Digital video broadcasting module

IPTV AND INTERNET TV

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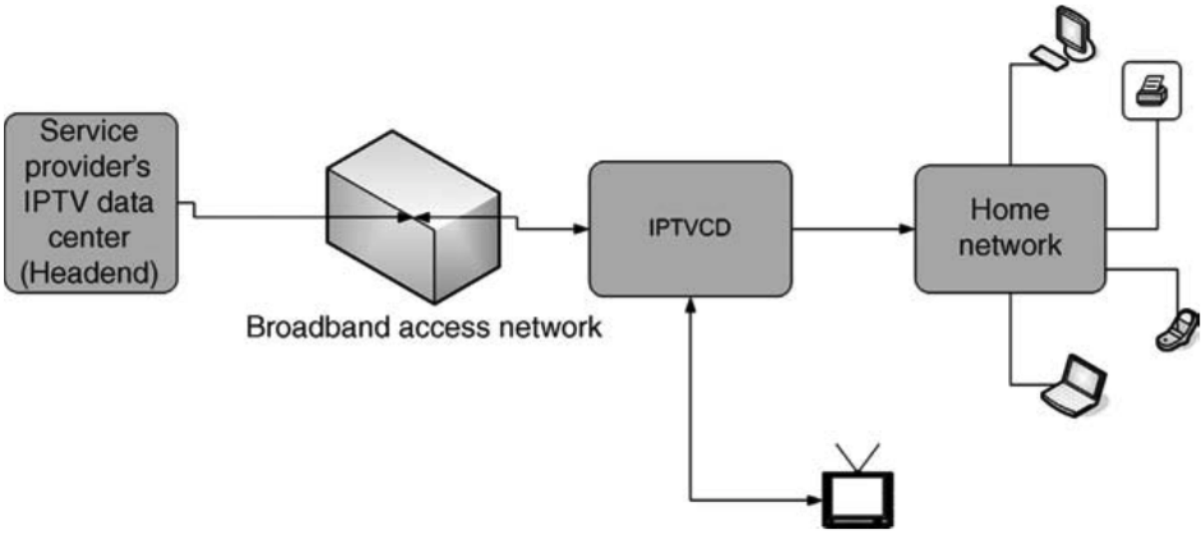
Week4: Day-4

Differeces between IPTV and Internet TV

- Different platforms
    - Internet TV leverages the public Internet to deliver video content to end users. IPTV, on the contrary, uses secure dedicated private networks to deliver video content to consumers. These private networks are managed and operated by the provider of the IPTV service.
- Geographical Reach
    - Networks owned and controlled by the telecom operators are not accessible to Internet users and are located in fixed geographical areas. The Internet, on the contrary, has no geographical limitations where television services can be accessed from any part of the globe
- Ownership of the Networking Infrastructure
    - Internet Protocol packets used to carry the video may get delayed or completely lost as they traverse the various networks that make up the public Internet. As a result, the providers of video over the Internet content cannot guarantee a TV viewing experience. In fact, video streamed over the Internet can sometimes appear jerky on the TV screen and the resolution of the picture is quite low. The video content is generally delivered to end users in a “best effort” fashion.
    - In comparison to this experience, IPTV is delivered over a networking infrastructure, which is typically owned by the service provider hence supporting the end-to-end delivery of high quality video.
- Access Mechanism
    - A digital set-top box is generally used to access and decode the video content delivered via an IPTV system whereas a PC is nearly always used to access Internet TV services. Depending on the content, a dedicated media player and a robust digital rights management (DRM) system could be required to support the access to the content.
- Costs
    - A significant percentage of video content delivered over the public Internet is available to consumers free of charge. This is however changing as an increasing number of media companies are starting to introduce fee-based Internet TV services. The costing structure applied to IPTV services is similar to the monthly subscription model adopted by traditional pay TV providers. Over time, many analysts expect Internet TV and IPTV to converge into a central entertainment service that will ultimately become a mainstream application.
- Content Generation Methodologies
    - A sizeable portion of video content generated by Internet TV providers is user-generated and niche channels, whereas IPTV providers generally stick with distributing traditional television shows and movies, which are typically provided by the large and established media companies.

Simplified block diagram of IPTV system



- Data centre (also called as headend)
    - Ingestion of contents from various sources incl. local video, content aggregators, content producers, cable, terrestrial, and satellite channels
    - Processing contents with number of components incl. encoders and video servers to IP routers and dedicated security hardware, subscriber management system
- Broadband delivery network
    - To establish one-to-one connections using Hybrid fiber and coaxial based cable TV infra- structures and fiber based telecommunication networks
        - Multicasting is also possible over fiber
- IPTV consumer devices (IPTVCD)
    - Connects to the broadband line and responsible for decoding and processing the incoming IP-based video stream as well as eliminating the effect of the network on the quality
- Home network
    - Small geographical area where all members of a family can connect their devices to the main hub such as IPTVDC

Main service flow interactions in a DVB IPTV network

- The main services are:
  - Service and service provider discovery
  - Live media broacast (LMB) service connection and streaming
  - Content-on-demand (CoD) and Live Media Broadcast with Trick Model (LMBwTM) service selection streaming and streaming control
  - Content download service (CDS) selection and download
  - Remote management service (RMS) firware update service (FUS)
- Once the HNED (headend) is equipped with an IP address, the HNED engages in the following steps:
  - Step0: through RMS-FUS, the HNED can be provided with the right configuration (e.g. at boot-up)
  - Step1: the DVB HNED first performs service provider discovery (e.g. through SD&S or via DHCP) and hence connects to an SD&S entry point
  - Step2 & 3: the DVB HNED discovers services by connecting to the SD&S service of a specific service provider and/or by receiving information from broadband content guide delivery server.
  - After receiving all necessary metadata, HNED can start consuming other services from the DVB IPTV service provider of its choice as examplified through flows 4, 5, and 6 in Figure 1
  - Flow 4 involves the connection to a Live Media Broadcast Service transported over multicast and subsequent streaming whereas flow 5 depicts the connection of an HNED to a Content-on-Demand Server (using RTSP) and subsequent consumption of the unicast content. Flow 6 depicts the connection to and consumption of the Content Download Service (unicast or multicast).

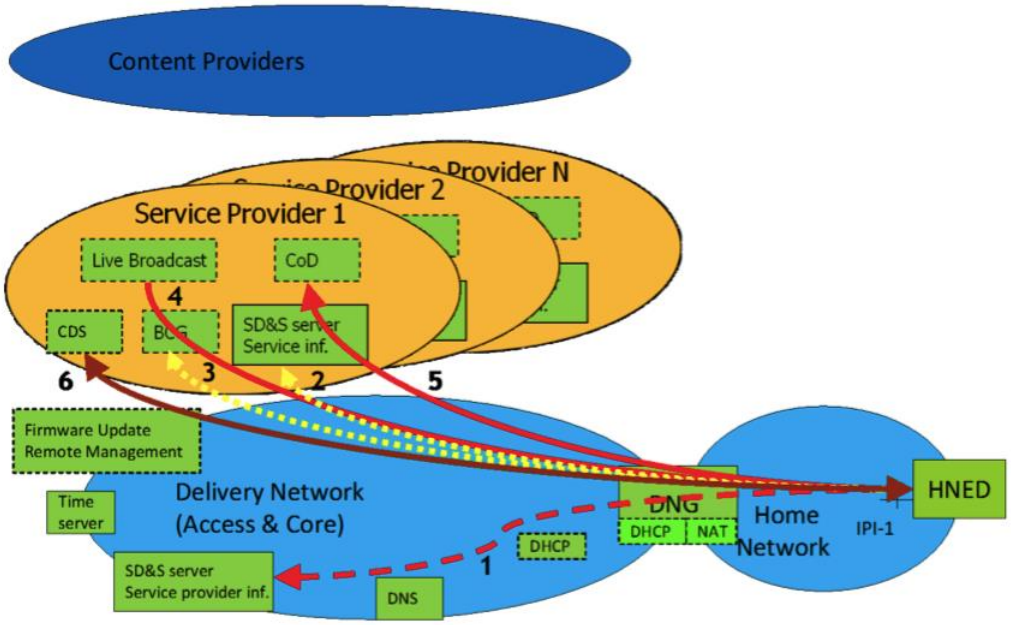
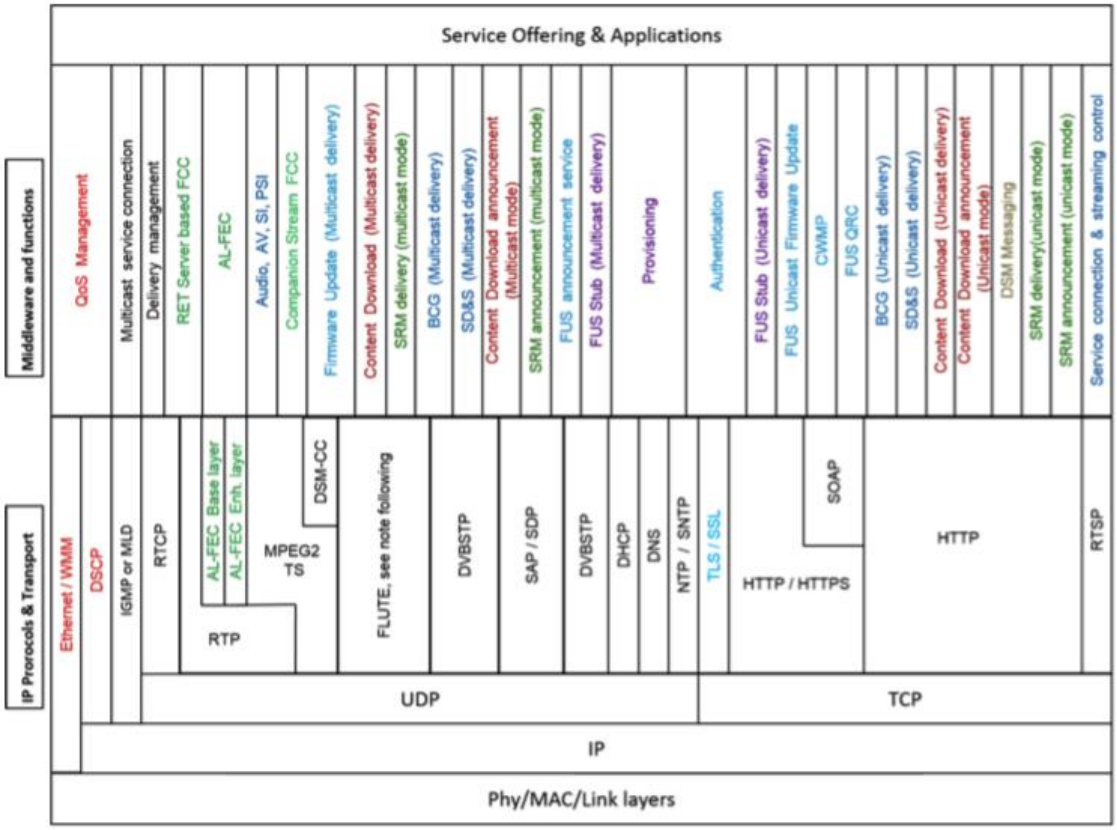


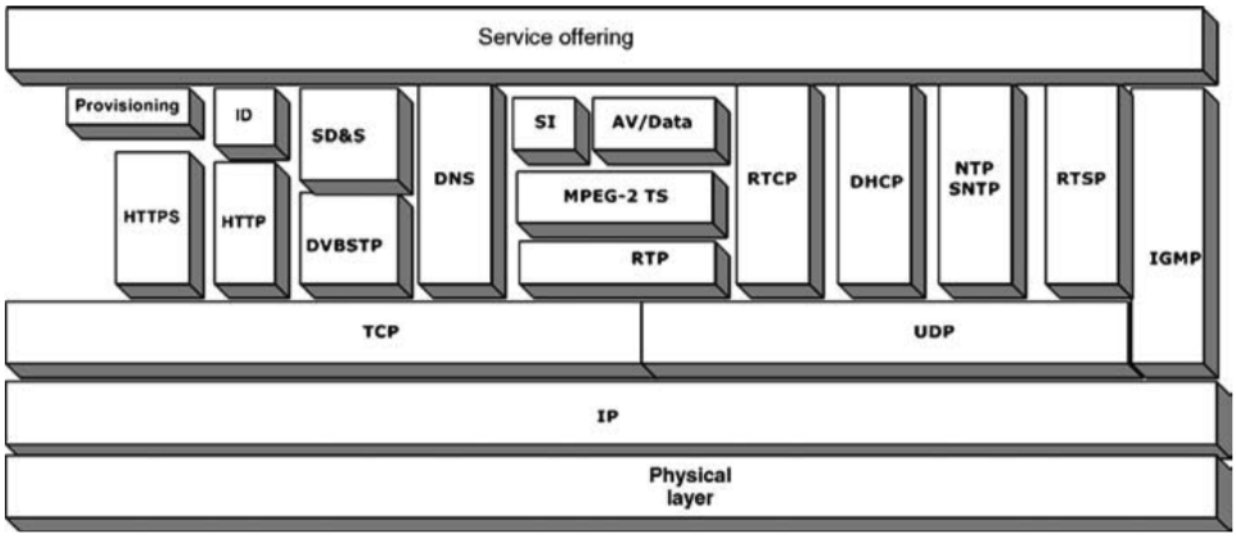
Figure 1: schematic overview of the main service flow interactions in a DVB IPTV network

Protocol stack of DVB IPTV services



NOTE 1: The profile of DSM-CC used for firmware delivery for RMS-FUS is as specified in ETSI TS 102 006 (V1.3.2) [105].
NOTE 2: The information exchanged in RTSP may be conveyed in an XML or SDP format.
NOTE 3: TLS/SSL indicates that either TLS or SSL can be used.
NOTE 4: HTTP/HTTPS indicates that either HTTP or HTTPS can be used.
NOTE 5: DSM-CC is the transport protocol used for SRM and RMS-FUS but has no relationship with Dynamic Service Management.

DVB-IPI protocol framework



IPTV network distribution technologies

- One of the primary challenges faced by IPTV service providers is providing enough bandwidth capacity in the network segment that lies between the core backbone and the end-users' home.
- A number of terms are used to describe this segment ranging from "local loop" and "last mile" to edge and broadband access network.
- There are six different types of broadband access networks that are scalable enough to meet the bandwidth requirements of IPTV:
    - Through a network built with fiber
    - Via an DSL network
    - Via a cable TV network
    - Via a satellite based network
    - Via a fixed wireless broadband connection
    - Via the Internet

IPTV over fiber access network

- Why fiber:
  - Increasing demand in bandwidth
  - Lower operating costs
  - Immunity in electromagnetic interference
  - Economic as multiple service operators (MSO) can use the fiber network
  - A very good candidate for IPTV services

❖ Supporting architectures for fiber networks:
  - Fiber to the regional office (FTTRO)
    - Fiber is used from IPTV data center to the nearest regional office owned by the telecommunication or cable company. Then, existing copper wiring is then used to carry signals from the regional office to the IPTV end user.
  - Fiber to the neighborhood or fiber to the node (FTTN)
    - Fiber is used from IPTV data center to a neighborhood splitter (node) located within 5000 ft from the subscriber. Digital subscriber line (DSL) over copper wire is then utilized to make the final link to the customer.
    - This would enable to offer a complete bundle of pay services incl. IP based TV, HD TV, VoD, etc.
  - Fiber to the curb (FTTC)
    - Installation of fiber within 1000 ft of home or business. Then coaxial cable or copper wire is used to connect optical fiber terminal at the curb on a street to the residential gateway.
  - Fiber to the home (FTTH)
    - Entire route from IPTV data centre to within the home is connected by optical fiber. Deployment costs of optical fiber is similar to installing copper cables, but provides higher bandwidth. FTTH is a full-duplex communication system and supports the interactive nature of IPTV services.
  - Fiber to the apartment (FTTA)
    - Distribution of the fiber cables from the central gateway located in the apartment block to each individual apartment.

Fiber optic deilvery methods

- Fiber optic network architectures can be delivered based on any of the following two approaches:
    - Passive Optical Network (PON)
        - It refers to point-to-multipoint networking topology that makes extensive use of fiber optic cabling and optical components – depicted in fig. 1
        - The OLT (optical line termination) uses components such as fiber cable and optical splitters to route network traffic to the ONTs (optical network terminals).
            - Fiber cable: OLT and various ONTs are interconnected by fiber optic cablling.
            - Optical splitters: to split/merge optical signals without transformations (e.g. to electrical pulses). Splitters allow up to 32 households to share the FTTx network bandwidth and are typically housed in accessible mechanical closures.
            - Wavelendth Division Multiplexer (WDM) is installed at the data center and inside the OLT that allow a PON to support the transmission of multiple parallel channels or wavelengths on the one piece of fiber.
    - Active Optical Network (AON)
        - It makes use of electrical components between the IPTV end user and the data center. In particular, the AON networking architecture utilizes Ethernet switches that reside between the IPTV data center and the end-point of the fiber network.

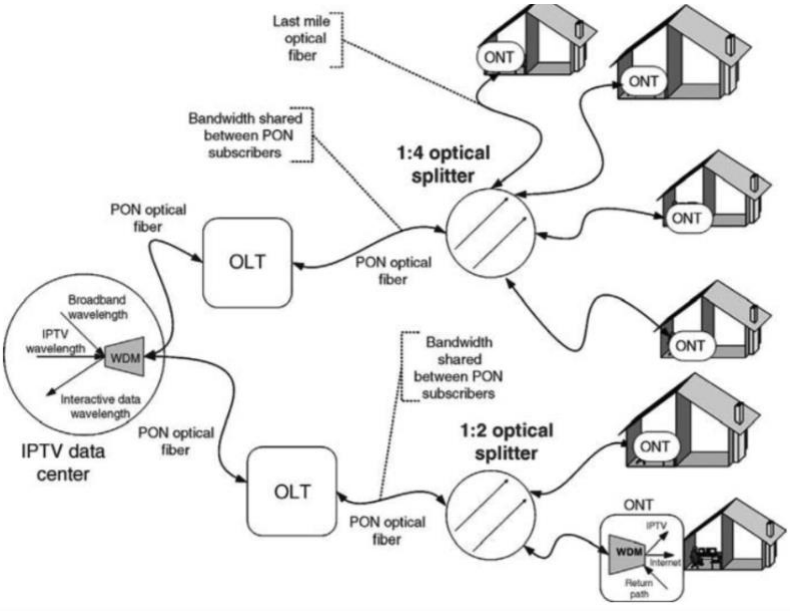


Figure 2: IPTV FTTH network using PON technologies

PON technology variants

- BPON – broadband PON
  - uses assymetric transmission method
  - downstream: one to one connection
  - upstream: time slot (reduced collision but also data rates)
  - can be configured for symmetric data traffic too
  - uses ATM which is popular for transferring high speed data using cells (header: 5 bytes and data: 48 bytes)
- EPON – Ethernet PON
  - Only supports Ethernet traffics and rates depend on the distance between OLT and ONTs.
- GPON – Gigabit PON
  - An upgrade to BPON specification supporting higher transmission rates, multiprotocols such as ATM, Ethernet, SON and also enhanced security features.

❖ Technology comparison:

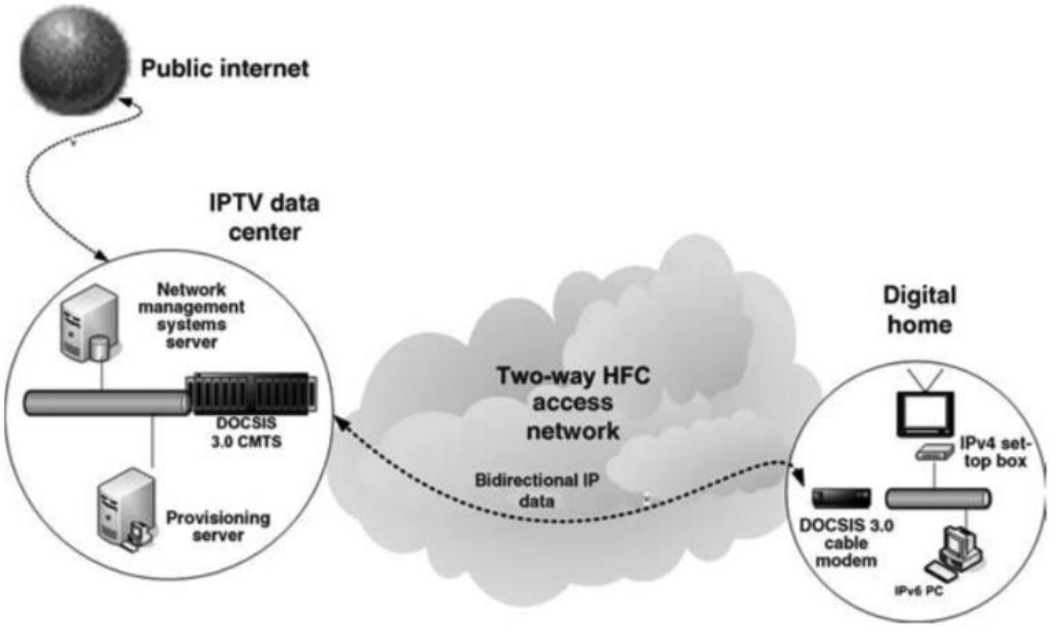
	ITU-T Specification	Data Rates	Transmission Protocol
BPON	G.983	622 Mbps downstream and 155 Mbps upstream	Primarily ATM however IP over Ethernet will also operate on the network
GPON	G.984	2.5 Gbps downstream and 1.5 Gbps upstream	Ethernet and SONET
EPON	P802.3ah	1.25 Gbps downstream and 1.25 Gbps upstream	Gigabit Ethernet

IPTV over DOCSIS

- DOCSIS: Data over Cable Service Interface SpecificationTheory
- Technology specification:

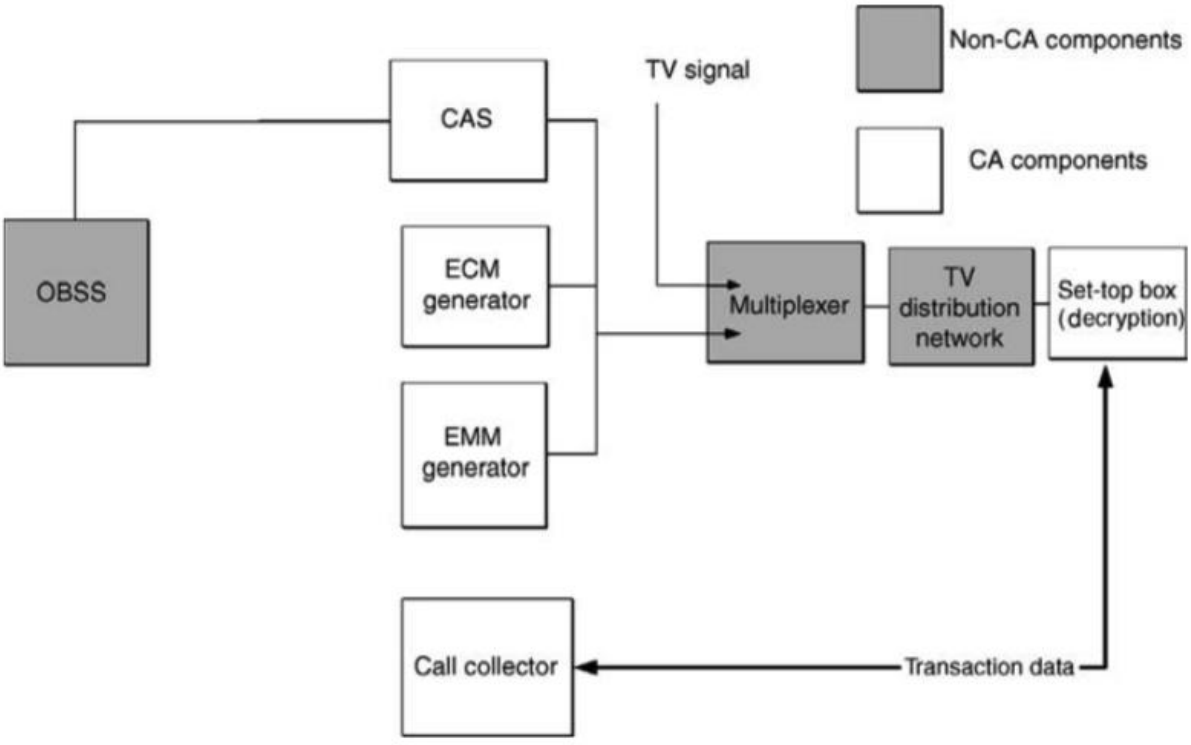
	DOCSIS 1.0	DOCSIS 1.1	DOCSIS 2.0	DOCSIS 3.0
Maximum downstream broadband capacity (Mbps)	40 and 55	40 and 55	40 and 55	160
Downstream frequency range (MHz)	50–750	50–750	88–870	88–1002
Maximum upstream broadband capacity (Mbps)	10	10	30	120 and above
Upstream frequency range (MHz)	5–42	5–42	5–42	Support for 5–42 MHz is mandatory. Manufacturers also have an option of using the 5–85 MHz frequency range
Modulation scheme	QPSK and 16 QAM	QPSK and 16 QAM	QPSK, 8 QAM, 16 QAM, 32 QAM, 64 QAM, and 128 QAM	QPSK, 8 QAM, 16 QAM, 32 QAM, 64 QAM, and 128 QAM
Upstream channel width	200 kHz, 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz	200 kHz, 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz	200 kHz, 400 kHz, 800 kHz, 1.6 MHz, 3.2 MHz, 6.4 MHz	1.6,3.2 and 6.4 MHz. Note that support for the 0.2, 0.4 and 0.8 MHz channels are optional for this version
Support for version 6 of the IP addressing system	No	No	No	Yes

- Highlevel networking infrastructure:

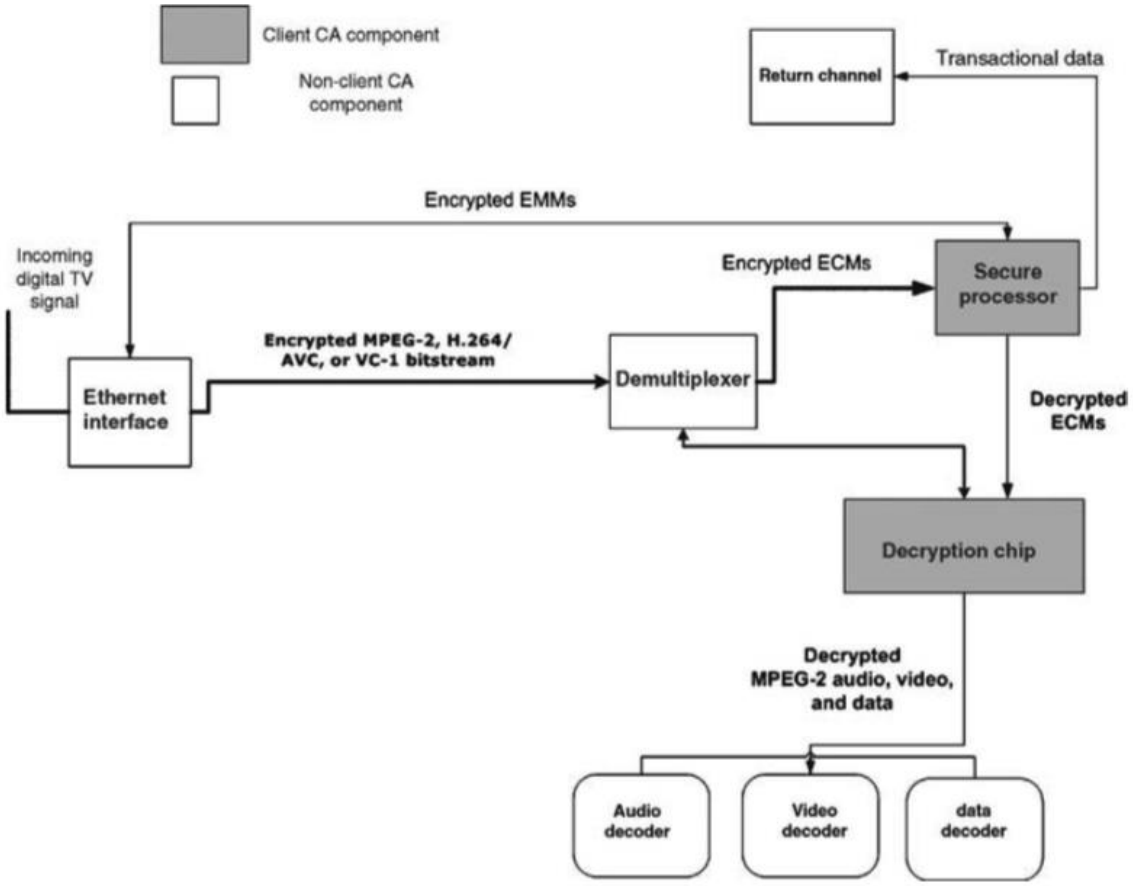


Security in IPTV

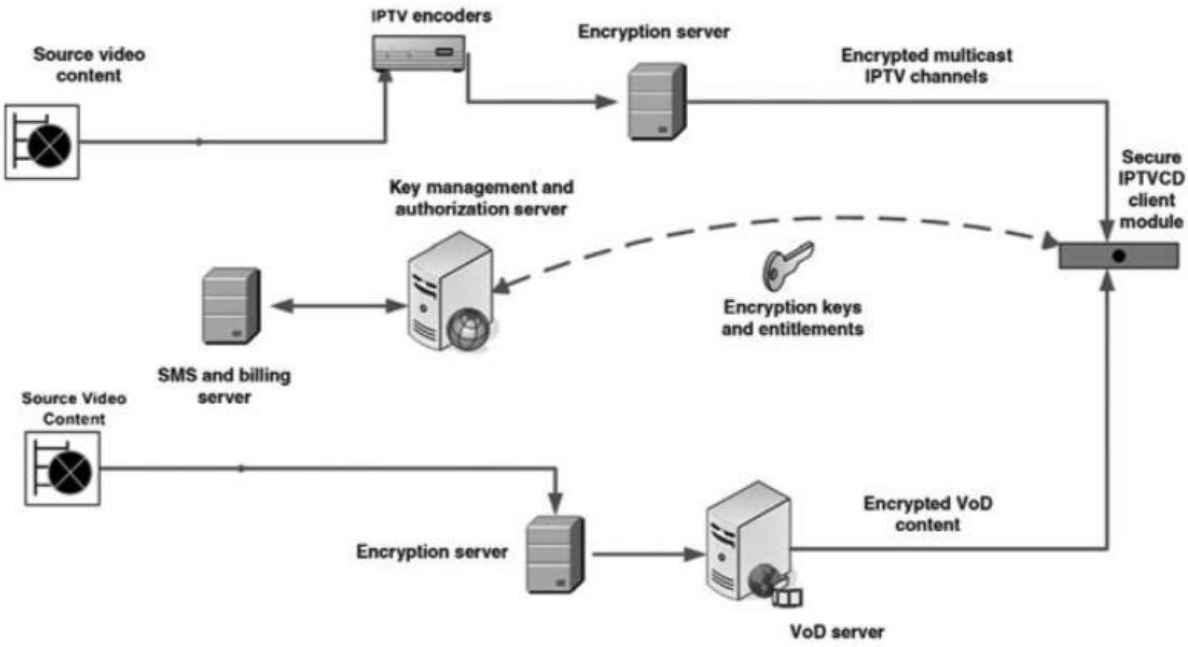
- There are three alternative approaches to IPTV conditional access systems.
    - Hardware: it is based on a a client- server networking infrastructure
    - Software
    - Hybrid hardware and software solutions
- Example:
    - End to end smartcard based conditional access (CA) system:
    - EMM: transfers user's rights upon purchasing IPTV services to the related smartcard. It can contain the following information:
        - Authorisation keys to view IPTV servies (IP-multicast services, VoD content)
        - Credit for future services
        - Service cancellations and renewals
        - Other subscriber data such as address and billing details
    - Note: EMMs are sent separate to the IPTV bitstream and often use a TCP communication session for delivery to the destination IPTVCD (devices)
    - A CA system makes extensive use of the bidirectional capabilities of IP broadband networks to gather transactional data from IPTVCDs, such as:
        - Identification codes for the smart card and IPTVCD
        - IP-VOD assets ordered
        - Credit amounts



Client IPTV (IPTVCD) architecture



Software centric CA system

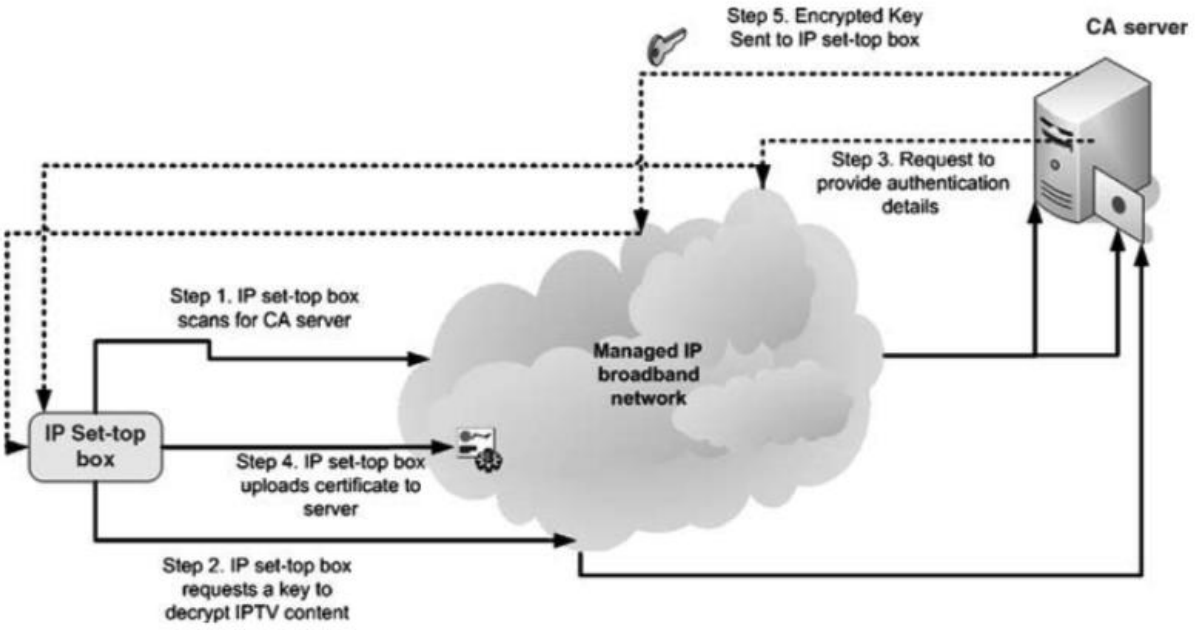


- Commonly used CA algorithms:

IPTV CA Algorithm	Description
RC4 (RCA)	This is a cryptographic software system supplied by a company called RSA Security Inc.
Data Encryption Standard (DES) Algorithm	DES is an encryption algorithm used to protect IPTV content. DES takes in a continuous stream of bits in the clear and outputs an encrypted stream of bits. There are different variants of DES. The most secure flavor is the Triple DES, in which three separate keys (168 bits) are used to perform a cryptographic operation.
Advanced Encryption Standard (AES)	AES is an encryption standard that has been adopted by the US government. AES uses 128-bit keys to encrypt video content and is widely deployed by the IPTV industry sector.
Common Scrambling Algorithm	The DVB has defined a Common Scrambling Algorithm (CSA) for transmitting digital television. The specification and licensing rights to the CSA and the Common Descrambling Algorithm are distributed under arrangements with the European Telecommunications Standards Institute.

Overview of IPTV software centric CA system

- An example of how a typical software centric CA solution operates is depicted below and explained in the following sections.
    1. Once the IP set-top box is powered up, it scans the network for a server that provides decryption keys and authentication services. The IP address parameter of the key management and authorization server is typically preconfigured on the IPTVCD.
    2. After locating the server, the secure IP set-top box software client informs the data center of its presence on the broadband network and requests a key to decrypt incoming video content.
    3. Once this request is received, the server will prompt the IP set-top box software to provide authentication details.
    4. The IP set-top box software will then upload a digital certificate to the server.
    5. Once received and authenticated by the server, the key is retrieved from the database, encrypted and returned back to the IP set-top box client software. The key is then used to decrypt the video content before passing onwards to the decoder chip for further processing.

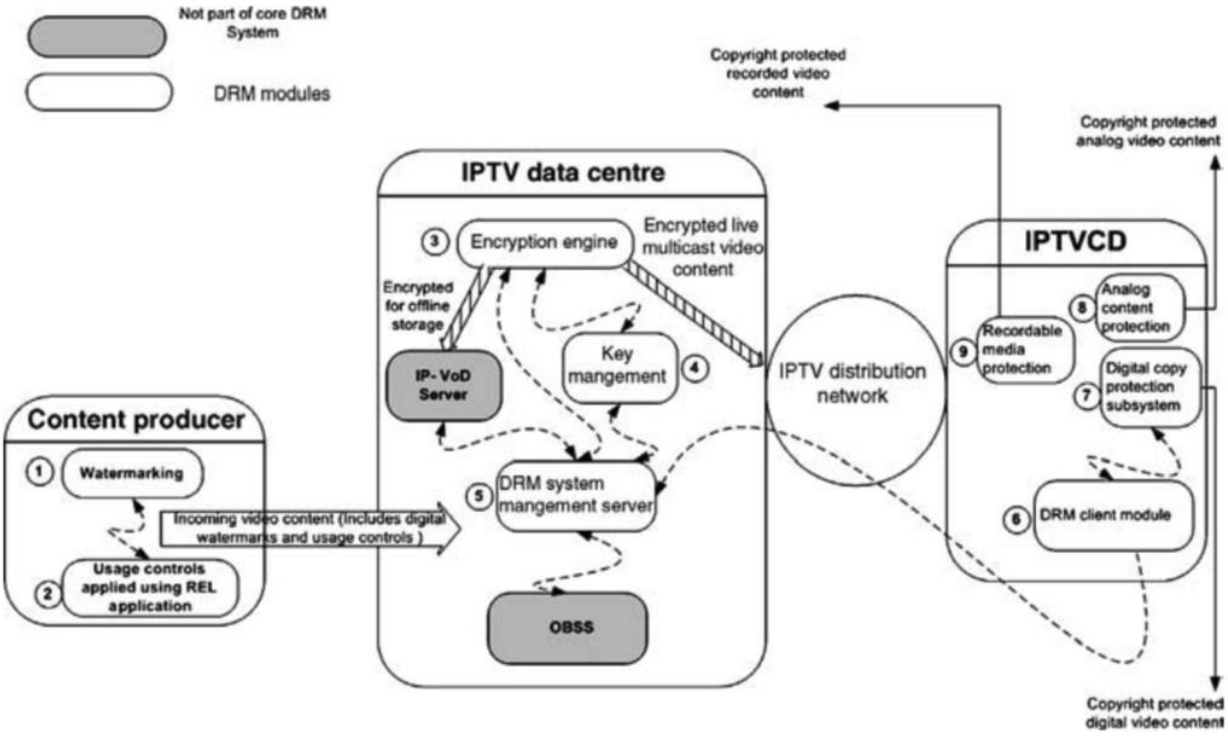


Other initiatives to secure channels (inherited from DVB)

- DVB opted for the development of two new protocols: SimulCrypt and MultiCrypt.
    - SimulCrypt:
      A SimulCrypt based system allows two CA systems to operate within a particular geographical area in parallel. The system uses multiple set-top boxes, each using a different CA system, to authorize the programs for display. The general architecture of a SimulCrypt access system is based on the transmission of ECMs and EMMs required by each CA system across the TV network. Each individual set-top box recognizes and uses the appropriate ECM and EMM needed for authorization while ignoring entitlement messages that are destined for other set-top boxes. In SimulCrypt based systems, scrambling and encryption are separate processes.
    - MultiCrypt
      The MultiCrypt concept allows the use of multiple CA systems in the same digital set-top box.

DRM software and hardware architecture

- Key components:
  - Digital watermarks
  - A Right Expression Language (REL) application
  - Encryption engine
  - Key management
  - DRM system management server
  - A DRM client module
  - A digital program copy protection subsystem
  - An analogue content protection system
  - Copyright protection for recordable media



- DRM process:
  - Step1: Registration of content owners rights
  - Step2: Post the protected IPTV asset on the VoD server
  - Step3: Playing the protected IPTV content

Video on demand (VoD) over IP delivery network

- Pay per view (PPV): A PPV system only allows authorized users to watch an event such as a movie or a football game.
    - Modes:
        - Impluse PPV (IPPV): allows users to store pre-purchased tokens in set-top box within electronic wallet which can be then used to instantly purchase PPV events without using the return channels
        - Pre-booked PPV: allows users to book in advance an event or multiple PPV events
- VoD: A VoD system is the “holy grail” of viewing TV and enables an individual subscriber located in geographically dispersed locations to demand a program or movie when and where they want it.
    - It is a pull-mode service
    - Steps to select a VoD title by IPTV users:
        - The subscriber selects a VoD title from the interactive TV application.
        - The IPTVCD accepts the command and sends this instruction to the headend or data center.
        - The conditional access system is checked to verify that the subscriber is authorized to view the particular VoD title.
        - Once authorization is complete, a unicast video stream is forwarded to the regional office and onward to the IPTVCD.
        - The IP stream is controlled by the subscriber.
    - Type of IP-VoD services:
        - Puch VoD: pushing contents from server to IPTVCD during off-peak time
        - Movie-on-Demand (MoD): delivery of DVD quality of contents with support of VCR type controls to IPTVCD
        - Subscription VoD (SVoD): same as MoD delivery but using subscription such as a fixed monthly fee
        - Television-on-Demand: recording real-time broadcast TV programs
        - High definition VoD
        - Subscription music on Demand
        - Network based digital video recording (nDVR): storage is at the IPTV data centre not locally
        - Free on Demand: free access to the library of contents
        - Bandwidth on Demand: allows users to increase bandwidth on the fly for specific services such as downloading HD contents
        - Extended VoD (EVOD): diverting contents from IPTVCD to another location(s).

EVoD delivery mode

- As shown below:
    - IP-set-top box is connected to a separate hardware device, which in turn is connected to the RG or internal home network.
    - This EVoD device takes the output from the IP set-top box and encodes into a format that is suitable for delivery over a number of different types of broadband access technologies.
    - In this example the VoD content is encoded and streamed across a 3G network to a phone that supports the viewing of mobile TV services.
    - This type of VoD application allows consumers to remotely view on-demand content while on the move.
    - Additionally, some of the more sophisticated EVoD systems allow mobile IPTV end users to remotely control A/V equipment such as DVRs.