– what’s new on DVB-T2?

Webinar by Ed Wilson – EBU TECHNICAL & DigiTAG

22 February 2011
Programme

- Why change a winning system like DVB-T?
- Is DVB-T2 technology living up to its promises?
- Progress on the first practical implementations
- Further plans for introducing DVB-T2 into service
- What future for terrestrial?
Why change a winning system like DVB-T?

- A look at DVB-T in 2011
- Research in transmission technology
- The 'commercial' requirements for DVB-T2
was standardised in 1996 and launched in the UK in November 1998

Set-top box cost around £350 or €550!
Was expected to spread like the ripples in a pond from the three launch countries of the UK, Sweden and Spain.

Unfortunately, the payTV services ONdigital in the UK and ONDAdigital in Spain failed in early 2002.
Digital terrestrial TV since then......

Boxer was quietly succeeding in Sweden 2002 - the UK relaunched with Freeview and now has over 10 Million primary homes and >60 Million DTT products.

Germany – launched in Berlin in 2002 and began switching off analogue TV six months later.

Italy – launched in 2004.

Spain relaunched in 2005 with success.

Digital terrestrial TV in Europe in 2011

European Union has target for analogue TV switch off by 2012.........
DVB-T Consumer products of all types:

IDTVs, Set-top boxes, SCART receivers, USB Sticks and DVB-T mobile phones
DVB-T product development continues......

In 2010 Garmin launched a SatNav GPS device with full diversity DVB-T reception.
Research in transmission technology

- In 2006, eight years after the commercial launch of DVB-T the DVB Technical Module launched a technical ‘Study Mission’ to consider all the improvements that could be made in a second generation terrestrial system:
  - Enhanced capacity/spectrum efficiency
  - Enhanced robustness
  - Enhanced mobility
  - Variation of robustness with service
  - More flexibility for IP services
  - More flexibility in bandwidth and frequency
  - Lower peak-to-average power ratio
  - Increased provision for SFNs

- They reported in June 2006 with a whole set of options
Technical options

- **Modulation scheme**
  - Removal of guard intervals together with some form of pulse shaping
  - Different (or no) pilot structures for channel equalisation

- **Channel Coding**
  - Better error correcting scheme
  - Time interleaving
  - MIMO (Multiple Input Multiple Output)

- **Signal pre-conditioning**
  - Flexible multiplexing schemes (as used with DVB-S2)
  - Variable coding & modulation depending on service
  - PAPR (Peak to Average Power Reduction) for transmitters
DVB Process

- The DVB was concerned that any new specification must be commercially justified and must not destabilise other DVB standards.

- So the Commercial Module was asked to start capturing commercial requirements.

- The CM sub-group presented the CRs at the DVB Steering Board in spring 2007.
Commercial Requirements

- Primarily for fixed reception using traditional rooftop antennas using existing transmitter sites and masts broadcasting to existing DVB-T domestic antenna and cable installations.

- Transmissions must meet the spectrum mask requirements defined in the ITU-R GE-06 frequency spectrum agreement, and must not cause more interference than DVB-T would.

- The DVB-T2 specification should target at least 30% increase in net payload capacity over DVB-T with similar or better robustness than DVB-T under the same conditions.
Other requirements

- Should provide for improved Single Frequency Network performance (nationwide SFNs)
- Should have mechanism for providing service-specific robustness
- Should provide for bandwidth and frequency flexibility for use in other broadcast bands
- Should provide means to reduce peak-to-average power ratio to make more efficient use of transmitter high power amplifiers
Has DVB-T2 lived up to its promises?

- The chosen features of DVB-T2
- Objectives achieved?
DVB-T2 chosen features

- Error protection as used in DVB-S2
  - Low Density Parity Check codes (Rates: 1/2, 3/5, 2/3, 3/4, 4/5, 5/6)

- Compatible system layer (Baseband Frames) as in DVB-S2

- ‘Classical’ Guard Interval – OFDM –like DVB-T but with more options:
  - FFT sizes: 1K, 2K, 4K, 8K, 16K, 32K
  - Guard Interval sizes: 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
  - Bandwidths 1.7, 5, 6, 7, 8, 10 MHz

- Up to 256QAM and hybrid (256/64QAM)

- 8 Scattered Pilot patterns to offer choice of bit rate overhead

- Continual pilots for common phase error rejection and fine frequency control
DVB-T2 chosen features - continued

- **Time interleaving at physical layer to improve impulse noise robustness**

- **Time slicing at physical layer**
  - Different PLPs (Physical Layer Pipes) can have different levels of robustness
  - Enables power saving in the receiver tuner

- **Sub-slicing within frame**
  - Increases time diversity/interleaving depth without increasing de-interleaver memory
DVB-T2 chosen features - continued

- P1 Pilot carrier symbol for frame sync. and for rapid detection as a DVB-T2 signal
- P2 Pilot carrier symbol carrying baseband frame construction data and PSI/SI information
- Three main levels of interleaving
  - Bit interleaving, Time interleaving and Frequency interleaving
- Rotated constellations
DVB-T2 chosen features - continued

- MISO (Multiple Input Single Output) capability (Alamouti-based transmit diversity)
- Peak-to-average-power reduction via tone reservation and constellation distortion
- Future Expansion Frames
- Signalling and compatibility with future implementations of Time Frequency Slicing
- Low-level transmitter identification signalling to manage and maintain SFNs
### 30% objectives achieved? - UK example

<table>
<thead>
<tr>
<th></th>
<th>UK DVB-T mode</th>
<th>UK DVB-T2 mode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modulation</strong></td>
<td>64QAM</td>
<td>256QAM</td>
</tr>
<tr>
<td><strong>FFT size</strong></td>
<td>2K</td>
<td>32K</td>
</tr>
<tr>
<td><strong>Guard Interval</strong></td>
<td>1/32</td>
<td>1/128</td>
</tr>
<tr>
<td><strong>FEC</strong></td>
<td>2/3 CC + RS</td>
<td>2/3LDPC + BCH</td>
</tr>
<tr>
<td><strong>Scattered Pilots</strong></td>
<td>8%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Continual Pilots</strong></td>
<td>2.6%</td>
<td>0.35%</td>
</tr>
<tr>
<td><strong>P1/P2 overhead</strong></td>
<td>0%</td>
<td>0.7%</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Standard</td>
<td>Extended</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>24 Mbit/s</td>
<td>40.2 Mbit/s</td>
</tr>
</tbody>
</table>

**Capacity = DVB-T + 67%**
Progress on practical implementation and verification

- Prototype equipment and first live demonstrations
- First Field trials and pilots
- Plugfest progress
The DVB Steering Board approved the DVB-T2 specification on 26 June 2008

On 27 June the BBC published a press release announcing the first live on air trials in conjunction with the broadcast network operator Arqiva from the Guildford transmitter mast

Source: BBC
IBC 2008 on the DVB stand

DVB-T2 live transmission in Amsterdam

Prototype
Modulators
and
Demodulators
DVB-T2 Rotated Constellation and Frequency Spectrum

Rotated 256-QAM Constellation (received off-air)

DVB-T2 spectrum channel 36 (received off-air)
Plans for introducing DVB-T2 into service

- UK soft launch in 2009
- UK Freeview HD launch in March 2010
- Sweden is next
- Realistic expectations
UK launched with real commitment

- UK Ofcom announced plans to use DVB-T2 from the end of 2009 in the Granada Region (North-West England) in replacing Multiplex B with 3 HDTV programmes and possibly 4 or 5 later.

Source: Digital UK
UK launched with real commitment

- Test transmissions began at Crystal Palace in London to provide industry with on-air test signals.

- Further DVB-T2 transmissions were to be squeezed in, well before Analogue Switch-Off, to give population coverage of 50% by the time of the South Africa FIFA World Football Cup in 2010.

- By December 2010, 1.2 Million DVB-T2 products were in use in the UK and DVB-T2 coverage reached 60% of the population.
UK Analogue Switch Off Progress in February 2011

Source: Digital UK
DVB-T2 in service in February 2011
Multiplex 7 in Sweden

Source: Teracom
Sweden - Mux 7 Modes used

<table>
<thead>
<tr>
<th>Mode</th>
<th>N7_VHF_Normal</th>
<th>N7_VHF_Long</th>
<th>N7_UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frekvensband</td>
<td>VHF</td>
<td>VHF</td>
<td>UHF</td>
</tr>
<tr>
<td>Bandwidth (MHz)</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Modulation &amp; code rate</td>
<td>256-QAM 2/3</td>
<td>256-QAM 3/4</td>
<td>256-QAM 3/5</td>
</tr>
<tr>
<td>FFT size</td>
<td>32KN</td>
<td>32KN</td>
<td>32KE</td>
</tr>
<tr>
<td>Pilot pattern</td>
<td>PP4</td>
<td>PP2</td>
<td>PP4</td>
</tr>
<tr>
<td>Guard interval fraction</td>
<td>19/256</td>
<td>1/8</td>
<td>19/256</td>
</tr>
<tr>
<td>Guard interval (μs)</td>
<td>304</td>
<td>512</td>
<td>266</td>
</tr>
<tr>
<td>C/N Gauss NorDig (dB)</td>
<td>20,4</td>
<td>22,9</td>
<td>18,9</td>
</tr>
<tr>
<td>C/N Rice (dB)</td>
<td>20,8</td>
<td>23,4</td>
<td>19,2</td>
</tr>
<tr>
<td>C/N Rayleigh (dB)</td>
<td>24,4</td>
<td>27,8</td>
<td>22,5</td>
</tr>
<tr>
<td>Capacity (Mbit/s)</td>
<td>~30,81</td>
<td>~31,59</td>
<td>~32,49</td>
</tr>
</tbody>
</table>

Source: Teracom
DVB-T2 in service and under test in February 2011
Plenty of other announcements

- DigiTAG surveyed its members and the public service broadcasters of the EBU.

- DVB-T2 is seen by everyone (including most recently France) as an exciting opportunity.

- The UK launch was particularly successful and there are plenty of DVB-T2 products of all kinds in the market.

- Several ‘greenfield’ countries around the world could go directly for DVB-T2, and others could extend with DVB-T2 after ASO.
DVB-T2 services have been announced for many more countries: Austria, Serbia, Slovakia, India, South Africa, Sri Lanka, Ukraine, Thailand, Kazakhstan etc...
Realistic expectations

- The DVB ‘commercially led’ process seems to give all members of the value chain - broadcasters, network operators, chip makers, professional and consumer manufacturers, and regulators - the confidence to invest in the technology and services.

- The falling prices of flat panel displays makes them ever more easily affordable. Broadcasters need to get HD programmes to them to compare well with Blu-ray discs and sophisticated Games consoles.

- The UK market have effectively ‘paid’ for some of the development costs of DVB-T2 and later countries will benefit from Moore’s Law impact on costs.
Final thoughts - what future for terrestrial?

- Threats to broadcasting:
  - The increasing political value of spectrum
  - Governments claiming back the Digital Dividend
  - Pragmatic or risky band sharing
  - Can Cognitive Radio really work in Europe?

- DVB-T2 may become an essential weapon in the broadcasters fight to retain access to spectrum!
Acknowledgements and more information:

- Many thanks go to the members of the Ad-hoc group DVB TM-T2 under the leadership of Nick Wells (BBC) for their amazing energy and inventiveness in the specification process and the impressive results achieved!

- Thank you to those whose material I have used and whose Websites I have plundered.

- If you’d like more information you could start with www.dvb.org and www.digitag.org

- Questions to tech@ebu.ch