Simple Economic Management Approaches of Overlay Traffic in Heterogeneous Internet Topologies

European Seventh Framework STREP FP7-2007-ICT-216259

Operator's vision about overlay traffic management

Telefónica I+D (TID)

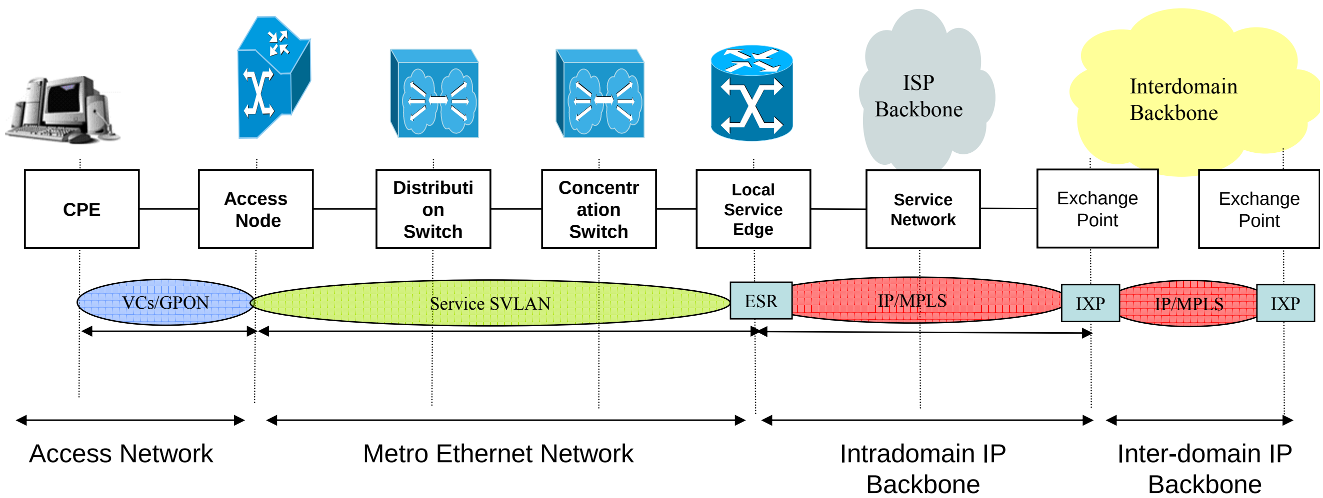
August, 2008

This presentation aims to show…

- …The different networks, technologies and players involved in the overlay traffic transport
- …The current existing options for ISP interconnection
  - Peering and transit
  - SLAs
  - Charging schemes
- …What are the main issues in overlay traffic management
  - QoS differentiation
  - Locality
- … What technical incentives may be offered by the network operator in order to promote the traffic locality

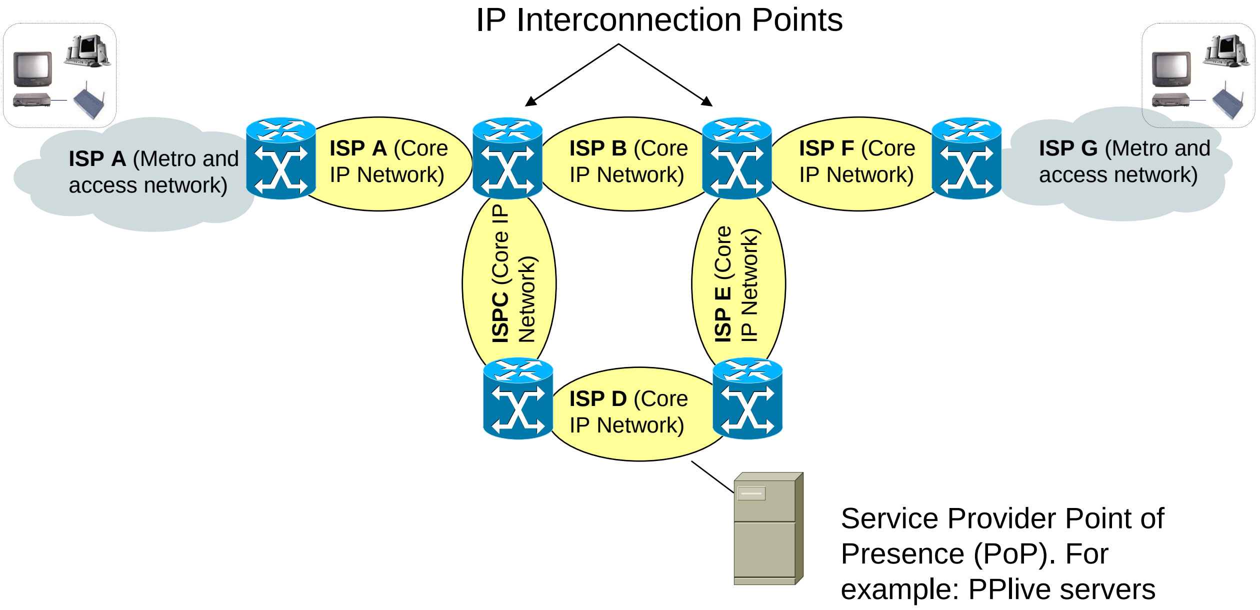
Network Topology

E2E Reference Network

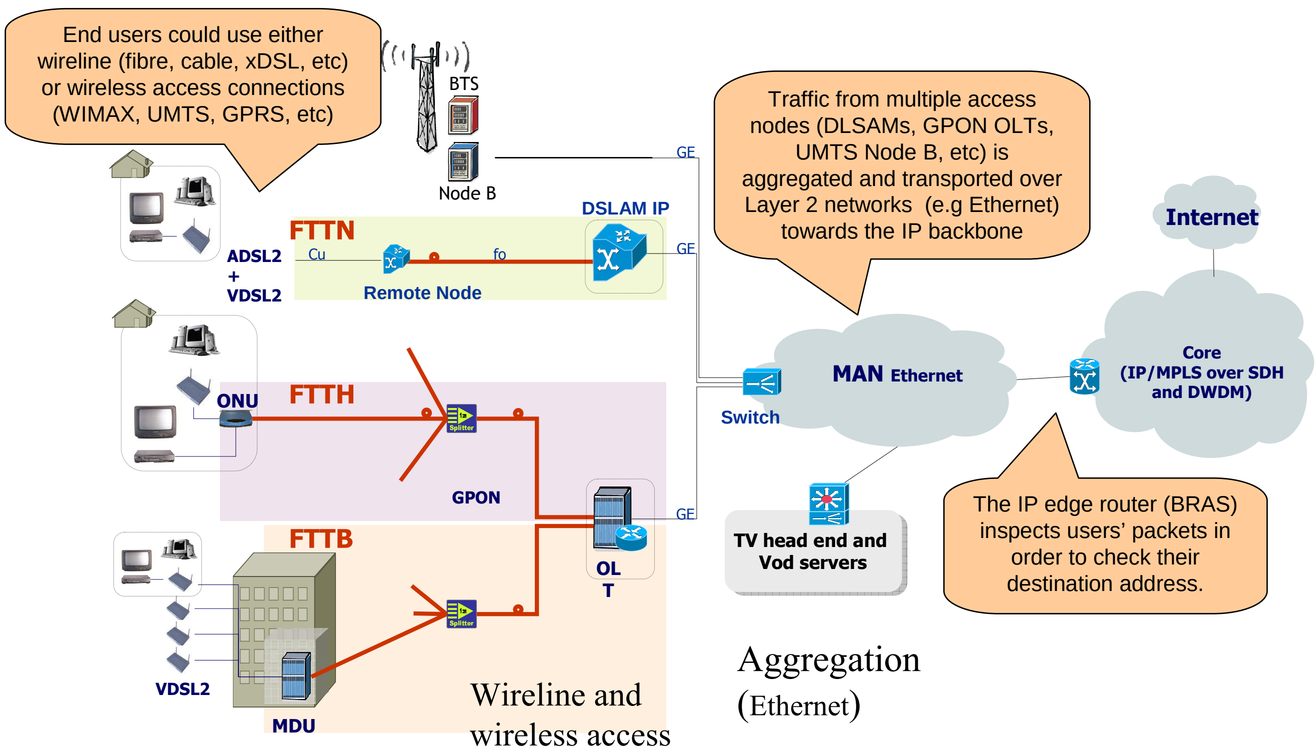


End to End Architecture

- Traffic between two peers could pass through multiple networks

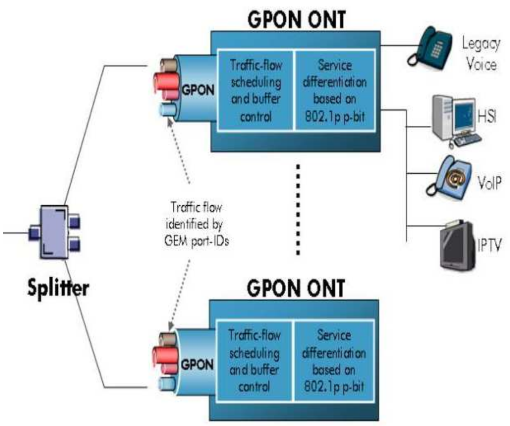


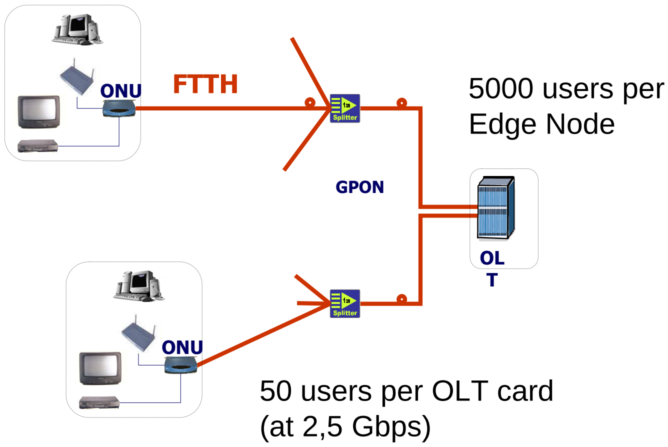
Metro and Access Network



GPON FTTH

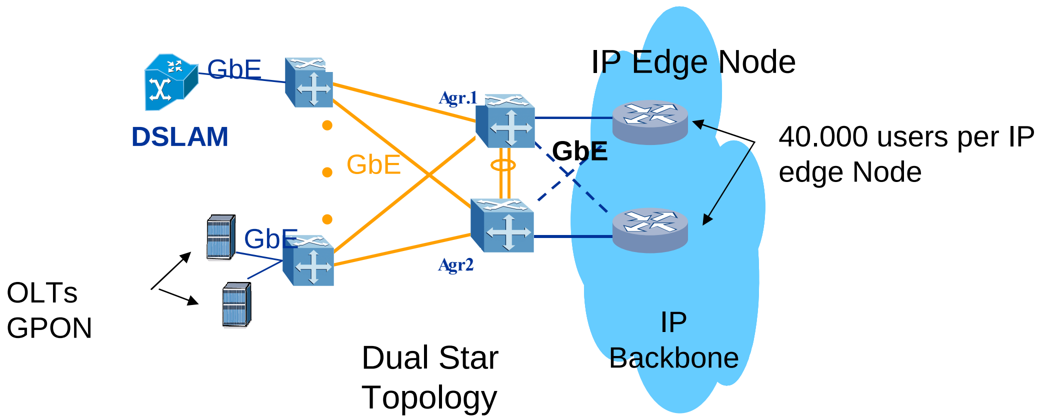
Bandwidth per user	50 Mbps downstream/ 10 Mbps upstream
Dynamic Bandwidth Allocation	Yes (defined in G.984.3)
Maximum delay between two users connected to the same OLT	<2,5 ms (specified in G.984.1)
QoS control	Yes (defined in G.984.3). The ONT associates different traffic flows with a specific virtual port ID





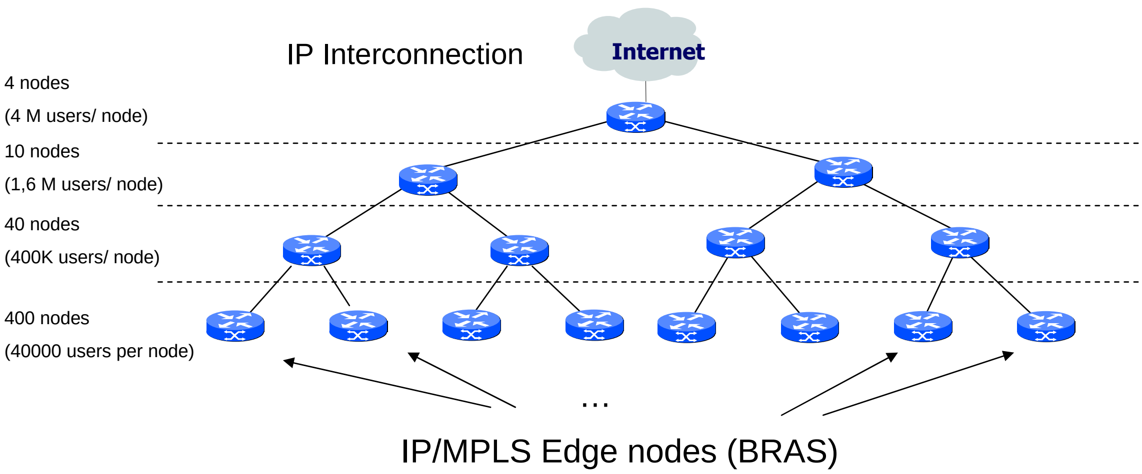
Metro-Ethernet Aggregation

Typical delay per Ethernet node (due to queuing, processing and switching)	1,5 ms
QoS control	IEEE 802.1p (up to 8 different CoS) IEEE 202.1q (VLAN) 802.1ad (S-VLAN)
OAM mechanisms	ITU Y.1731 , IEEE 802.1ag, IEEE802.3ah



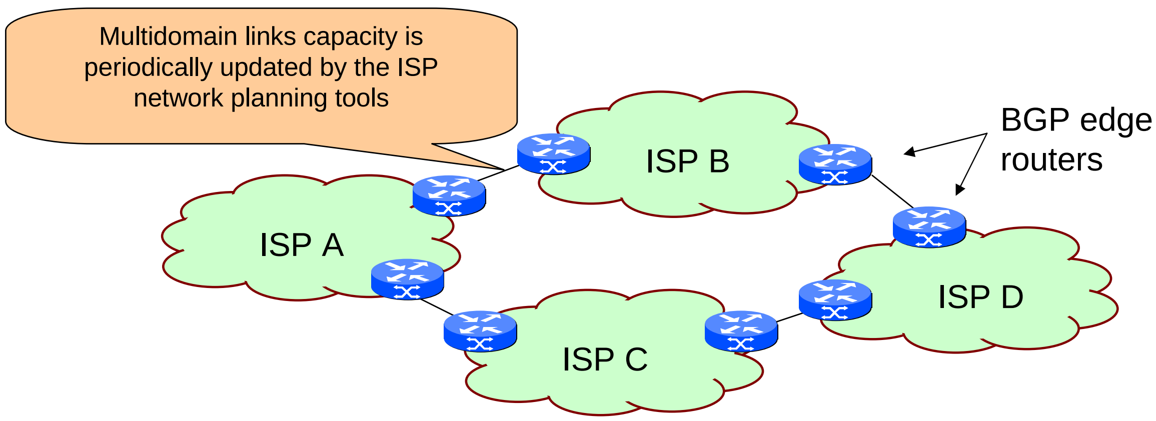
IP intradomain Backbone

Typical delay per hop (due to queuing, propagation, processing and switching)	3 ms
Propagation delay	1ms/ 200 Km
QoS control	DiffServ Different MPLS LSPs per CoS
OAM mechanisms	BFD and LSP Ping



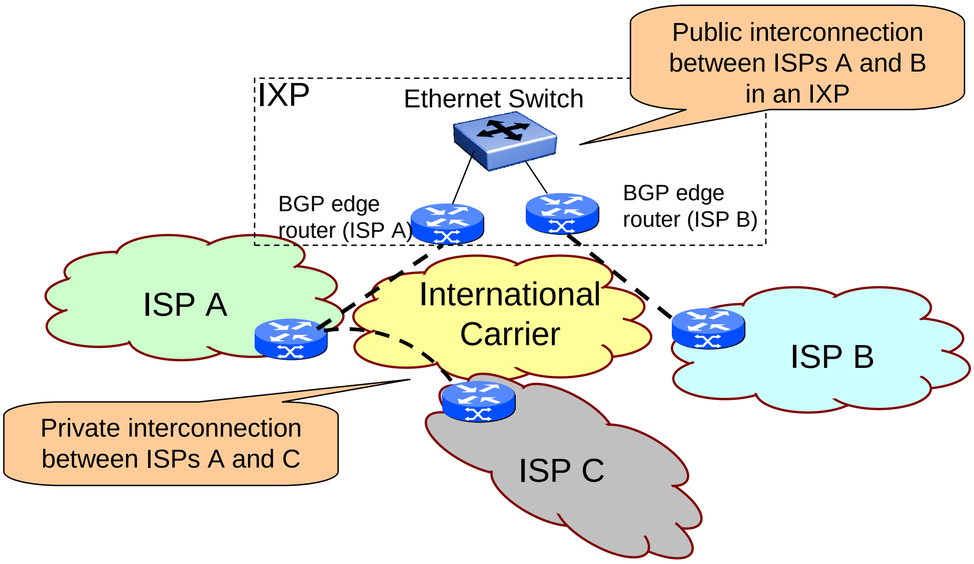
ISP Interconnections-Routing

- ISPs' networks are interconnected as autonomous routing domains
- Global routing is based on BGP (Border Gateway Protocol)
  - BGP works by maintaining a table of IP networks or 'prefixes' which designate network reachability among autonomous systems (AS)
  - BGP neighbors, or peers, are established by manual configuration between routers



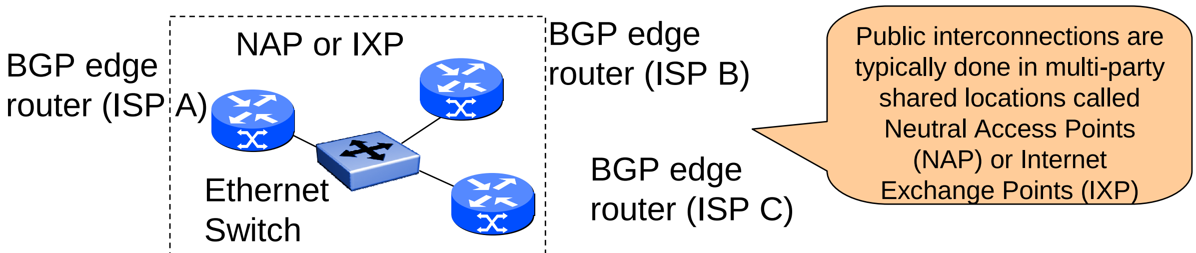
- Routers that sit on the boundary of one AS, and exchange information with another AS, are called border or edge routers.

ISP Interconnections-Routing

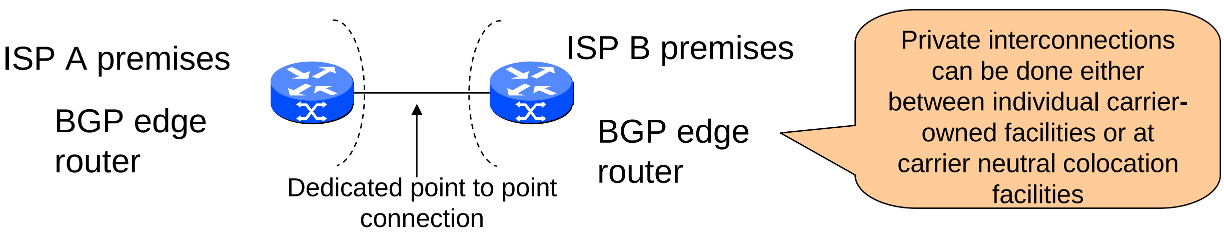


ISP Interconnections-Physical connectivity

- The physical ISP interconnections are categorized into two types:
  - **Public interconnection**: Interconnection utilizing a multi-party shared switch fabric such as an Ethernet switch.

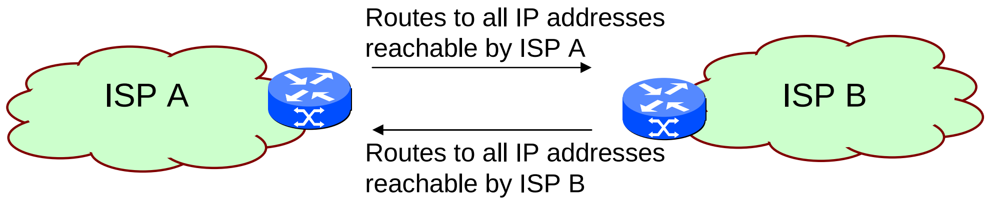


  - **Private interconnection**: Interconnection utilizing a point-to-point interconnection such as a patch-cable or dark fiber between two parties.



ISP Interconnections-Business relations

- The ISP interconnection consists of the advertisement by an ISP of
  - …routes to its customer's IP addresses to the other ISPs (i.e soliciting inbound traffic)
  - …a set of routes to all of the reachable destinations by the other ISP, to the ISP's customer (i.e soliciting outbound traffic)



- Such exchange of reachability information and traffic could be done freely or not depending on the ISPs business relationship

- The relationships between ISPs are generally described by one of the following categories:
  - Peer: Two networks exchange traffic between each other's customers freely
  - Transit: An ISP pays to another ISP for the traffic exchange

ISP Interconnections- Charging

- In the IP transit model the purchaser has to pay the difference between outbound and inbound traffic

- Pricing is typically offered on a Mbps/Month basis and requires the purchaser to commit to a minimum volume of bandwidth

- For example a common charging model for IP transit is based on **95th percentile method:**
  - The difference between the average inbound and outbound traffic is measured every 5 minutes and recorded in a log file
  - At the end of the month, the top 5% of data is thrown away, and that next measurement becomes the billable utilization for the month

$$C_{month} = P_{95}\ \{\text{Average(outbond-inbound)}\} \times \text{Price/Mbps}$$

C_{month} : Cost per month; **P_{95}**: 95th Percentile; **Average(outbond-inbound):** Average traffic samples measured every five minutes during one month; **Price/Mbps**: Price per Mbps agreed between the ISPs

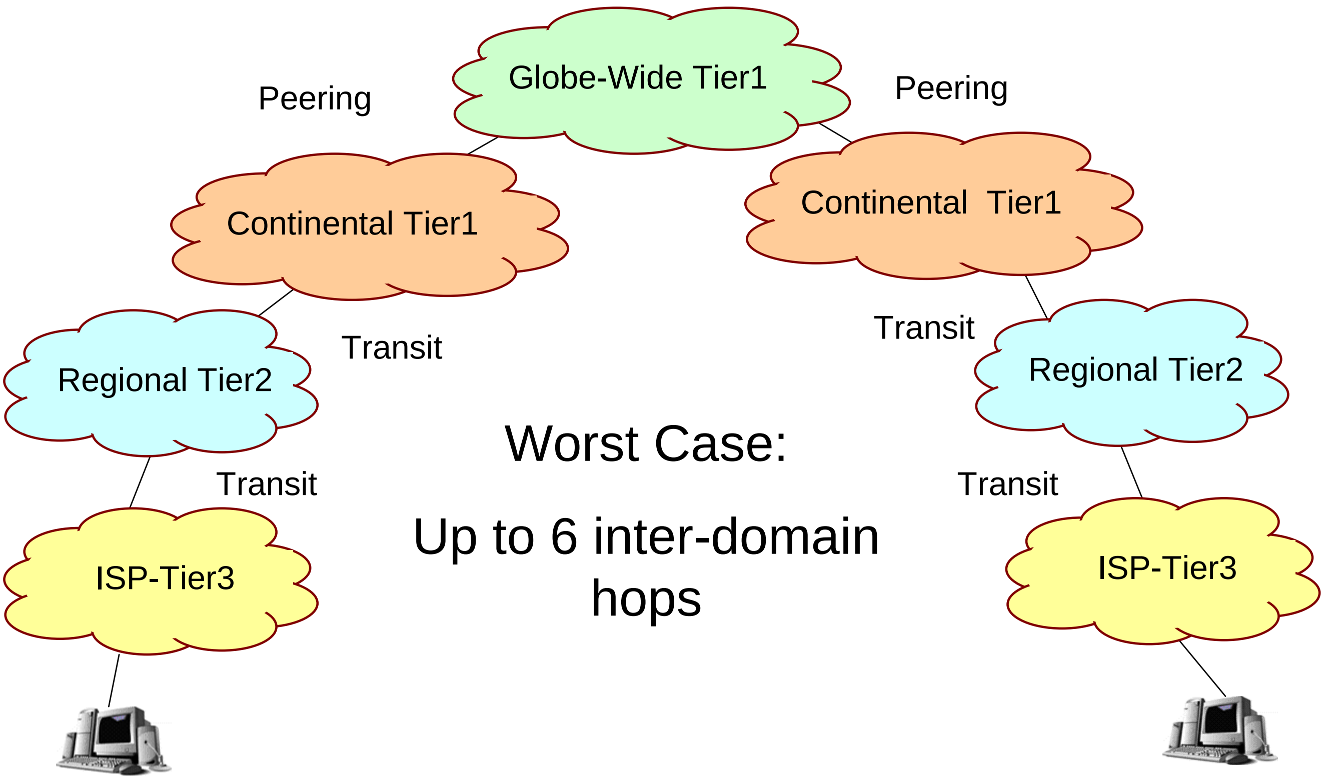
ISP Interconnections- SLAs

- Currently the Service Level Agreement (SLA) between ISPs involved in peering or transit agreements are based on two main parameters:
  - **Bandwidth** (e.g average and peak rates). The physical link capacity (e.g 1 Gbps, 2,5 Gbps etc) use to be periodically updated (e.g every six months)
  - **Survivability** (e.g 99,999% connection availability)

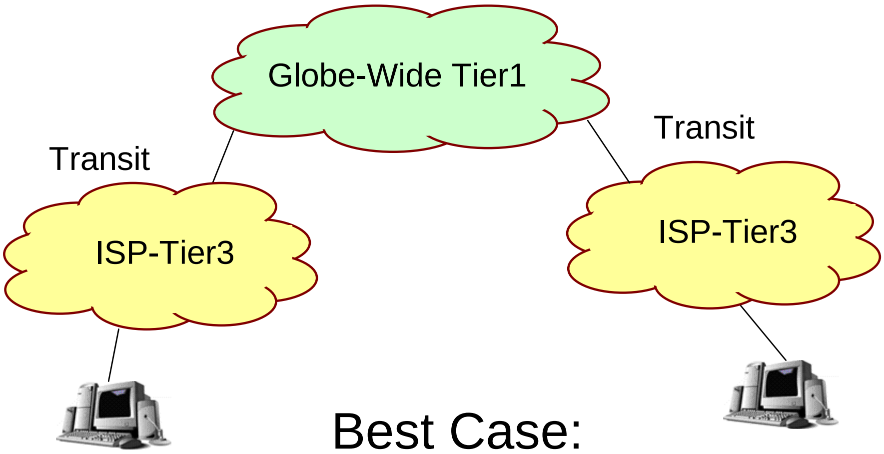
- Usually, an SLA includes a penalty framework. For example, an ISP can offer a refund based on the number of hours the connection is unavailable

- On the other hand, new monitoring techniques would allow to add QoS parameters in the SLA
  - Packet loss rates (which could significantly impact on IP-TV quality)
  - Jitter and end to end delay (which could impact on VoIP, gaming or videoconference)

IP Intra-domain Backbone



IP Intra-domain Backbone

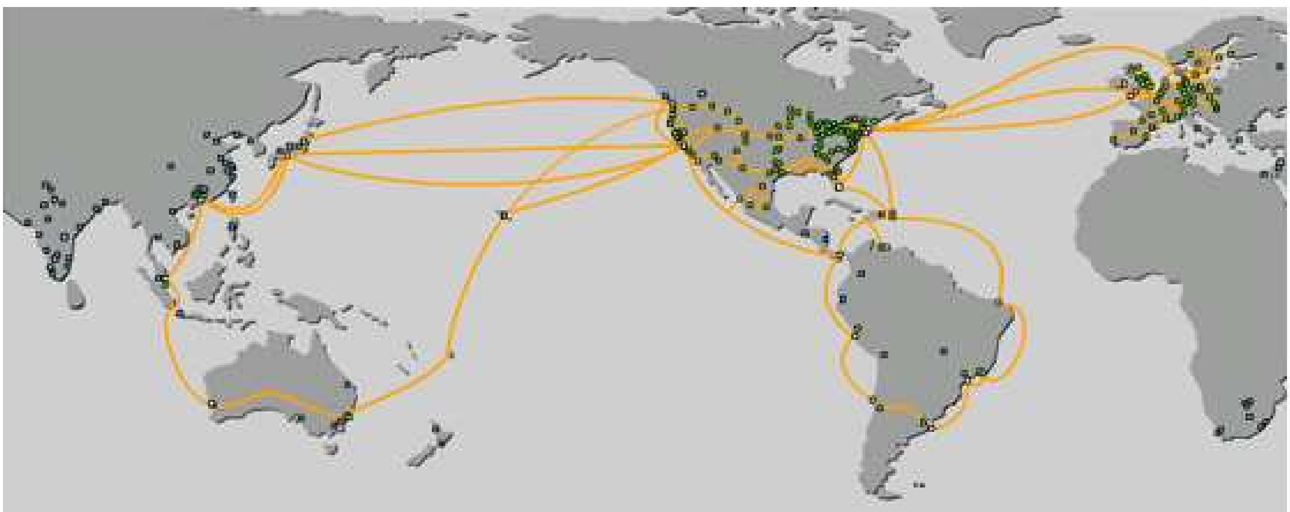


Best Case:

Only 2 inter-domain hops

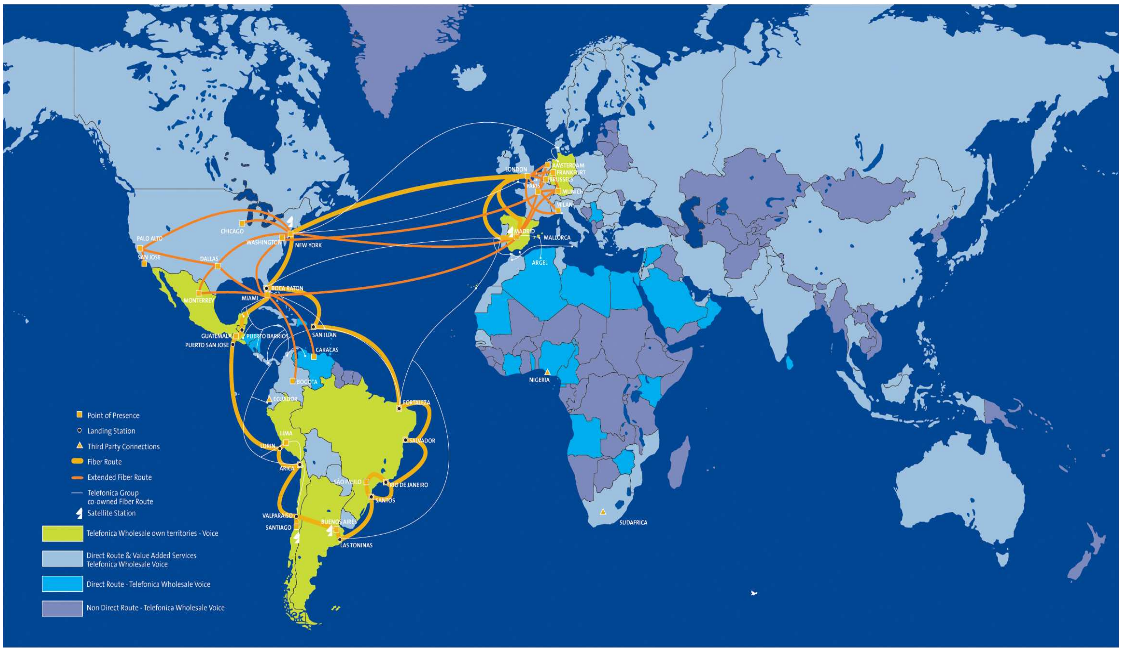
Global-Wide Tier 1

Global Crossing Network is covering large areas around the world



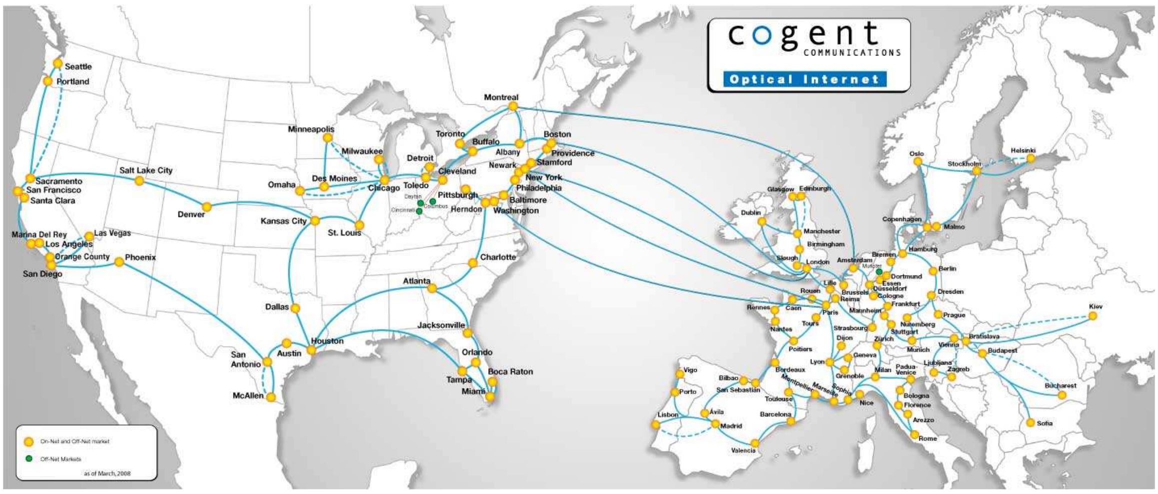
Regional Tier 1

TIWS is covering large areas of Europe, EEUU and Latin America



Regional Tier 2

Cogent covers Europe and EEUU



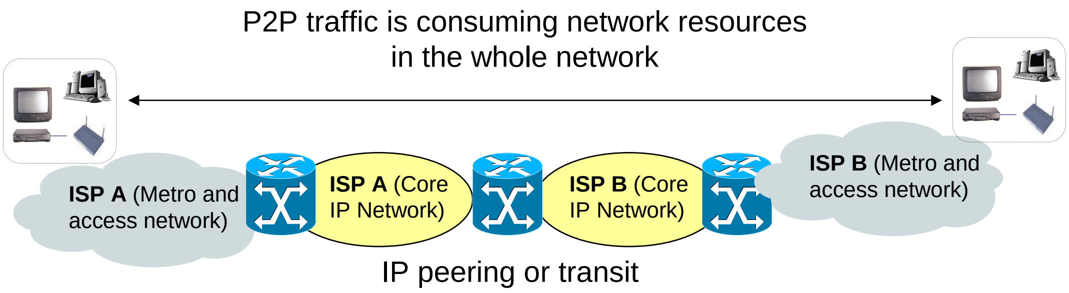
Main issues in overlay traffic management

Main issues in overlay traffic management- QoS differentiation

- Currently, Internet traffic (e.g http, overlay, etc) is transported according to a "best effort" approach
- However, some overlay applications such as IP-TV, VoD, VoIP, videoconference or gaming present strict requirements in terms of delay and/packet loss
- The introduction of application-aware transport services able to provide the required QoS for each application would improve the QoE perceived by the end user
- Why might operators be interested in increasing the QoE of overlay applications?
  - To increase the broadband customers fidelity and reduce the churn rate
  - To sell new broadband connectivity services specially adapted to Internet real-time and streaming applications

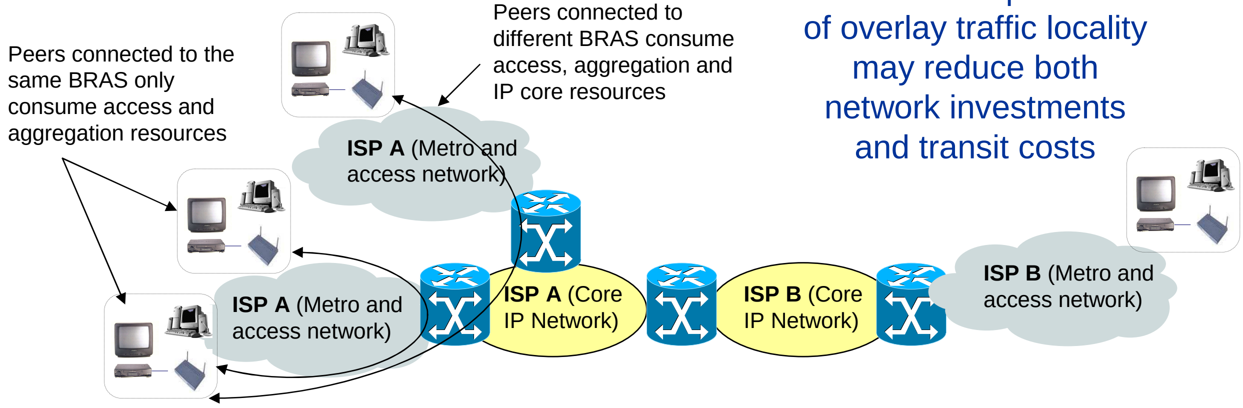
Main issues in overlay traffic management - Network planning

- Currently, a very high percentage of Internet traffic comes from overlay applications
  - For example, around an 80% of total Internet traffic in Spain is generated by P2P applications
- The amount and distribution of overlay traffic strongly impacts total network costs (CAPEX and OPEX).
  - For example:If and ISP customer is exchanging P2P traffic with a customer of another ISP then such traffic is consuming resources in the whole ISP network: access, aggregation, IP "national" core and IP interconnection (peering or transit)



Traffic Locality

- As higher the percentage of "multidomain" traffic as higher the network resources consumption and total costs:
  - Multidomain traffic passes through the whole network. Therefore, it consumes more transmission and switching resources than internal traffic
  - In case of having an IP transit agreement then multidomain traffic should be paid to another ISP
- On the other hand, internal P2P traffic doesn't consume interconnection bandwidth



Therefore the promotion of overlay traffic locality may reduce both network investments and transit costs

Potential incentives for File-sharing applications

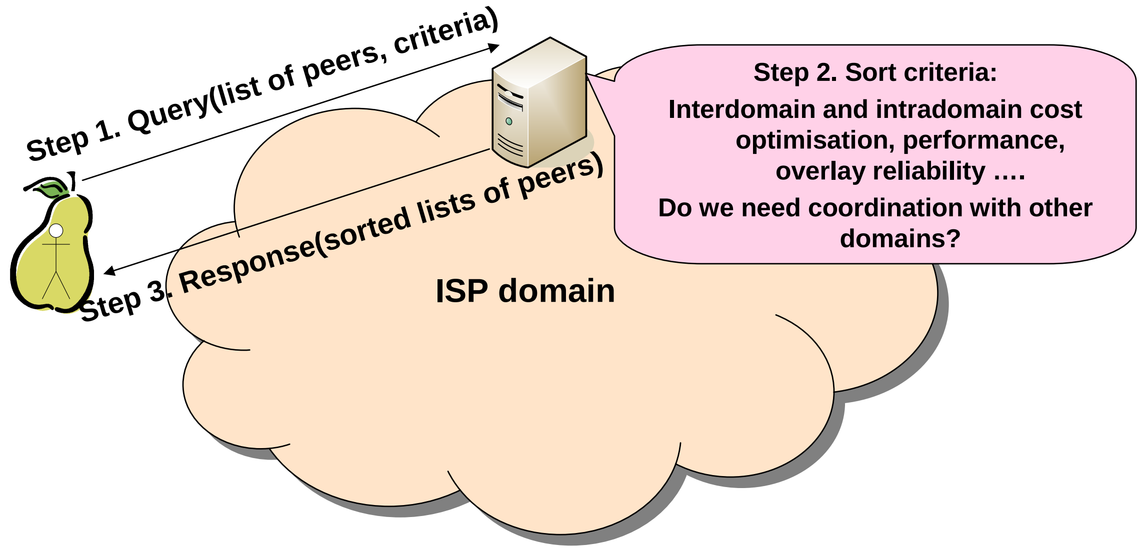
Main objective of ISP and P2P collaboration

ISP and P2P collaboration should be profitable for both ISP and end user

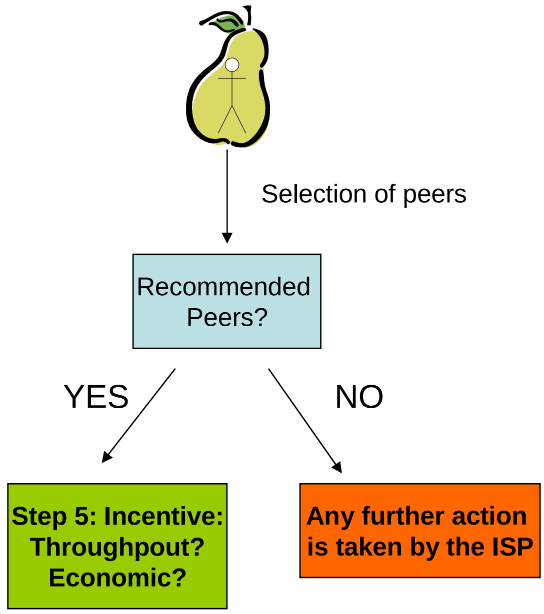
- **ISP benefits**: Increase the percentage of P2P intra-domain traffic
  → Cost optimisation (especial attention to interconnection costs).

- **User's benefits**
  - Faster downloads (↑ Throughput)
  - Potential economic incentives if different charging schemes than flat rate are used (e.g Charging schemes per traffic volume)

Steps 1-3



Steps 4: Selection of peers



Sorted list of peers provided by the ISP

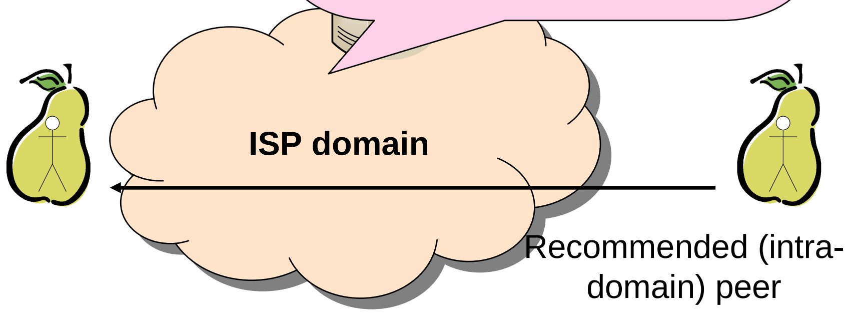
Peer 1	ISP Recommended
Peer 2	ISP Recommended
…	…
Peer N	Not recommended

Step 5: Technical incentive

Sorted list of peers provided by the ISP

Peer 1	ISP Recommended: High Throughpout
Peer 2	ISP Recommended: High Throughpout
...	...
Peer N	Not recommended

The ISP could automatically increase the recommended peer upstream capacity. However, the key technical challenge is how to assure that such bandwidth increase will not be also used for inter-domain flows. Furthermore P2P applications use to limit the upstream capacity.



SUMMING UP: The introduction of technical incentives for file-sharing applications might be very complex

Step 5 (bis): Economic incentive

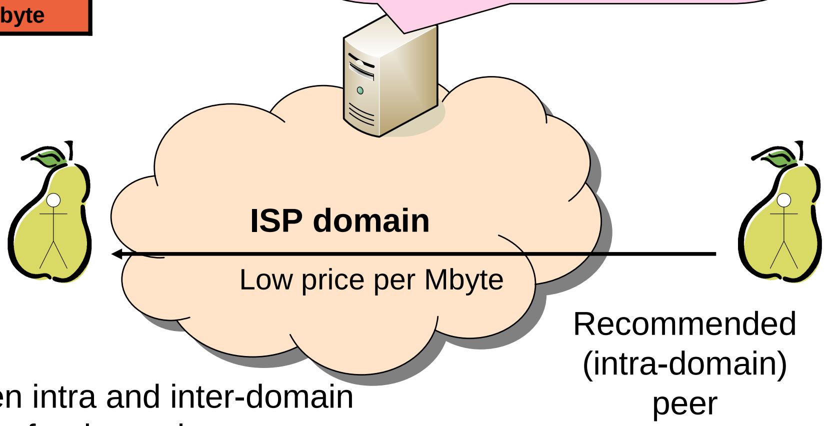
Sorted list of peers provided by the ISP

Peer 1	ISP Recommended: Low price per Mbyte
Peer 2	ISP Recommended: Low price per Mbyte
...	...
Peer N	Not recommended: Standard price per Mbyte

In charging models based on the bandwidth consumption, the total price at the end of the month depends on the amount of information transported over the Internet connection (Cmonth = Mbytes x Price/Mb). This charging model is often used in wireless (3G, 2G) Internet connections. Such charging models might be updated in order to reduce the Price/Mbyte of intradomain flows.

Important: privacy requirement should be considered.

Repositories of P2P users might generate legal problems



Billing differentiation between intra and inter-domain traffic might not be very clear for the end user

Potential incentives for P2P real-time Applications

Main objective of ISP and P2P collaboration

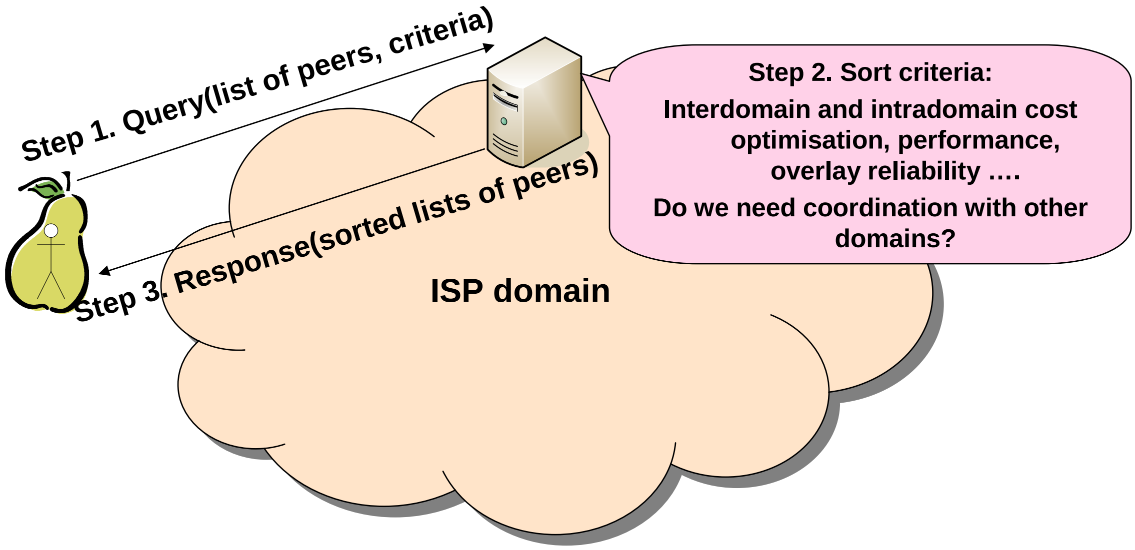
ISP and P2P collaboration should be profitable for both ISP and end user

- **ISP benefits**: Increase the percentage of P2P intra-domain traffic
  - → To increase the broadband customers fidelity and reduce the churn rate
  - → To sell new broadband connectivity services specially adapted to real-time and streaming applications
  - → Cost optimisation (this benefit is more significant in file-sharing applications)

- **User's benefits**
  - Better QoE (lower delays and packet loss rates)

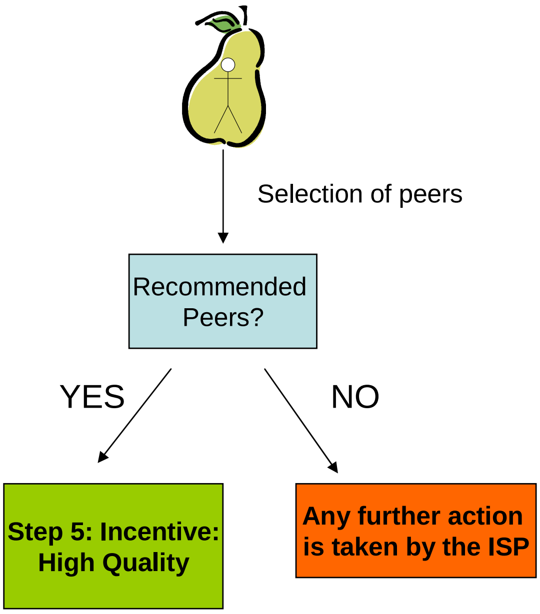
User's potential benefits are different in this case

Steps 1-3



The sorted list sent back to the users would be organised according to QoS criteria

Steps 4: Selection of peers



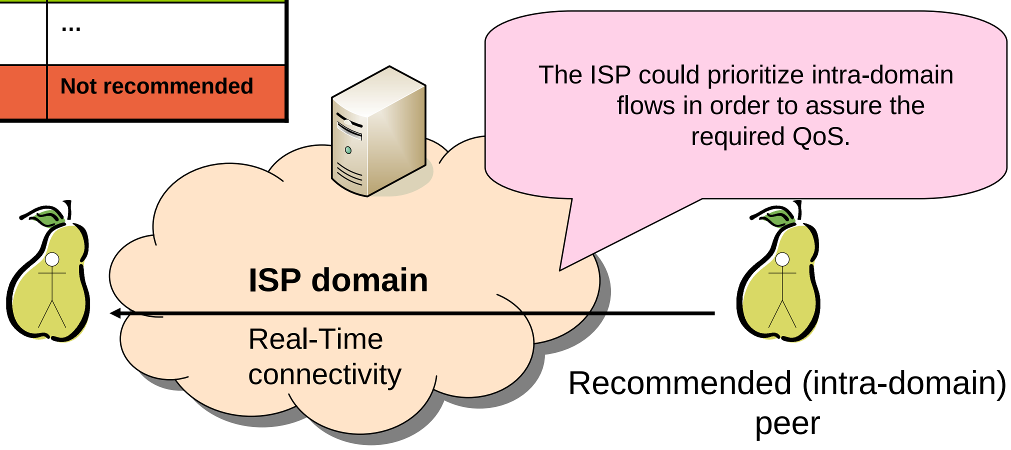
Sorted list of peers provided by the ISP

Peer 1	**ISP Recommended High Quality**
Peer 2	**ISP Recommended High Quality**
…	**…**
Peer N	**Not recommended**

Step 5: Technical incentive

Sorted list of peers provided by the ISP

Peer 1	**ISP Recommended: High Throughpout**
Peer 2	**ISP Recommended: High Throughpout**
...	**...**
Peer N	**Not recommended**



SUMMING UP: The provision of QoS incentives is technically feasible

Conclusions

- There are two key traffic management measures that would strongly impact on both the operator's network planning and the QoE perceived by the end users

1) Overlay traffic locality
   - Under an operator's perspective traffic locality promotion may reduce both network investments and transit costs
   - Under an end user's point of view locality will imply technical incentives (e.g faster downloads)
2) Overlay traffic QoS differentiation
   - Under an operator's perspective QoS differentiation would allow:
     - To increase the broadband customers fidelity and reduce the churn rate
     - To sell new broadband connectivity services specially adapted to real-time and streaming applications
   - Under an end user's point QoS differentiation will imply better QoE in real time and streaming overlay applications