Internet Interconnection

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PLAN OF PRESENTATION

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- Structure of Internet interconnection
- An interconnection networks protocol: BGP
- Types of interconnection arrangements
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- Part 2: Competition & regulation of Internet
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Structure of Internet interconnection (1)

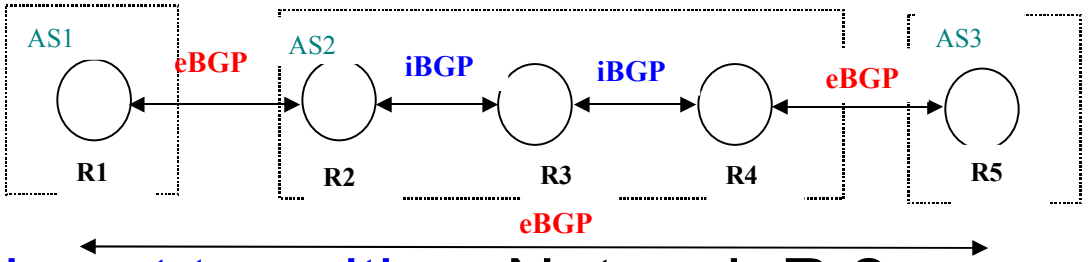
- Internet traffic is designed to take the 'easiest route' from two points, typically referred to as the path of least resistance (best-path).
- Frequently, this results in most traffic being routed through the US or Europe because of the high capacity to handle.
- As consequence, in regions without a major hub or backbone, such as Africa, simple Internet communications between neighbouring African countries are often routed via the US or Europe.
- As a result, smaller countries are required to pay transit charges to access larger backbones.

Structure of Internet interconnection (2)

- Internet is a large network comprising many smaller networks
- Individual computers (clients) and website hosts (servers) communicate with one another through a series of interconnections
- Clients and servers are connected first to a Point Of Presence (POP), which is provided by ISPs or large institutions. From there, ISPs connect to the Network by joining with other ISPs or by connecting with large backbones at various Network Access Points (NAP).
- Thanks to interconnection, individuals can gain access to any other client or server in the world

An Interconnection networks Protocol: BGP

- BGP is a protocol for the interconnection of operators networks: BGP4(IPv4), BGP4+(IPv6)
- BGP(eBGP, iBGP)



- iBGP is not transitive: Network R 2 cannot use Network R3 to gain access to Network R 4
- eBGP is transitive by default
- BGP4 has introduced the function aggregation

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- It is possible to intervene on the routing policy (dampening,...), to screen networks or AS-paths, to apply priorities on some AS-paths
- If no particular screening is configured on the eBGP router, this later will retransmit to it neighboring the overall known networks
- It is possible to set a limit on the number of networks from a BGP neighboring to protect oneself against a neighboring which could announce – 'by mistake'- a great number of networks (full-routing).

Types of interconnection arrangements (1)

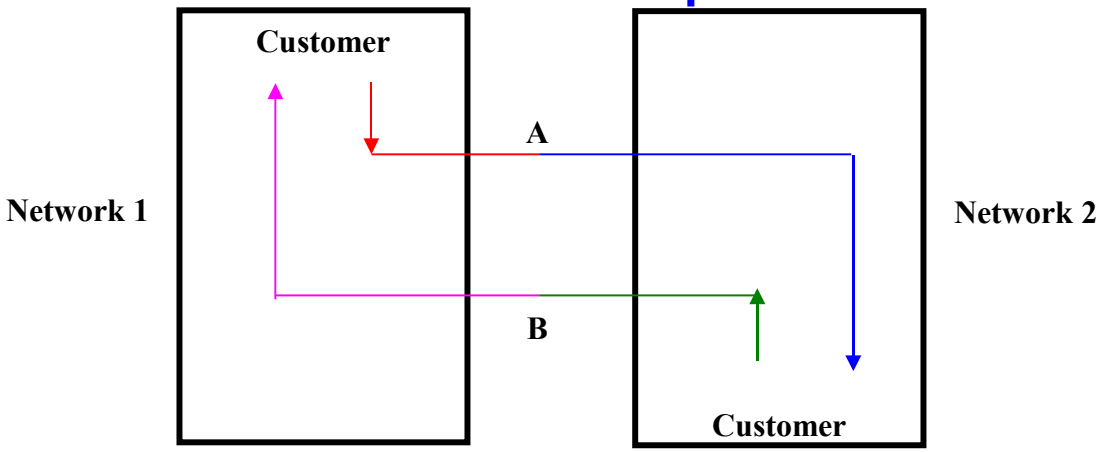
- There are two main types of interconnection arrangements for Internet traffic: peering and transiting
- Peering

Peering is essentially the same as **bill and keep** in voice interconnection, where networks do not bill each other for terminating calls.

Peering works well when networks have the '**similar value**', as it reduces the cost of measurement and billing. In other words, a backbone may choose to peer with another if it perceives an **equal net benefit** from doing so, based on the nature of the criteria used to measure this value.

Types of interconnection arrangements (2)

- One problem occurs when backbones with multiples NAPs have the incentive to carry traffic the least distance possible.

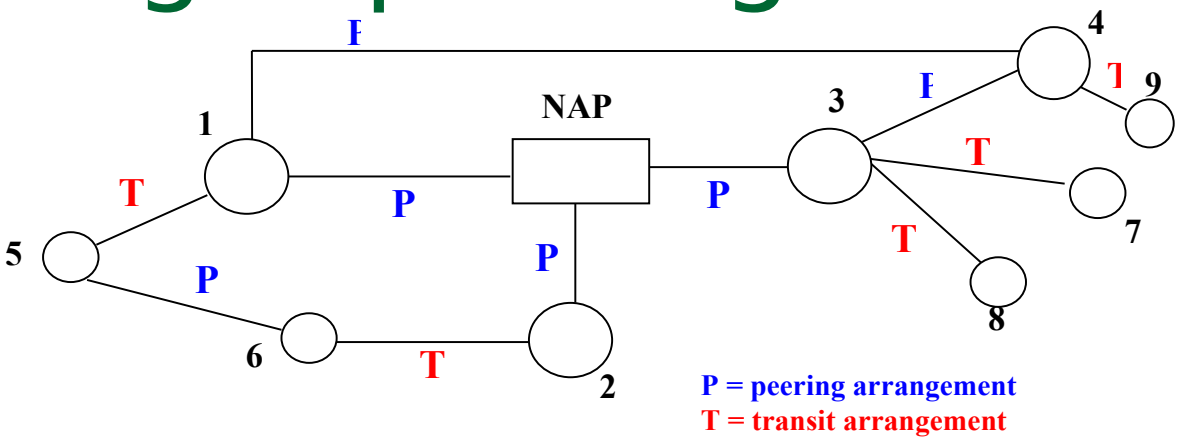


- This is resolved with hot-potato routing technical way (first feasible NAP choice)
- Network 1 cannot insist that only NAP A be used; this would be unfair to network 2…

Transiting & Peering

- **Transiting** occurs when small backbones wish to connect with large backbones, and therefore must pay a charge for this access.
- Transit fees paid by a backbone allows it to gain access to customers of the other backbones and their peering and transit partners.
- This helps to ensure that small backbones can provide universal coverage to its customers.

Transiting & peering



- Networks 1,2 and 3 are large backbones that peer with each at a common peering point (NAP). Network 4 peers also with network 1.
- These larger backbones offer transit services to smaller networks. Network 5 pays Network1, Networks 6 pays Network 2 etc

Transiting & peering

- These smaller networks are paying for access to the entire network via the backbone it transits with.
- Note that Network 3 has two transit arrangements. Network 3 could use this as a bargaining strategy when peering with other networks.
- If Networks 5 and 6 have substantial traffic with one another, it may be beneficial to enter into a separate peering arrangement, thus avoiding transiting through Networks 1 and 2, respectively.

Interconnection: Policy & Strategy

- Criteria to measure the equal net benefit to peer
  - Number of BGP routes to exchange
  - Volume of estimated traffic between the two partners
  - The interconnection flow (symmetric or asymmetrical)
  - Location of the peering place and associated costs to connect to
- Most major operators require the signing of a peering agreement which should mention:
  - Technical conditions: QoS, SLA, overprovisioning, and *GTI* or *GTR* in case
  - Some time, financial conditions…

PART II

Competition & Regulation of Internet

Information economics terms

- cost-based access pricing meaning that prices are based on the actual cost of providing the service.
- Externalities are benefits or cost incurred as a result of an action that is born on a third party
- As a network grows, the network value to the customer increases, which entices even more customers to join and expands the network even more: Network effects (positive externalities)

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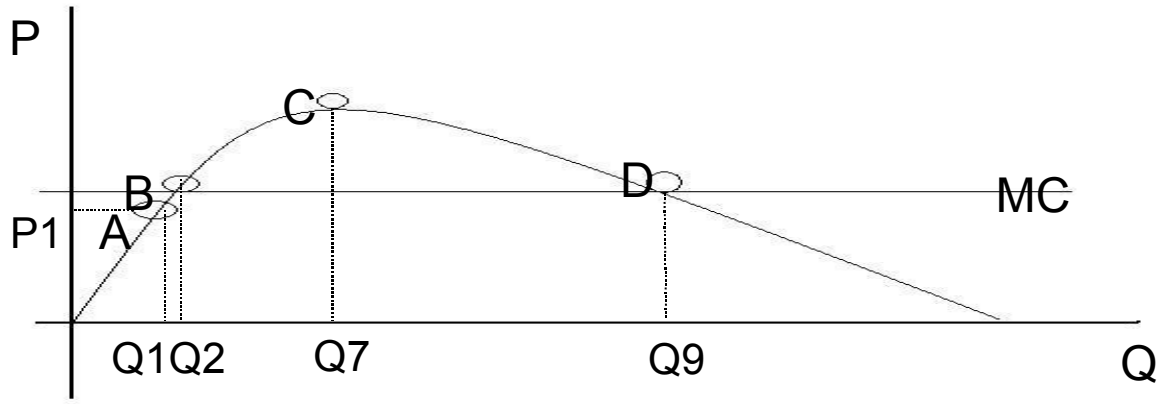
- At A (negative profits), B (to earn profits), C(highest price), D (Maximize profits)



- A network market demand curve first rises then falls (traditional downward sloping demand curve)

Telecom & Internet: Different industries

- Telecom industries operated as monopolies (Firm then serves the entire market and has complete market power (ability to set prices)

Whereas, Internet was largely built up collectively by different companies

- It is potentially costly for a telecom operator to interconnect with another one.

Whereas, for large Internet operators these costs are minimal, thanks to economies of scale (positive network externalities) created by larger Internet

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- In traditional telecom industry there is only one ‘route’ to connect to.

Whereas, for Internet there are endless ways to interconnect. This leads to a healthy competition among Internet providers which compete to keep transit charges near their costs (MC)

Why is the need of regulation reduced in Internet industry?

- Competition between backbones tends to replicate a sound Market environment. The Internet industry is most accurately characterized as an outcome of business and technology interaction.
- Network effects allow to make the scale economics which increase revenues
- Internet is therefore self-regulated.

Conclusion

- Interconnection is the glue that holds Internet together
- Regulation is unnecessary for international Internet interconnection.
- Given the potential for Internet expansion in the developing world and corresponding demand, reliance on dominant backbones will become less a prominence issue later on. Clearly, the empirical data illustrate these trends.

End

I thank you for your attention!