Video Streaming

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Artificial Intelligence &
Information Analysis Lab

Video Streaming

- **File Transfer**
- Media Streaming
- Media Streaming Technology
- Streaming Media Encodings
- Publishing and Communication
- Media players
- Videoconferencing
- Multimedia Frameworks
- Mobile TV

File Transfer

- A media can refer to music or video.
- Since the two are often intertwined we will refer to them as such.
- 4 different types of transferring media files:
  - Traditional Media Transfer
  - Progressive Download
  - Web Server Streaming
  - Media Streaming.

Traditional Media Transfer

- Users must wait for the entire file to be transferred.
- It creates a copy users can playback at any time.
- Users keep the copy.
- Easy illegal distribution.
- Copyright infringement.

Progressive Download

- Also known as ***Pseudostreaming***.
- Transfers the file.
- Allows playback, while the file is not fully transferred.
- Saves a copy on user's system.
- Easier and less costly than media streaming.

Web Server Streaming

- Also known as ***HTTP streaming***.
- Creates a locally-cached copy of the file.
- Users can copy the files.
- It can get through firewalls.

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Media Streaming

- ***Media streaming*** is defined as the continuous transmission of media files over a Local or Wide Area Network (LAN, WAN).
- Allows media reproduction during streaming.
- Data are transferred, played back and then deleted.
- Performed real-time, allows live broadcast.

Media Streaming Benefits

- Facilitates ***user-content*** interaction.
- Allows users to navigate through the content.
- Real-Time or On-Demand access to content.
- Offers more copyright protection.

Media Streaming Process

- ***Media creation*** is the process of media content production.
- ***Media encoding*** converts the media content in a format that can be streamed.
- ***Media publishing*** is media layout design and demonstration.
- ***Media hosting*** allows users can access the streaming media.

Media Streaming Categories

- ***Streaming on Demand***:
  - Files are placed on a media server.
  - Can be played back at any time.
  - Providers are not required to have a lot of bandwidth.
- ***Live Media Broadcasting***:
  - Real-Time encoding and uploading to a media server.
  - All users simultaneously connected to the server.
  - Requires a ***large bandwidth*** and ***multiple stream servers***.

A few interesting statistics

- Every minute, ***Facebook*** users view ***2.7 million*** videos.
- Each minute, ***300 hours*** of video are uploaded to ***Youtube***.
- ***1 billion hours*** are spent watching ***Twitch*** each month.
- In 2018, ***Netflix***:
  - had spendings of ***12 billion*** dollars and
  - a revenue of ***16 billion*** dollars.
- Global TV earned more than ***265 billion*** dollars in 2018.

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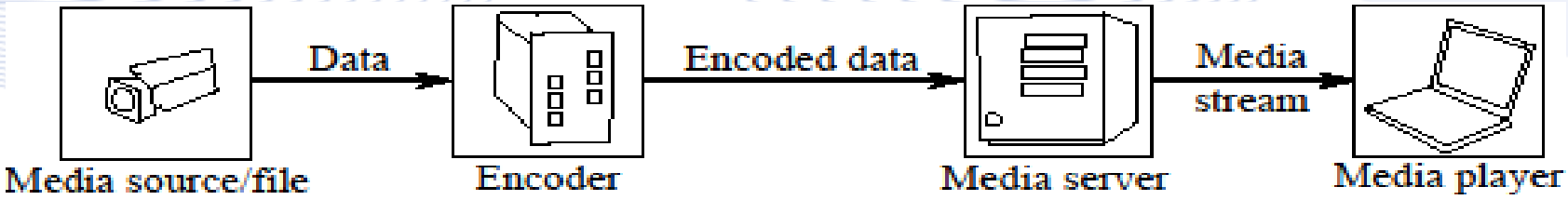
Media Streaming Technology

- Streaming requires a specialized media server.
- Files must be encoded by a media encoder.
- Each encoding is optimized for different transmission rates.
- ***Internet Transport Protocols*** are used (TCP, UDP, etc.).
- ***No error correction most times***, data are lost forever.
- Media players handle video playback.



Media Streaming Technology

- Streaming depends on available bandwidth.
- The ***bit rate*** can be lowered by:
  - Reducing the video frame spatial resolution.
  - Lowering the video frame rate.
  - ***Video compression***.
- These methods reduce playback quality when applied.
- ***Multiple Bit Rate*** encoding offers the best solution. Media are encoded for and at different bit rates.

Media Streaming Technology

- ***Protocols***:
  - Set the principles of information exchange between systems.
  - Low interoperability between them.
- ***File formats***:
  - Describe how they are stored to form a streaming file.
  - Many different types, no universal one.
- ***Codecs***:
  - Encode and decode media information.

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Streaming Media Encoding

- ***Video codecs*** must adopt a ***bit rate distribution strategy*** in order to improve transmission.
- Different encoding for different bit rates. Maximizes quality.
- ***Key frames*** are encoded first, then the difference frames.
- The higher the resolution, the more bits required.
- Many encoding methods.

Streaming Media Encoding

- ***Constant Bit Rate*** (***CBR***) encoding:
  - Uses a ***video buffer*** to control data rate.
  - Dynamically alters compression rate.
  - Cannot begin playback, until the buffer is full (memory delay).
- ***Two-pass CBR*** encoding:
  - ***First pass*** finds the bits required to encode each frame.
  - ***Second pass***, determines bit allocation per video frame.
  - Better quality, doubles encoding time.
  - Requires future information.

Streaming Media Encoding

- ***Variable Bit Rate*** (***VBR***) encoding:
  - Allows output data rate variations.
  - Less bits to easy scenes, more to difficult.
  - Best used for long videos and movies.
- ***Quality-Based VBR*** encoding:
  - Uses a media quality scale.
  - Attempts to reach the requested quality on the whole file.

Streaming Media Encoding

- ***Average Bit Rate*** (***ABR***) encoding:
  - Two pass procedure.
  - Tries to maintain average bit rate, not quality level.

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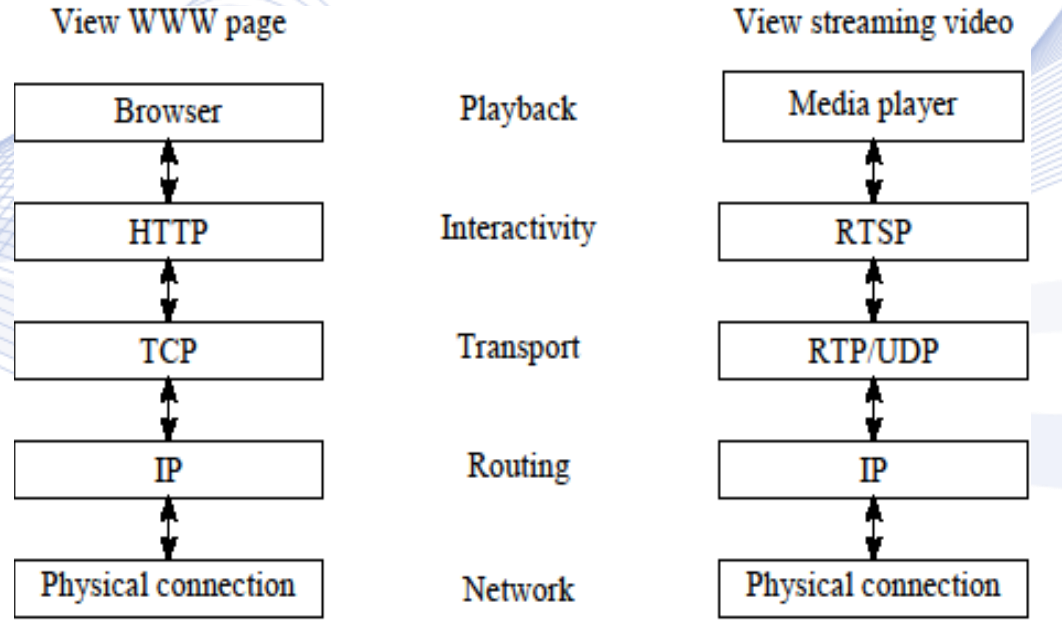
Publishing & Hosting

Publishing is the process of making the streaming media available to the public.

- Media files can be transferred via ***HTTP*** or other protocols.
- They can be played on a browser with appropriate software, or on a separate ***media player***.



Streaming Media Communication

Streaming media can be delivered in three ways.

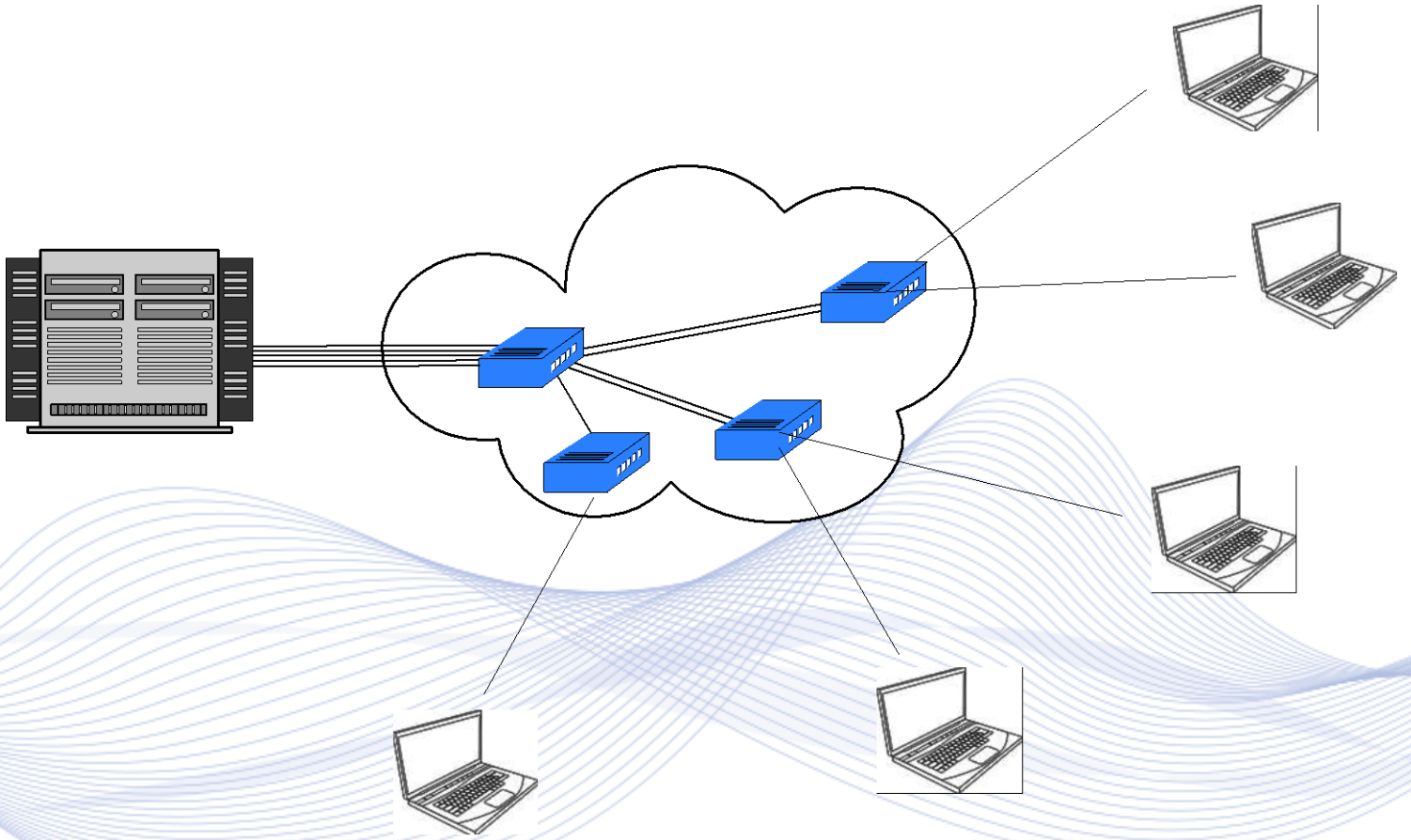
- ***Unicast***:
  - A server delivers a stream copy to each user.
  - On-demand.

- ***Broadcast***:
  - A single stream is delivered to multiple users.
  - Live broadcasting.

Streaming Media Communication

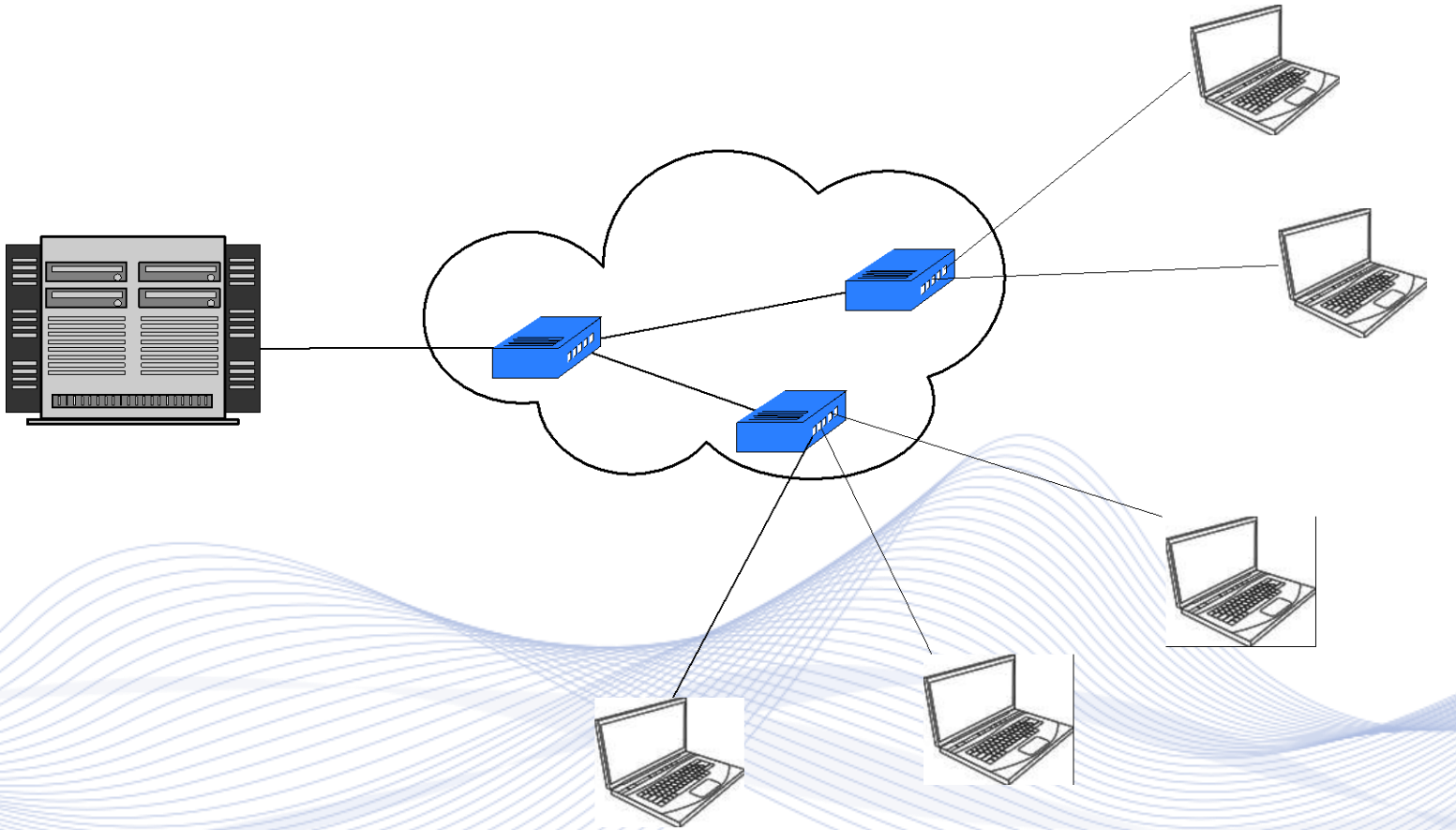
- ***Multicast***:
  - A single stream is transmitted over a network.
  - It is replicated in network nodes to reach multiple users.

Streaming Media Communication



Unicast.

Streaming Media Communication



Multicast.

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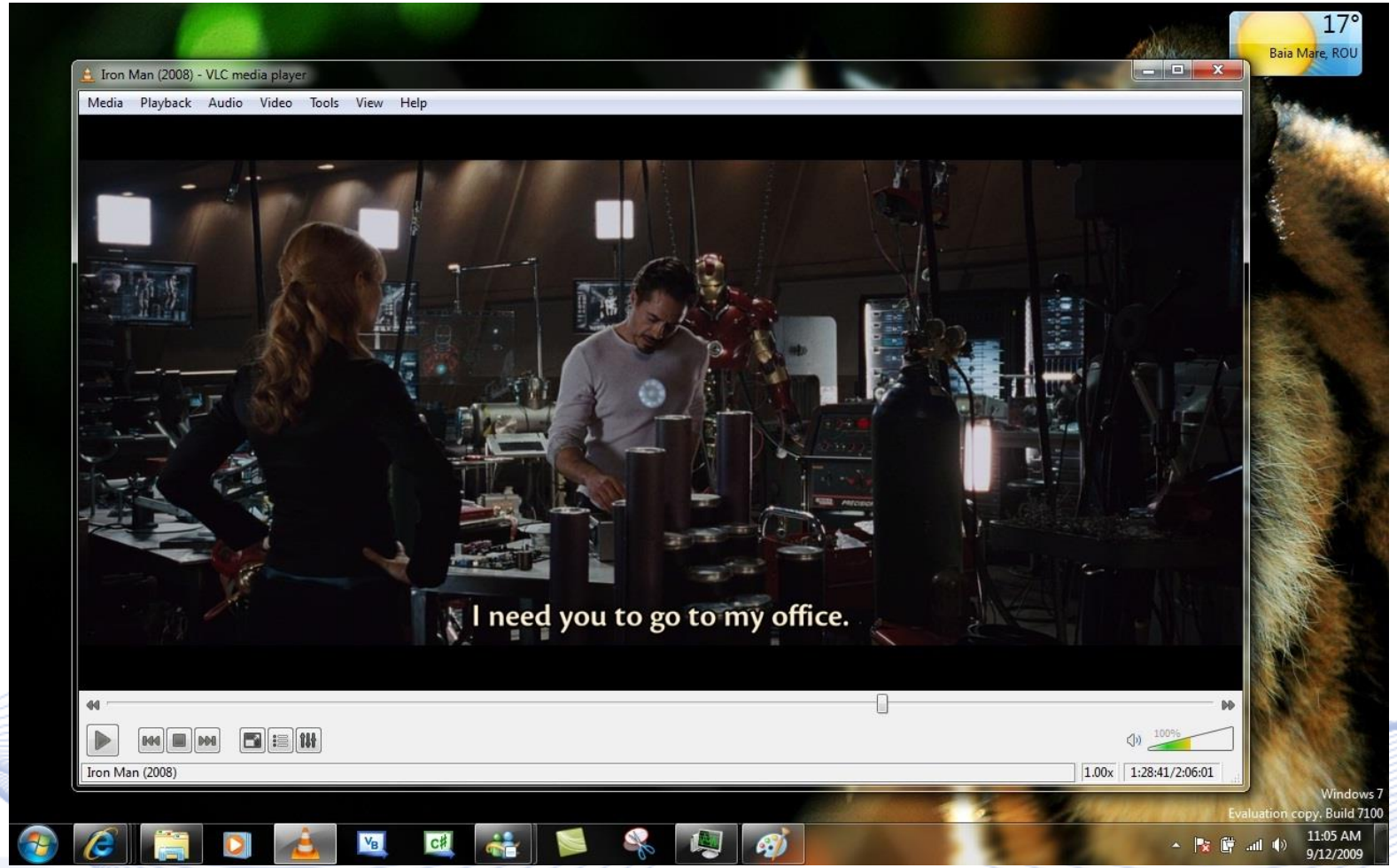
VLC Media Player

- Developed by VideoLAN.
- Available to most operating systems.
- Free and Open Source.
- Able to play files, discs and streams.
- Supports 3D videos using anaglyph technology (red & blue glasses).
- Advanced control options for audio, video, subtitles, etc.
- Customizable appearance.

VLC Media Player



VLC Media Player [VLC].

Real Player

- Developed by Real Networks.
- Available for many operating systems, including cellphones.
- ***RealPlayer*** for Windows, ***RealTimes*** for other OS.
- Able to:
  - Download and play videos.
  - Trim videos.
  - Play music and create playlists.
  - Create videos out of photos with RealTimes.
  - Share videos.

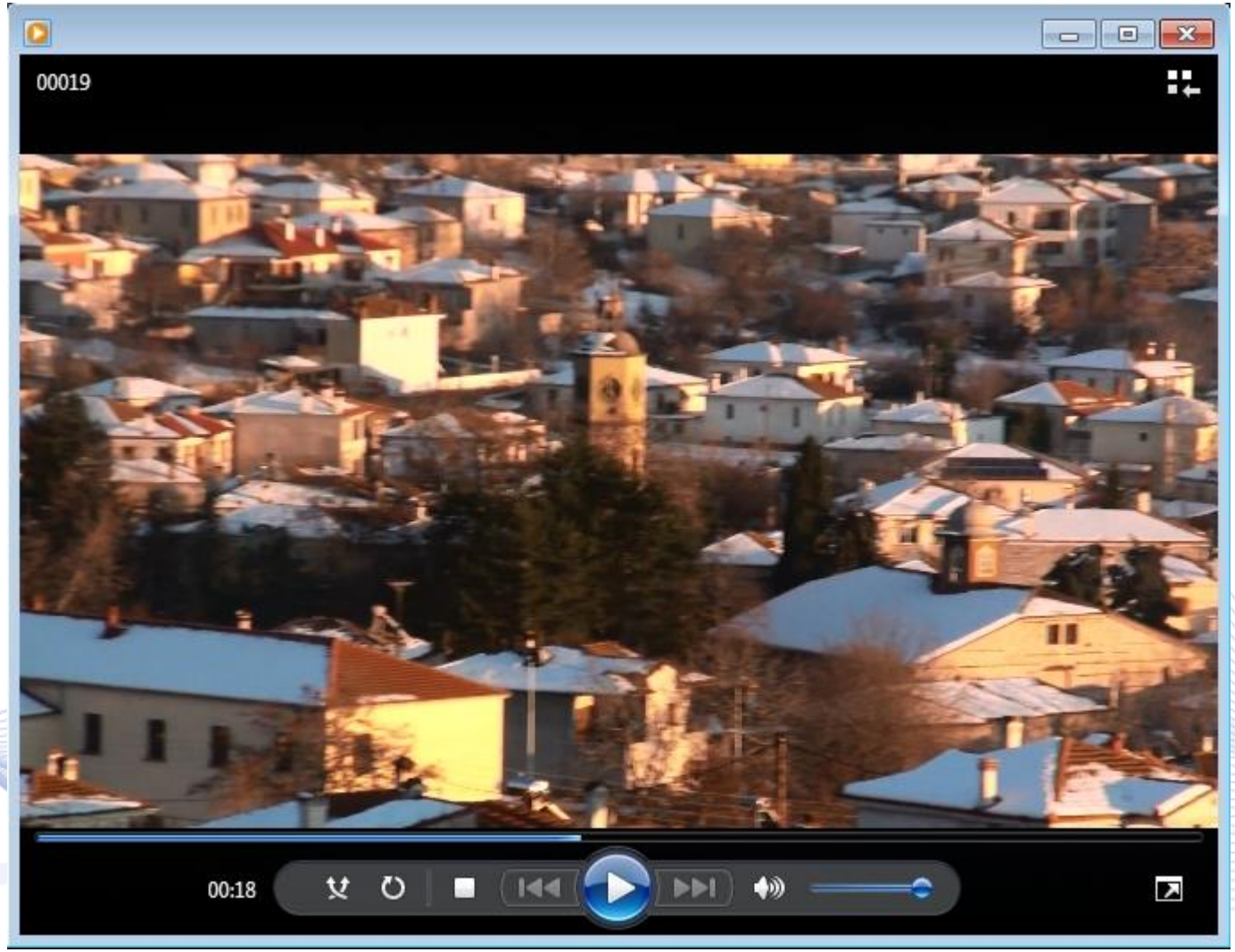
Real Player

Real Player [RPL].

Windows Media Player (WMP)

- Developed by Microsoft.
- Only available for ***Windows***.
- WMP version 12 included in Windows 7 and newer.
- Supports many video and audio file formats.
- Capable of using codecs of other applications.
- Can play audio and video from CDs and DVDs.
- Able to burn audio or video to CDs or DVDs.

Windows Media Player (WMP)



QuickTime

- Developed by Apple.
- Newer versions available only for ***Mac OS***.
- Older unsupported versions for other operating systems.
- Can handle video, audio, animations and panoramic images.
- Allows trimming and splitting content to parts.
- QuickTime video compression format was the basis of MPEG-4 video compression standard.

QuickTime

QuickTime Panoramic Image.

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Videoconferencing

Videoconferencing is a two-way audiovisual communication between two or more sites/users.

- Created in the 30s for analog videos.
- Digital videoconferencing begun in the 80s.
- Moderate initial success, used mainly to reduce travel costs.
- ***Videoconferencing over IP*** and powerful compression tools like the H.323 standard lead to the modern day prevalence.
- Since 2020, it is an indispensable tool for ***teleworking***.

Skype

- Available for both computers and cellphones for free.
- Calls can be made over the Internet, mobile and fixed telephone networks.
- Videoconferences of up to 50 people.
- Has messages, live subtitles and screen sharing.
- Calls to non Skype users' telephone is charged.

Skype for Business

- Paid version of Skype, aimed to be used by companies.
- Greater number of participants and file transferring limits.
- Industrial-strength security for meetings.
- Will stop be supported in July 2021 in favor of Teams.

Microsoft Teams

- A unified communication and collaboration platform.
- Contains all the features of Skype for Business.
- Has improvements like a shared storage space.
- Comes with free and paid packages.

Google Meet

- Previously known as Hangouts Meet.
- Provided either for free or included in G Suite.
- Available for most operating systems.
- Can be accessed through a web browser or an app.
- Meetings of up to 250 people.
- Same security as the rest of Google services.
- Compatible with SIP and H.323 standards.

Zoom

- Developed by ***Zoom Video Communications***.
- Available for both computers and cellphones.
- Comes with a limited free and paid business or education packages.
- Allows HD videoconferences and multiple shared screens.
- Extensive use of calendars for scheduling meetings and organizing the chat.
- Provides high quality and toll based audio for global cross platform meetings.

Discord

- Free videoconferencing application.
- Available as an app for computers and cellphones.
- Or it can be opened on a web browser.
- Users communicate through private servers and are able to:
  - Put verification levels on their servers.
  - Select who can message and send them friend requests.
  - Choose who can join their servers.

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Multimedia Frameworks

- Used by/for media players, not media players by themselves.
- Can be used to create media players, audio editors, etc.
- Easy to add support for new file formats.

GStreamer

- A development framework for creating applications.
- Written in C.
- Pipeline Based.
- Uses and combines many different plugins.
- Mainly targeting ***Linux*** systems.
- Used as backend in many applications.

GStreamer

- Contains an API for multimedia applications.
- Has architectures for both plugins and pipelines.
- Provides mechanisms for synchronization and media type negotiation.
- Comes with a set of tools.
- Object Oriented and Extensible.

GStreamer

- Uses GLib ***GSlice*** allocator.
- Has light-weight links between plugins.
- Provides mechanisms to directly work on the target memory.
- Allows hardware acceleration through specialized plugins.
- Contains dedicated streaming threads.
- Has a plugin registry.

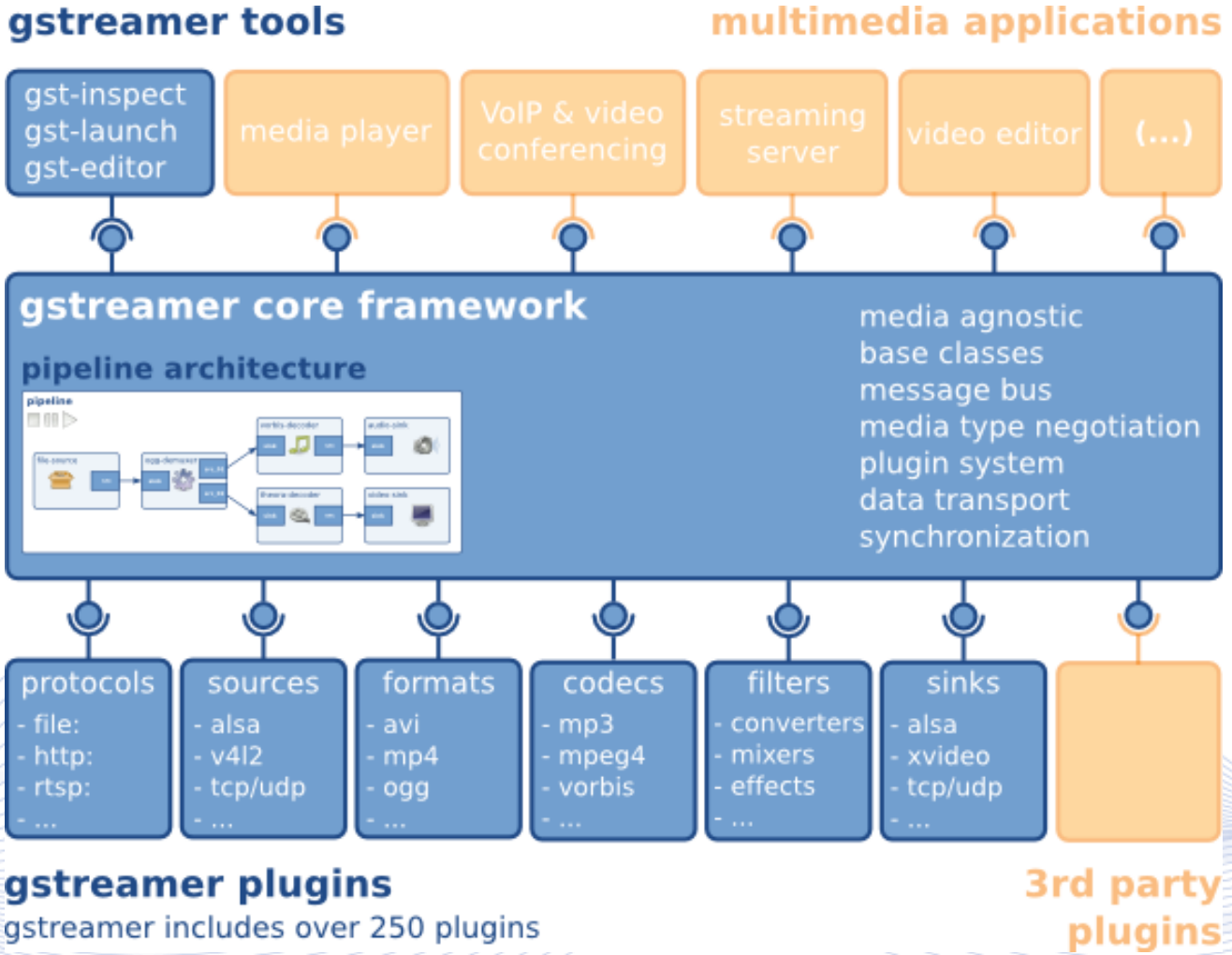
Gstreamer Plugins

- GStreamer classifies its plugins into:
  - Protocols
  - Sources
  - Formats
  - Codecs
  - Filters
  - Sinks.

Gstreamer Plugins

- GStreamer plugins come in three different sets:
  - ***Good***, a set of quality plugins.
  - ***Ugly***, good quality but they can pose distribution problems.
  - ***Bad***, bad quality plugins.

GStreamer



Gstreamer plugin architecture [GSP].

Gstreamer Foundations

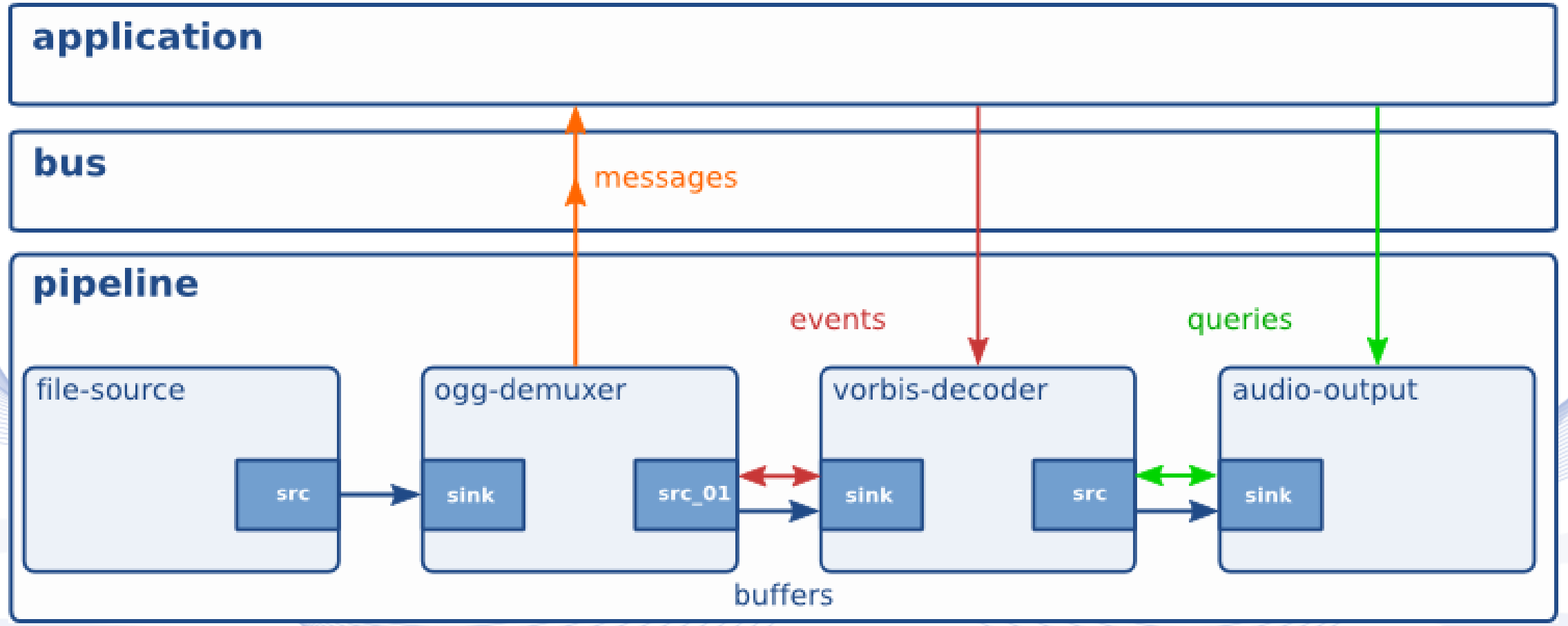
- ***Elements*** are object classes of objects.
  - They have a specific function around the management of data.
  - They are the building blocks of pipelines.
- ***Pads*** are the input and output of elements.
  - They work as links between them.
- ***Bins*** are containers for collections of elements.
- ***Pipelines*** are top-level bins.
  - They provide a bus for the applications and manage the synchronization of their children.

Gstreamer Communication

The communication between applications and pipelines is done through:

- ***Buffers***: objects that pass streaming data between elements.
- ***Events***: objects sent between elements.
- ***Messages***: objects posted by elements on the pipeline bus.
- ***Queries***: that allow applications to request information.

Gstreamer Communication



Application-Pipeline communication [APC].

HTML5

HTML5 is a ***markup language***.

- It is the fifth version of HTML, released in 2014.
- Previous versions were released throughout the 90s.
- Alongside Javascript and CSS is the basis of the Internet.
- Introduced the *video* tag.
- Used by famous companies (Youtube, Netflix, etc.).

HTML5 Video Tag

- Allows the ***video playback*** of supported video formats.
- No need for third party plugins.
- Can specify the video dimensions.
- Allows the use of existing controls or the creation of new ones.
- Has options for ***preloading*** and ***autoplay***.
- Multiple files of different formats and links can be embedded.
- The browser checks and plays the first it can.

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Mobile TV

- The wide use of smartphones has renewed interest on multimedia broadcasting technologies.
- Many standards and formats exist.
- Two of the more famous ones:
  - ***DVB-H***, ***DVB-NGH*** (EU)
  - ***ATSC-M/H*** (USA).

DVB-NGH

Digital Video Broadcasting – Next Generation Handheld (***DVB-NGH***) is a handheld evolution of DVB-T2lite.

- Standardization finished in 2012.
- First to incorporate MIMO antenna schemes.
- Supports ***MPEG TS*** and ***IP*** transport protocols.
- Improved bandwidth utilization efficiency.
- Allows inserting and providing local content.
- No need for terrestrial network in ***S*** and ***L bands***.

DVB-NGH

DVB-NGH has four different profiles:

- Base (terrestrial) profile
- MIMO terrestrial profile
- Hybrid profile
- Hybrid MIMO profile

- Only the base profile is mandatory.
- The other profiles use it as reference and are defined by their differences from it.

ATSC-M/H

Advanced Television Systems Committee – Mobile/Handheld (***ATSC-M/H***) performs stream delivery over IP transport.

- Has energy saving receivers.
- Can be decoded under high Doppler rate conditions.
- Provides information about the services that are available.

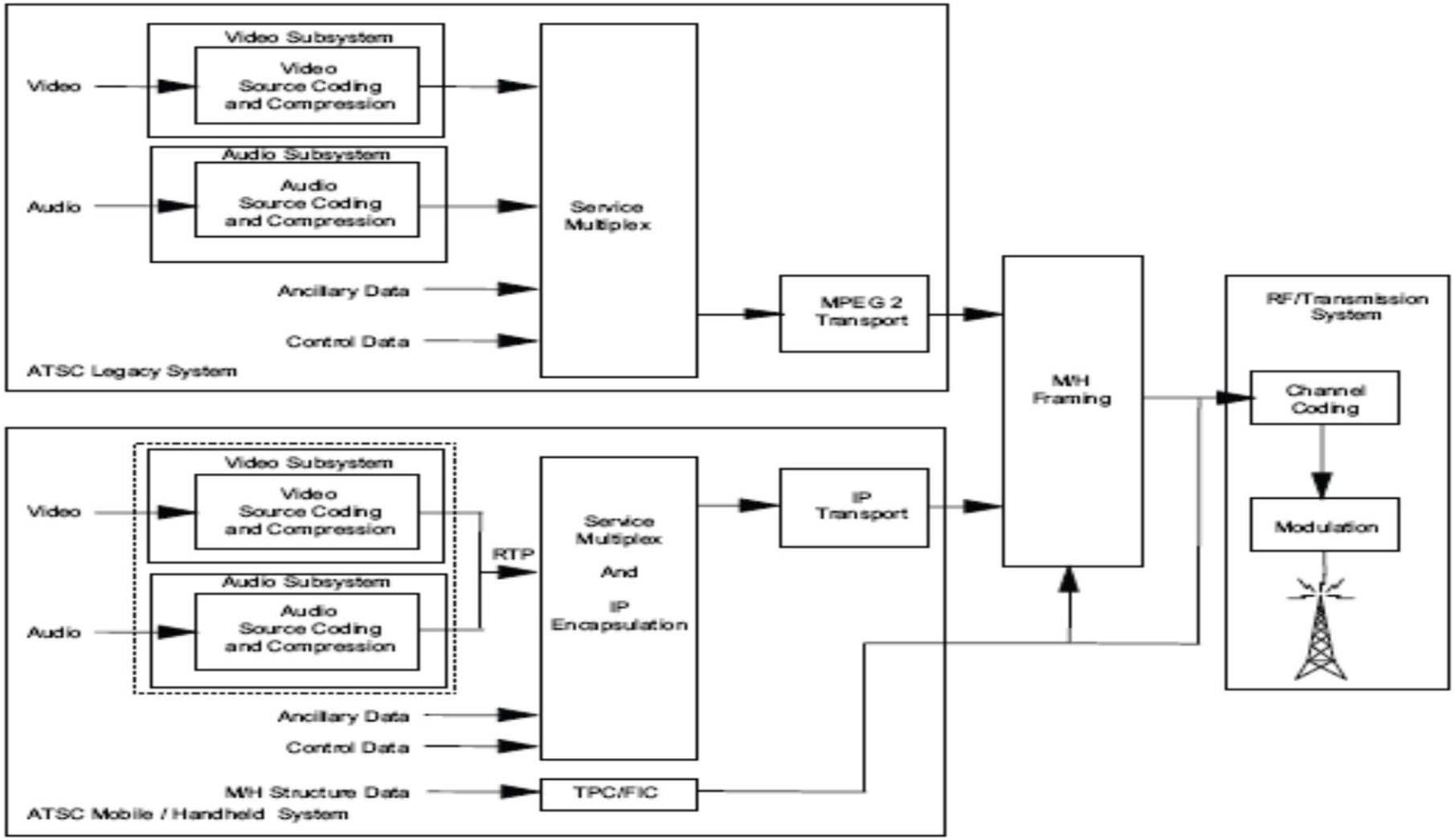
ATSC-M/H

- Data are divided into Ensembles.
- Each ***Ensemble*** contains one or more services.
- Each service forms TV or audio programs which are controlled by the broadcaster.
- Can be decoded to different error protection layers, according to the application.

ATSC-M/H

- Provides content protection, especially for the paid one.
- Once received, the broadcaster has no control over the content.
- Supports two protection modes:
  - ***Interactive mode*** providing an ***interaction channel*** between the receiver and the content provider.
  - ***Broadcast-only mode***, which has no interaction channel. The receiver requests access to the content through out-of-band mechanisms (telephone, etc.).

ATSC-M/H


Video Subsystem
Video
Source Coding
and Compression
Video
Audio Subsystem
Audio
Source Coding
and Compression
Audio
Service
Multiplex
Ancillary Data
Control Data
ATSC Legacy System
MPEG 2
Transport
M/H
Framing
RF/Transmission
System
Channel
Coding
Modulation
Video Subsystem
Video
Source Coding
and Compression
Video
Audio Subsystem
Audio
Source Coding
and Compression
Audio
RTP
Service
Multiplex
And
IP
Encapsulation
IP
Transport
Ancillary Data
Control Data
M/H Structure Data
TPC/FIC
ATSC Mobile / Handheld System

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Q & A

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

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