EBU732U: Digital Broadcasting

Dr. Faisal Tariq
&
Dr. Hamidreza Shirazi

Module Team

- Lecturers:
  - Dr. Atm Shafiul Alam (Module Organiser)
    - Email: a.alam@qmul.ac.uk
- TA: (to be appointed)
  - Will be announced via QMPlus
- Module Reps:
  - Two of you [discuss among yourself and let me know details of two representatives]
  - Mainly responsible for SSLC reporting

Module Summary

- To introduce students to the basic ideas behind digital broadcasting.
- To study in detail compression of audio and video.
- To study broadcasting techniques and systems.
- To introduce legal issues governing broadcasting; content protection, frequency allocation, cross-border signals etc.
- To allow students to make an informed decision about whether digital broadcasting is the industry for them.

Module Aim

- To impart an understanding of the technology used in digital radio and television broadcasting
- To impart an understanding of the probable future developments in digital broadcasting
- To enable students to obtain employment in the digital broadcasting industry

Learning outcome in subject specific skills

- Knowledge of the development of digital broadcasting
- Understanding of the operation of audio compression techniques
- Understanding of the operation of video compression techniques
- Understanding of modulation techniques that are used in digital broadcasting
- Understanding of conditional access techniques that are used in digital broadcasting
- Understanding of the standards currently used for satellite, cable, terrestrial and audio digital broadcasting.
- Knowledge of likely future developments in digital broadcasting.

Lecture Schedule

First two weeks

week1		25-Feb	26-Feb	27-Feb	28-Feb	01-Mar
	08:00-10:00		TB3-535			TB3-535
	10:00-12:00			TB3-535		
	13:30-15:30					
	15:30-17:30	TB3-535			TB3-535	
	18:30-20:30					

week6		01-Apr	02-Apr	03-Apr	04-Apr	05-Apr
	08:00-10:00		TB3-535			Tomb Sweeping
	10:00-12:00			TB3-535		
	13:30-15:30					
	15:30-17:30	TB3-535			TB3-535	
	18:30-20:30					

Second two weeks

week13		20-May	21-May	22-May	23-May	24-May
	08:00-10:00		TB3-535			TB3-535
	10:00-12:00			TB3-535		
	13:30-15:30					
	15:30-17:30	TB3-535			TB3-535	
	18:30-20:30					

week14		27-May	28-May	29-May	30-May	31-May
	08:00-10:00		TB3-535			TB3-535
	10:00-12:00			TB3-535		
	13:30-15:30					
	15:30-17:30	TB3-535			TB3-535	
	18:30-20:30					

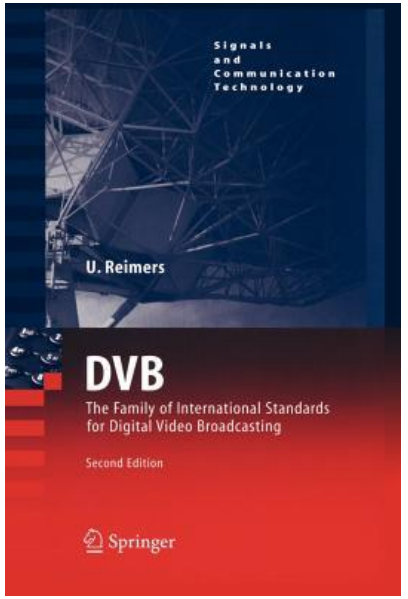
Tutorials:	On weeks 1, 6, 13, 14	Wed 17:30 - 18:30	TB3-435

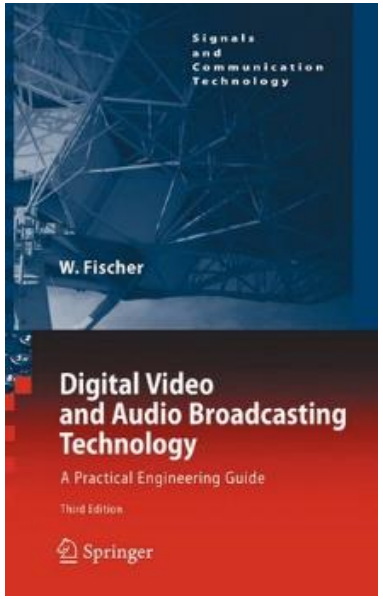
Module Examination/Assessment

- Final Exam (carries 80% weight):
  - Written, Closed book, 2 hours, 4 questions
  - Each question carries 25 marks roughly covering content of 1 week
- Coursework assessment (carries 20% weight)
  - Class Test in week 2 (10% weight of total score)
  - Class Test in week 4 (10% weight of total score)
- A minimum total mark of 40% is required to pass this module.
- A minimum total coursework mark of 30% is required to pass this module.

Resources

- Text Books
- Standard documents [regulatory and government organisation]
- Research articles/technical papers
- **Regularly** check QM+ for updates & additional material





Content Coverage:

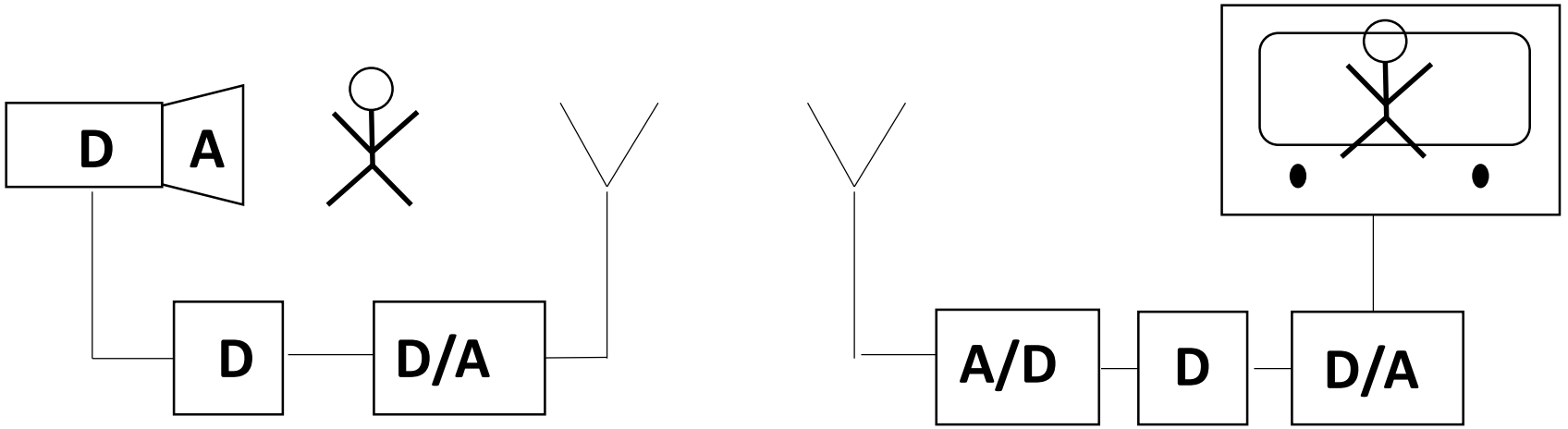
- Week 1 & 2:
  - Introduction,
  - Standardisation
  - US, Japanese, Chinese and European Standards
  - Encoding and Decoding of Audio/Video
  - Compression techniques
  - Modulation and Transmission & Single Frequency Networks
- Week 3 & 4
  - Conditional access & Interactive Systems
  - MPEG-4, H.264, HEVC
  - Middleware
  - IPTV/OTT
  - Intellectual Property Rights
  - Future developments in digital broadcasting
  - DRM and metadata management

What is Broadcasting?

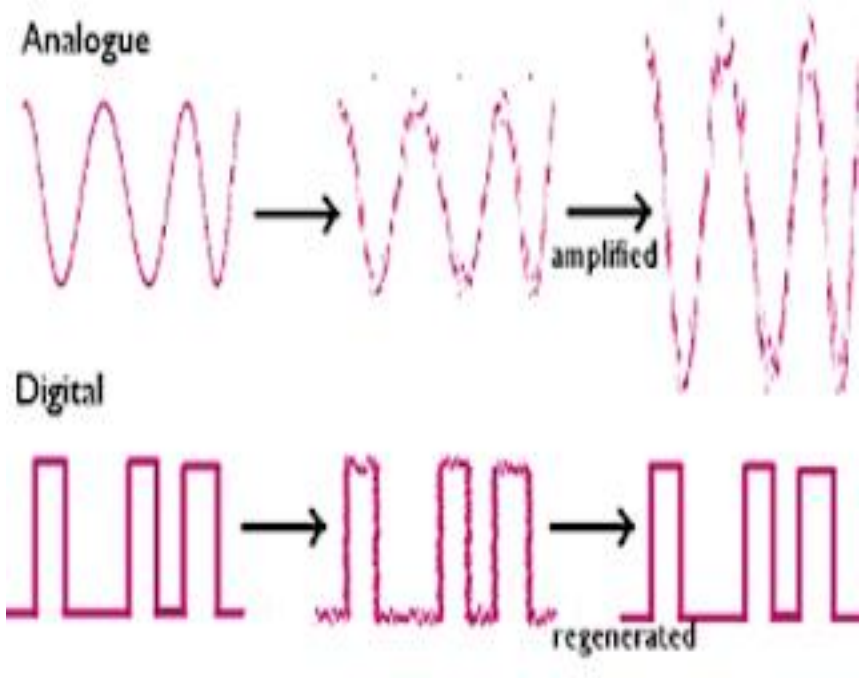
- In Telecommunications, broadcasting refers to a method of transferring a message to all recipients simultaneously
- Traditionally Point-to-multipoint communication
  - Simpler transmission scheme than point-to-point
  - High transmission power ($1/r^2$) (cost!)
- In principle: one-way communication
  - In practice: increasingly interactive, thanks to digital technology
    - View on demand
    - Two-way (movies, shopping, …)
    - IP- and MHP-based platforms

What is Digital?

- Strict definition: elements that can be counted on fingers (‘digits’)
- In practice: analogue (A) signal is sampled & quantized to digital (D) discrete binary values
- In DAB and DVB: several A/D/A stages



Digital over Analogue [Technical issues]



- Noise Immunity (Robustness against interference) (+)
- Multiplexing (+)
- Storage (+)
- Error correction and detection (+)
- Synchronisation (-)
- Extra Circuit requirement (-)

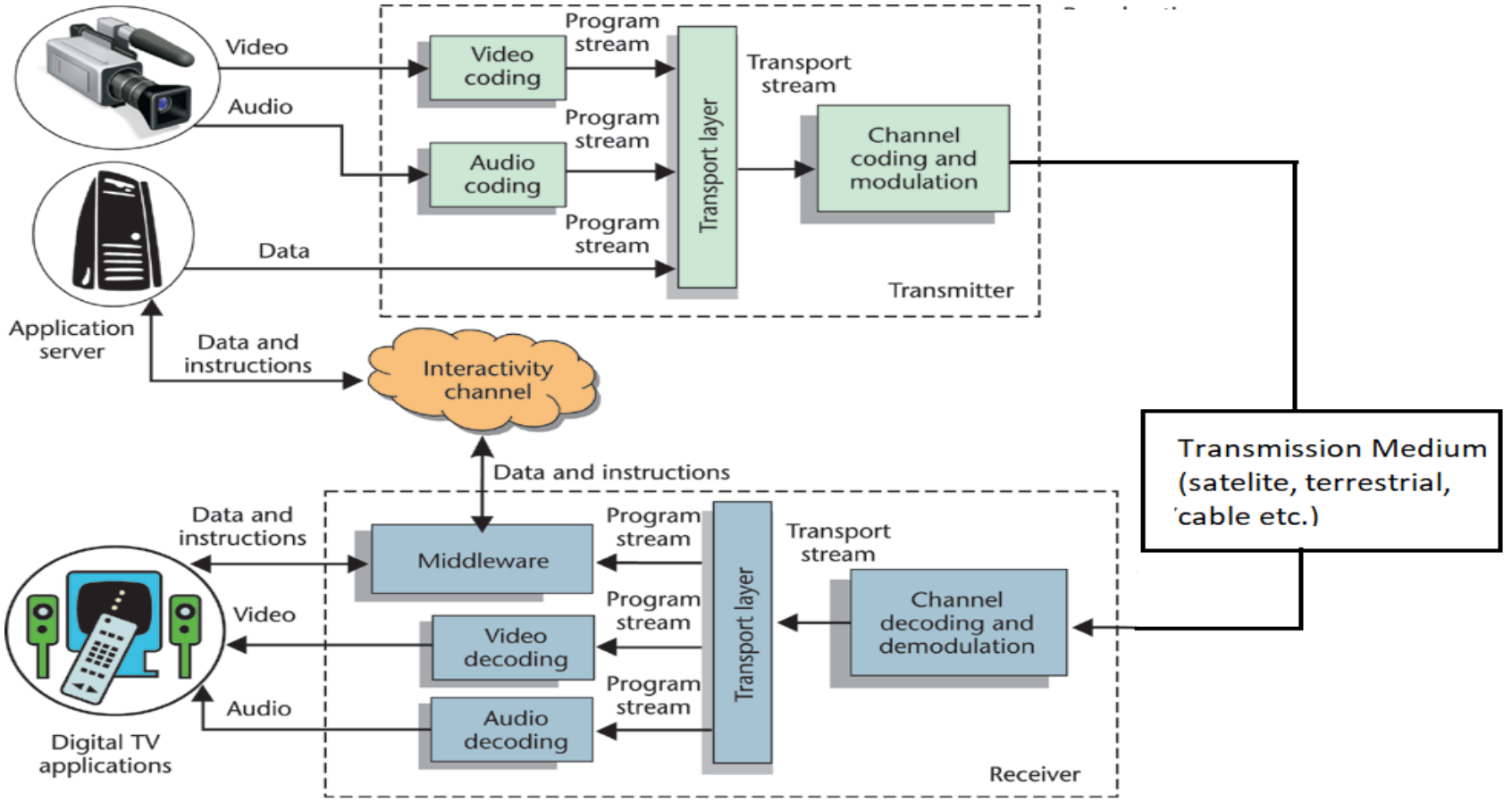
Aspects of Digital Broadcasting

- Essential stages:
  - Channel coding: error protection of bits
  - Modulation: for transmitting signal onto carrier
- But also…
  - Source coding: data compression
  - Multiplexing: combining into single data stream
  - Signal processing
- Involves video/audio and data

Why Digital Broadcasting

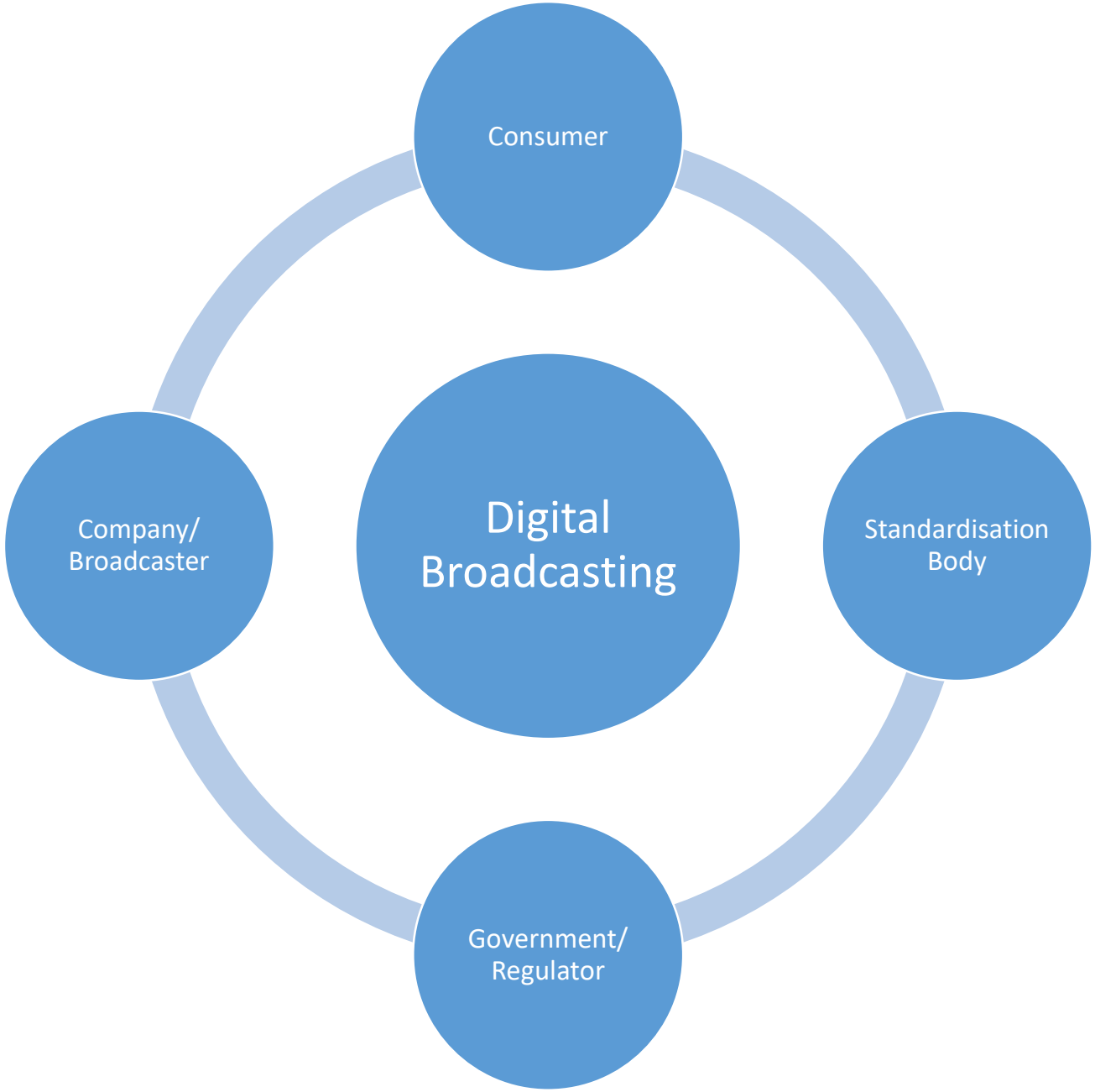
- Digital signals are more rugged
- Better quality: lossless data transmission
- More reliable
- Less expensive
- More flexible
- Time- vs. Frequency-Domain Multiplexing
- Additional devices requiring digital data
- Commercial reasons: better spectral efficiency, more channels, more services (gaming, shopping, internet), mobile reception, data transmission

Building blocks of Digital Broadcasting System



Benefits of Digital Switchover

- Potential benefits to consumers:
  - A greater choice of services
  - Extra information on programmes and interactive features
  - Easier tuning and new functions
  - Less interference to pictures or sound
- Potential benefits for the company:
  - Less cost due to no more need of simultaneous analogue/digital transmission
  - Requires less spectrum and so saves huge CAPEX
  - Possibility of diversifying devices, services and applications
- Potential Benefit to Government/regulatory body
  - Wider coverage [reducing digital inequality]
  - Freeing up spectrum which can be sold/offered for other services
  - Better management/regulation


Consumer
Company/
Broadcaster
Digital
Broadcasting
Standardisation
Body
Government/
Regulator

Why do we need standards?

- Safety and reliability
  - users perceive standardized products and services as more dependable
  - increases sales and the take-up of new technologies
- Support of government policies and legislation
  - Standards are frequently referenced by regulators and legislators for protecting user and business interests
  - Standards play a central role in the European Union's policy for a Single Market
- Interoperability
  - The ability of devices to work together relies on products and services complying with standards.

Why we need standards?

- Business benefits
  - standardization provides a solid foundation upon which to develop new technologies and to enhance existing practices.
  - Specifically standards:
    - Open up market access
    - Provide economies of scale
    - Encourage innovation
    - Increase awareness of technical developments and initiatives
- Consumer choice
  - Standards provide the foundation for new features and options
  - Mass production based on standards provides a greater variety of accessible products to consumers.

What the world would be like without standards?

- Products might not work as expected
- They may be of inferior quality
- They may be incompatible with other equipment – in fact they may not even connect with them
- In extreme cases, non-standardized products may be dangerous
- Customers would be restricted to one manufacturer or supplier
- Manufacturers would be obliged to invent their own individual solutions to even the simplest needs, with limited opportunity to compete with others

- Further info: http://www.etsi.org/standards/why-we-need-standards

Standardisation Process (ETSI Example)

- Process is based on consensus: agreement among members
  - what to standardize
  - the timing and resourcing of the task
  - the approval of the final drafts
- A proposal to start an item of work, such as to create a new standard or to update an existing one, needs the agreement of just **four members** of ETSI.
- Entire membership is given the opportunity to endorse the proposal, or to object to it if they so wish.

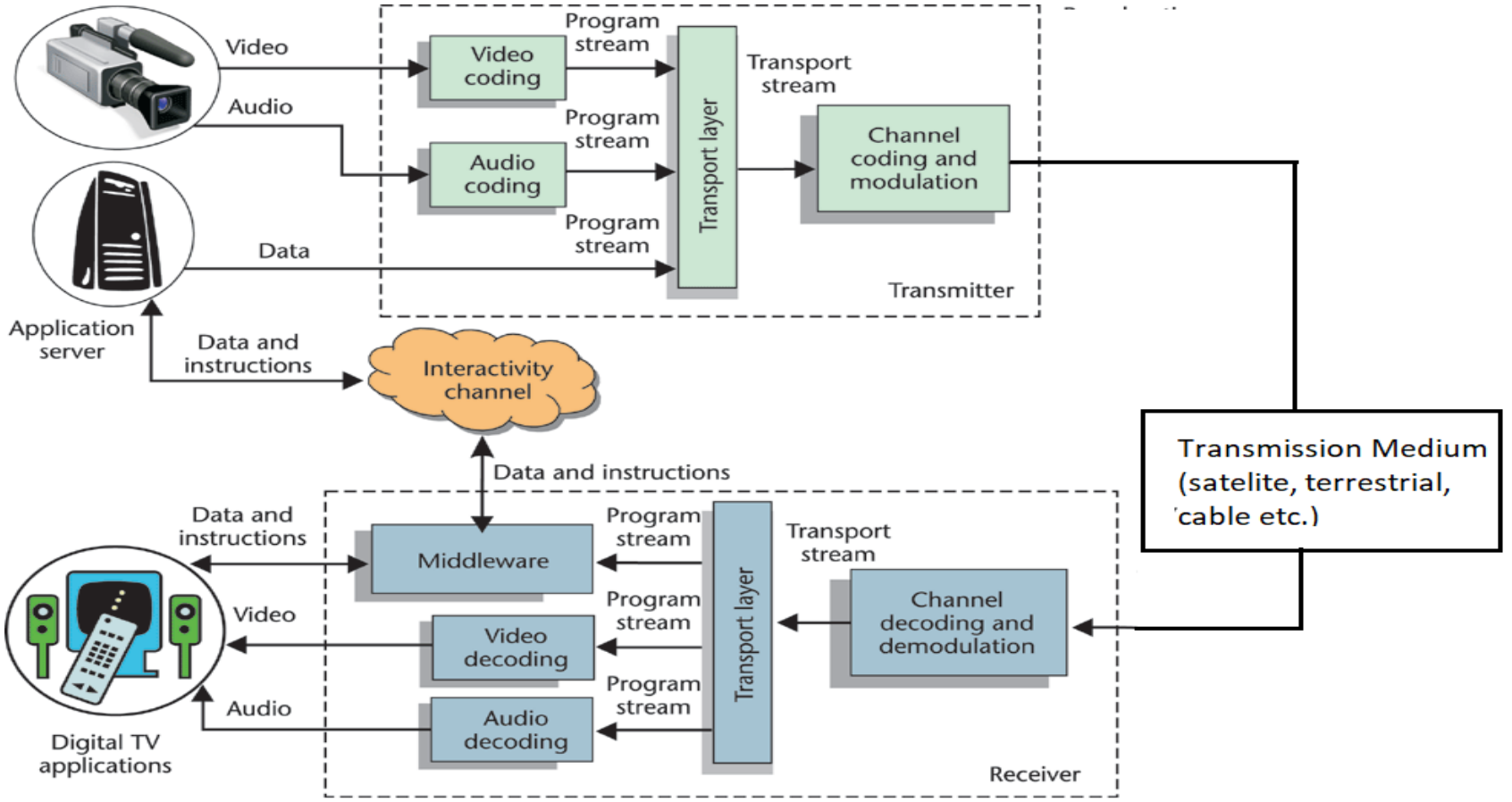
Standardisation Process (ETSI Example)

- Who does the standardization work?
  - **Technical committees or other types of working groups,** made up of representatives of our members and led by a ‘Rapporteur’, draft most of the standards.
- Specialist Task Forces (STFs)
  - Set up to accelerate the work where there is an urgent need.
  - STFs are groups of technical experts who come together for a defined period to work intensively on specific items.
- Industry Specification Groups (ISGs):
  - Set up quickly to address specific technology areas
- Depending on the type of document, it will be approved by either:
  - the participants in the relevant committee or
  - the entire ETSI membership

Major Standards for DB.

- Digital Video Broadcasting (DVB)
  - Europe, Singapore, Australia and New Zealand.
- Advanced Television System Committee (ATSC):
  - United States, Canada, Mexico, South Korea, Dominican Republic and Honduras.
- Integrated Services Digital Broadcasting (ISDB)
  - Japan and the Philippines.
- Digital Terrestrial Multimedia Broadcasting (DTMB)
  - Peoples Republic of China, including Hong Kong and Macau.

Building blocks of Digital Broadcasting System



Fundamental Components of DB

- Audio,
- Visual (Still/Video), and/or
- Data

- Transmitter:
  - Compression (source coding), e.g. using discrete cosine transform (DCT)
  - Multiplexing information to single transport stream (TS)
  - Forward error correction (channel coding), e.g., Reed-Solomon
  - Modulation (e.g. OFDM)
  - Transmission (antenna (Yagi-Uda, dish) or optical fibre)
- Reverse process at receiver

DB Standards

- Amalgamation of technical, commercial, political aspects & interests
- Backward compatibility is key concern
- Earliest developments for HDTV got ‘blocked’
  - 1980-1990: HD-MAC [High Definition - Multiplexed Analogue Components](Europe) and MUSE (Japan) based on satellite/cable broadcasting: technically ready, but …
    - … against commercial interests (TV advertising) of US advertisers (national terrestrial networks)
  - early 1990s: focus on terrestrial and cable ‘pure’ DTV (HD-DIVINE in Scandinavia)

DB Standards

- DVB receivers accounted for 61 per cent of all receivers in use at the end of 2011 while ATSC and ISDB receivers reached 21 per cent and 6 per cent respectively
- Amongst digital broadcast receivers, DVB represents 68 per cent of the total, with ATSC taking 23 per cent and ISDB variants 7 per cent, as of end of 2011.
- DVB: “Success needs worldwide accepted standard with balanced technical/commercial interests”
  - international MPEG as basis for European DVB (1993)
  - DVB became focus for ARIB/ISDB (Japan 1994), ATSC (US 1995; Canada, S. Korea 1997), DTMB (China 2006)

DVB (Digital Video Broadcasting)

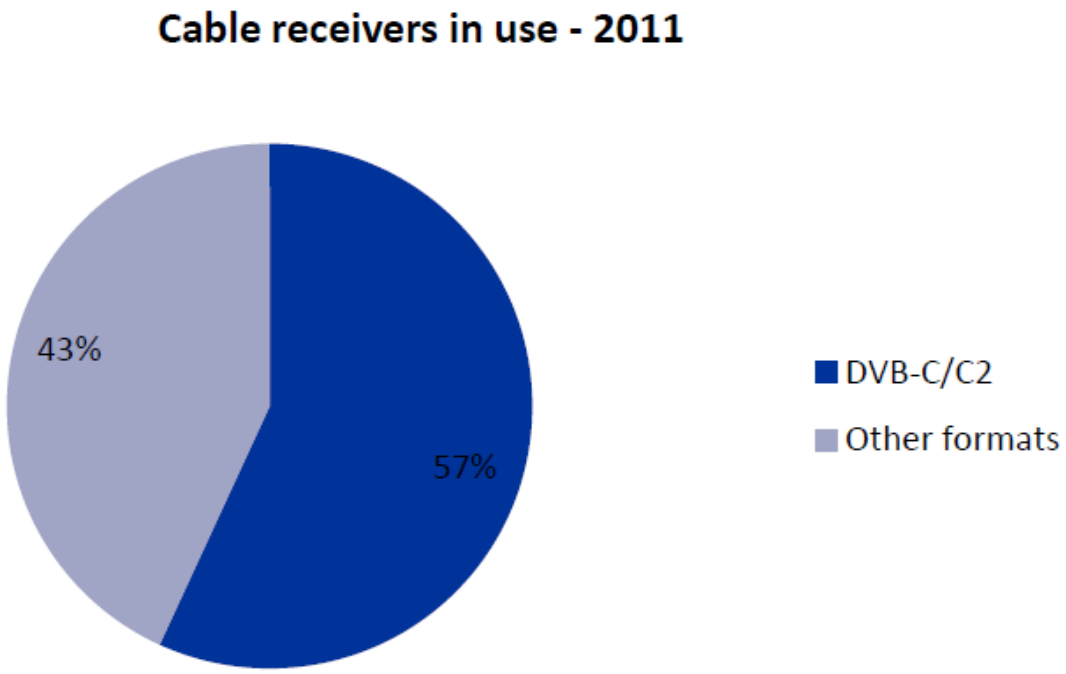
- DVB is a set of standards that defines digital broadcasting using existing satellite, cable, and terrestrial infrastructures
- DVB is the most widely used transmission standard in the world
- 4 modules: commercial, technical, promotional, intellectual property rights (IPR)
- Based on MPEG audio source coding, expanded to MPEG-2 and adopted by DVB, ASTC, ARIB
- DVB-S (1993), -C (1994), -T (1995), -SH, …
  - Different coding and modulation w.r.t. channel:

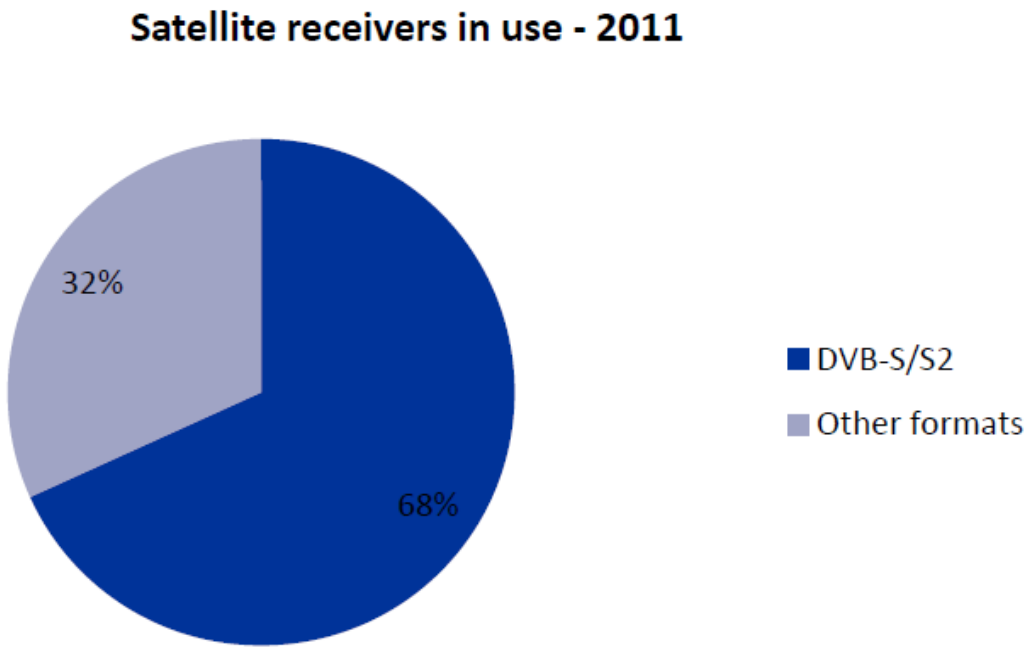
  e.g. QPSK in DVB-S, QAM in DVB-C, COFDM in DVB-T
- Spawned ISDB-T, -C, -S (Japan) and A/53-T (US)

DVB Standards

- Focus of digital television development for most of the world
- Established in 1993
- DVB uses MPEG compression standards as its core
- Seven main standards developed (there are more reports):
  - DVB-S and DVB-S2 for satellite broadcasting
  - DVB-C for cable systems
  - DVB-T and DVB-T2 for terrestrial broadcasting
  - DVB-H for handheld systems
  - DVB-SH for satellite-to-handheld systems
  - DVB-IPDC for internet protocol datacast over DVB-H
  - DVB-CPCM for content protection & copy management

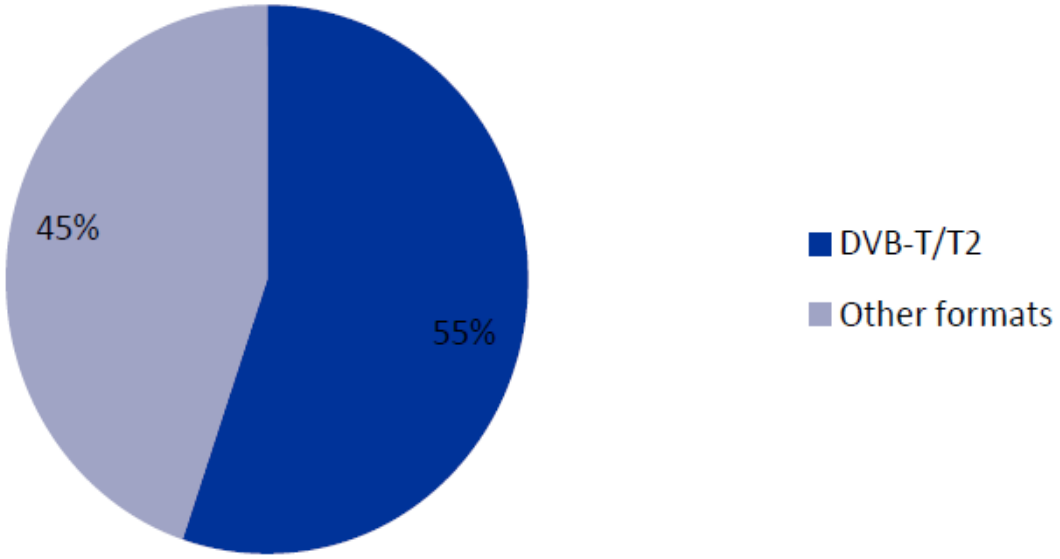
DVB: Some Statistics



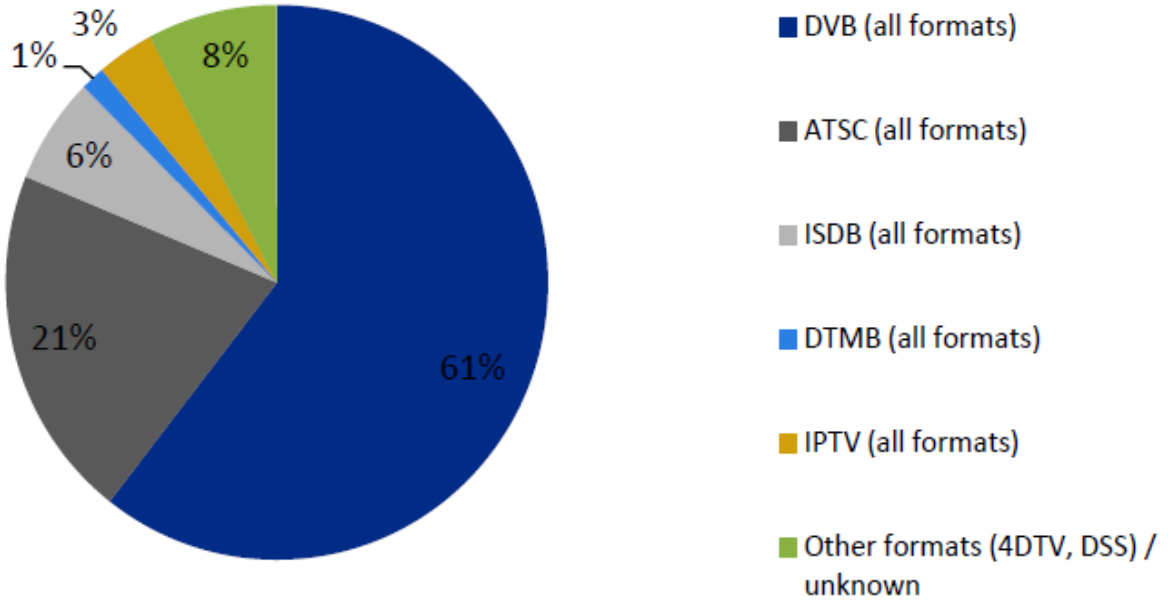


DVB: Some statistics

Terrestrial receivers in use - 2011

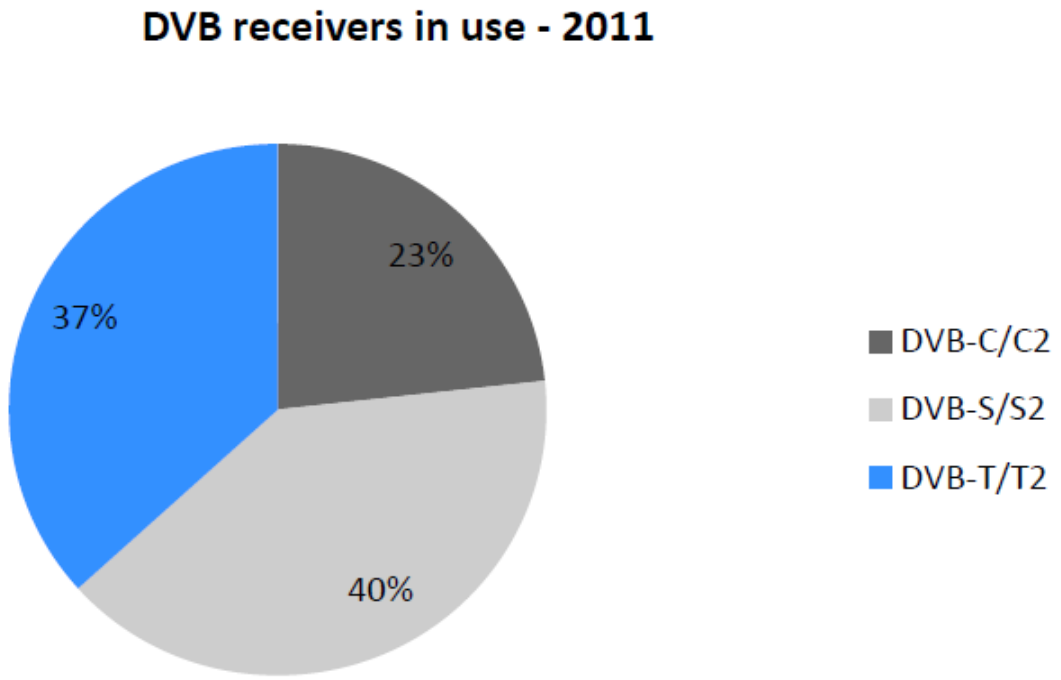


Total digital receivers in use - 2011



DVB: Some Statistics

- DVB transmitters and repeaters make up 84 per cent and 74 per cent of the global installed base respectively.
- The current installed base of DVB receivers splits relatively fairly between cable, satellite and terrestrial
- As a proportion of all DVB receivers deployed, satellite fell by 4 per cent since 2010 while terrestrial continues to grow by reaching to 37 per cent of all DVB receivers currently in use.



ISDB (Integrated Services Digital Broadcasting)

- Covers digital television (DTV) and digital radio
- Maintained by Association of Radio Industries and Businesses (ARIB), Japan
- Main differences compared to DVB:
  - ISDB-S uses 8-PSK and Trellis coding instead of QPSK in DVB-S
  - In ISDB-T, single 6 MHz TV channel can be split into 13×432 kHz subchannels for adaptive use:
    - digital audio (1 subchannel),
    - SDTV (multiple subchannels),
    - HDTV (all 13 subchannels).

ISDB Standards

- The standard covers
  - ISDB-S for satellite television
  - ISDB-T for terrestrial television: derivative; mainly used in South America
  - ISDB-Tsb for terrestrial sound
  - ISDB-C for cable television
  - ISDB-1seg: for cell phones, laptops, vehicles
- MPEG-2 or MPEG-4 standards

ATSC

- Advanced Television Systems Committee
- ATSC depends on numerous interwoven standards
  - ATSC (Terrestrial, Cable, Satellite)
  - ATSC-M/H
- Established 1990s
- Original specification for HDTV
- Uses Dolby, not MPEG for audio
- Mobile reception difficult/impossible until 2008
  - New ATSC-M/H since 2009

DTMB

- Digital Terrestrial Multimedia Broadcast
  - Chinese GB20600-2006 standard
  - Initially called DMB-T/H
  - DMB-T ≠ T-DMB (South Korea)
- Established 2006
- China (PRC) including SARs Hong Kong and Macau
- CMMB
  - Chinese Mobile Multimedia Broadcasting
  - Mobile and stationary
  - Satellite and terrestrial
  - Standard GY/T 220.1