Access networks – Services
What services? - Triple Play
Triple Play – economical reasons

Voice/data inflection point
Internet > Voice
=> Best Effort (WWW)

Video inflection point
Video+VoIP > Best Effort
=> Triple Play architecture

DSL Broadband
Best-Effort Internet
~128 kb/s per subscriber

Source: Alcatel
Convergence

- Service convergence
- Device convergence
- Network convergence
The network convergence

One provider - everywhere
- Common services
- Common profile
- Common billing

Beneficial for
- Provider
- User
Changing Trends

- **Fixed line** based services are decreasing
- **Mobile users** are increasing despite that penetration is high
- **Broadband Internet** installations are increasing
## Convergence of operators

<table>
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<th>Data</th>
<th>Video (TV)</th>
<th>Mobile</th>
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Video services

- IPTV – Broadcast
  - SDTV
  - HDTV
  - Typical implementation: Multicast

- VoD – Video on Demand
  - Bandwidth depends on content quality
  - Typically unicast

- Other services (Time-shift, etc) – do not represent different requirements
Video service architecture

- STB
- HGW
- ADSL2+ or VDSL DSLAM
- Aggregation
- Edge Router
- Video Server
- TV Source

Home network | First Mile (DSL) | Ethernet aggregation
VoD vs. IPTV

● A VoD service requires higher bandwidth!

● IPTV broadcast, 300 channel bandwidth demand
  ● 300 MPEG-2 channel, 1.5Mbit each =~1Gigabit

● VoD bandwidth demand – depends on # of users
  ● 20000 user 10%-os peak usage =~7.5Gbps

● The IPTV is more important – priority over the VoD
  ● High availability => overprovisioning, protection
Voice services - VoIP

- VoIP – cost effective
  - The HGW has gateway function or IP phone is required
  - Service convergence

- VoIP protocols
  - IP, TCP, UDP (User Datagram Protocol)
  - RTP (Real Time Protocol), RTCP (Real Time Control Protocol)
  - SIP (Session Initiation Protocol), H.323 (ITU-T)
VoIP service architecture

- Coding, framing, queuing
- Buffering
- Transport
- Jitter buffer
- Decoding

- Home network
- First Mile (DSL)
- Ethernet aggregation
Data communication - HSI

- Typical usage
  - Internet access
  - VPN access

- Requirements
  - Best Effort
  - 1.5-2 Mbps usually enough
    - Except heavy p2p
HSI service architecture

PPPoE

PC

HGW

ADSL2+ or VDSL
DSLAM

Aggregation

BRAS

Internet
Triple-Play network requirements

- **Video**
  - Low delay, low jitter, no loss
  - High bandwidth
  - Effective broadcast/multicast mechanism
  - VoD scalability
  - Below 1 sec recovery

- **Voice**
  - Low delay and Jitter
  - Low loss
  - Sub-second recovery in case of failure

- **HS Internet**
  - Guaranteed bandwidth
  - Possible bursty transfer

- **Business users**
  - Guaranteed bandwidth
  - Low packet loss ratio
  - 50ms protection

- **General**
  - Good cost/performance ratio
  - Signaling support
  - Network – service cooperation
  - Support for resilient architecture
Generic service architectures

- Access network-
Service Architecture

![Diagram of Service Architecture](image)
Ethernet in the MAN

- Large scale deployment anticipated
  - MAN - Metro Ethernet
  - First mile: EPON, GPON

- “Carrier grade” requirements:
  - Scalability: many thousands of users
  - Restoration, protection: high availability required (5x9), 50ms
  - Service management (OAM)
  - QoS support: SLA, guarantee
  - Security

- Ethernet based services
  - Standardization in progress
Standardization

- MEF: services – from user perspective
- ITU-T: services – from network perspective, restoration and protection
- IEEE: Higher level functions: Ethernet OAM, provider bridges, EPON
- IETF: Ethernet over MPLS (Ethernet wire) és VPLS (Virtual Private LAN Service)
Single-Edge architecture
Single Edge - 2

- Old fashioned architecture
  - PPPoE tunnel to the BRAS

- Strengths
  - Authentication
  - Traffic containment
  - Security

- Drawbacks
  - Multicast is not possible
    - Big disadvantage for IPTV!
Multi-Edge architecture
Multi-Edge architecture - 2

- Internet access still uses PPPoE
  - Internet access through the BRAS
- VoIP and Video uses IPoE
  - IP address by DHCP
  - Service access through BNGs
- Advantages
  - Multicast possibility
  - Less overhead
  - Lower load at the BNG
IPoE and PPPoE

- PPPoE – Point to Point Protocol
  - Authentication: user/pass, line ID
  - PPP tunnel ends in the BRAS
  - Connection oriented
  - Not all devices support

- IPoE – DHCP
  - Authentication: MAC addr, +DHCP option line ID
  - „flat rate online”
  - Connectionless, Multicast is possible
  - All devices support
PPPoE overhead

- PPPoE
  - Two level L2 encapsulation
  - 10 byte overhead for each packet
  - PPPoE supports only point-to-point

- IPoE
  - Fancy name for the basic IP/Ethernet encapsulation
IPoE and PPPoE: requirements

- In both cases the authentication can be done at the DSLAM
  - PPP termination is required at the DSLAM

- PPPoE
  - PPPoE intermediate agent is required to add additional information to PPPoE packets

- IPoE
  - DHCP option 82 for line identification
  - DHCP relay agent to convert DHCP request to unicast
Definitions Auto configuration and AAA

Autoconfiguration: process of establishing a connection

AAA

Authentication
- process of determining whether someone or something is, in fact, who or what it is declared to be.
- based on identifiers and security attributes.
- part of an actual access to a network/service in the context of a SLA or contract, and often is linked with a fee (Accounting)

Authorization
- process of giving individuals access to system objects based on their identity.

Accounting
- recording, classifying, summarizing, and interpreting of events of a financial character in a significant manner
Autoconfiguration: PPP model

- Characteristics:
  - PPP = Point-to-Point Protocol
  - PPP session performs (between CP modem - PPP peer)
    - Link establishment (LCP packets)
    - Authentication (optional, PAP or CHAP)
    - Network-layer protocol (NCP packets: e.g. IPCP: CP gets its IP@)
  - PPP encapsulation stays during session
- Origin of PPP for Internet Access via voice band modems (fig.)
  - Continued to be used in DSL
PPPoE

- PPPoE needed when PPP transported over Ethernet: allows
  - transport over shared medium
  - PPP session multiplexing

- Autoconfig Procedure:
  - Detection of server(s): PPPoE Active Discovery Initiation (PADI)
  - Server(s) reply: PPPoE Active Discovery Offer (PADO)
  - Choice of server: PPPoE Active Discovery Request (PADR)
  - Server confirmation: PPPoE Active Discovery Session-confirmation (PADS)
### PPPoE initialisation

**PPPoE Client**
- **Ethernet:**
  - DA: Broadcast
  - SA: User MAC@
  - ISP-Name

**Modem Terminator**
- **<PADI>**
- **Ethernet:**
  - DA: Broadcast
  - SA: User MAC@
  - ISP-Name

**Access Node**
- **<PADO>**
  - **Ethernet:**
    - DA: Unicast/Multicast
    - SA: User MAC@
    - ISP-Name

**Ethernet Switch**
- **<PADR>**
  - **Ethernet:**
    - DA: Server MAC@
    - SA: User MAC@

**PPPoE Server in Edge Node**
- **<PADS>**
  - **Ethernet:**
    - DA: Server MAC@
    - SA: User MAC@
Autoconfiguration : DHCP model

● Characteristics :
  ● DHCP = Dynamic Host Configuration Protocol
  ● DHCP works in client/server mode
  ● DHCP is carried over IP, only during config phase
  ● DHCP session (host - server) :
    – delivers host-specific config parameters
    – allocates NW addresses to host
      ● automatic : permanent IP@
      ● dynamic : leased IP@ (limited time)
      ● manual

● Autoconfig procedure :
  ● Discovery of DHCP server (DHCPDISCOVER)
  ● Replies of server(s) (DHCPOFFER)
  ● Host selects server (DHCPREQUEST)
  ● Server acks and sets config (DHCPACK)
Mac Forced Forwarding

● DSLAM only sends to BNG
  ● All other dropped

● Operation:
  ● PPP: sends to BRAS only
  ● IPoE:
    – ARP request results in BNG address always
    – Packets sent to other destinations dropped

● Can also be done with VLANs
DSLAM acts as PPPoE relay
The PPPoE relay adds PPPoE line and DSLAM ID in PPPoE VSA
The BRAS forwards the information as NAS Port ID
**DHCP option 82**

A DHCP 82 option contains:
- DSLAM ID, DSLAM port ID
- PVC
- Or any other information such as phone number
QoS

- End-to-end
  - From user to Video/VoIP server
    - In fact to the BNG

- Possible bottlenecks
  - First mile
  - Ethernet Aggregation
  - Regional IP core

- The interworking between technologies is required
QoS support

● Priority based on 802.1Q VLAN tag
  ● 3 bit = 8 classes
● The priority bits described in 802.1p
  ● VLAN priority and IP TOS are similar
  ● Not all switches support 8 classes

● P-bits are in VLAN header, but not associated to the ID
Multicast

- Very important in case of broadcast video
  - Support needed in aggregation too
- In case of PPPoE it is not possible
  - Except if the PPPoE is terminated at DSLAM
  - If it terminates at the BRAS, each user gets in Unicast from BRAS
- Possible with IPoE
  - Support needed: IGMP snooping
  - The DSLAM can be IGMP proxy
    - Lower load on the multicast router
Metro Ethernet Architecture

Triple Play implementation
Optimal network utilization

- Different solution for each service
- Video
  - Multicast, low statistical multiplexing
    - Possible gain since video is VBR, with many channels
- VoIP
  - Call level statistical multiplexing
    - Erlang formulas help in dimensioning
- HSI
  - Packet level statistical multiplexing
    - Multiple models exist, e.g. Guérin
Thank You for your attention!

Questions?