Goals of this lecture

• After this lecture you should know
  – What network services are and what other services an ISP might offer?
  – What options the ISP has for traffic differentiation?
  – What a SLA is and what it contains?
  – How different types of services should be measured?
Network services – private access

• **Access service**
  – Private access service is based on the control of the customer’s access line (and control of the attached closed service network)
  - Fixed lines
    » xDSL or DOCSIS-technologies for home users
    » Any symmetrical technology in enterprise usage
    - Dial-in access to ISDN/PSTN
  - ISPs may offer differentiated access services based on customer’s access bit rate.
    - xDSL, PDH and ATM –based access lines make it easy to change the access bit rate

Network services – public access

• **Access service**
  – Public access service is based on customer/transit contracts made by the ISP with other ISPs
  - If a customer uses this service he/she/it is offered
    - Global IP-addresses (no NAT, no private IP-addresses)
    - Access point from where traffic is routed onwards.
  - ISP controls the performance and service level of the access.
Network services - transit

**Transit service**
- Enable the networking of ISPs
- Small ISPs are customers to larger ISPs
  - Large ISPs forward the traffic as their customer traffic
- Equal size ISPs work together as partners
  - Each are other’s customers
  - Mutual contracts contain mainly restrictions regarding the forwarded traffic.

Separate services

**L1-leased line**
- **Blackfiber**, customer has full access to the physical layer (the fiber)
  - Customer operates the fiber and everything on it
- **Colorfiber**, customer gets only the logical access
  - Physical operating based on line technology and on ISP responsibility
  - Logical operation on customer responsibility

**L2-leased line**
- Parts of operator capacity on layer 2
- Capacity may be changed as needed (and possible)
Separate services

• **L3-leased line**
  – Customer is offered IP tunnels between access points.
  • Service is based on
    – IP-tunneling
      » Secure (IPSec) or unsecure (PPTP, GRE)
      » Service controlled with IP management
    – L2+ tunneling (MPLS)
      » Capacity and routing separate from other network

Value add services

• All supportive services that support network traffic are referred to as **value add services**
  • Virtual network services (VPN)
  • Operating application services (email, web hosting, …)
  • Managing name services (and their integrity) (DNS)
  • Controlling and managing customer equipment (DHCP on the very basic level)
Differentiating traffic - QoS

- **Traditional concept** of QoS is based on fulfilling **commonly accepted** parameters
  - For instance PSTN call blocking should be less than 2%
  - There is no differentiation of traffic based on QoS
- **IP-networks and related business** is heavily competed
  - ISPs aim to offer network level QoS (and thus stand out from other ISPs)
    - Performance values are attached to network level services
      - These values must be able to be measured
    - Other services of the ISP are evaluated with quantitative measures
      - Quality certificates etc.

Bringing life to QoS

- ISPs have limited methods and power to offer quality differentiated services
  - More hardware, faster hardware,…
    - Traffic shaping
    - Usage based billing
  - Differentiated Services (DiffServ)
  - Multiprotocol Label Switching (MPLS)
More hardware…

- **Overdimension the network (with proper gusto)**
  - All customer traffic can be carried in any situation
  - True utilization will notably low
    - On average there is a lot of unused capacity (waiting that the “any situation” will happen).

Faster hardware…

- **Differentiation is achieved by**
  - **Actively shaping traffic at user access point**
    - Customer is offered a certain capacity and customer traffic is shaped/buffered to this capacity
      - More traffic, more delay (or more drops)
  - **Billing users according to offered traffic**
    - Customer controls traffic based on what she/he is willing to pay.
      - Slow reaction time (depending on the billing system)
Multiprotocol Label Switching

• MPLS builds virtual connections based on information from IP routing (on top of any L2 technology)
  – Connection identifiers within the L2-header or between L2 and L3 headers
  – Enables end-to-end virtual networks

Differentiated Services

• DiffServ is a method to build logically separate IP-networks into one physical IP-network
  – Logical network is identified with IP-header DSCP / ToS - field
  – Each logical network is treated individually and separate from others
  • Although, the resources used by one logical network have an effect on the other logical networks
Service Level Agreement - definition

- SLA is a contract that describes the service provided and the cost of the service.
- Contract has two parties
  - Customer
    - End-user
      - Enterprise
      - Home user
    - Or a service provider as a client to another ISP
  - Service provider

Service Level Agreement - general

- The task of the SLA is to clearly define the roles, rights and obligations of contract parties at the service interface
- The contents of the contract depend upon the service type and structure offered to the customer
  - Network service (=ISP)
  - Application service (=ASP)
- The contract should contain only those services/applications over which the ASP/ISP has direct control
Service Level Agreement - details

• Contract defines
  – Service(s) offered
  – Cost of the service offered
  – Methods to control the service level
  – Procedures to follow in case of network malfunction

• The definition of service should contain all areas of the service and related performance and quality parameters
  • Network services
  • Application and other value-add services
  • Support services

Service Level Agreement - Examples

• Examples of measured performance and quality parameters:
  – Network capacity is $x$ bps and its usability is $y\%$ over time $z$.
  – The webpage usability is $a\%$ measured over time $b$. The download capacity is $c$ bps and the response time is less than $d$ ms. The complete data is backed up every $f$ days/weeks/months.
  – Customer VPN is offered a capacity of $m$ bps with maximum end-to-end delay of $n$ ms
Service Level Agreement - usability

- Service availability (or usability) indicates the time that the service is available (or usable).

- Common terms and definitions with availability/usability are
  - **MTBF - Mean Time Between Failures**
  - **MTBI - Mean Time Between Interruptions**
  - **MTTR - Mean Time To Recover**
  - **These define the availability slightly better than just plain percentage values.**
    - Not a vague definition “over time t…”
    - Not just one long break in the service

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<th>MTBI (pv)</th>
<th>MTTR (min)</th>
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Service Level Agreement – costs of ISP

- The level of SLA parameters defines the cost of offering the service (for the ISP)
  - Key objective: Aim for high utilization!
    - Exact knowledge of traffic profile and behavior
    - Or accept the fluctuation of the service level (because of statistical multiplexing)
  - Low level of utilization increases the unit cost (significantly)

- **Example:** 99.99% usability over one week period means a service that is unusable for less than a minute (within that same week)
  - This does not make it possible even to maintain the equipment without redundancy
    - Redundant equipment (and access to the network)
  - 99% usability enables the maintenance without contract violation
ISP ideal

- The aim of the ISP is
  - To increase incoming cash flow
    - Higher unit price to services with higher priority
    - Utilize network infrastructure to the fullest
      - Statistical multiplexing
  - Ensure market position

What do you sell with SLAs?

- Managed services
  - Including
    - (Differentiated) network service
    - Value add services
      - Email
      - WWW
      - Security services
  - Built upon
    - The know how and equipment of the ISP
  - Covering
    - ISPs own network
    - Outside of ISPs network only a limited set of services are offered
Measuring service quality

• **When defining quality measure, remember to measure only that what is quantitative**
  
  – Measured value should be defined in the SLA so that they can be measured by the operator and customer alike. (Delay, BW, Packet drops)
  
  – Do not attach any qualitative or otherwise unexact values (no “feelings of good network service level”)
  
  – Vague definitions lead to controversy that most probably lead to a sensation of unsatisfying (total) quality of service.

  • “Collective effect of service performances which determine the degree of satisfaction of a user of the service” [ITU-T E.800]
Measuring service level

• Quantitative service level (measure)
  – Describes the service performance on different (protocol) levels
  – Defined unambiguously
    • Service logic illustrated as flow chart
    • Numerical values of performance attached
      – Can be measured

• Qualitative service level (based customer experience)
  – Illustrates the service level/service response experienced by the customer
  – The response depends on factors that cannot be measured
  – Ambiguous definition
    • Can not be measured

It is in the best interest of the customer to control that the contract (=SLA) is fulfilled.
  – Measure the parameters mentioned in the SLA with the best applicable practice (that could also be documented in the SLA)

• Service is measured where service is used
  – Customer premises, workstations, access points
  – From the transit point towards the ISP value add service point.
Measuring service level

- Typically measured between the transit points
  - Service guarantees reach to these points but not beyond.

Measuring VPN-service

- At the ends of VPN-tunnels or measurement points within the customer network
  - Independent measurements between all points
Application service measurements

- The ASO has measurement points within its network.
  - The usability is checked from these points
    - Placed at least to transit points

Summary on SLAs

- Network operators and their customers use service level agreements (SLA) to come to an understanding on the offered network service level and means to verify it.
  - Actual form and content of an SLA always depends up on the negotiations between provider and customer.
- In an ideal situation SLA verification process should include both active and passive measurements.
  - Passive measurements consist of network equipment monitoring, service monitoring and traffic monitoring to determine throughput, capacity usage and delays.
  - Active measurements interfere with the existing workload by inserting measurement probes to monitor for delays, losses, response times etc.