Internet Infrastructure

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Overview

- Internet Infrastructure
- Visualising the interconnection
- South Asia Internet Infrastructure
- Live Demo
- Looking ahead
Internet Infrastructure
An introduction to Internet numbers
What do I mean by Infrastructure

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

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)
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

**Examples**:
- **202.178.112.0/24**
- **2400:3E00:DD::/48**
- **AS24478**
- **AS52378**
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

AS64496

Upstream

Peer

Access network

Services
View within an AS: University

AS64497

Upstream

Peer

Main campus

Services

Campus A

Campus B
View within an AS: Data centre

AS64498

Main DC

Upstream
Peer

DC-1

DC-2
View within an AS: Corporate
Visualising the interconnection
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
Global AS Core

CAIDA's IPv4 & IPv6 AS Core
AS-level INTERNET Graph
Archipelago January 2014

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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

Lowest ASN shown at the top, followed by higher ASNs in a clockwise direction.
Darker nodes/path means there are more IP addresses involved in that route.
South Asia views
Afghanistan

IPv4

IPv6

ETISALATAFG

GCN-DCN

AWCC

INSTATELECOM
Bangladesh

IPv4

SUMITCOMMUNICATIONS
MANGOTELESERVICE
BDHUB

IPv6

MANGOTELESERVICE
DELTA-IIG
Bhutan

IPv4

DRUKNET

132232

38740

17880

59219

38004

IPv6

DRUKNET

17880

38740

TASHICELL
Pakistan

IPv4

IPv6

PKTELECOM

TWA

TWA
Sri Lanka

IPv4

IPv6

SLTINT
India Internet infrastructure
India

IPv4

IPv6

BBIL

TATACOMM

RELIANCE-COMMUNICATIONS

BBIL

TATACOMM
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
Looking ahead
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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