DIGITAL TELEVISION BROADCASTING

ENG (MRS) PN KARUNANAYAKE

COMMUNICATION SYSTEMS

LECTURE 15

INTRODUCTION

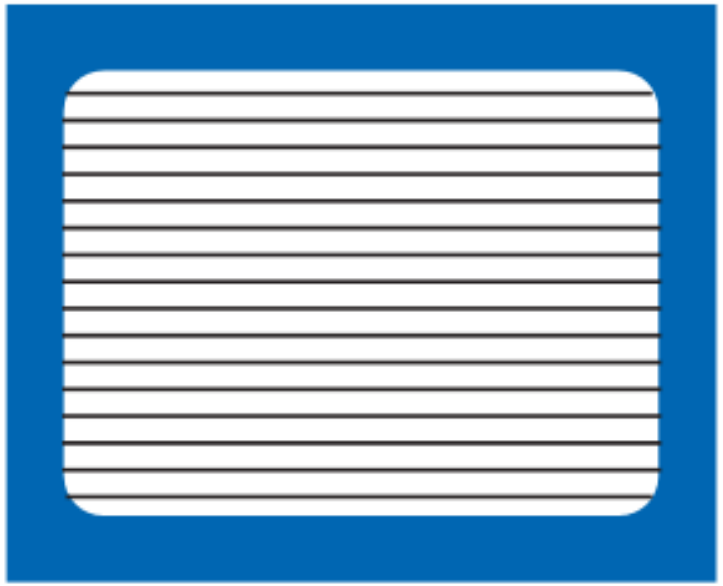
- Digital TV (DTV), also known as high-definition TV (HDTV), was designed to replace the analog TV system.
- The goal of HDTV is to greatly **improve the picture and sound quality.**
- Major difference between conventional NTSC analog TV and HDTV is that **HDTV can use progressive line scanning rather than interlaced scanning**.

VARIATIONS OF THE BASIC FORMATS IN HDTV

Standard	Aspect Ratio	Pixels/ Horizontal Line	Vertical Pixels*	Scan Rate, Hz
480p	4:3	640	480	24, 30, 60†
480i/p	4:3 or 16:9	704	480	24, 30, 60
720p	16:9	1280	720	24, 30, 60
1080i	16:9	1920	1080	24 or 30

*Number of scan lines.
†Standard PC VGA format.

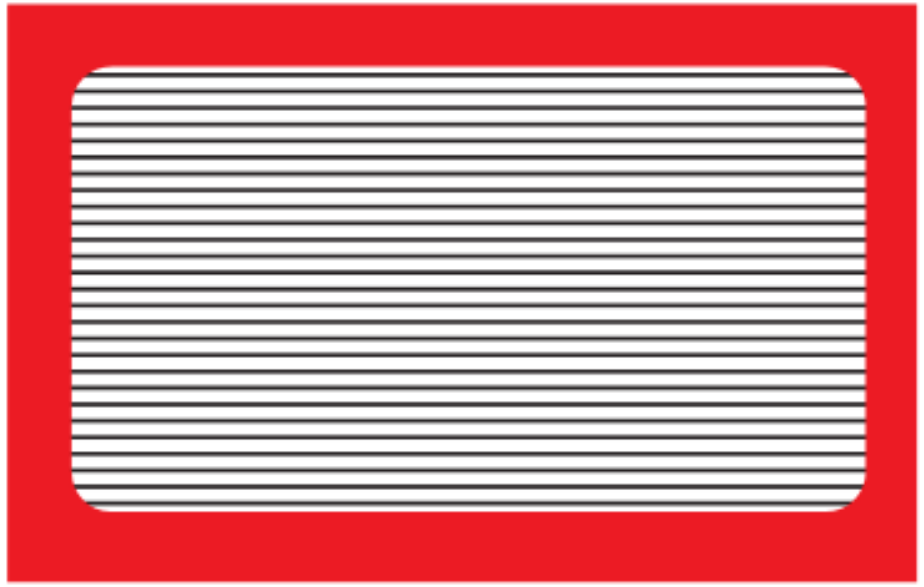
TV PICTURE STANDARDS



Aspect ratio = 4:3

Number of lines = 525 (interlaced scanning)

(*a*)



Aspect ratio = 16:9

Number of lines = 1080 (interlaced scanning)

Number of lines = 720 (progressive scanning)

(*b*)

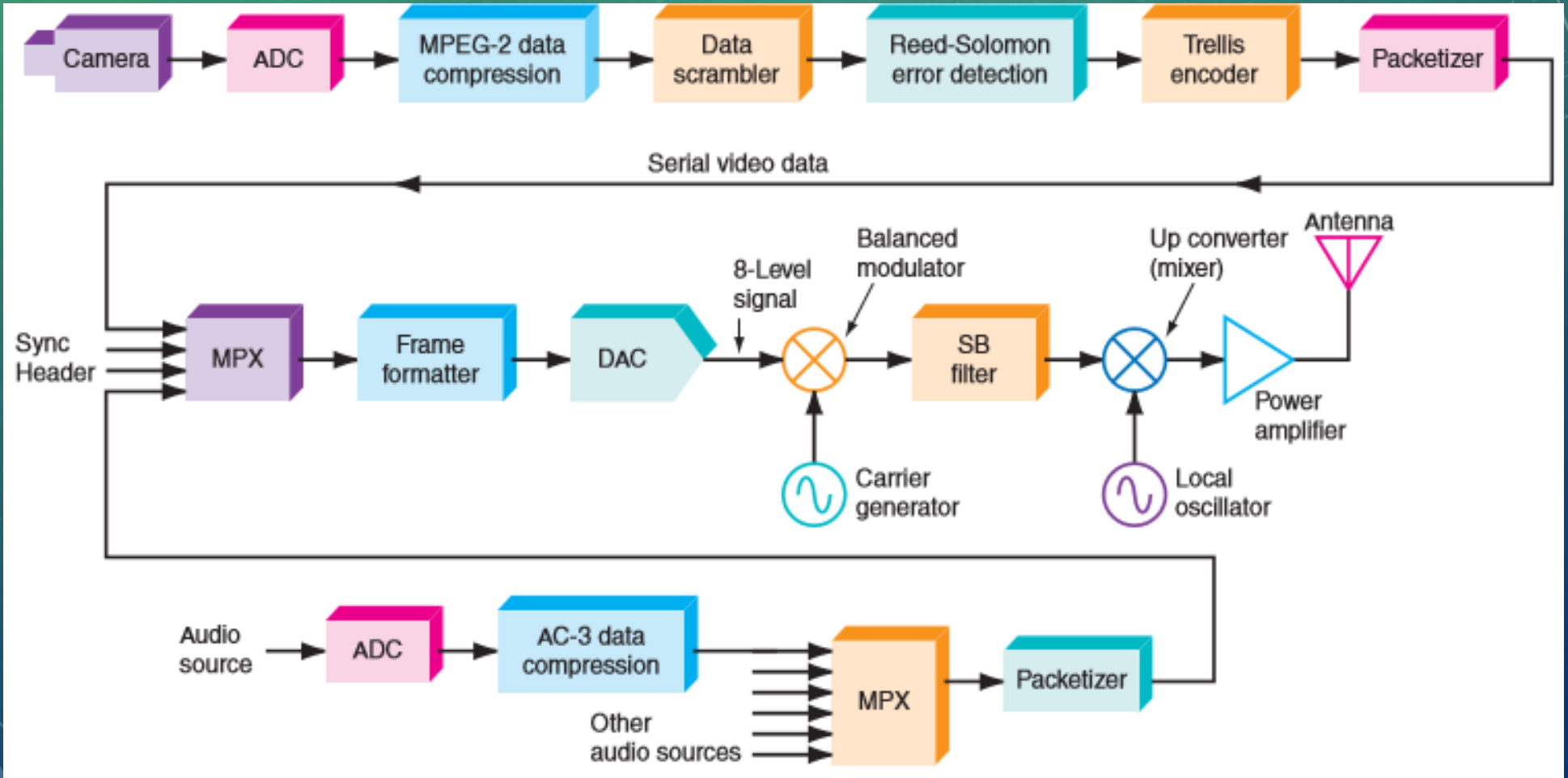
HDTV TRANSMISSION CONCEPTS

- In HDTV both the video and the audio signals must be digitized by A/D converters and transmitted serially to the receiver.
- Because of the very high frequency of video signals, special techniques must be used to transmit the video signal over a standard 6-MHz-bandwidth TV channel.
- Because both video and audio must be transmitted over the same channel, multiplexing techniques must be used.

KEY COMPONENTS OF A DIGITAL TV SYSTEM

- **Encoder** – Compresses video/audio (e.g., MPEG-2, H.264)
- **Multiplexer** – Combines multiple streams
- **Modulator** – Prepares signal for transmission
- **Transmitter** – Sends signal via RF
- **Receiver (Set-Top Box / TV)** – Decodes signal for display

HDTV TRANSMITTER



HDTV TRANSMITTER

- The video from the camera consists of the **R, G, and B signals that are converted to the luminance and chrominance signals.**
- These are **digitized by A/D converters**.
- The luminance sampling rate is 14.3 MHz, and the chroma sampling rate is 7.15 MHz.
- The resulting **signals are serialized and sent to a data compressor**. The purpose of this device is to reduce the number of bits needed to represent the video data and therefore permit higher transmission rates in a limited-bandwidth channel.

HDTV TRANSMITTER

- MPEG-2 is the data compression method used in HDTV. T
- he MPEG-2 data compressor processes the data according to an algorithm that effectively reduces any redundancy in the video signal. The algorithm also uses fewer bits to encode the color than to encode the brightness because the human eye is much more sensitive to brightness than to color.
- The MPEG-2 encoder captures and compares successive frames of video and compares them to detect the redundancy so that only differences between successive frames are transmitted.

HDTV TRANSMITTER

- The signal is next sent to a data randomizer.
- The randomizer scrambles or randomizes the signal.
- This is done to ensure that random data is transmitted even when no video is present or when the video is a constant value for many scan lines.
- This permits clock recovery at the receiver.

HDTV TRANSMITTER

- Random serial signal is passed through a Reed-Solomon (RS) error detection and correction circuit.
- This circuit adds extra bits to the data stream so that transmission errors can be detected at the receiver and corrected.
- This ensures high reliability in signal transmission even under severe noise conditions.
- In HDTV, the RS encoder adds 20 parity bytes per block of data that can provide correction for up to 10 byte errors per block.
- The signal is next fed to a trellis encoder. This circuit further modifies the data to permit error correction at the receiver. Trellis encoding is widely used in modems.

AUDIO TRANSMISSION IN HDTV

- The audio portion of the HDTV signal is also digital.
- It provides for compact disk (CD) quality audio.
- The audio system can accommodate up to six audio channels, permitting monophonic sound, stereo, and multichannel surround sound.
- The channel arrangement is flexible to permit different systems. For example, one channel could be used for a second language transmission or closed captioning.

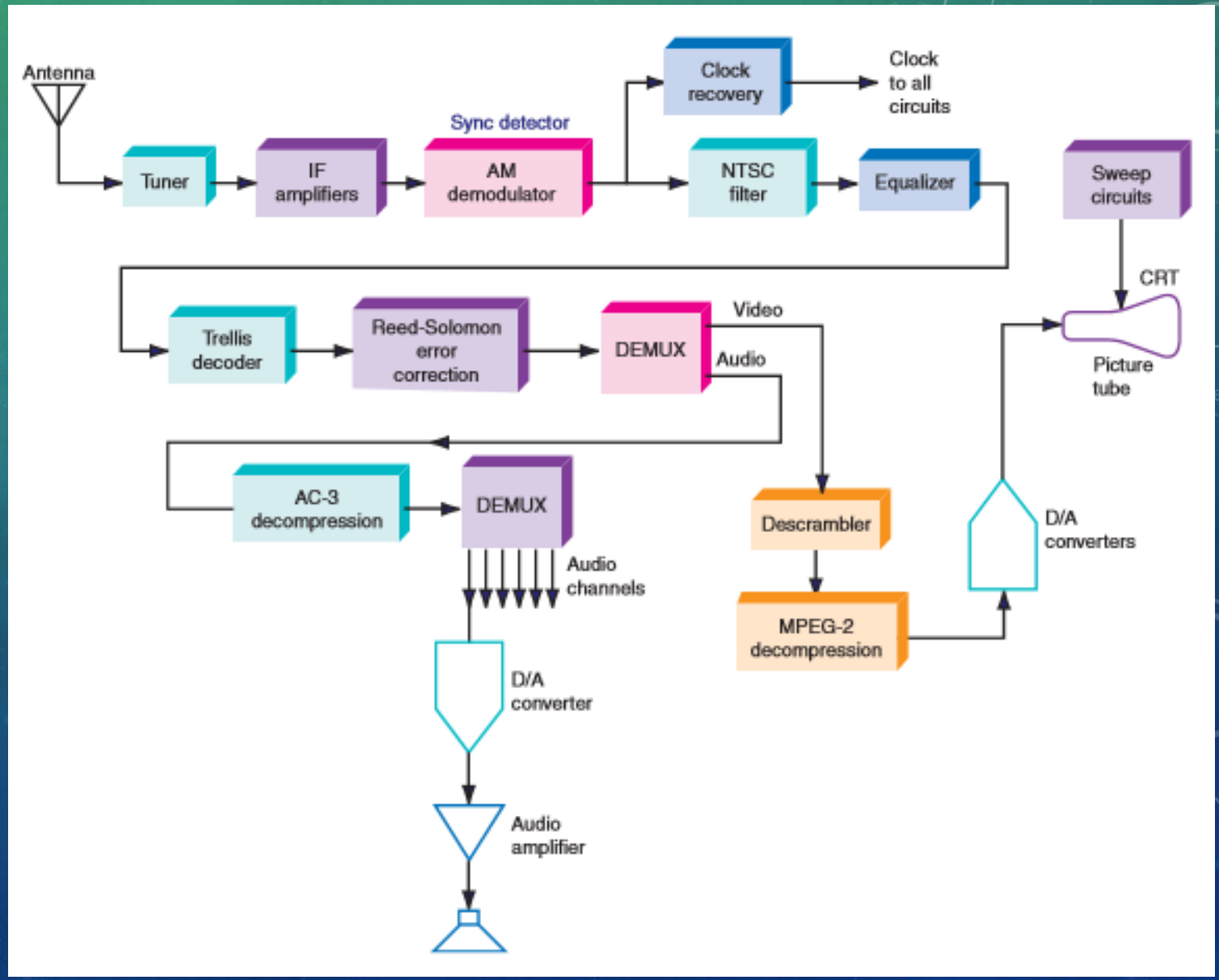
D/A CONVERION

- The modulation scheme used in HDTV is 8-VSB (in USA. In Europe coded orthogonal frequency-division multiplexing (COFDM) with 16-QAM or 64-QAM is used), or eight-level vestigial sideband, amplitude modulation.
- The carrier is suppressed, and only the upper sideband is transmitted.
- The serial digital data is sent to a D/A converter where each sequential 3-bit group is converted to a discrete voltage level.
- This system encodes 3 bits per symbol, thereby greatly increasing the data rate within the channel.

HDTV TRANSMITTER

- The modulated signal is up-converted by a mixer to the final transmission frequency, which is one of the standard TV channels in the VHF or UHF range.
- A linear power amplifier is used to boost the signal level prior to transmission by the antenna.

HDTV RECEIVER



DIGITAL TV STANDARDS

- **DVB (Europe)** – Digital Video Broadcasting
- **ATSC (USA)** – Advanced Television Systems Committee
- **ISDB (Japan)** – Integrated Services Digital Broadcasting
- **DTMB (China)** – Digital Terrestrial Multimedia Broadcast

MODULATION TECHNIQUES

- QAM (Quadrature Amplitude Modulation)
- COFDM (Coded Orthogonal Frequency Division Multiplexing)
- Robust against multipath interference
- Efficient bandwidth use

Modulation	Used in Standard	Typical Symbol Rate	Bandwidth per Channel	Efficiency (bits/sec/Hz)	Notes
QPSK	DVB-S (Satellite)	~27.5 Msymbols/s	~36 MHz	~1.0–1.2	Robust, low data rate, used in noisy channels
16-QAM	DVB-T, DVB-C	~6.9 Msymbols/s	8 MHz (DVB-T), 6 MHz (DVB-C)	~3.5–4.0	Higher throughput, moderate robustness
64-QAM	DVB-T, DVB-C	~6.9 Msymbols/s	8 MHz	~5.0–6.0	Common in DVB-T, sensitive to noise
256-QAM	DVB-C	~5.36 Msymbols/s	6 MHz	~7.0	Very high throughput, mostly for cable
8-VSB	ATSC (USA)	10.76 Msymbols/s	6 MHz	~2.7	Vestigial Sideband, single carrier
OFDM (COFDM)	DVB-T / ISDB-T	Up to 8K carriers, ~6.9 Msymbols/s	6/7/8 MHz	Depends on modulation used	Resistant to multipath interference
DTMB (TDS-OFDM)	DTMB (China)	Up to 7.56 Msymbols/s	8 MHz	~4.9	Uses pseudo-random noise as guard interval

TYPES OF DIGITAL TV BROADCAST

- **Terrestrial (DVB-T / ATSC)** – Over-the-air TV
- **Satellite (DVB-S)** – Wider coverage
- **Cable (DVB-C)** – High-capacity, local networks
- **IPTV** – Internet-based streaming

IPTV (INTERNET PROTOCOL TV)

- TV is transmitted using standard TCP/IP over high-speed Internet connections.
- Standard phone companies will compete with cable TV companies to distribute TV to consumers.
- The adoption of more advanced video compression techniques such as the ITU-T's H.264 standard, also known as MPEG-4 compression, is expected to further improve picture quality while minimizing bandwidth

SPECTRUM EFFICIENCY

- Multiplexing multiple channels in one frequency
- Dynamic bandwidth allocation
- Supports HD, 4K, and future services

ADVANTAGES OF DIGITAL TV

- Superior picture and sound
- More channels, including HD
- Interactive features (EPG, subtitles, multiple audio tracks)
- Lower transmission power per channel