Digital Radio Mondiale: DRM: DRM30, DRM+

Lindsay Cornell
Principal Systems Architect, BBC
Chairman Technical Committee, DRM

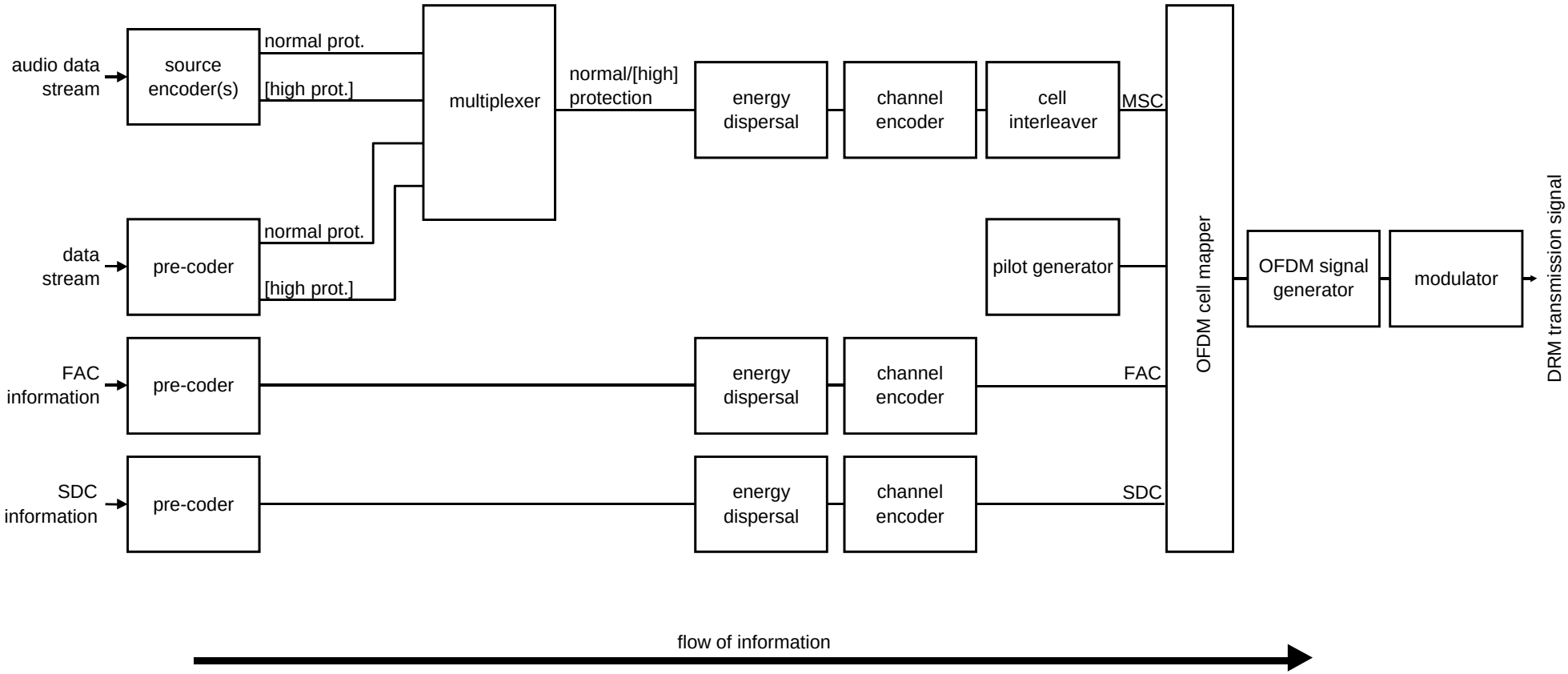
DRM: technology basics

- Fully digital system
- Uses OFDM for robustness to errors
- Various modes to suit propagation conditions
- Provides high quality audio coding
  - MPEG 4 AAC, CELP, HVXC
- Provides multimedia capabilities
  - Stream and packet data modes

System Architecture

- DRM is a fully digital system
  - Designed to work in all the broadcast bands below 174 MHz
  - Designed to work in the transition period from analogue to digital
  - Designed to provide high quality delivery of high quality radio services
  - Designed to improve the listener experience
    - Improved usability
    - Improved audio quality
    - New multimedia features

System block diagram



Propagation

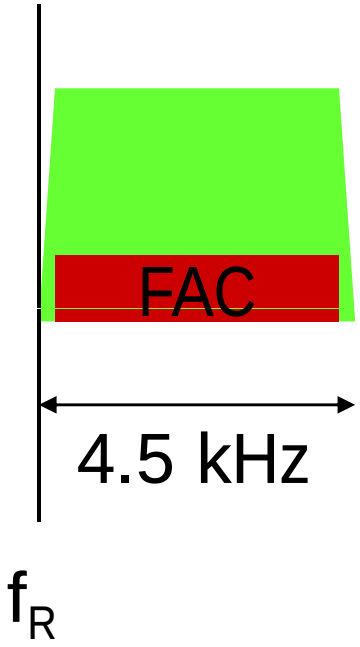
- Within the target frequency range, channel widths and propagation varies considerably
- DRM uses various techniques to deal with this
  - Signal bandwidth related parameters
  - Transmission efficiency related parameters

Bandwidth related parameters

- DRM below 30 MHz
  - The channel widths are 9 and 10 kHz
  - The ITU spectrum mask is respected
    - tougher than the mask used in many countries
    - gives maximum service density
    - and simpler receiver issues
  - Half and double channel modes are available
    - Allowing AM and DRM to be mixed
    - Allowing higher quality and multimedia
- DRM above 30 MHz
  - The channel width is 100 kHz

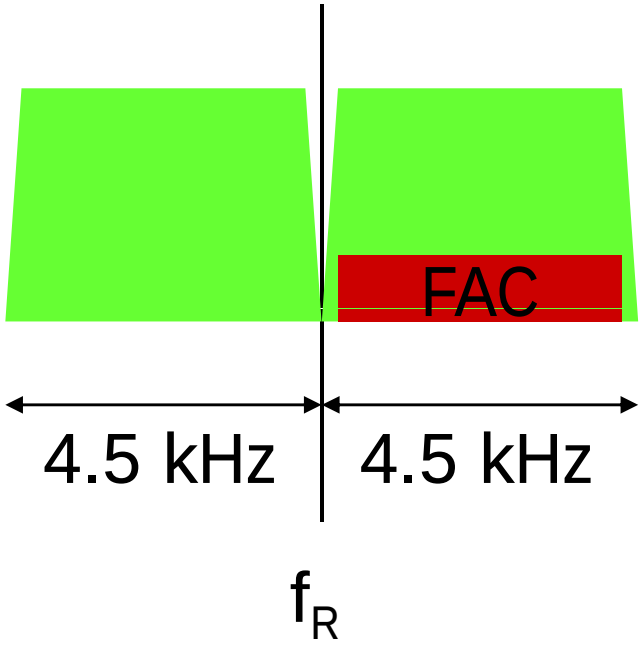
Spectrum occupancy

4.5 kHz channel



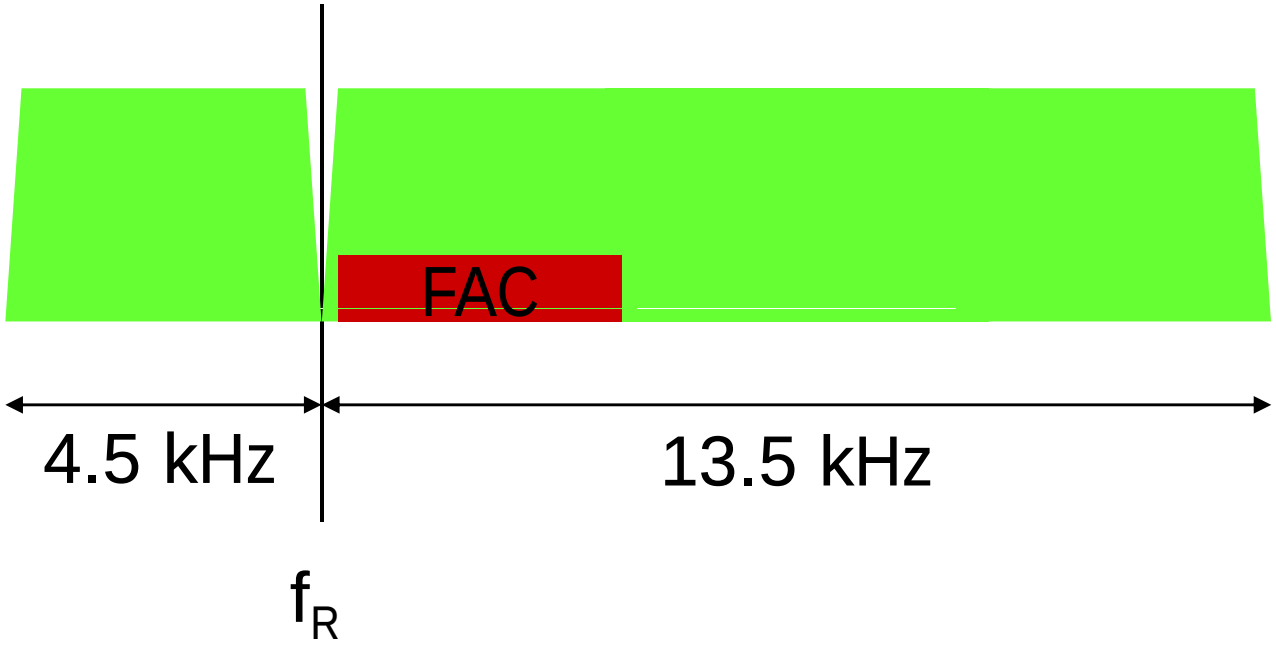
Spectrum occupancy

9 kHz channel



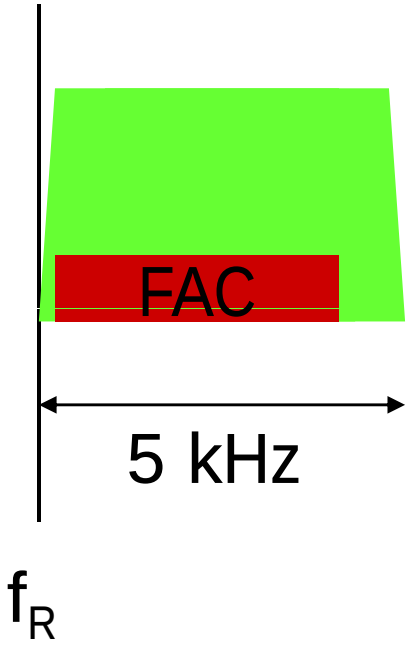
Spectrum occupancy

18 kHz channel



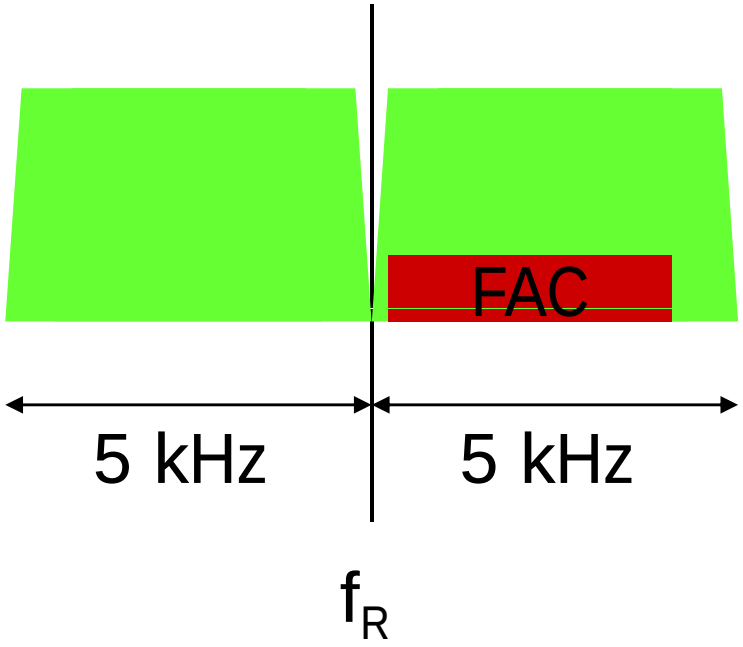
Spectrum occupancy

5 kHz channel



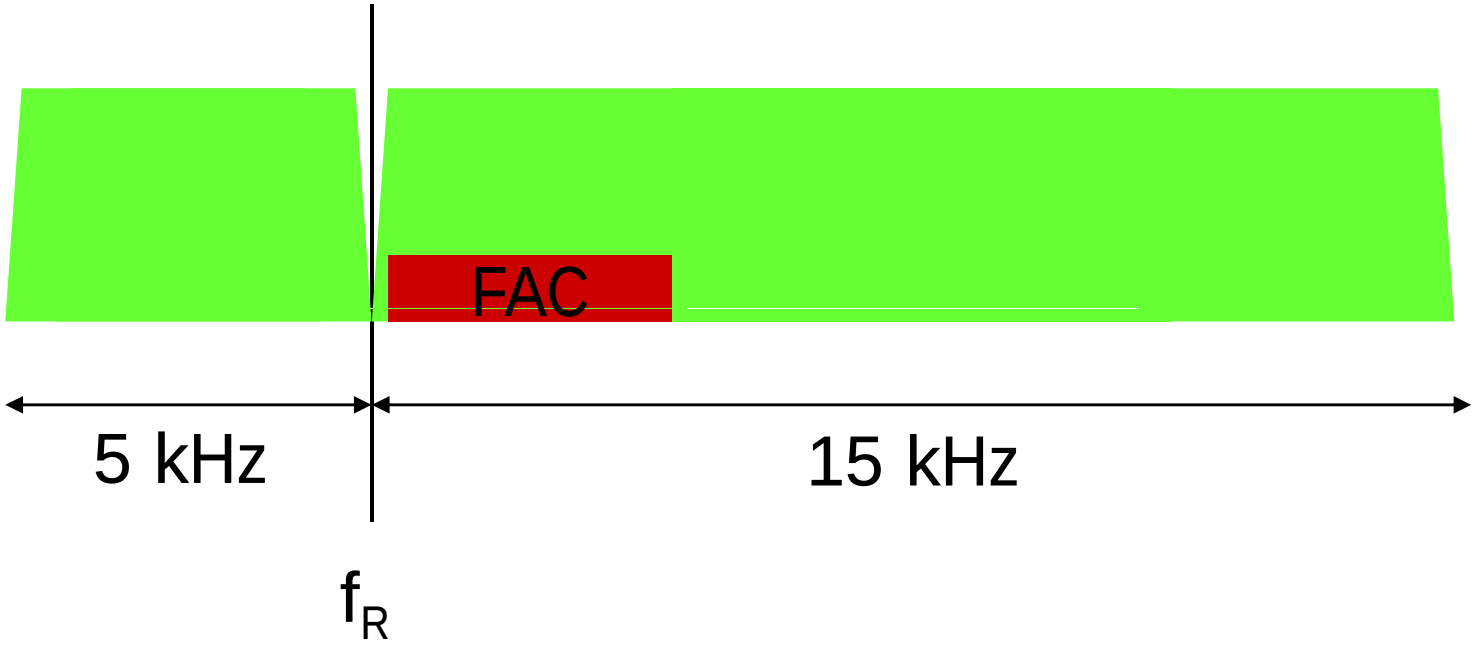
Spectrum occupancy

10 kHz channel



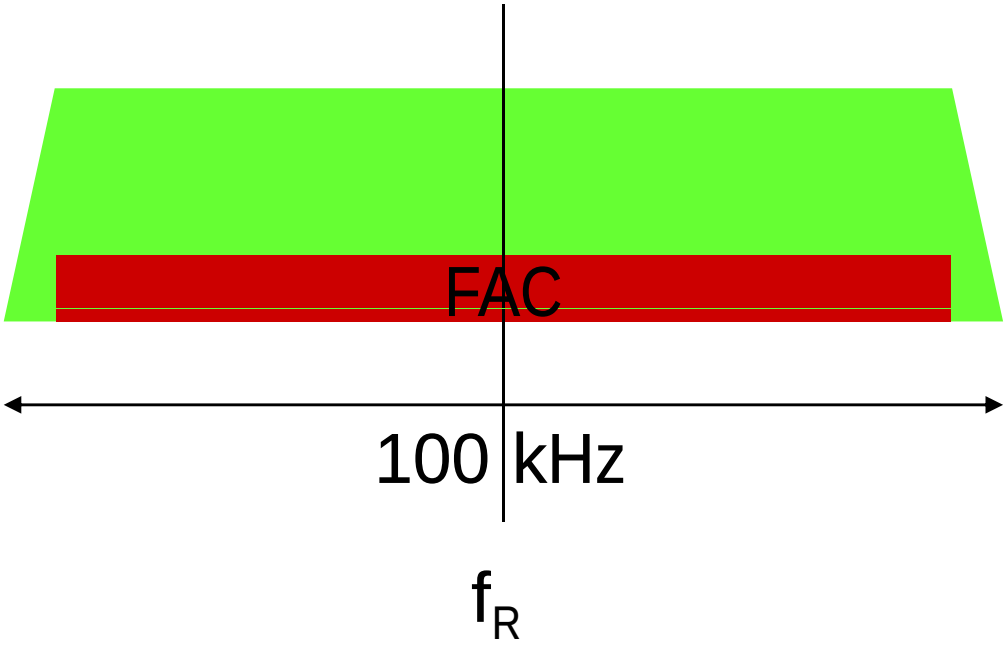
Spectrum occupancy

20 kHz channel



Spectrum occupancy

100 kHz channel



Transmission efficiency

- Code rates and constellation
  - Choice of code rates and constellations to allow trade-off between capacity and error performance
- OFDM parameter sets
  - Choice of “robustness modes”
    - Symbol duration
    - Guard interval
    - Carrier spacing
    - Transmission frame length (symbols per frame)

Robustness modes

Robustness mode	Typical propagation conditions (typical transmission bands)
A	Gaussian channels, with minor fading (LF and MF bands)
B	Time and frequency selective channels, with longer delay spread (MF and HF bands)
C	As robustness mode B, but with higher Doppler spread (HF, multiple hop)
D	As robustness mode B, but with severe delay and Doppler spread (HF, NVIS)
E	Time and frequency selective channels (low VHF bands including FM band)

Robustness modes

Robustness mode	Duration Tu	Carrier spacing 1/Tu	Duration of guard interval Tg	Duration of symbol Ts = Tu + Tg	Tg/Tu	Number of symbols per frame Ns
A (ground wave)	24 ms	$41^{2/3}$ Hz	2.66 ms	26.66 ms	1/9	15
B (sky wave)	21.33 ms	$46^{7/8}$ Hz	5.33 ms	26.66 ms	1/4	15
C (sky wave)	14.66 ms	$68^{2/11}$ Hz	5.33 ms	20 ms	4/11	20
D (NVIS)	9.33 ms	$107^{1/7}$ Hz	7.33 ms	16.66 ms	11/14	24
E (DRM+)	2.25 ms	$444^{4/9}$ Hz	0.25 ms	2.5 ms	1/9	40

Audio

- DRM has 3 audio coders
  - MPEG-4 AAC 14 kbps+
  - MPEG-4 CELP 10-12 kbps
  - MPEG-4 HVXC 2-4 kbps
- AAC is the main coder and can be used for all programming
- CELP and HVXC may be used for speech only programmes to allow very low bit rates to be used (DRM30 only)

SBR, PS, MPS

- SBR stands for Spectral Band Replication
  - Base coder provides detail at low audio frequencies
  - SBR provides side information to reconstruct high frequencies in the receiver
- PS stands for Parametric Stereo
  - PS provides side information to reconstruct the stereo image in the receiver from a mono base coded signal
- MPS stands for MPEG surround
  - MPS provides side information to reconstruct a multi-channel image in the receiver from a mono or stereo base coded signal

Data

- DRM allows data to be carried as
  - Synchronous streams
  - Packetised streams
  - Packetised files
- Packet mode is very flexible to allow reliable transfer in very small bit rates
  - Packet size is configurable
  - Additional FEC is configurable

Basic architecture

DRM uses a multiplex of three sub-channels:

- Fast Access Channel
- Service Description Channel
- Main Service Channel

Fast Access Channel

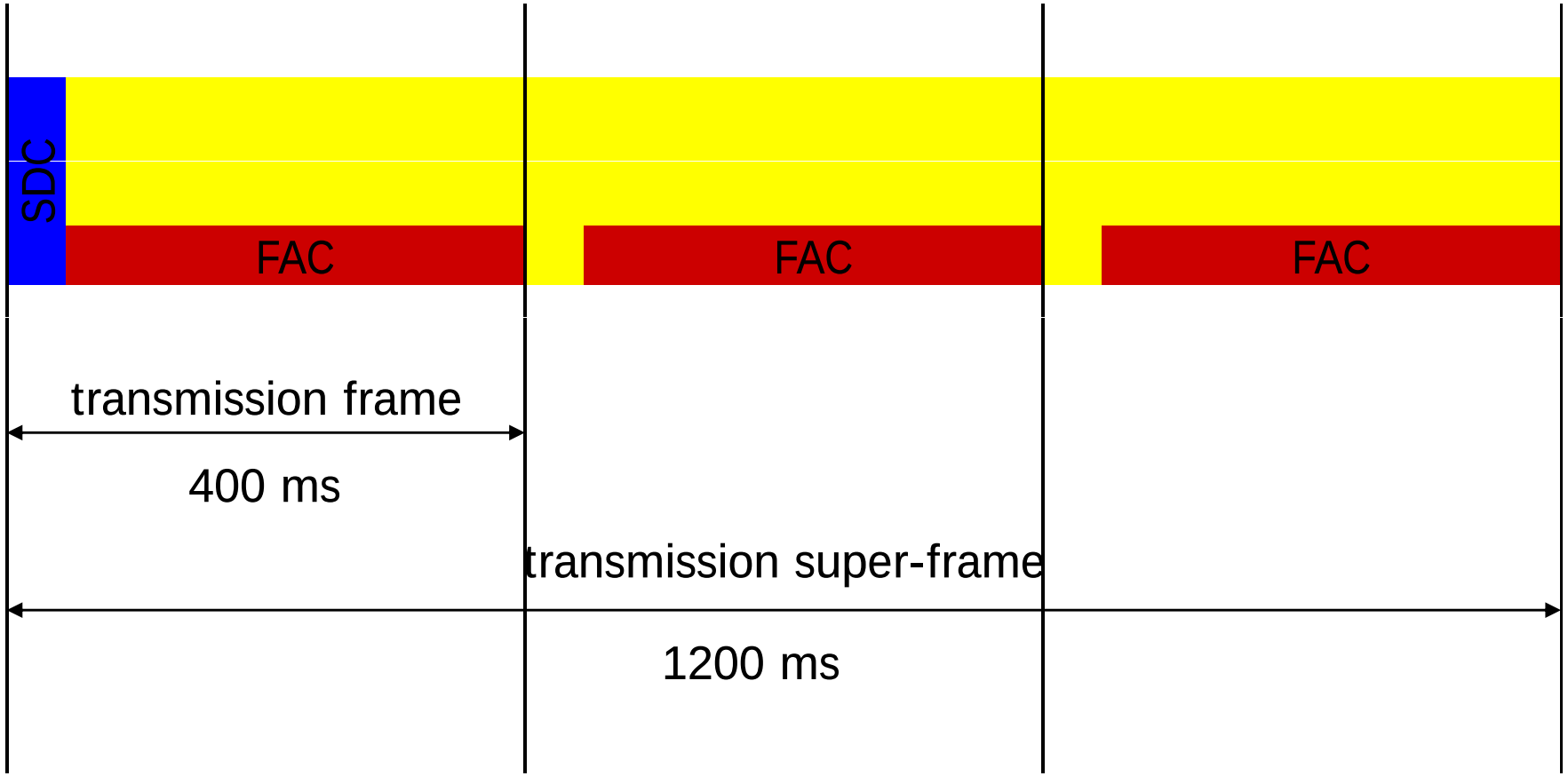
- Permits channel acquisition
- Mode indication to allow further decoding
  - Spectrum occupancy
  - Constellation of SDC and MSC
  - Time Interleaving depth
- Selection information for fast scanning
  - Service identifier
  - Language
  - Programme type for audio
  - Application type for data

Service Description Channel

- Permits service acquisition
  - Multiplex description
    - How the MSC is used for the streams and services
  - Service information
    - Label - up to 16 characters: UTF-8 coding
    - Audio/data parameters
    - Frequency information
    - ...
- Permits Alternate Frequency Switching (AFS)
  - No MSC data during the SDC symbols

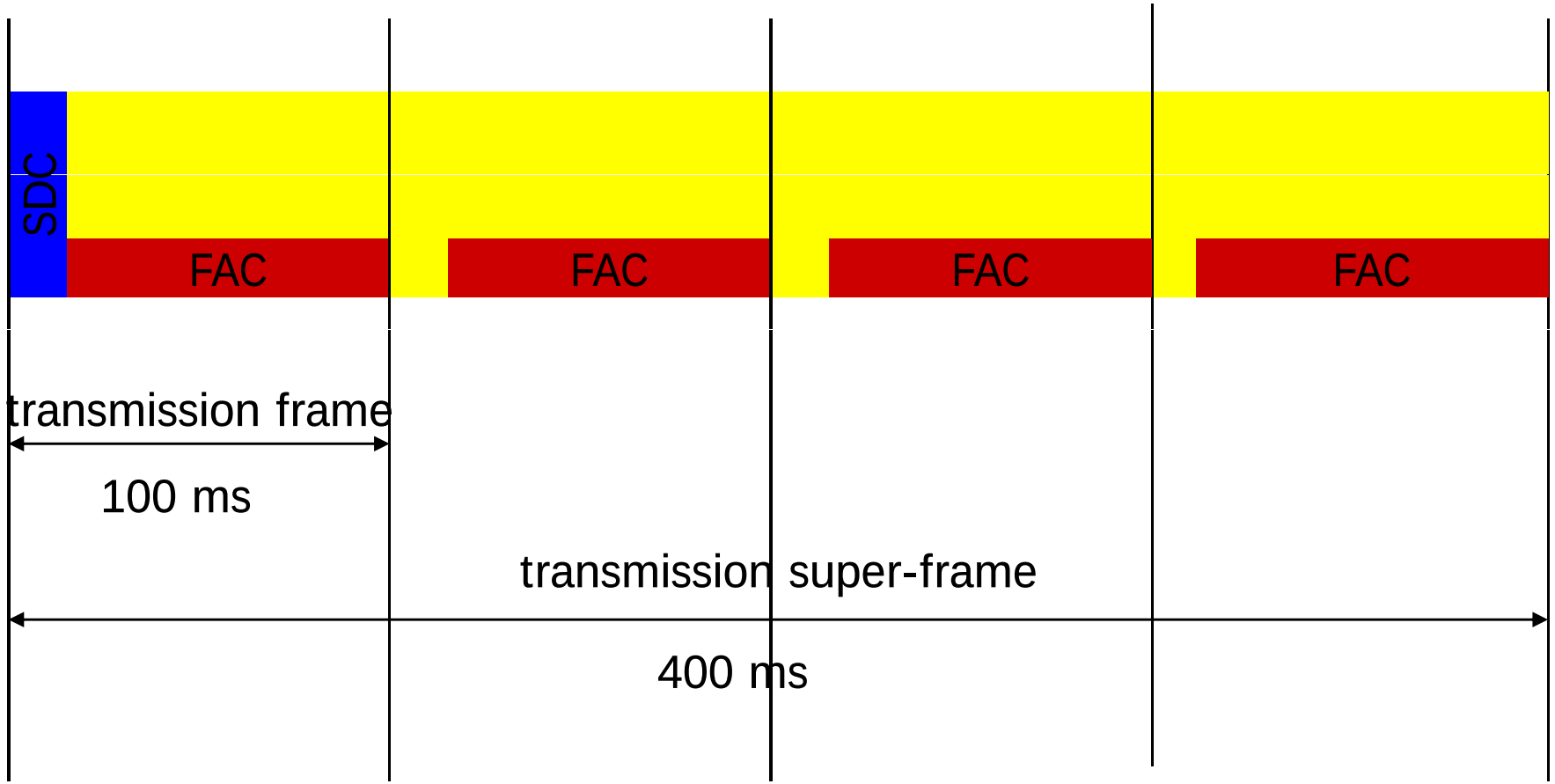
Framing

Channel below 30 MHz



Framing

Channel above 30 MHz



Main Service Channel

- May carry up to 4 services – audio or data
- May carry up to 4 streams
- May contain 2 protection levels
- Each stream is configured separately

Streams and services

- Services may be audio or data
  - Audio services consist of
    - One audio component
    - Zero or one associated data component
  - Data services consist of
    - One data component
- A stream may contain
  - One audio component
  - One data component in synchronous stream mode
  - Up to 4 data components in packet mode

Streams and services

- A DRM multiplex may therefore contain:
  - 4 audio services (no data components): 4 streams
  - 4 data services: 1 to 4 streams
  - 3 audio services and 1 data service: 4 streams
    - Any or all of the audio services could have associated packet data components if the data service is carried in packets
  - ...
  - 1 audio service and 1 data service : 2 streams
  - 1 audio service with data component : 2 streams
  - 1 audio service without data component : 1 stream
  - 1 data service : 1 stream

Multiplex reconfiguration

- The SDC contains the necessary signalling to allow the capacity of the MSC to be reallocated amongst the streams
- Services and streams can enter and leave the multiplex
- Many changes can be performed which allow the audio to continue uninterrupted
- Some changes mean the audio decoder must be reset or change the OFDM parameters

Summary

- DRM has great strengths
  - Worldwide open standard
  - Simple to use receivers
  - High audio quality
  - Multimedia capability
  - Covering all the analogue radio bands
    - LF, MF, HF, Band I, Band II, OIRT, ...

Thank you

Lindsay Cornell
Lindsay.Cornell@bbc.co.uk