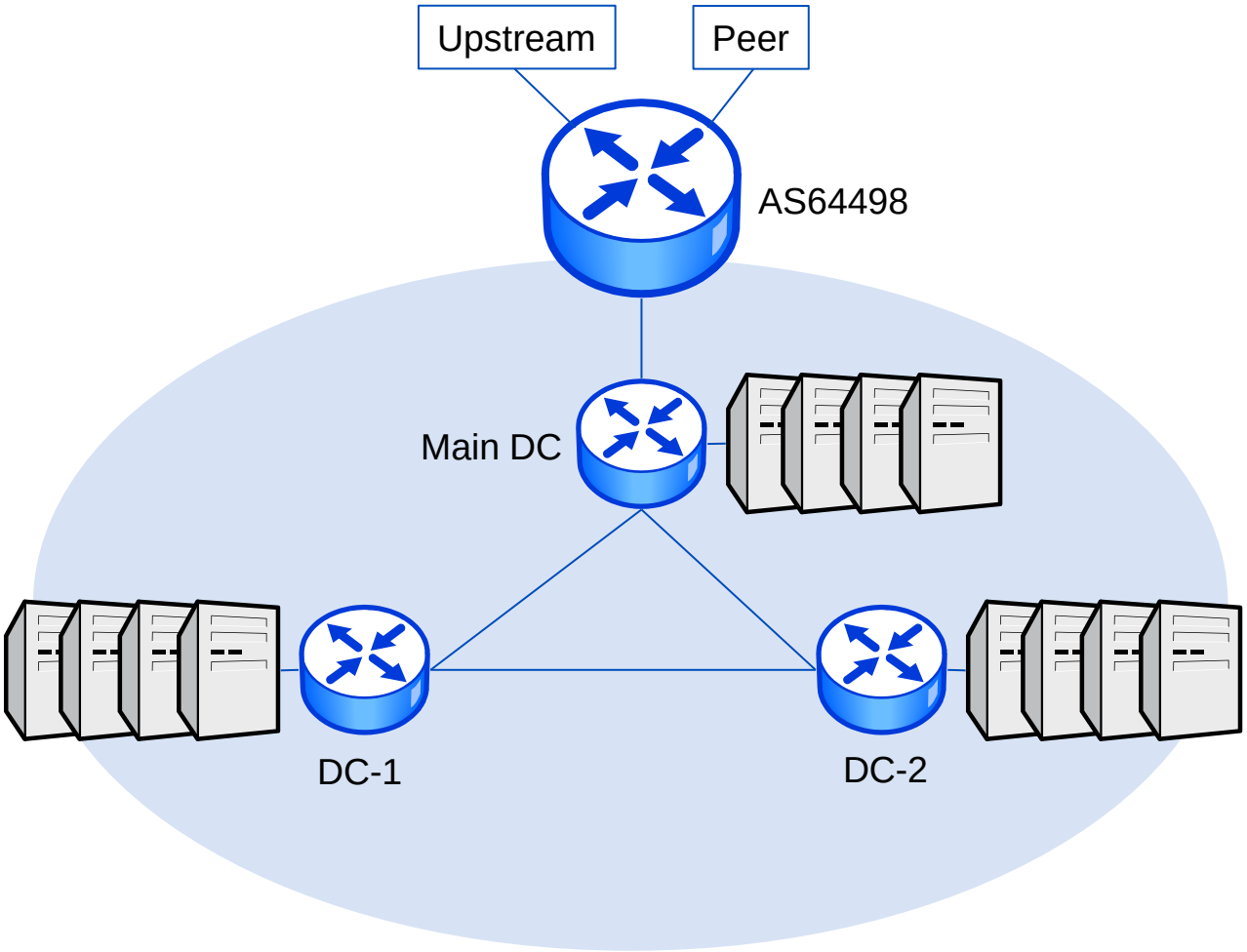
View within an AS: Telco/ISP



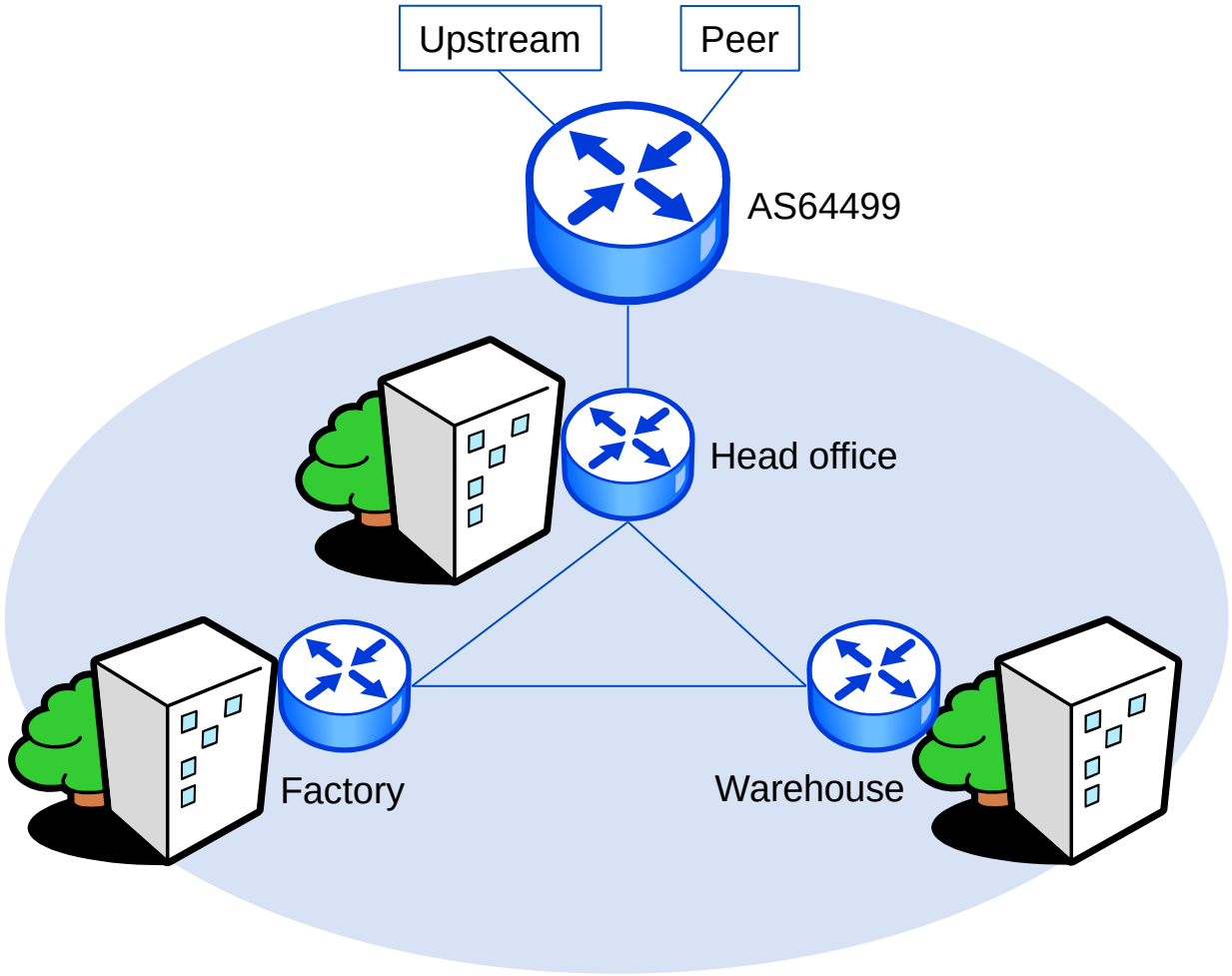
View within an AS: University



View within an AS: Data centre



View within an AS: Corporate



Visualising the interconnection

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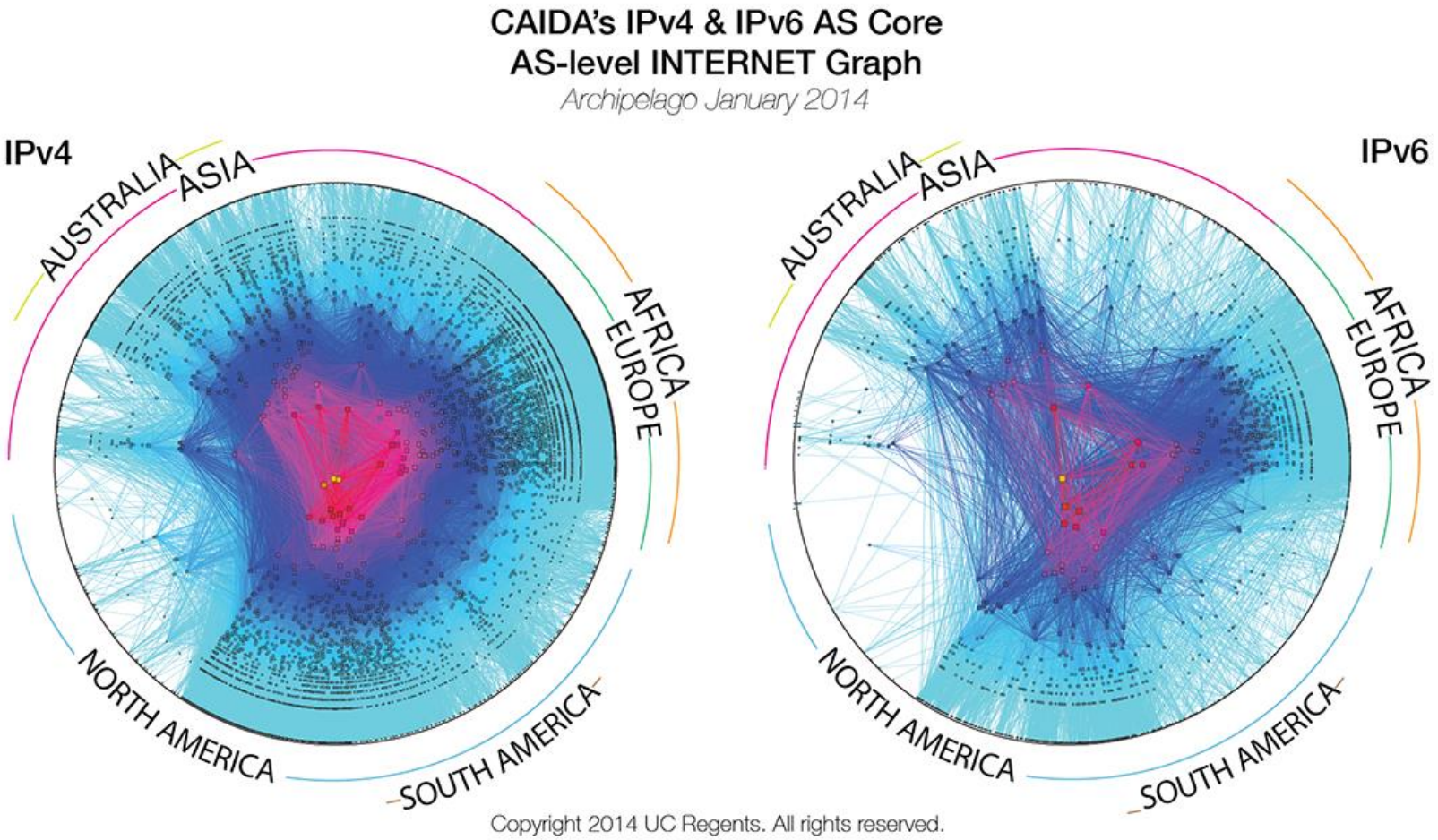
The Internet

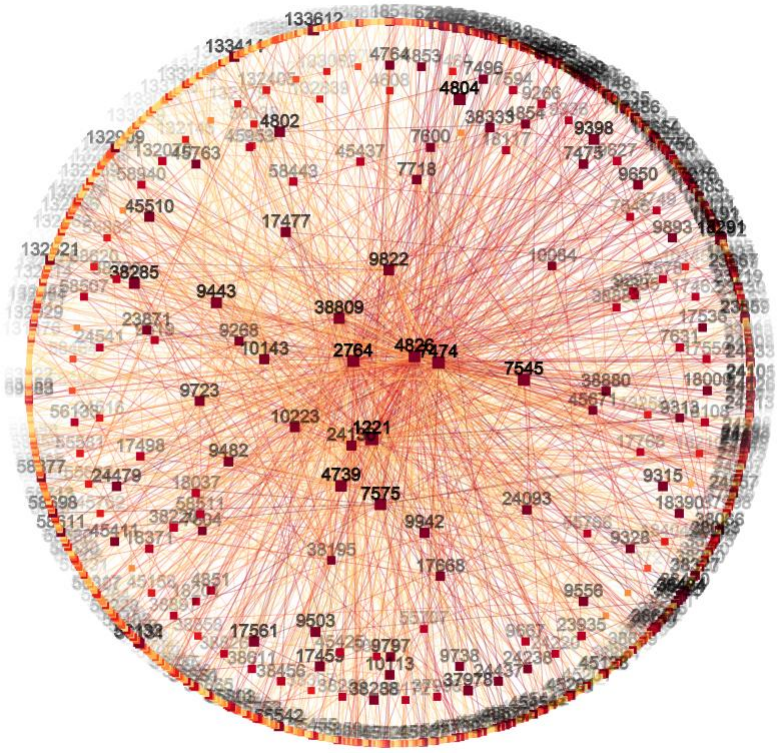
- **Networks worldwide interconnect** to form the Internet. They include ISPs, Internet Exchange Points, Universities, Corporate networks, etc.
- Each dot represents an AS
- There are **44,500+ ASNs** currently active in the Internet

peer1.com

Global AS Core



Economy level ASN transit map



Data source

- Routeviews.org
  - RIBs from routers located in various locations (mostly Internet Exchanges) around the world (US, Japan, Korea, UK, Australia, Brazil, Singapore, Serbia)
- First week of April 2015 data
- RIBs collected every two hours
  - This is a snapshot, not live data
- This visualisation tool is a work in progress
  - APNIC values your feedback

Sample data

12.180.218.0/24 195.208.112.161 3277 3267 1299 7018 15253

12.180.218.0/24 80.91.255.137 1299 7018 15253

12.180.218.0/24 216.221.157.162 40191 3257 701 15253

12.180.218.0/24 208.51.134.246 3549 7018 15253

12.180.219.0/24 217.192.89.50 3303 3320 7018 19111

12.180.219.0/24 66.185.128.1 1668 7018 19111

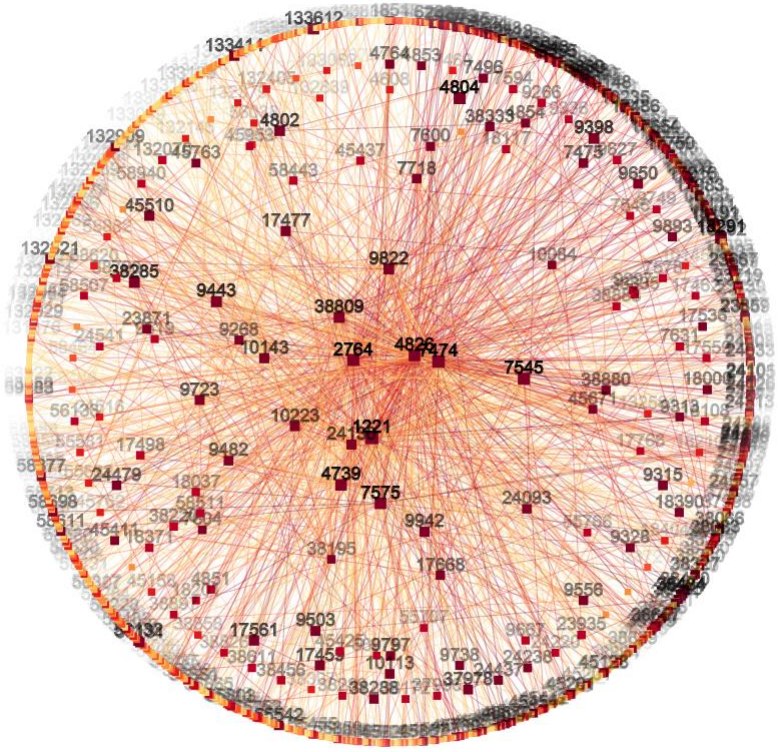
12.180.219.0/24 192.241.164.4 62567 2914 7018 19111

12.180.219.0/24 5.101.110.2 3.5410 2914 7018 19111

12.180.219.0/24 198.129.33.85 293 6939 1299 7018 19111

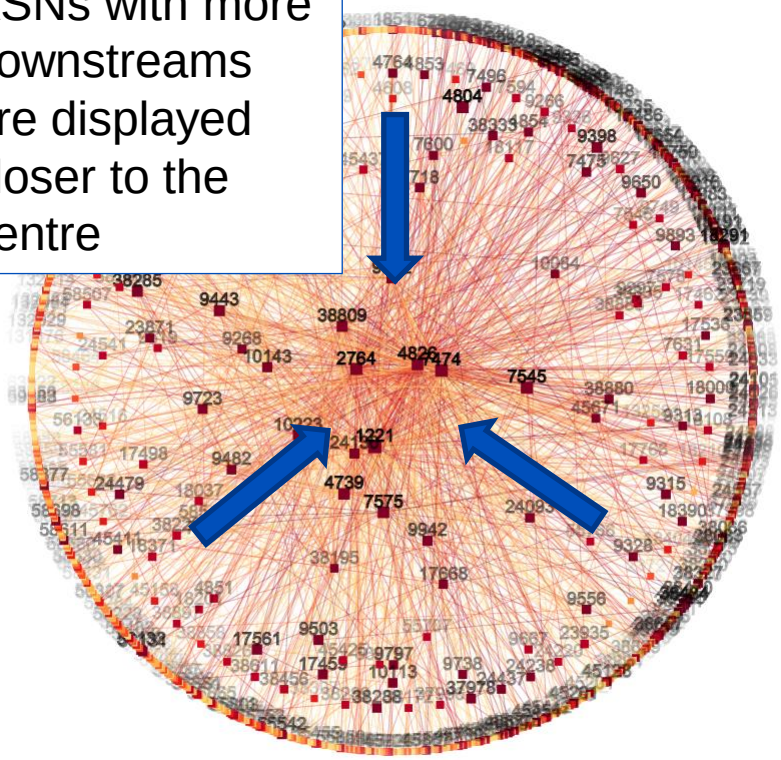
12.180.219.0/24 129.250.0.11 2914 7018 19111

Explanation

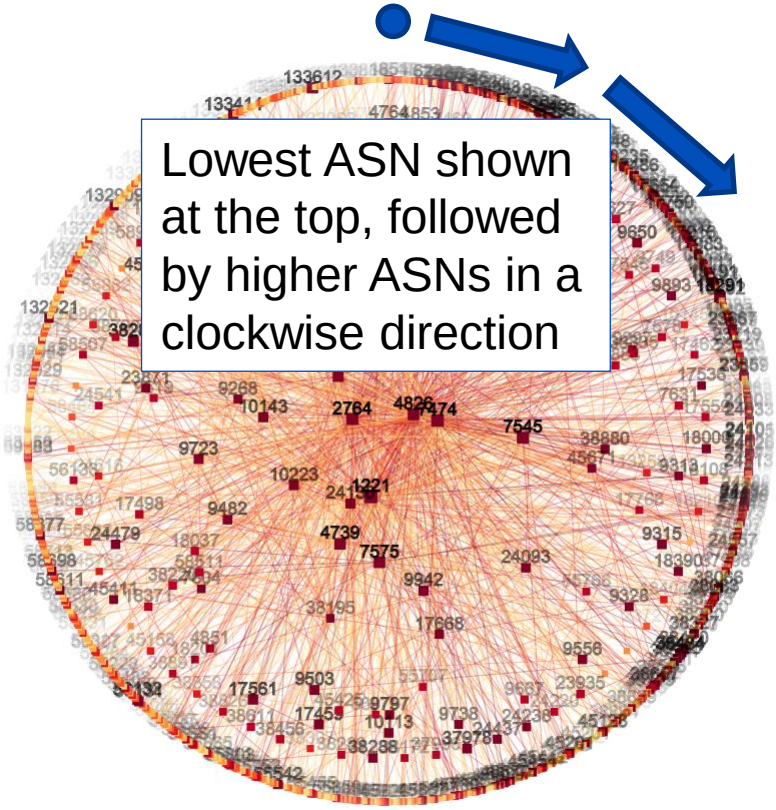


Explanation

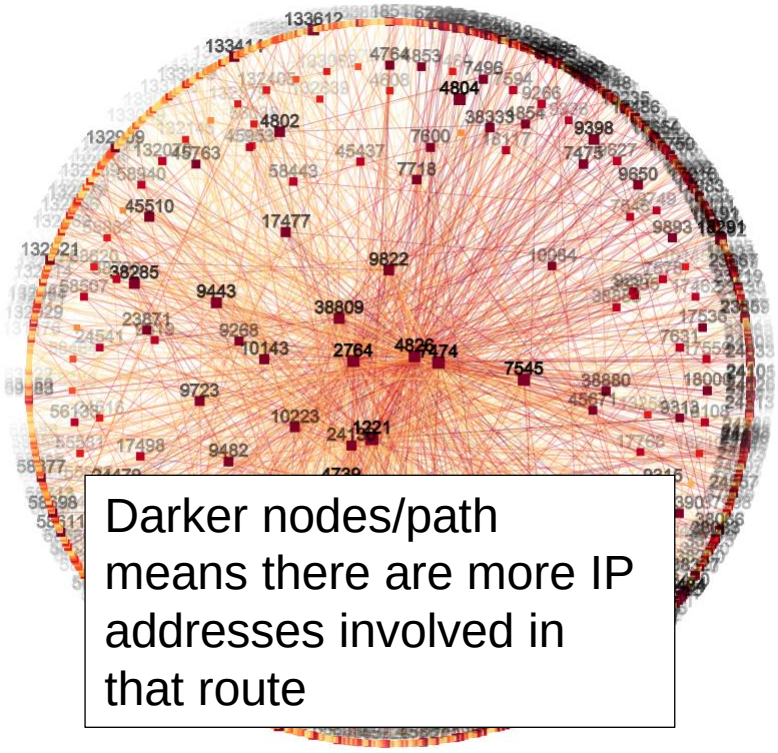
ASNs with more downstreams are displayed closer to the centre



Explanation



Explanation



Darker nodes/path means there are more IP addresses involved in that route

South Asia views

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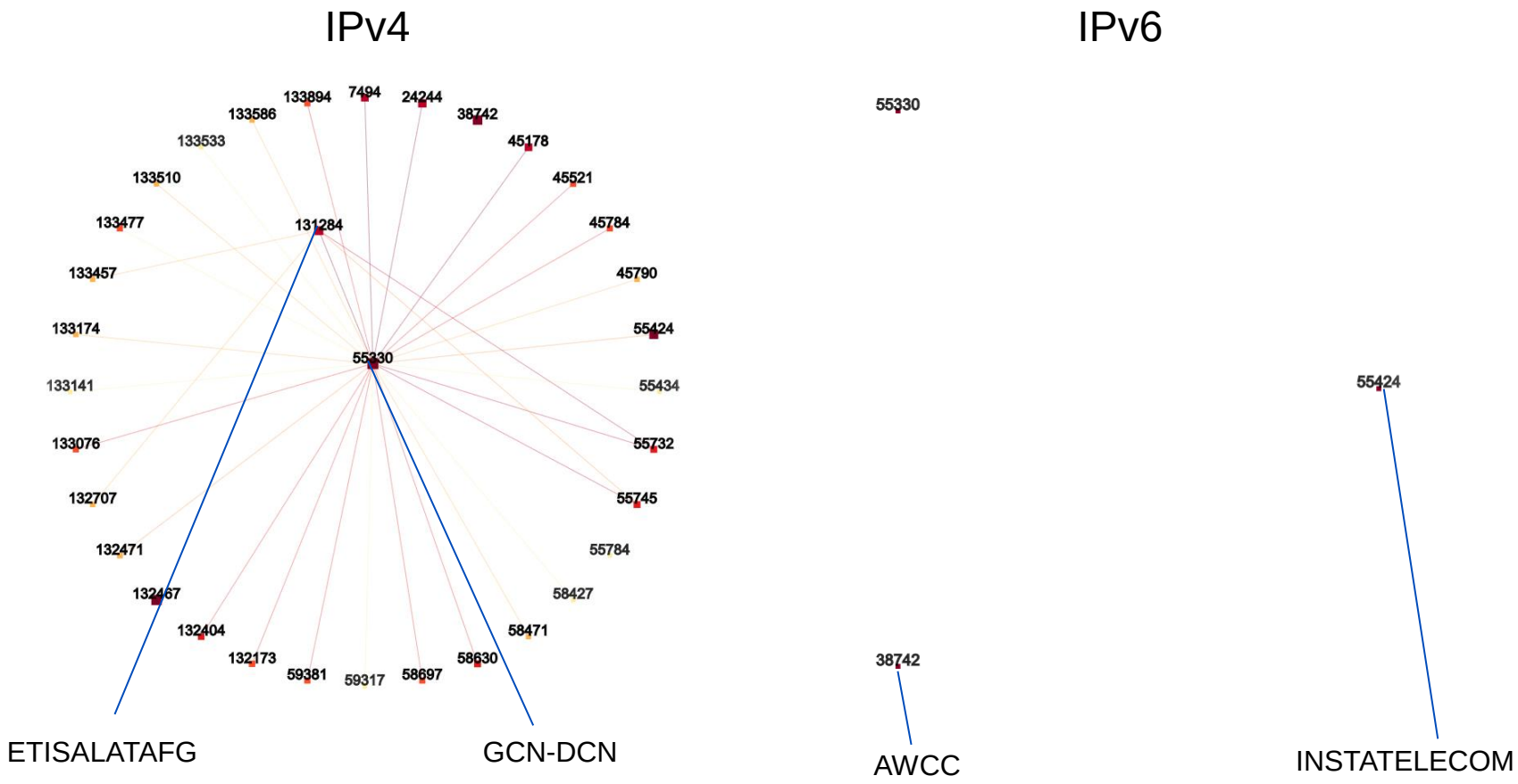
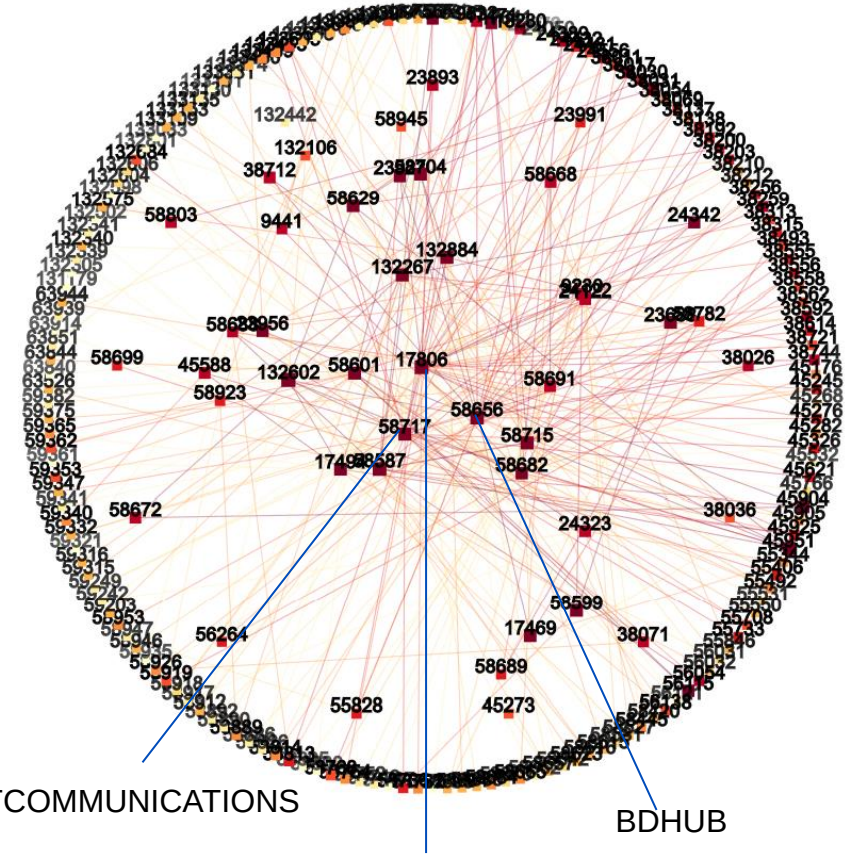
Afghanistan



Bangladesh

IPv4

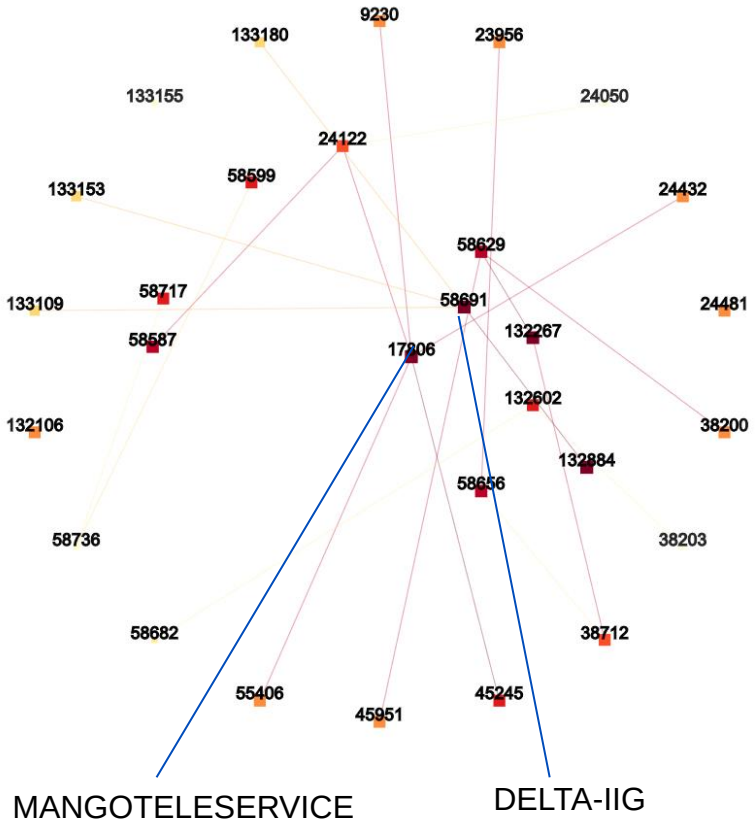


SUMITCOMMUNICATIONS

MANGOTELESERVICE

BDHUB

IPv6

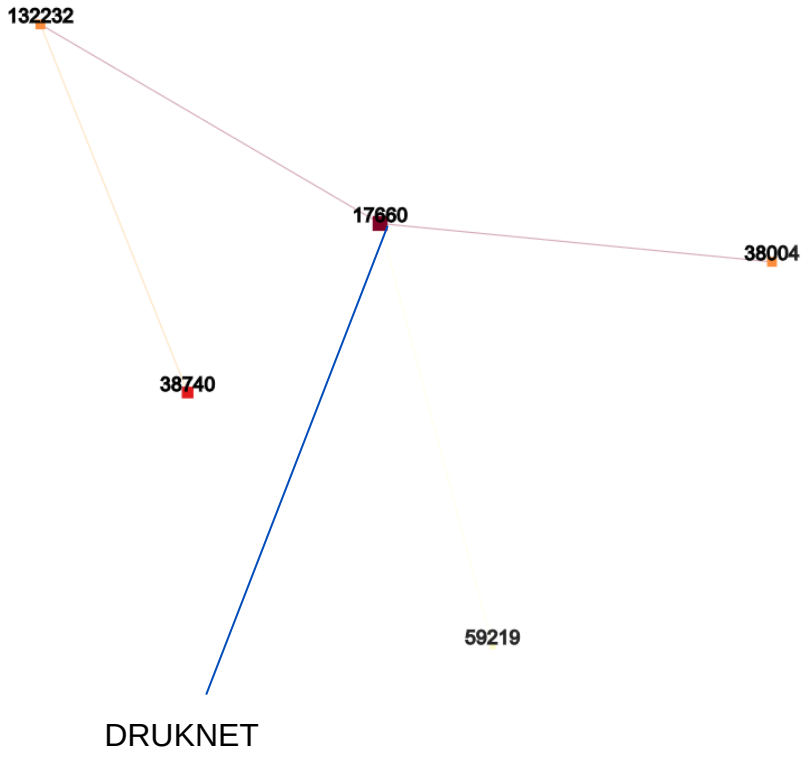


MANGOTELESERVICE

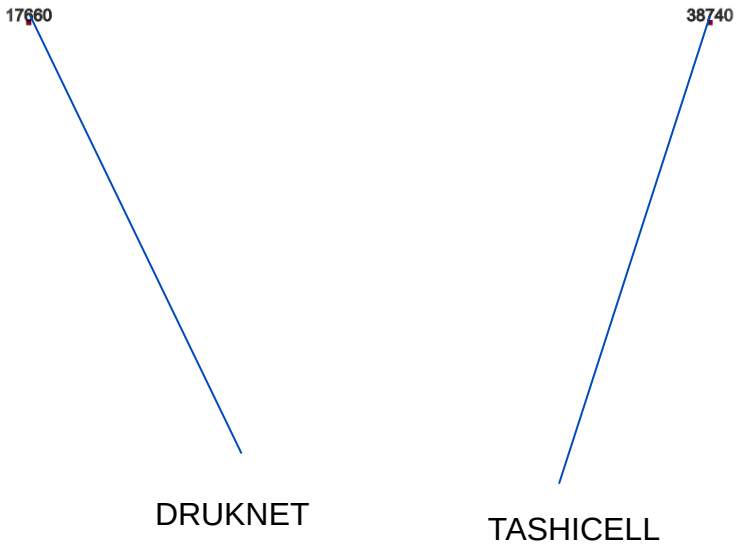
DELTA-IIG

Bhutan

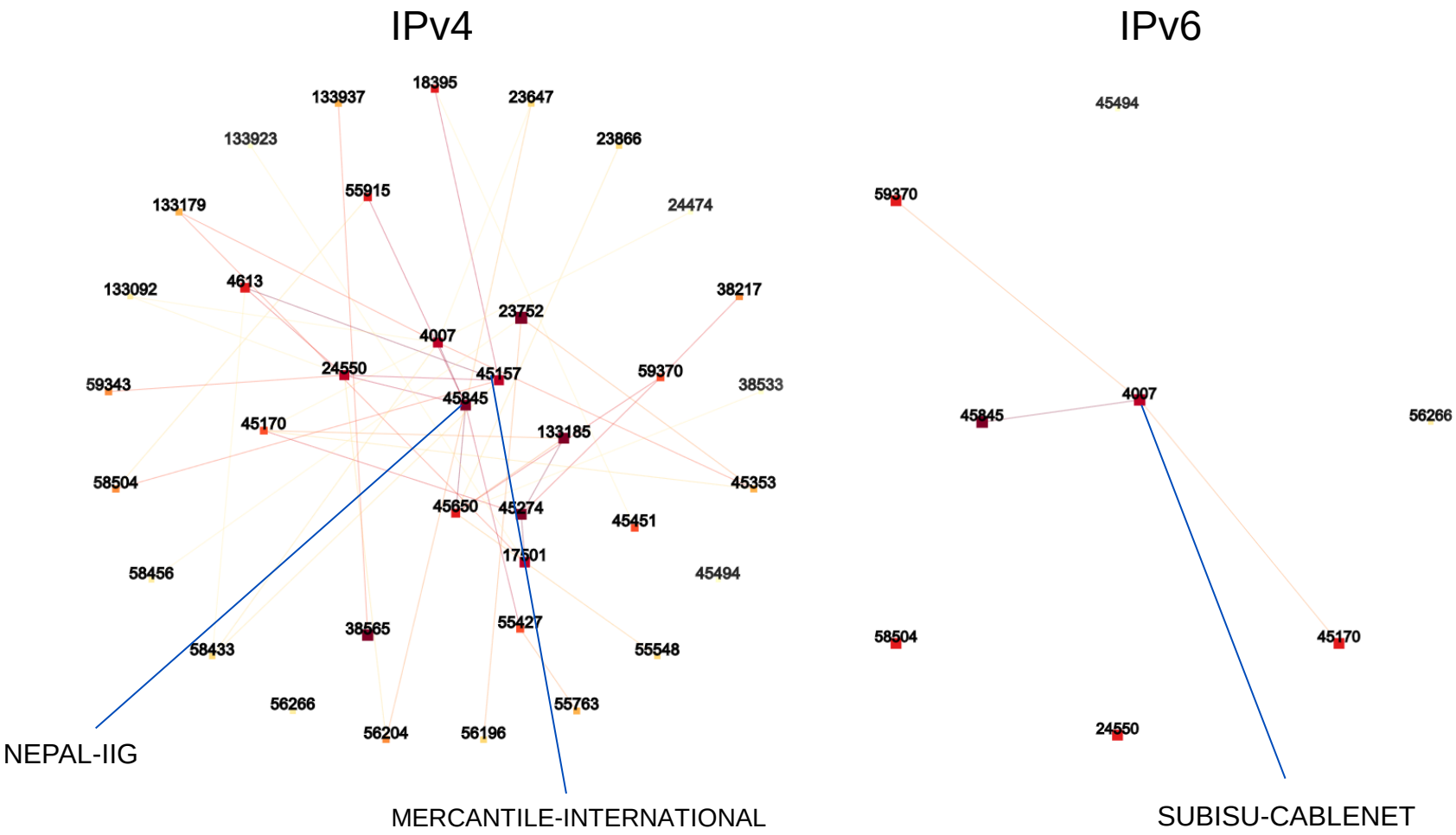
IPv4



IPv6

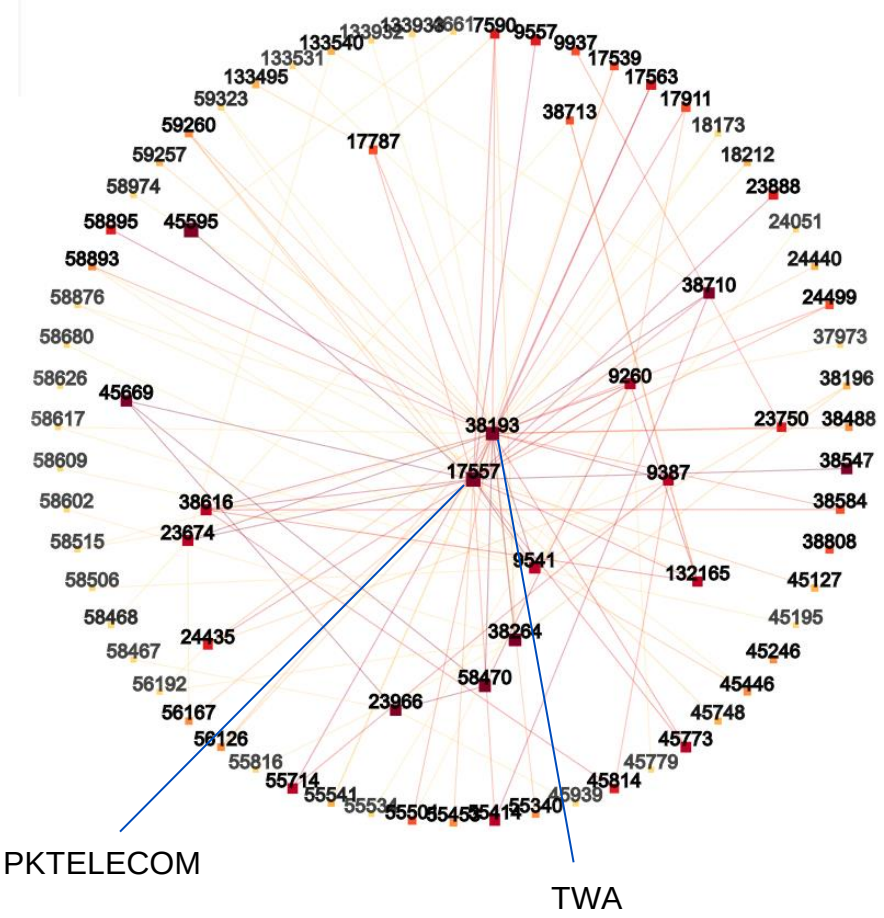


Nepal


IPv4
IPv6
18395
133937
23647
133923
23866
55915
133179
24474
133092
4613
38217
23752
4007
24550
45157
59370
59343
38533
45845
45170
133185
58504
45353
45650
45274
45451
17501
58456
45494
38565
55427
58433
55548
56266
55763
56204
56196
NEPAL-IIG
MERCANTILE-INTERNATIONAL
45494
59370
4007
45845
56266
58504
45170
24550
SUBISU-CABLENET

Pakistan

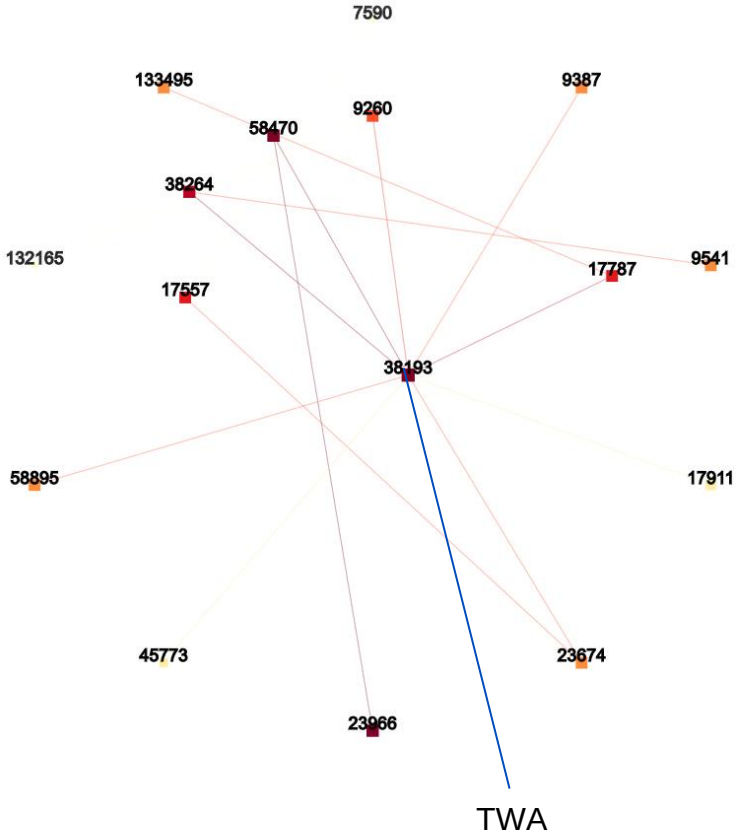
IPv4



PKTELECOM

TWA

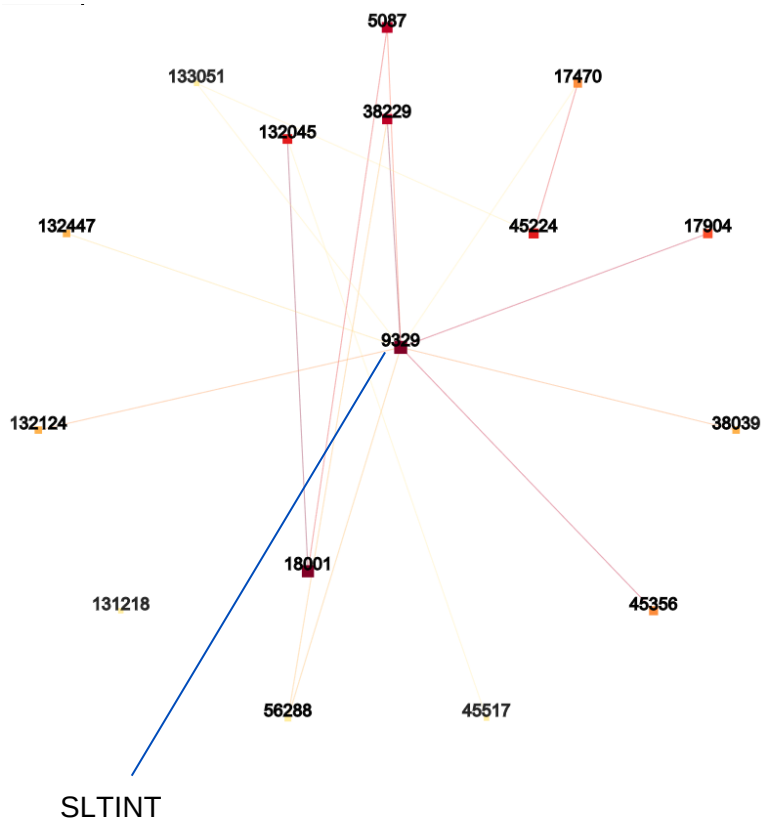
IPv6



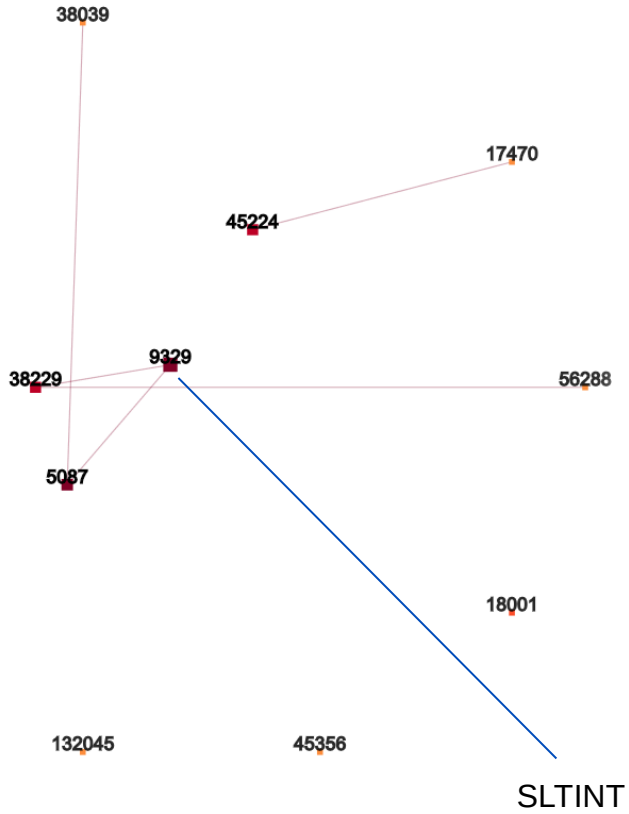
TWA

Sri Lanka

IPv4



IPv6



India Internet infrastructure

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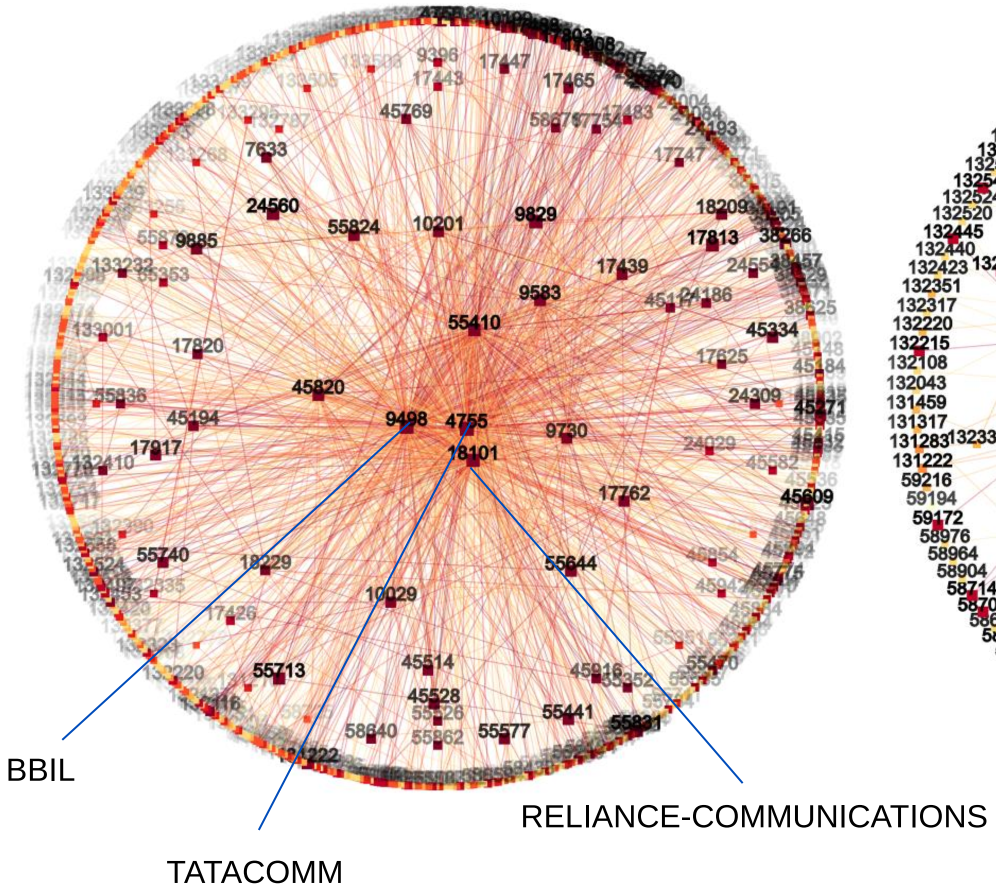
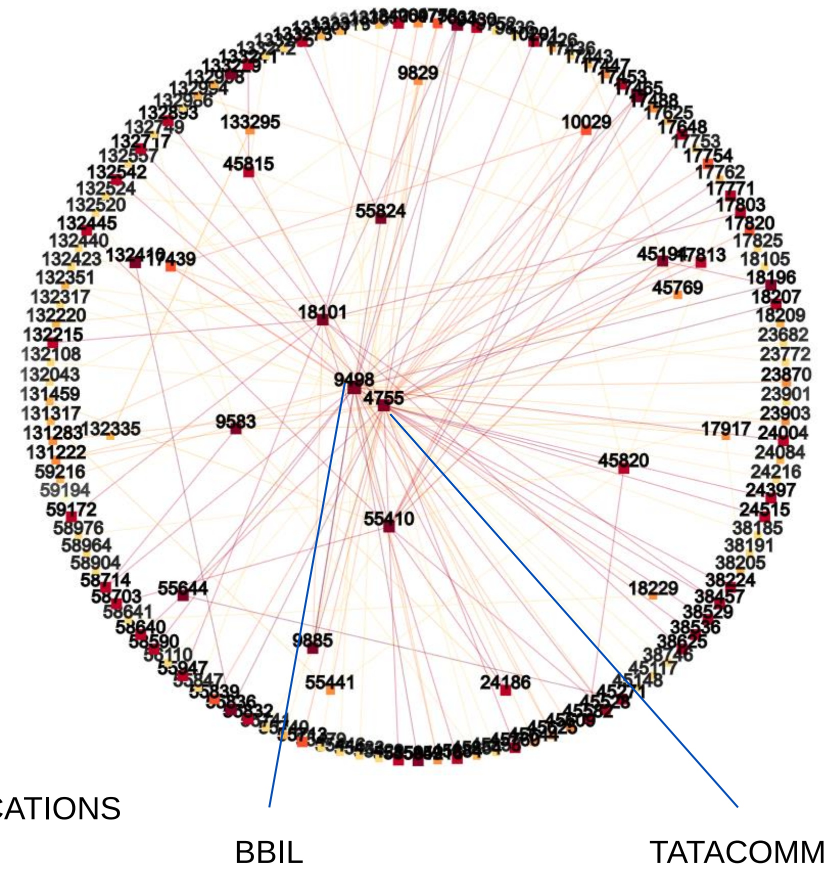
India

IPv4



IPv6



In summary

- The first networks in India are predominantly service providers and academics
- The newer networks are mostly from corporates
- Core networks are established
- Edge networks are growing

Demo

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Looking ahead

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Looking ahead

- Global trends
  - As more organisations interconnect with upstreams, downstreams and peers, the number of advertised ASNs will continue to grow
  - Opportunities to reduce cost, improve resiliency and performance will be available to those with awareness of this rich network ecosystem
  - New technologies such as SDN and network virtualisation will drive innovations and change the way networks are interconnected, so expect to see a more dynamic ecosystem in the future

India IPv6

- Similar core network players as IPv4
- Populated by service providers and academic networks
  - Just like IPv4 when it started back in 1990
- Hoping to see more networks turning on their IPv6
  - Internet of Things network
    - Manufacturers
    - Utility companies
    - Smart cities

For discussion

- What's the Internet experience like in India?
  - From consumer's point of view
  - From corporation's point of view
  - From academic's point of view
  - From service provider's point of view
- What can be done better?
- What will India's Internet infrastructure looks like in the future?

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