Fundamentals on network interconnection and traffic exchange

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Summary

- Refreshing definitions
- Network interconnection and IXPs
- Routing and traffic exchange
- What else are IXPs useful for?

Refreshing definitions

- The Internet is a **decentralised** network of 5,000+ autonomous commercial interests.

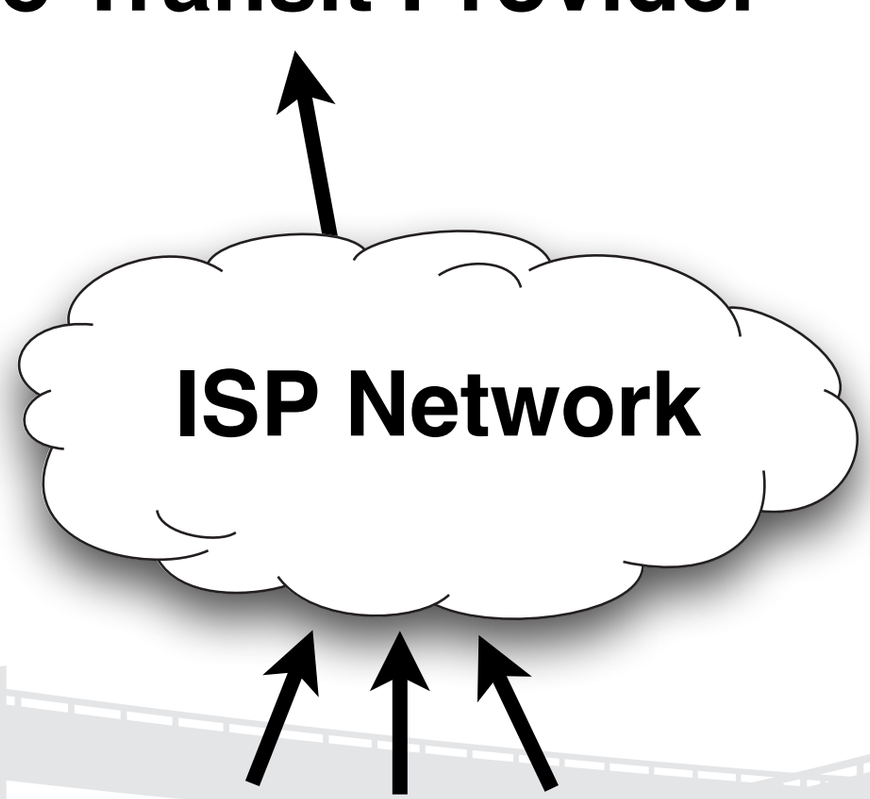
- Internet Service Providers (ISPs) operate by exchanging traffic at their border, forwarding data from its source to its destination.

- The business relationships among ASes are of two forms:
  - *peering*: settlement-free traffic exchange among *peers*.
  - *transit*: one entity (customer) pays another entity (provider).

- *Peering* is an economic efficiency over *transit*.

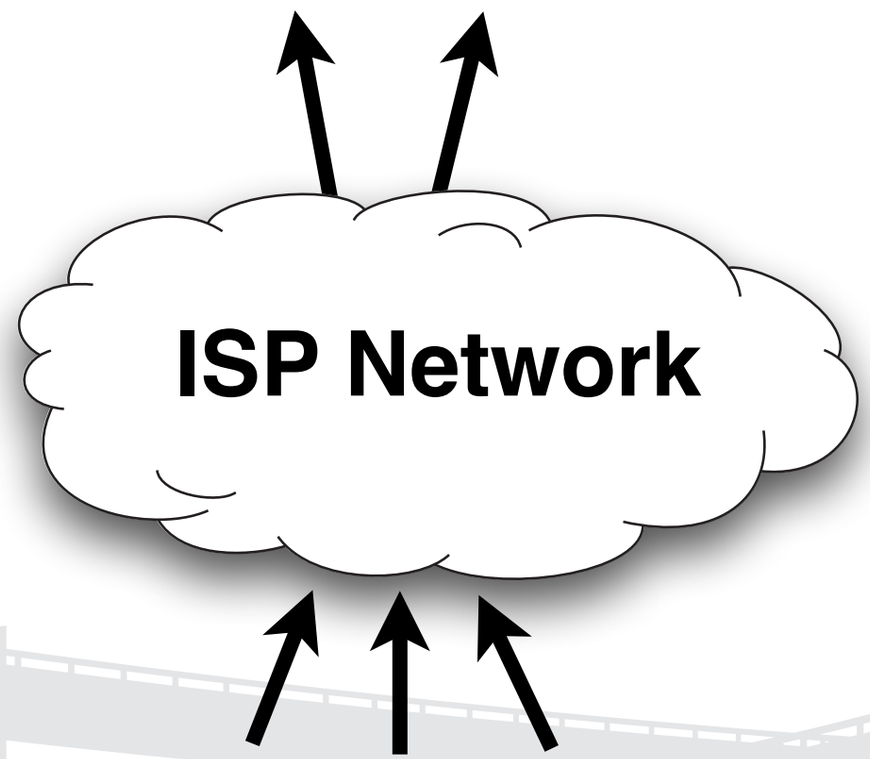
ISP lifecycle

Step I: Simple Aggregator



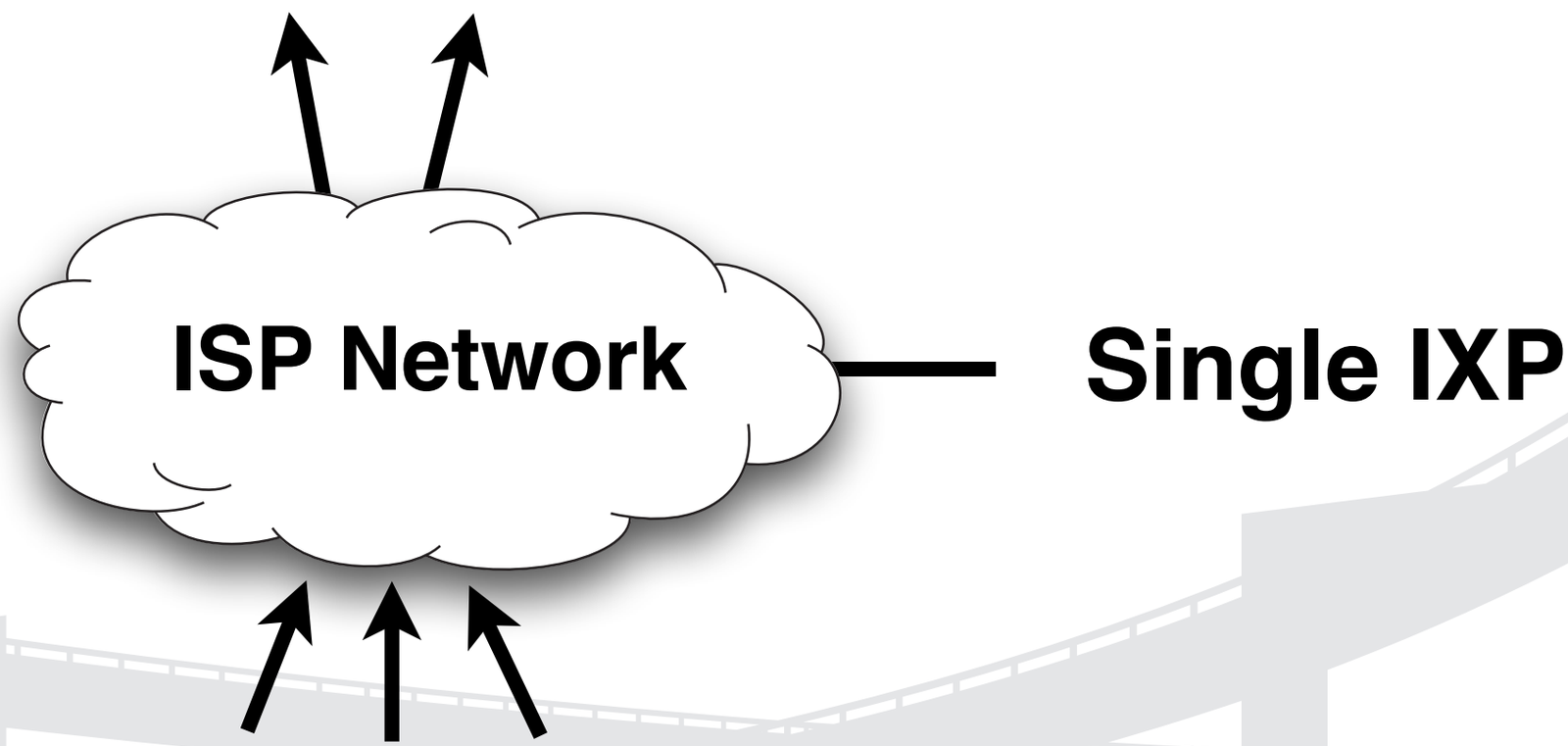
ISP lifecycle (ii)

Step II: Redundancy and LCR



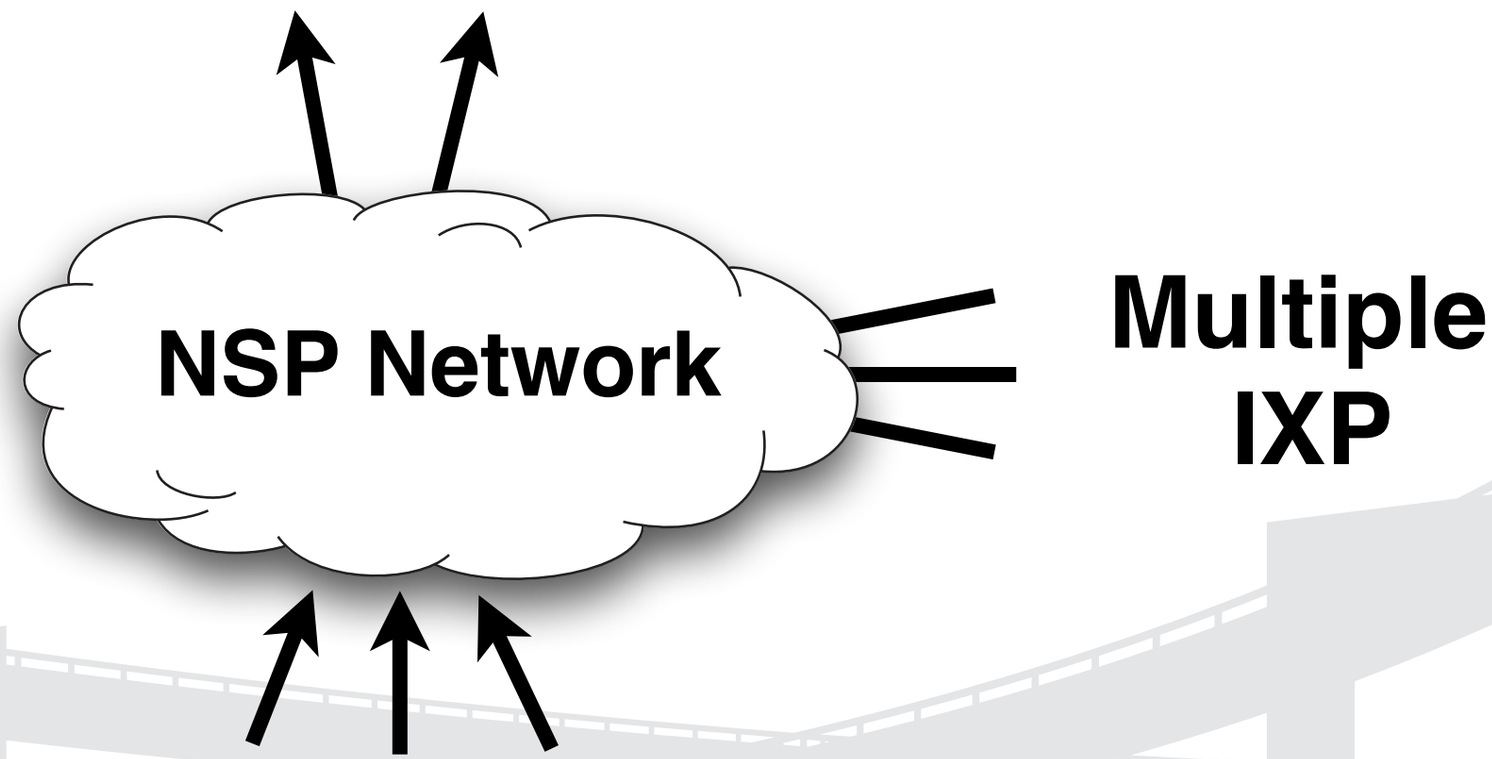
ISP lifecycle (iii)

Step IV: Local Peer



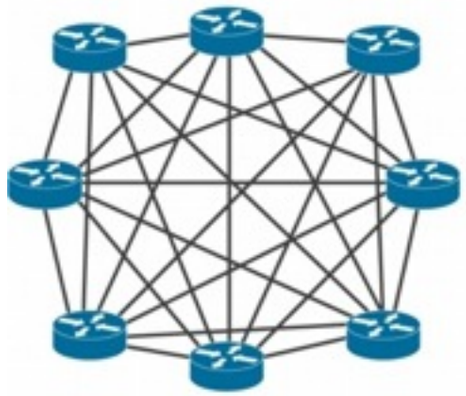
ISP lifecycle (iv)

Step IV: Network Service Provider



Network interconnection

- Network interconnection in the Internet cannot take place between all networks in a full mesh
  - Geographic reasons.
  - Scalability issues.



Nodes	Probes
2	1
3	3
4	6
5	10
6	15
7	21
8	28
...	...
100	4,950

- Number of probes is equal to N (N-1)/2, where N is number of nodes.
- This does not scale.

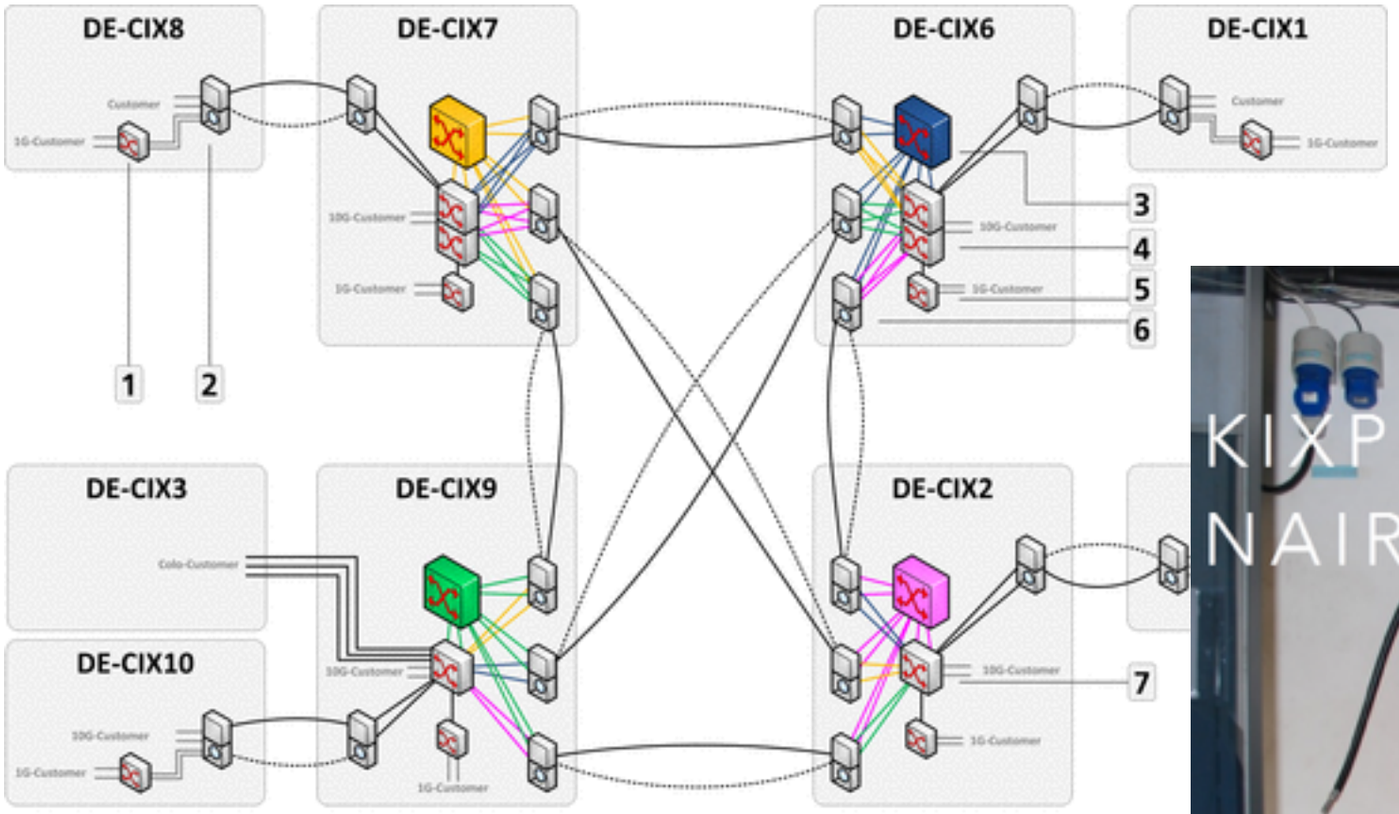
- A successful model for network interconnection is to use Internet exchanges points
  - Reduces the number of connections required.
  - Model allowing localisation of traffic.

Internet exchange points

- Physical infrastructure (layer 2 switching) that facilitates network interconnection.
  - Peering relationship between participants.
  - Internet bandwidth value creation.
  - Network effect.
  - Direct routes are the shortest routes (and also the cheapest!)
- Today there's about 430 IXPs built in 114 countries.

Internet exchange points (ii)

Technical dimension: DE-CIX topology

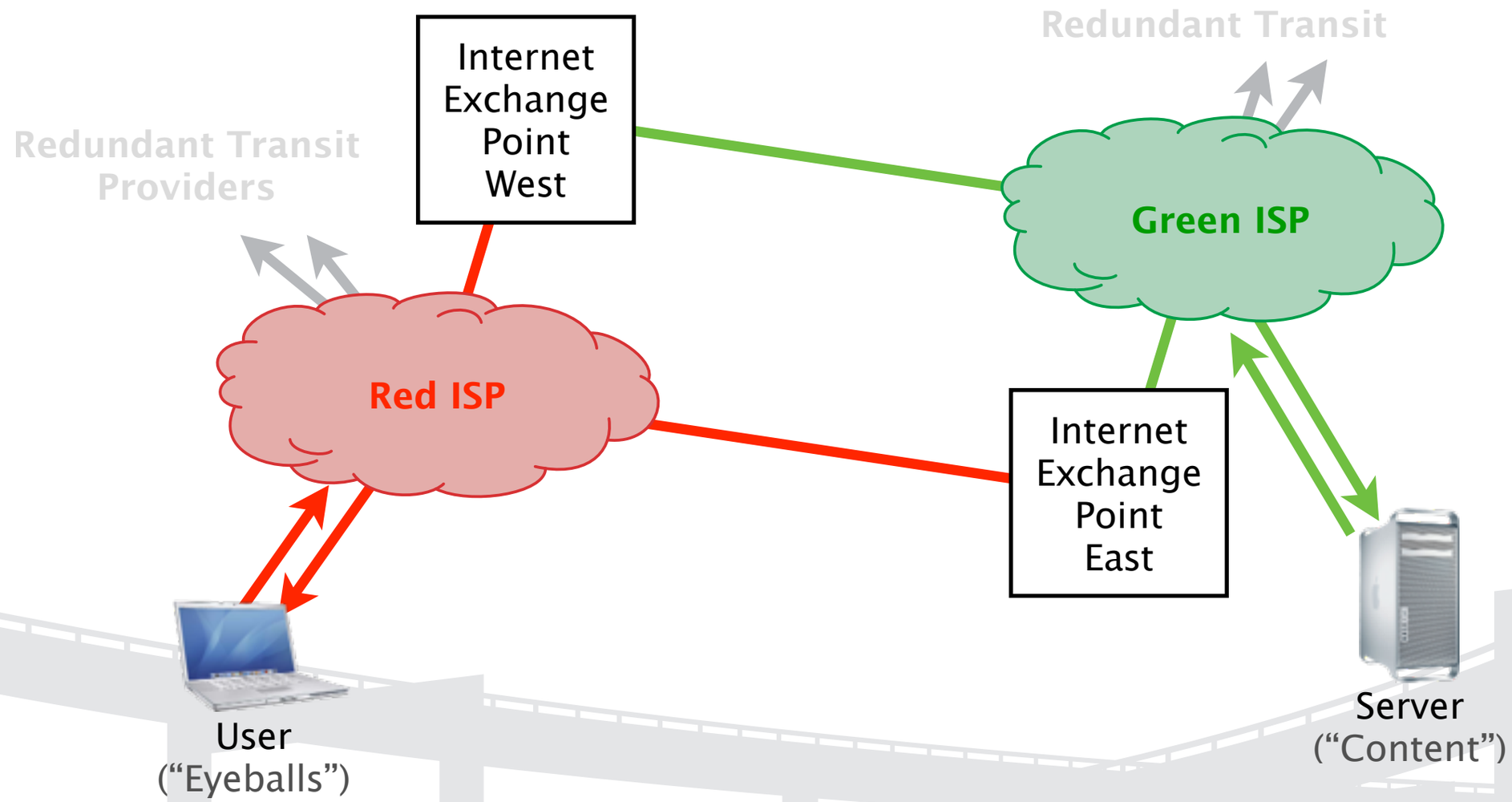


1 Alcatel-Lucent 7210 SAS-M
2 ADVA FSP3000R7 for Remote-Locations
3 Alcatel-Lucent 7950XRS20 Core-Node
4 Alcatel-Lucent 7950XRS40 Edge-Node
5 Alcatel-Lucent 7210 SAS-M
6 ADVA FSP3000R7 for Interconnect-Connections
7 Alcatel-Lucent 7950XRS20 Edge-Node

Human dimension
Peering at KIXP

Routing example

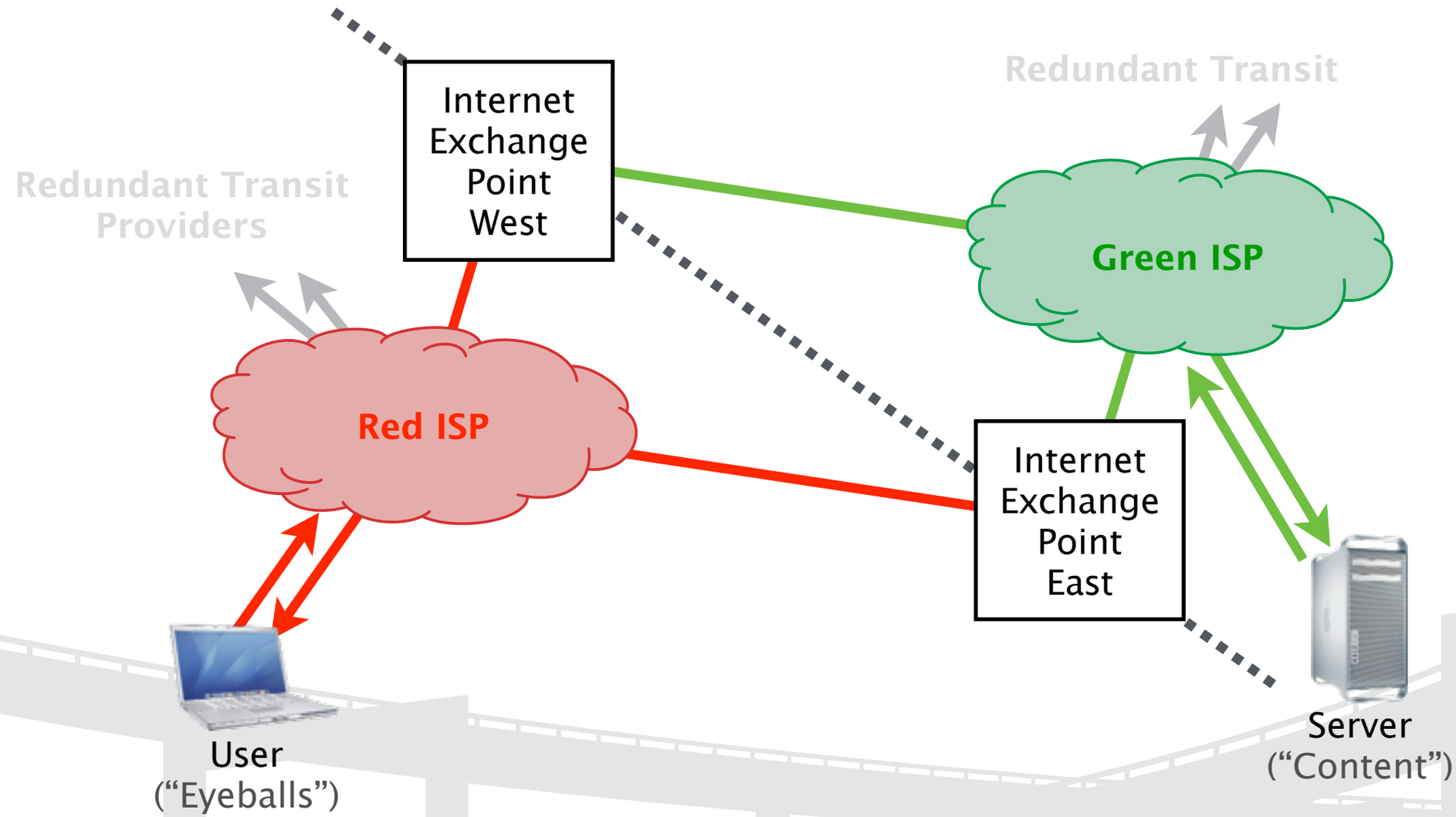
Packets from customer are routed by Red ISP via IXP West



Green ISP backhauls from distant IXP and delivers to customer

Routing example

Symmetry: Each network is responsible for its own costs



Measurements at IXPs

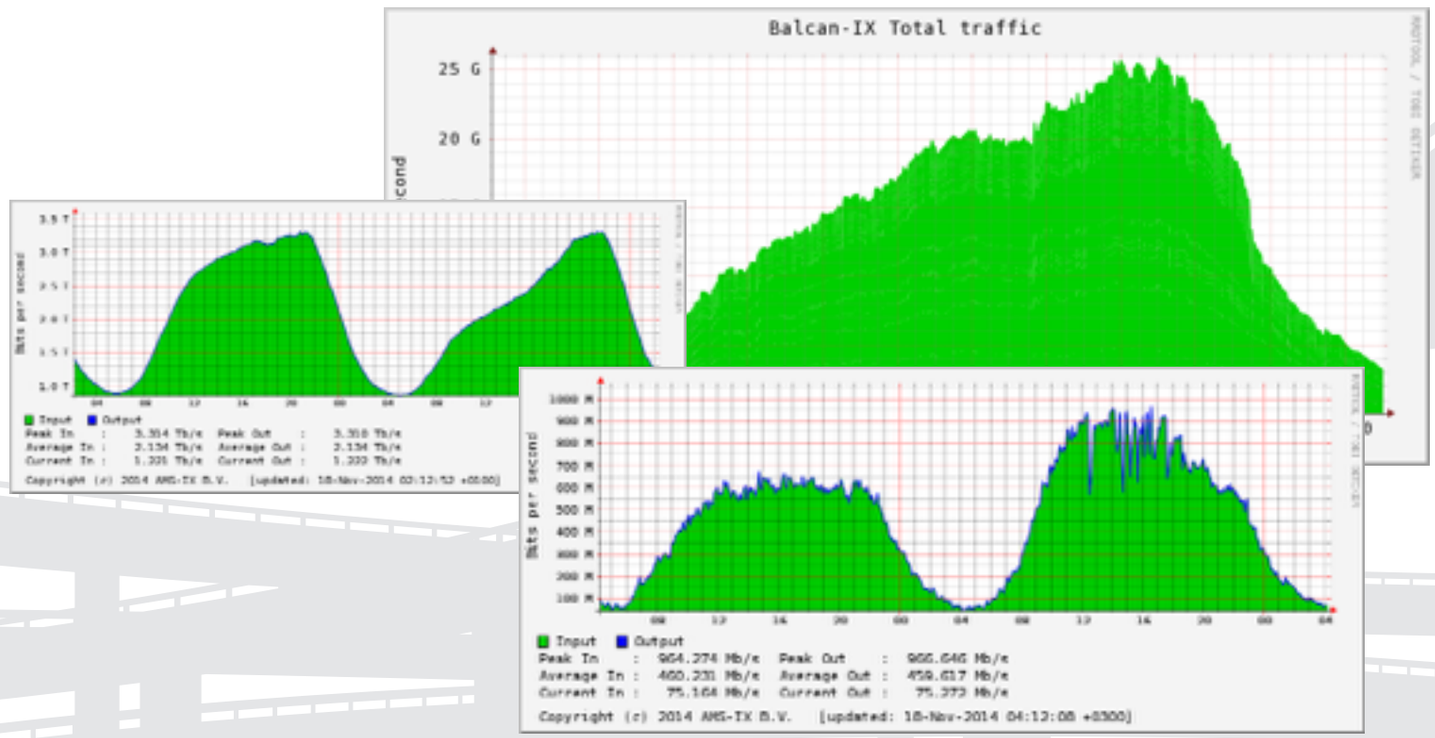
- Why are exchange points a good location to perform network measurements?
  - Neutral point of interconnection (good for measurements).
  - Multiple service providers (up to several hundreds).
  - Exchange of routing information
- What type of measurements?
  - Performance
  - Reachability

Local examples

- Looking glass route collectors to help ISPs troubleshooting routing issues.

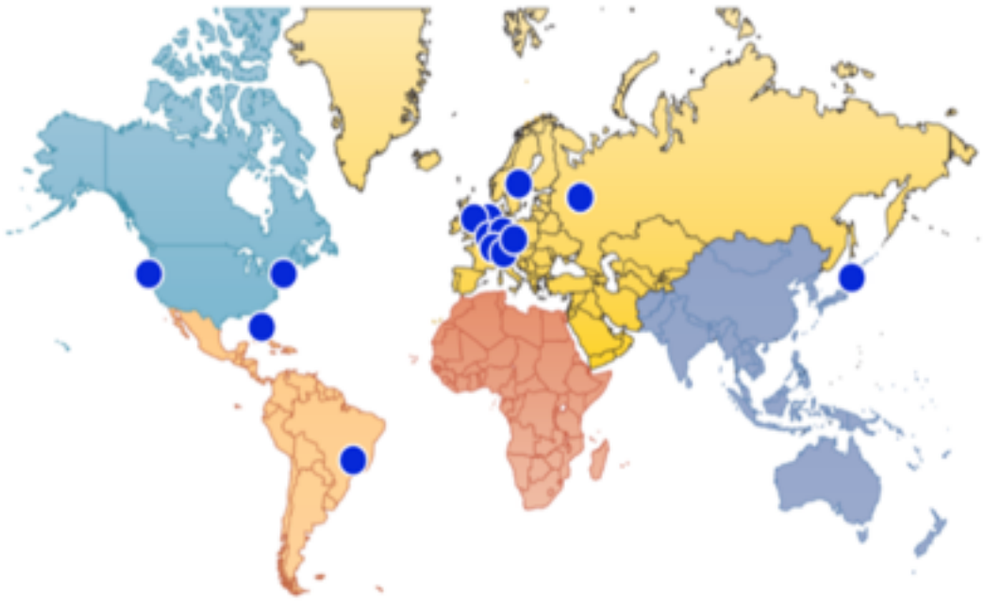
```
BGP router identifier 74.80.119.4, local AS number 3856
RIB entries 120773, using 7548 KiB of memory
Peers 21, using 52 KiB of memory
Peer groups 10, using 160 bytes of memory
Dampening enabled.

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
74.80.119.1     4    42   46299   46265        0    0    0 04w4d03h        47
206.108.236.2   4 20940   39210   39484        0    0    0 03w6d10h         1
206.108.236.4   4  6079   25522   25400        0    0    0 02w3d15h       169
206.108.236.11  4 17356   87096   81352        0    0    0 04w0d06h         4
206.108.236.25  4 62929   85173   79005        0    0    0 03w6d10h         7
206.108.236.26  4 32286   64184   59701        0    0    0 02w4d17h         7
206.108.236.29  4 62947   60082   55842        0    0    0 02w5d09h         2
206.108.236.30  4  6939  410430   46463        0    0    0 04w4d06h     59577
206.108.236.31  4 32334   18891   17442        0    0    0 6d01h21m         1
206.108.236.32  4  2906   87803   81332        0    0    0 01w2d10h         1
206.220.231.55  4  3856   48597  191401        0    0    0 04w5d18h         0
```

- Traffic exchange statistics to analyse global and regional traffic growth trends



Global examples

- **RIPE RIS Project**
  - Remote Route Collectors (RRCs) used in the RIPE RIS Project are connected to Internet exchanges



- **PCH Routing Archive**
  - A historical archive of network adjacencies and reachability from about 80 IXPs

Questions?

Thanks for your attention

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Packet Clearing House is the global non-profit organisation providing operational support and security to Internet critical infrastructure.

Check out the Global Directory of Internet Exchanges at
http://www.pch.net/ixpdir