ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

Multimedia Technology

Section # 18: IPTV

Instructor: George Xylomenos

Department: Informatics

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- Traditional TV
- IPTV services
- IPTV implementation
- IPTV issues

Traditional TV

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What is Television? (1 of 2)

- A set of channels is transmitted
  - Each with video, audio, subtitles (and teletext!)
- The user selects a channel
  - Can change it at any time
  - Small delay during channel change
- Channels do not depend on users
  - Everyone watches the same content
  - Ideal for broadcast (or multicast)

What is Television? (2 of 2)

- Service characteristics
  - Within a service area
  - Number of available channels
  - Media quality (video / audio)
  - Analog or digital transmission
  - Analog or digital encoding
  - Channel change time
    - This is the bane of digital encoding!

Service types (1 of 3)

- Terrestrial TV
  - Uses UHF band (previously, VHF)
  - DVB-T for digital transmission
  - One antenna (or two) at some high point
    - Otherwise, TV tower needed
  - Limited number of channels
    - Channels use up precious bandwidth
    - UHF is ideal for mobile telephony!

Service types (2 of 3)

- Satellite TV
  - SHF bands (C-band, 4-8 GHz)
  - DVB-S for digital transmission
  - TV satellites cover large areas
    - Hard to reuse frequencies
    - Competition from other applications
  - Requires extra reception equipment
    - Satellite dish, amplifier, decoder

Service types (3 of 3)

- Cable TV
  - HFC network (Hybrid Fiber - Coax)
    - Large costs to lay down cable
    - Does not take up radio frequencies
    - May have very large number of channels
  - DVB-C for digital transmission (in Europe)
  - Requires simple equipment (just a tuner)
    - Often, embedded in the TV

IPTV services

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Why IPTV? (1 of 3)

- Disadvantages of terrestrial and satellite
  - Competition for radio frequencies
  - Limited number of channels
  - Requires special equipment (antennas, dishes)
- Disadvantages of cable
  - Requires laying our cable
    - Can also be used for Internet
    - Combines two networks (like DSL)

Why IPTV? (2 of 3)

- IPTV services
  - TV transmission over the Internet
    - Media sent inside IP packets
    - Can be combined with HFC or DSL
    - Can coexist with VoIP telephony
  - One network for everything
    - IP routers
    - Ethernet switches

Why IPTV? (3 of 3)

- Exploits well-known technologies
  - IP for routing
  - RTP/RTCP for media transport
  - HTTP for additional services
    - Web-based program guide
  - Allows encrypted content
    - Pay per view channels
    - Decoded in a set-top box (STB)

Problems to solve

- IP does not guarantee anything!
  - Fluctuating traffic -> fluctuating quality
  - Same problems as for VoIP telephony
- Needs a “special” network
  - Differentiating IPTV data
  - Applying priorities
  - Normally, limited to a single ISP
    - Example: Cosmote TV

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IPTV implementation

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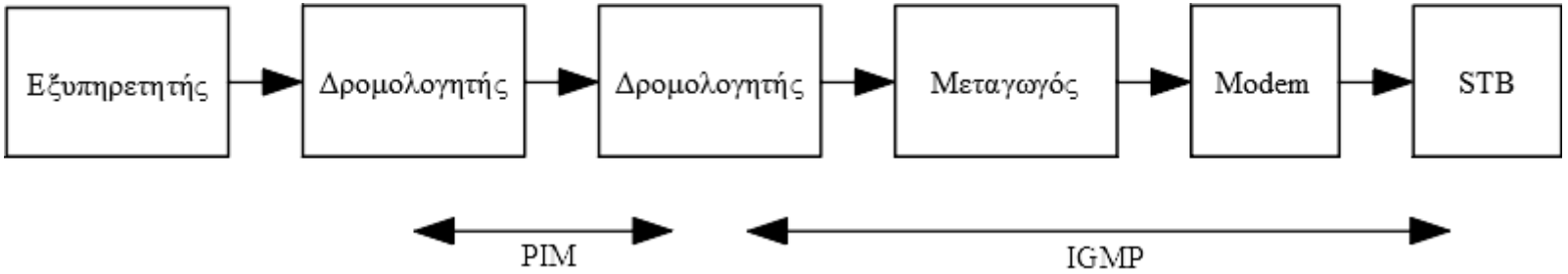
Network overview



- IPTV relies on IP multicast
  - The server sends each channel to a class D address
    - Constant bit rate per channel
  - Routers use PIM for multicast
    - Limited to ISP's core network
  - Users rely on IGMP for channel selection
    - Requires some extensions to the access network

Servers (1 of 2)

- Normally, two separate servers used
- Media server
  - Sends each channel to separate address
    - Uses multicast to cover all users
    - Does not get any feedback from users
  - Typically, all channels sent all the time
  - May be replicated for reliability
    - But, due to multicast, it has a constant load

Servers (2 of 2)

- Program server
  - Plain web server
  - Shows a web page with the channels
  - STBs are connected to this server
    - To get the IP address of the channel
  - Load depends on the number of users
    - Normally, a server farm for scaling
    - Load balancer assigns users to servers

Core network (1 of 2)

- Transport from media server to POP
  - Accepts one media stream per address
    - Each channel corresponds to one address
  - Each POP asks for the channels it wants
  - PIM used to route streams to the POPs
    - Alternatively, MPLS may be used
  - Bandwidth reserved to ensure service
    - Channels need a constant bitrate

Core network (2 of 2)

- Do we actually need multicast?
  - That depends on the network
  - Networks are usually simple
    - Simple mesh with few nodes
  - Most of the time, each POP wants all channels
    - Say that a POP handles 10,000 subscribers
    - Most likely, at least one user will want each channel
  - We could just use broadcast!

Access network (1 of 8)

- From POP to user, we turn to switching
  - The network is quite simple
    - Basically, a tree!
    - Some extra links for reliability
    - It is derived by the telephone network
  - IP routers are expensive
  - Ethernet switches are cheaper
    - And with very high port density

Access network (2 of 8)

- But: Ethernet does not do routing!
- In IP, addresses are not random
  - Each router handles a range of addresses
  - Its parent handles a larger range
  - Essentially, routing is hierarchical
- In Ethernet, addresses are random
  - They start with a manufacturer prefix
  - Then, just a production sequence number
  - In practice, inside a LAN they seem totally random

Access network (3 of 8)

- How do we know where to forward a frame?
  - Say that a frame was received from port i
  - We mark down who the sender was
    - The sender must be reachable via port i
  - If we have not seen the receiver before
    - Broadcast to all other ports
  - If we have seen the receiver before
    - Unicast via the appropriate port
  - Gradually, the switch learns the addresses

Access network (4 of 8)

- The Spanning Tree Protocol (STP)
  - Ethernet must be a tree
    - Otherwise, packets will keep getting broadcast
  - What can we do with the extra links?
    - STP protocol creates a LAN map
    - A root is elected for a LAN tree
    - Some links are disabled to make it a tree
    - If a link goes down, we enable them again

Access network (5 of 8)

- Multicasting changes this picture
  - The group address is virtual
    - Special Ethernet address
    - No packets ever come from there
  - Packets are always sent via broadcast
    - To all ports except the incoming one
  - All channel packets reach every user!
    - But we do not have that kind of bandwidth

Access network (6 of 8)

- The solution: IGMP Snooping
  - IGMP operates at the network layer (IP)
  - Some switches “snoop” inside the frames
  - They monitor IGMP packets
    - A REPORT on port i means forward the channel on i
    - A LEAVE on port i means drop the channel on i
    - These messages do not get always forwarded
    - Only the first REPORT and the last LEAVE
    - This basically truncates the broadcast tree

Access network (7 of 8)

- Client modem
  - And router/firewall/switch
  - Receives all data from the Internet
  - Splits other data from IPTV (and VoIP)
    - They reside in different VLANs
  - Applies priorities
    - IPTV (and VoIP) are prioritized for quality
  - Just forwards the IGMP message

Access network (8 of 8)

- STB (Set Top Box)
  - Provided and programmed by the ISP
  - Connects to the internal LAN/WLAN
  - Part of the IPTV VLAN
  - Connects to program server
    - To find the IP address for each channel
  - Depending on channel choice, sends a message
    - IGMP REPORT for the new channel
    - IGMP LEAVE for the old channel

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IPTV issues

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Channel changes (1 of 3)

- Channel change in analog TV
  - Must tune to new channel
  - And wait for the next field
  - Delay of up to 1/50 or 1/60 sec
- Channel change in digital TV
  - May need to tune to new channel
  - And wait for next I-frame
    - We cannot start decoding without it!

Channel changes (2 of 3)

- Channel change in IPTV
  - Send REPORT (new) and LEAVE (old)
    - Sent by the STB
  - Forwarded towards tree root
- REPORT stops at a node receiving the channel
  - Someone already watches the channel downstream
  - This allows the data stream to flow
  - Channel must be decoded at the receiver
  - Which also requires an I-frame

Channel changes (3 of 3)

- LEAVE stops when other ports are live
  - Someone still watches the channel downstream
  - Data flow stops from that point
  - Some bandwidth wasted up to then
- Speeding up channel change
  - Unicast new channel to user
  - Stops when multicast arrives
  - Some bandwidth wasted

Routing changes

- Say that a link fails
  - If there is an alternative link, it is enabled
    - It was previously disabled by STP
  - The distribution tree changes
  - Some port states will be wrong!
    - The source frames will come from other ports
    - Specifically, REPORT/LEAVE frames!
    - Network needs to fall back to broadcast

Customers in other networks

- IPTV relies on a custom network
  - With priorities, multicasting, IGMP snooping
  - Normally, be restricted within an ISP
  - What happens if the customer is elsewhere?
    - For example, on a cell phone
  - We either do not provide the service
  - Of offer it OTT (over the top)
    - See next section on streaming

End of Section # 18

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