New TV Technologies for Science Education

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Digital TV Delivery Platforms

• Digital Terrestrial TV Broadcasting
• Digital Cable TV
• IPTV
• Mobile TV
• DTH
• Satellite – Digital Multimedia Broadcasting
• 2G/3G/MBMS (Multimedia Broadcast Multicast Service)
## Spectrum for Digital TV Broadcasting

<table>
<thead>
<tr>
<th>Digital Broadcasting Service</th>
<th>Broadcast Spectrum</th>
<th>Amount (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Cable TV</td>
<td>Not applicable (wired service)</td>
<td>–</td>
</tr>
<tr>
<td>DTH</td>
<td>`KU’ Band (11.7 – 12.2 GHz) 'K’ Band (21.4 – 22.0 GHz) 'Ka’ Band (40.5 – 42.5 GHz)</td>
<td>500 600 2000</td>
</tr>
<tr>
<td>IPTV</td>
<td>Not applicable (wired service)</td>
<td>–</td>
</tr>
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</table>
## Spectrum for Digital TV Broadcasting

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<thead>
<tr>
<th>Digital Broadcasting Service</th>
<th>Broadcast Spectrum (MHz)</th>
<th>Amount (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite – Digital Multimedia Broadcasting</td>
<td>‘L’ Band (1452 – 1492)</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>‘S’ Band (2310 – 2360)</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(2535 – 2655)</td>
<td>120</td>
</tr>
<tr>
<td>Digital Terrestrial TV Broadcasting (DTTB) / DVB-T</td>
<td>VHF Band I (54 – 68)</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>VHF Band III (174 – 230)</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>UHF Band IV (470 – 585)</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>UHF Band V (585 – 806)</td>
<td>221</td>
</tr>
<tr>
<td>Digital Mobile TV (DVB-H, MediaFlo, T-DMB, ISDB – One SAG)</td>
<td>VHF Band III (174 – 230)</td>
<td>56</td>
</tr>
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<td>221</td>
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Special Features of Digital TV Broadcasting

- Superior Quality
- Transmission of several programmes from one transponder/transmitter
  - DTH (10 to 14 TV channels)
  - Digital Cable TV (10 to 14 TV channels)
  - DTTB (5 TV channels)
  - Mobile TV (30 TV channels)
- Multimedia broadcasting (TV, Radio, Data)
- Trade off between quality and number of channels (Dynamic allocation of bits among different channels)
- Digital Terrestrial Broadcasting designed for reception under fixed, portable and high speed mobile environment
- Sudden degradation of reception (against graceful degradation which happens in analog transmission)
- Planning of service for higher percentage of time availability (80%, 90%, 95%)
- Need for Gap fillers/Repeaters
- Single Frequency Network possible
Digital Terrestrial TV Broadcasting (DTTB)
Competing Standards

- ATSC (Advanced Television Standard Committee)
- DVB-T (Digital Video Broadcasting-Terrestrial)
- ISDB-T (Integrated Services Digital Broadcasting)
• Developed in Europe
• DVB is a consortium of 230 broadcasters, network operators & regulatory bodies from 30 countries
• Family of Systems DVB-S, DVB-C, DVB-T, DVB-RCS, DVB-H etc.
• MPEG-2/MPEG-4 Video compression
• Multi-carrier OFDM Modulation
OFDM - A Multi Carrier approach

Guard interval introduces a first loss in transport capacity
Spectrum Arrangement for Interleaved Multi-carrier Audio Signals using OFDM Technique

Programme 1
Programme 2
Programme 3
Programme 12

1 2 3 12 13 14 15 24 25 26 27 1536

Frequency Block (Contains 1536 carriers) in a BW = 1.54 MHz
Distribution of the Modulated Symbols in Time & Frequency Domain in OFDM

\[ t_s = \text{Useful Symbol Period} \]
\[ \Delta = \text{Guard Interval} \]
\[ T = t_s + \Delta = \text{Total Symbol Period} \]
\[ f = \frac{1}{f_s} = \text{Sub-channel separation} \]
Modulation constellations

QPSK
- 2 bits per carrier

16QAM
- 4 bits per carrier

64QAM
- 6 bits per carrier
Single Frequency Network (SFN)

Useful Duration (Tu)

Guard Interval (Tg)

OFDM Symbol Period

Maximum Distance Allowed = 73 km with Tg = 243 μs
Channel bandwidth can be used in different ways

- Multiple SDTV Programmes
- Single HDTV Programme
- Simulcast HDTV & SDTV Programmes
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Feature</th>
<th>VHF Band (174-230 MHz)</th>
<th>UHF Band (470-960 MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobile Reception</td>
<td>Good (+)</td>
<td>Fair (-)</td>
</tr>
<tr>
<td>2</td>
<td>Propagation Loss</td>
<td>Lower (-)</td>
<td>Higher (+)</td>
</tr>
<tr>
<td>3</td>
<td>Antenna Gain</td>
<td>Lower (-)</td>
<td>Higher (+)</td>
</tr>
<tr>
<td>4</td>
<td>Size of Transmitting Antenna</td>
<td>Higher (-)</td>
<td>Lower (+)</td>
</tr>
<tr>
<td>5</td>
<td>Size of Receiving Antenna</td>
<td>Higher (-)</td>
<td>Lower (+)</td>
</tr>
<tr>
<td>6</td>
<td>Building Penetration Loss</td>
<td>Lower (+)</td>
<td>Higher (-)</td>
</tr>
<tr>
<td>7</td>
<td>Man made Noise</td>
<td>Higher (-)</td>
<td>Lower (+)</td>
</tr>
<tr>
<td>8</td>
<td>Losses due to Doppler Effect</td>
<td>Lower (+)</td>
<td>Higher (-)</td>
</tr>
</tbody>
</table>
MOBILE TV
Limitations of Cellular Mobile Technologies

- Although 3G is able to offer up to 2 Mbps bandwidth, the data rate for single user may not exceed 300 kbps.
- This is because total bandwidth of a 3G cell is shared between all active users.
- If large no. of users subscribe broadcast TV during a popular event, 3G network will choke.
- Long video applications like broadcast TV which requires continuous high data rate (more than 300 kbps) are therefore unsuitable for delivery through 3G.
- 3G is useful for individual delivery of medium size data such as web access, E-Mail, Gaming, Video Clips, Video-on-Demand etc.
Mobile TV

Mobile TV Channels

Mobile Broadcast Network

High Power Transmitters, High Towers, SFN, VHF/UHF TV Bands

Cellular Network

For voice, web access, E-mail, game, video clips and Interactive TV, Billing, Customer care

Mobile Terminal
Mobile TV - Convergence of Broadcasting & Cellular Mobile Service

- Multichannel TV/Radio/Data to mobile handsets will be provided in broadcasting mode by laying a separate terrestrial network
  - High power transmitters (5 to 100 kW erp) and tall antennas (100 to 300 metres) will be deployed. UHF band (470 to 806 MHz) will be assigned (Preferred band may be 470 to 720 MHz)
  - Separate spectrum
  - A separate license will be needed
  - Service may be provided in Free to Air (FTA) mode as well as Pay (Subscription) mode
- Mobile handset will receive Mobile TV transmissions as well as work as a normal cellular phone.
Mobile handsets will be individually addressable

Integration of TV in mobile handsets will open large number of possibilities/Value Added Services apart from Interactive TV

Existing Cellular Mobile Networks will not be loaded since TV transmission will use separate infrastructure and spectrum

However, consumers will be billed by a single company for both phones as well as TV services

Similarly customer care centres will be common.
Mobile TV Technologies

- **DVB-H** (developed by DVB group, Europe)
- **Media FLO** (developed by Qualcomm, USA)
- **T DMB** (developed in Korea)
- **ISDB-OneSEG** (developed in Japan)
Aims of Mobile TV Technologies

- Suitable for small screen (low video resolution) handheld devices (e.g. mobiles, PDAs etc)
- Delivery of Multiple TV, Radio and Data Channels
- Low Battery Consumption (Typically 4 hours)
- Internal Antenna and light weight handset
- Unimpaired reception in fast moving vehicles
- Interactivity through 3G
- Seamless handover
- Spectrum efficient (SFN deployment)
- Both FTA and Pay TV options available
Principle of Time Slicing to Save battery Power

Burst Duration

10%

Off-time

90%

Burst Size

Constant Bitrate

Burst Bitrate
# Doordarshan’s DVB-H Transmission

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel</td>
<td>Channel 26 (UHF)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>8 MHz</td>
</tr>
<tr>
<td>Max Data rate available</td>
<td>5.563 MBPS</td>
</tr>
<tr>
<td>Raw video Bit Rate/Channel</td>
<td>384 kbps</td>
</tr>
<tr>
<td>Raw Audio Bit Rate/Channel</td>
<td>64 kbps</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK</td>
</tr>
<tr>
<td>FEC</td>
<td>3/4</td>
</tr>
<tr>
<td>Guard Interval</td>
<td>1/8</td>
</tr>
<tr>
<td>No. of Sub-carriers</td>
<td>8 K</td>
</tr>
</tbody>
</table>
Digital Cable TV
Digital Cable TV System Architecture

- Antenna System
  - Satellite
- Head end
  - Signal reception, processing & conditioning, encryption, subscriber management
- Distribution Plant
  - Optical & RF Amplifiers, Traps and Trunk, Feeder & Drop Cables
- Digital Set Top Box (STB)
  - De encryption
Why Digital?

- Using QAM 64 Modulation one can carry 38 Mbps of MPEG-2 video i.e. 12 – 14 TV Channels per 8 MHz RF carrier

- A 860 MHz Network can carry 1000 channels i.e. close to 4 – 5 Gbps of Video
# Spectrum used in Cable TV

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Spectrum</th>
<th>No. of Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Band I (47 to 103 MHz)</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Midband (111 to 174 MHz)</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Band III (174 to 230 MHz)</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Superband (230 to 300 MHz)</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Ext. Superband (302 to 446 MHz)</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Band IV (470 to 606 MHz)</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>Band V (606 to 862 MHz)</td>
<td>32</td>
</tr>
</tbody>
</table>

**Total = 102 Channels**
<table>
<thead>
<tr>
<th>Forward Bandwidth (MHz)</th>
<th>Maximum number of channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>550</td>
<td>67</td>
</tr>
<tr>
<td>750</td>
<td>92</td>
</tr>
<tr>
<td>860</td>
<td>106</td>
</tr>
</tbody>
</table>
Typical Spectrum used in Cable TV Network

Service Provided: Analog TV, Digital TV, Broadband, Telephone (VOIP)

NOTE:
1. Up stream channel bandwidth could be 0.8 MHz, 1.6 MHz, 3.2 MHz or 6.4 MHz
2. Down Stream channel bandwidth is 7 MHz between 54 MHz & 300 MHz and 8 MHz between 300 & 860 MHz
3. (a) Analog TV uses PAL ‘B’ and ‘G’ System
(b) Digital TV uses DVB-C/ QAM-64 modulation
(c) Broadband Down Stream uses QAM-256/ QAM-64 modulation
(d) Broadband Up Stream uses QPSK/ QAM-16/ QAM-64 modulation
Internet Protocol Television
( IPTV )
Difference between Internet TV & IPTV

• Internet TV provides only low resolution poor quality video through public Internet

• IPTV is a robust platform which is capable of providing high resolution excellent quality video mostly over a managed IP network
Types of DSL Technologies

- **Asymmetric DSL (ADSL)**
  - ADSL Light
  - Rate-Adaptive DSL (RADSL)
  - ADSL 2
  - ADSL 2+

- **High bit rate DSL (HDSL)**
  - Symmetric DSL (SDSL)
  - Single-pair high speed DSL (SHDSL/HDSL2)

- **Very High Data Rate DSL (VDSL)**
- **Other DSL Technologies: IDSL & VoDSL**
# Comparison of xDSL Technologies

<table>
<thead>
<tr>
<th>xDSL</th>
<th>Modulation Method</th>
<th>Symmetric or Asymmetric</th>
<th>POTS Support</th>
<th># of Twisted Pairs</th>
<th>Maximum Reach (km)</th>
<th>Maximum Bitrate Downstream</th>
<th>Maximum Bitrate Upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADSL</td>
<td>QAM/CAP or DMT</td>
<td>Asymmetric</td>
<td>Yes</td>
<td>1</td>
<td>5.5</td>
<td>6 Mbit/s</td>
<td>640 kbit/s</td>
</tr>
<tr>
<td>ADSL light</td>
<td>QAM/CAP or DMT</td>
<td>Asymmetric</td>
<td>Yes</td>
<td>1</td>
<td>5.5</td>
<td>1.5 Mbit/s</td>
<td>512 kbit/s</td>
</tr>
<tr>
<td>HDSL</td>
<td>2B1Q</td>
<td>Symmetric</td>
<td>No</td>
<td>1, 2, 3</td>
<td>3.6</td>
<td>2 Mbit/s</td>
<td>2 Mbit/s</td>
</tr>
<tr>
<td>SDSL</td>
<td>2B1Q</td>
<td>Symmetric</td>
<td>No</td>
<td>1</td>
<td>6.5</td>
<td>2.3 Mbit/s</td>
<td>2.3 Mbit/s</td>
</tr>
<tr>
<td>SHDSL</td>
<td>PAM</td>
<td>Symmetric</td>
<td>No</td>
<td>1, 2</td>
<td>6.5</td>
<td>4 Mbit/s</td>
<td>4 Mbit/s</td>
</tr>
<tr>
<td>IDSL</td>
<td>2B1Q</td>
<td>Symmetric</td>
<td>No</td>
<td>1</td>
<td>5.5</td>
<td>144 kbit/s</td>
<td>144 kbit/s</td>
</tr>
<tr>
<td>VDSL</td>
<td>QAM/CAP or DMT</td>
<td>Asymmetric or Symmetric</td>
<td>Yes</td>
<td>1</td>
<td>1</td>
<td>52 Mbit/s</td>
<td>6 Mbit/s</td>
</tr>
</tbody>
</table>

Contd...
Comparison of xDSL Technologies

Contd.
Data Capacity of xDSL and Fibre/Ethernet

- ADSL: 1.5 to 6 Mbps
- VDSL: 13 to 55 Mbps
- Fibre: > 10 Mbps

Depending on distance
Satellite Mobile TV Technologies
Satellite Mobile TV Technologies

- A dedicated satellite with high EIRP required
- Dense Terrestrial Transmitter network in S’ Band needed for indoor coverage
- Synchronization of terrestrial transmitters with direct satellite beam required
- Good for rapid deployment of service over large geographical area
Satellite Mobile TV Technologies

S-DMB/MBCo (Korea / Japan)

ICO (USA)

ISRO (India)

CMMB (China)

Sirius Radio / XM Radio (USA)

WorldSpace (International)
DVB-SH Systems

- A hybrid satellite/terrestrial system
- Designed to use frequencies below 3GHz.
- System and specifications have been published as ETSI standards.
- Successfully demonstrated by Alcatel at NAB, Las Vegas, 2008
Thank You

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