System Comparison
T-DMB vs. DVB-H

DVB Technical Module 2006
Outline

- T-DMB and DVB-H Physical Layer Options
- True differences between T-DMB and DVB-H
- DMB claims vs. facts
- True technical maturity
- Network coverage and planning issues
- Network cost comparison
# DVB-H and T-DMB Main Physical Layer Options

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T-DMB</th>
<th>DVB-H</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Channel Bandwidths (MHz)</strong></td>
<td>1.712</td>
<td>5, 6, 7, 8</td>
</tr>
<tr>
<td><strong>FFT Sizes</strong></td>
<td>2k, 1k, 0.5k, 0.25k</td>
<td>8k, 4k, 2k</td>
</tr>
<tr>
<td><strong>Guard Intervals (us)</strong></td>
<td>246, 123, 62, 31</td>
<td>224, 112, 56, 28, 14, 7</td>
</tr>
<tr>
<td><strong>Inner Modulations</strong></td>
<td>Differential-QPSK</td>
<td>QPSK, 16QAM, 64QAM</td>
</tr>
<tr>
<td><strong>Error Protection</strong></td>
<td>Convolutional code + RS FEC</td>
<td>Convolutional code + RS FEC + MPE-FEC</td>
</tr>
<tr>
<td><strong>Convolutional code rates</strong></td>
<td>$\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{4}{9}$, $\frac{4}{7}$, $\frac{2}{3}$, $\frac{4}{5}$</td>
<td>$\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$</td>
</tr>
<tr>
<td><strong>Time interleaving</strong></td>
<td>384ms</td>
<td>Practically up to 1000ms depending on MPE-FEC selection, typically 200-500 ms</td>
</tr>
<tr>
<td><strong>MPE-FEC code rate</strong></td>
<td>No MPE-FEC</td>
<td>Free selection (most likely $\frac{1}{2}$ to $\frac{7}{8}$)</td>
</tr>
<tr>
<td><strong>Time Slicing</strong></td>
<td>Micro time slicing (reduced power saving)</td>
<td>Time slicing (good power saving)</td>
</tr>
<tr>
<td><strong>Protocol stack</strong></td>
<td>Raw MPEG-4 (i.e. no IP layer)</td>
<td>IP Layer</td>
</tr>
<tr>
<td><strong>Theoretical data rate range (Mbit / s)</strong></td>
<td>$1.06 - 2.3 , (@1.712 \text{ MHz channel})$</td>
<td>$2.49 - 31.67 , (@8\text{MHz channel})$</td>
</tr>
<tr>
<td><strong>Practical data rate</strong></td>
<td>$1.06 , (@1.712 \text{ MHz channel, } \frac{1}{4} \text{ GI } \frac{1}{2} \text{ CR + RS-FEC})$</td>
<td>$3.32 - 13.8 , (@8\text{MHz channel, } \frac{1}{4} \text{ GI QPSK } \frac{1}{2}\text{CR MPE-FEC 2/3 - 1/8 GI 16QAM } \frac{3}{4}\text{CR MPE-FEC 5/6})$</td>
</tr>
</tbody>
</table>
True Differences Between DVB-H and T-DMB

- **Bandwidth**
  - T-DMB is narrowband (1.712 MHz).
  - DVB-H is broadband (8 MHz).
  - Conclusion: DVB-H has better frequency diversity i.e. smaller probability for flat fading.

- **Inner modulation**
  - T-DMB differential QPSK.
  - DVB-H QPSK, 16QAM, 64QAM.
  - Conclusion: DVB-H QPSK has 3dB advantage over T-DMB D-QPSK in Gaussian channel.
  - In practical channels the difference is even larger.

- **Error coding**
  - T-DMB, two layers of error coding (Conv + RS-FEC).
  - DVB-H, three layers of error coding (Conv + RS-FEC + MPE-FEC).
  - Conclusion: MPE-FEC brings additional advantage in mobile channel (2-3dB i.e. total 5-6 dB DVB-H advantage).

- **Capacity (data rate) per multiplex (coverage)**
  - T-DMB practically limited 1.06 Mbit/s i.e. 3 services (@1 T-DMB block, 1.712MHz)
  - DVB-H offers
    - Even in the QPSK mode 4 times more capacity (@1 DVB-H channel, 8MHz).
    - With higher modulations (16QAM, 64QAM) the capacity and spectral efficiency can be increased.
  - Conclusion: DVB-H offers more flexibility and capacity.
True Differences Between DVB-H and T-DMB

- **Scalability per multiplex (coverage)**
  - T-DMB spectral efficiency is fixed (0.62 bit/s/Hz) (only D-QPSK mode)
  - DVB-H offers several possibilities (0.415 – 1.73 bit/s/Hz) (QPSK, 16QAM and 64QAM modes)
  
  **Conclusion:** DVB-H is future proof and grows with the business.

- **Time Division Multiplex Systems**
  - T-DMB uses micro time slicing
  - DVB-H uses real time slicing
  
  **Conclusion:** DVB-H has advantage in power consumption (average DVB-H 80mW, T-DMB 250mW)

- **Protocol Stack**
  - T-DMB has fixed protocols for MPEG-4 etc.
  - DVB-H uses IP
  
  **Conclusion:** With IP DVB-H has more flexibility and is future proof.

- Other properties in the two standards make no practical difference
DMB Claims

- T-DMB and DAB related organisations have made a number of public claims such as:
  - T-DMB network transmission power is lower than DVB-H.
  - DVB-H network is ten times more expensive than T-DMB network.
  - T-DMB offers unlimited SFN network size.
  - DAB investment already done that can be reused for DBM-T unlike in DVB-H.
  - DAB network is not used therefore it is available for T-DMB almost for free.
  - DAB networks exist and they have full coverage in several countries. No extra network investments needed for T-DMB services.
  - T-DMB is best system if the required number of services is low.
  - No frequencies for DVB-H, DAB frequencies only chance.
  - Faster to start with T-DMB due to frequency and existing investments.
  - T-DMB commercial terminals are available, DVB-H not.
  - Channel switch time in DVB-H is much longer than in T-DMB.
  - DVB-H has interference problems with GSM that do not exist with DAB.
  - T-DMB receiver implementation is cheaper and smaller than DVB-H.
  - T-DMB antenna gain is higher.
Transmission Power (1/2)

**Claim:** T-DMB network transmission power is lower than DVB-H.

**Facts:**

- In indoor reception conditions T-DMB C/N requirement is ~10dB and DVB-H 6.4 dB. (both using QPSK modes i.e. same spectral efficiency).
- In mobile reception conditions T-DMB C/N requirement is ~14dB and DVB-H 8.5 dB. (both using QPSK modes i.e. same spectral efficiency).
- The better sensitivity due to the smaller bandwidth in T-DMB is almost compensated by better C/N performance of DVB-H and DVB-H offers four times more capacity.

### Terminal sensitivity calculation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Portable T-DMB</th>
<th>Portable DVB-H</th>
<th>Mobile T-DMB</th>
<th>Mobile DVB-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth MHz</td>
<td>1.5</td>
<td>7.61</td>
<td>1.5</td>
<td>7.61</td>
</tr>
<tr>
<td>Noise Floor dBm</td>
<td>-112.2</td>
<td>-105.2</td>
<td>-112.2</td>
<td>-105.2</td>
</tr>
<tr>
<td>Rx Noise Figure dB</td>
<td>7</td>
<td>6.0</td>
<td>7</td>
<td>6.0</td>
</tr>
<tr>
<td>C/N QPSK 1/2 dB</td>
<td>11.0</td>
<td>6.4</td>
<td>14.0</td>
<td>8.5</td>
</tr>
<tr>
<td>Rx sensitivity dBm</td>
<td>-94.2</td>
<td>-92.8</td>
<td>-91.2</td>
<td>-90.7</td>
</tr>
</tbody>
</table>

### Sensitivity difference compared to DVB-H [dB]

<table>
<thead>
<tr>
<th></th>
<th>Portable</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-DMB</td>
<td>-1.5</td>
<td>-0.6</td>
</tr>
</tbody>
</table>
Claim: DVB-H network is ten times more expensive than T-DMB network.

Facts:

- Based on the analysis on previous slide, the required transmission power for similar coverage is roughly the same.
- Therefore cost for one multiplex (coverage) is the same. However DVB-H offers four times capacity (using QPSK mode) with the same investment.
**Claim:** T-DMB offers unlimited SFN network size, DVB-H only < 100 km.

**Facts:**
- The SFN-capabilities are related to two parameters:
  - C/I (C/N) - performance
  - Guard Interval length
- In comparable modes these are very similar, DVB-H even having an advantage in C/N performance.
- The longest Guard Interval in T-DMB is 246us and in DVB-H 224us.
- Therefore the technical capabilities are practically the same.
- In the real world the SFN-size is a given parameter from the frequency plan.
Network Investments (1/3)

Claims:
• DAB investment already done. It can be reused for T-DBM unlike in DVB-H.
• DAB network is not used therefore is available for T-DMB almost for free.

Facts:
• DAB networks can only be used for T-DMB in cases where they are not used for normal audio services. Even if the number of DAB receivers is low it is difficult to close down the audio service.
• The value of the “unused” DAB network increases if there is a possible business use for the network. Surely they are not for free (at least utility value)?
• The current DAB networks (VHF III) have been planned for car radio reception with external antenna. The DAB L-band networks are worse again. Therefore the networks do not provide the required coverage for handheld terminals indoors.
• DAB is as useful for T-DMB as DVB-T for DVB-H when building coverage.
• DAB is less useful for T-DMB than DVB-T for DVB-H as it can not share the spectrum.
Claim: VHF III DAB networks exist and they have full coverage in several countries. No extra network investments needed for T-DMB services.

Facts: Countries with full nationwide DAB coverage are rare and even in these cases the coverage is planned for car receivers. True indoor coverage for handheld devices from these networks is very limited.
Network Investments (3/3)

Claim: L-Band DAB networks exist and it can be utilized with T-DMB as they are not used for digital radio services.

Facts:

- Operational L-band networks are very rare
- In cases they exist, the coverage is very limited
- Example network, Bavaria L-band (car receiver)
Low Number of Services Required

**Claim:** T-DMB is the best system if the required number of services is low.

**Facts:**

- DVB-H network investment is lower than T-DMB network with similar coverage (T-DMB in VHF III band and DVB-H in UHF band). DVB-H however provides four times more capacity with lower investment. Even if the originally required number of services is low DVB-H offers future expansion capabilities with smaller investment.

<table>
<thead>
<tr>
<th>DMB</th>
<th>DVB-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5 channels per multiplex</td>
<td>Up to 60 channels per multiplex</td>
</tr>
</tbody>
</table>
Spectrum issues

**Claims:**
- No frequencies for DVB-H, DAB frequencies only chance.
- Faster to start with due to frequency and existing investments.

**Facts:**
- No allocations for T-DMB have been made, the allocations are for DAB.
- In CEPT area (Europe) most of the administrations are targeting for 6 to 7 DVB-T multiplexes in the UHF band reserving one or two for mobile use (= DVB-H). In APAC area the UHF frequencies for DVB-H are widely available.
- In most countries UHF frequencies are available regionally or even nationwide already 2006.
- Total DAB spectrum, VHF III 56MHz, L-band 25MHz i.e. 81 MHz.
- Total DVB-H spectrum, with GSM900 IOP 470-750MHz i.e. 280MHz, without GSM900 TX 470 – 862 MHz i.e. 392 MHz.
- Both DAB VHF III and DVB-H sharing frequency band with analog & digital TV.
- DVB-H can share spectrum (and investment) with DVB-T with hierarchical modulation or multiplexing.
Claim: T-DMB commercial terminals are available, DVB-H not.

Facts:

- Most of the TV-terminals sold in Korea as of the start of 2006 are S-DMB terminals, not T-DMB terminals. In practice there are only two major vendors for T-DMB terminals: Samsung & LG.

- All Korean terminals are CDMA terminals i.e. not suitable for EU market. The GSM terminals are prototypes.

- Nokia has announced a real S60, 3-Band EGSM+WCDMA, WLAN, BT, DVB-H capable N92.

- DVB-H terminals will be commercially available from Nokia, Motorola, Siemens, Samsung, Sagem, LG (these have been shown in exhibitions).
Claim: Channel switch time in DVB-H is much longer than in T-DMB.

Facts:

- By selecting the DVB-H time slicing parameters correctly, DVB-H physical layer delay is negligible i.e. 1-2 s. With these parameters the power consumption is still low enough. The major part of delay in channel switching is coming from the video player latency, which is the same for any system. This can be corrected by optimizing the video player design.

- The commercial S-DMB terminals in Korea have similar channel switch times (without Time Slicing) than DVB-H terminals because of video player delays.

![Diagram showing channel switch time in DVB-H](image-url)
Cellular interoperability

**Claim:** DVB-H has interference problems with GSM that do not exist with DAB / T-DMB.

**Facts:**

- DVB-H only has issues with GSM900 after channel 55, within channels 21-55 the problem is solved with filters.
- DAB in VHF-band does not have cellular interoperability issues.
- DAB in L-band has even more severe issues with GSM1800 transmitter!
**Claim:** T-DMB receiver implementation is cheaper and smaller than DVB-H.

**Facts:**

- The RF part in T-DMB and DVB-H is very similar → same complexity and cost in RF.
- The base band part complexity difference between T-DMB and DVB-H is minor. With modern sub-micron silicon technology (90nm / 65nm) the base band size and cost will be almost the same.
- There are far more silicon vendors providing DVB-H solutions → cost benefit for DVB-H from competition.
**Antennas**

**Claim:** T-DMB antenna gain is higher than DVB-H.

**Facts:**

- The antenna gain comparison should be done with same size terminals and integrated antennas.
- Antenna does not know which modulation or system is used!
- The antenna gain in the same frequency band would be the same.
  - VHF III antenna gain is -25dBi with integrated antenna.
  - UHF antenna gain is -7 dBi.
- Higher antenna gain benefit in the L-band (-2 dBi) is lost in worse propagation (-8 dB) when compared with UHF.
Conclusions from the Claims Analysis

Receiver performance
- DVB-H has power consumption advantage over T-DMB (60% lower power).
  **Reason:** DVB-H has real Time Slicing.
- DVB-H has 3-6dB C/N performance advantage over T-DMB.
  **Reason:** T-DMB differential QPSK vs. DVB-H QPSK.
  **Reason:** Lack of MPE-FEC in T-DMB.
- DVB-H has less probability for flat fading.
  **Reason:** Wider bandwidth in DVB-H.

Network cost
- With lower network investment DVB-H offers 3-4 times more capacity.
  **Reason:** DVB-H C/N advantage and better antenna gain @ UHF band.
- Existing DVB-T networks are better starting point for DVB-H than existing DAB networks for T-DMB.
  **Reason:** The VHF III is already occupied by DAB and DVB-T services. L-band networks are rare.

Spectrum issues
- Getting spectrum for T-DMB is not easier than getting spectrum for DVB-H
  **Reason:** Amount of possible spectrum is smaller than for DVB-H. There are more users for existing DAB-spectrum than for DVB-H.
- DVB-H spectral efficiency is scalable (same as DAB or 3 times more)
  **Reason:** DVB-H has 16QAM and 64QAM options.

Terminal availability
- T-DMB and DVB-H terminal availability is at similar level – and many more vendors are developing DVB-H terminals than T-DMB

Network elements availability (physical layer and service management systems)
- DVB-H network elements are readily available, T-DMB are under construction
Technical Maturity and availability of systems

**Conclusion: DVB-H fully specified, T-DMB still with much work to do.**

- **Standardization**
  - **DVB-H**
    - Standard has existed since Oct 2004
    - Full specifications published for ESG, copy protection, service purchase, etc...
  - **T-DMB**
    - Standard has existed since 2005
    - No proper standards for ESG, copy protection, purchase

- **Receiver chips**
  - **DVB-H**
    - Several players (Dibcom, Philips, Samsung, Siano, ST, TI, Freescale, Microtune etc.)
  - **T-DMB**
    - Only few player (Frontier Silicon, Radioscape etc.)

- **Network elements & service system**
  - **DVB-H**
    - Several modulator, repeater etc. providers
    - Proper service management systems available
  - **T-DMB**
    - Only couple of companies providing network elements
    - No service management system available
Mobile TV Land / Province
Cost Comparison for an Imaginative Country

- Coverage only to areas of sufficient population density

- Urban, 190 sqkm
- Suburban, 3908 sqkm
- Rural, to be covered 22076 sqkm
- Main roads, 450 km
Network Cost Comparison Scenarios
Main network assumptions

VHF 200MHz
- Urban, 45 m mast, EIRP 1.5kW
- Suburban, 55m mast, EIRP 3kW
- Rural, 70m mast, EIRP 6kW
- Roadside, 70 m mast, EIRP 10 kW (bi directional antenna)
- 1 Urban area TV Tower, 120m, EIRP 25kW
- 1 Suburban area TV Tower, 200m, EIRP 25kW
- Lower antenna gain by 6dB, higher output power by 3dB, EIRP round 2-3 dB lower

UHF 600Mhz
- Urban, 45 m mast, EIRP 2.5kW
- Suburban, 55m mast, EIRP 5kW
- Rural, 70m mast, EIRP 10kW
- Roadside, 70 m mast, EIRP 16 kW (bi directional antenna)
- 1 Urban area TV Tower, 120m, EIRP 40kW
- 1 Suburban area TV Tower, 200m, EIRP 40kW

L-Band 1460MHZ
- Urban, 45 m mast, EIRP 2.5kW
- Suburban, 55m mast, EIRP 5kW
- Rural, 70m mast, EIRP 10kW
- Roadside, 70 m mast, EIRP 16 kW (bi directional antenna)
- 1 Urban area TV Tower, 120m, EIRP 16kW
- 1 Suburban area TV Tower, 200m, EIRP 16kW
- Tx output power lower by 3 dB, but antenna gains higher -> same EIRP, but limited to 16 kW

95% indoor (Urban & Suburban) + 95% outdoor (rural & roadside) coverage probability, 90% sites exists
Assumptions

- DVB-H is using 8k QPSK GI=1/4 CR=1/2 MPE-FEC CR= 3/4 mode
  - 8 MHz version @UHF 3.75 Mbit/s
  - 7 MHz version @VHF 3.28 Mbit/s
  - 6 MHz version @L-Band 2.81 Mbit/s
- T-DMB is using mode 1 GI=1/4 CR=1/2
  - 1.71 MHz channel raster @ VHF and L-Band 1.06 Mbit/s (RS included)
- Antenna gain for all systems.
  - VHF III -25dBi
  - UHF -7 dBi
  - L-Band -3 dBi
- Standard deviation of signal outside 5.5 dB
- Car loss 6 dB
- Building Loss:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>VHF III Urban</th>
<th>Sub Urban</th>
<th>UHF Urban</th>
<th>Sub Urban</th>
<th>L-Band Urban</th>
<th>Sub Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building loss [dB]</td>
<td>12</td>
<td>8</td>
<td>11</td>
<td>7</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>STD of BL [dB]</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>
### Detailed Link Budget for the Systems

#### Link Budget

<table>
<thead>
<tr>
<th>Rx Parameter</th>
<th>Unit</th>
<th>UHF</th>
<th>UHF</th>
<th>UHF</th>
<th>VHF III</th>
<th>VHF III</th>
<th>VHF III</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
<th>Indoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>MHz</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
<td>1460</td>
</tr>
<tr>
<td>Noise Floor PN=kTB dBm</td>
<td></td>
<td>-105.2</td>
<td>-105.2</td>
<td>-105.2</td>
<td>-105.7</td>
<td>-105.7</td>
<td>-105.7</td>
<td>-106.4</td>
<td>-106.4</td>
<td>-112.2</td>
<td>-112.2</td>
<td>-112.2</td>
<td>-112.2</td>
<td>-112.2</td>
<td>-112.2</td>
</tr>
<tr>
<td>Rx Noise Figure F</td>
<td>dB</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>C/N QPSK 1/2 C/N dB</td>
<td></td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Rx sensitivity P rx min dBm</td>
<td></td>
<td>-92.8</td>
<td>-92.8</td>
<td>-90.7</td>
<td>-93.3</td>
<td>-93.3</td>
<td>-91.2</td>
<td>-94.0</td>
<td>-94.0</td>
<td>-91.9</td>
<td>-94.2</td>
<td>-94.2</td>
<td>-91.2</td>
<td>-94.2</td>
<td>-94.2</td>
</tr>
<tr>
<td>Rx antenna gain G rx dB</td>
<td></td>
<td>-7.0</td>
<td>-7.0</td>
<td>-7.0</td>
<td>-25.0</td>
<td>-25.0</td>
<td>-25.0</td>
<td>-3.0</td>
<td>-3.0</td>
<td>-25.0</td>
<td>-25.0</td>
<td>-25.0</td>
<td>-3.0</td>
<td>-3.0</td>
<td>-3.0</td>
</tr>
<tr>
<td>Isotropic power Pl dBm</td>
<td></td>
<td>-85.8</td>
<td>-85.8</td>
<td>-83.7</td>
<td>-68.3</td>
<td>-68.3</td>
<td>-66.2</td>
<td>-91.0</td>
<td>-91.0</td>
<td>-89.9</td>
<td>-69.2</td>
<td>-69.2</td>
<td>-66.2</td>
<td>-91.2</td>
<td>-91.2</td>
</tr>
<tr>
<td>Location variation L lv dB</td>
<td></td>
<td>13.3</td>
<td>13.3</td>
<td>9.0</td>
<td>10.3</td>
<td>10.3</td>
<td>9.0</td>
<td>13.3</td>
<td>13.3</td>
<td>9.0</td>
<td>10.3</td>
<td>10.3</td>
<td>9.0</td>
<td>13.3</td>
<td>13.3</td>
</tr>
<tr>
<td>Building loss ave L B dB</td>
<td></td>
<td>11.0</td>
<td>7.0</td>
<td>6.0</td>
<td>12.0</td>
<td>8.0</td>
<td>7.0</td>
<td>12.0</td>
<td>8.0</td>
<td>6.0</td>
<td>12.0</td>
<td>8.0</td>
<td>7.0</td>
<td>12.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Minimum power outside P min dBm</td>
<td></td>
<td>-61.5</td>
<td>-65.5</td>
<td>-68.7</td>
<td>-46.0</td>
<td>-50.0</td>
<td>-50.2</td>
<td>-65.7</td>
<td>-69.7</td>
<td>-73.9</td>
<td>-46.9</td>
<td>-50.9</td>
<td>-50.2</td>
<td>-65.9</td>
<td>-69.9</td>
</tr>
<tr>
<td>Minimum field strength E min dBuV</td>
<td></td>
<td>71.3</td>
<td>67.3</td>
<td>64.1</td>
<td>86.7</td>
<td>82.7</td>
<td>82.5</td>
<td>67.1</td>
<td>63.1</td>
<td>58.9</td>
<td>85.9</td>
<td>81.9</td>
<td>82.6</td>
<td>66.9</td>
<td>62.9</td>
</tr>
</tbody>
</table>

#### Equations
- $P_{tx} = $ Transmitter power
- $L_f = $ Feeding loss
- $G_{tx} = $ Transmitter antenna gain
- $L_{rp} = $ Radio path loss
- $E_{min} = $ Minimum field strength
- $P_{min} = $ Equivalent minimum power
- $L_B = $ Building loss
- $L_{lv} = $ Location variation
- $P_N = $ Noise floor
- $F = $ Noise figure
- $C/N = $ Required C/N
- $P_{rx min} = $ Rx sensitivity
- $G_{rx} = $ Rx antenna gain
Network Scenarios

- **VHF 200MHz**
  - Transmitters
  - Repeaters
  - **CAPEX**

- **UHF 600MHz**
  - Transmitters
  - Repeaters
  - **CAPEX**

- **L-Band 1460MHz**
  - Transmitters
  - Repeaters
  - **CAPEX**

- **VHF 200MHz**
  - Transmitters
  - Repeaters
  - **CAPEX**

- **L-Band 1460MHz**
  - Transmitters
  - Repeaters
  - **CAPEX**
DVB-H UHF 600 Mhz

DVB-H Network Structure

Access to DVB-H Tx Sites

Transmitters, 93
Repeaters, 198
Total CAPEX 22.4 Meur
UHF is Optimal Band for Mobile TV

- **UHF 600MHz**
  - Transmitters: 93
  - Repeaters: 198
  - CAPEX: 22.4 Meur
  - 1.5 Meur/service

- **VHF 200MHz**
  - Transmitters: 241
  - Repeaters: 492
  - CAPEX: 49.3 Meur
  - 3.8 Meur/service
  - 1) Assuming 250 kbit/s / service

- **L-Band 1460MHz**
  - Transmitters: 246
  - Repeaters: 588
  - CAPEX: 58.2 Meur
  - 5.3 Meur/service

- **L-Band 1460MHz**
  - Transmitters: 239
  - Repeaters: 572
  - CAPEX: 56.7 Meur
  - 14.2 Meur/service
UHF is Optimal Band and DVB-H Optimal Technology for Mobile TV

- **Graph 1**: CAPEx
- **Graph 2**: Capacity

- **Y-axis**: Mbits/s
- **X-axis**: DVB-H VHF, T-DBM VHF, DVB-H UHF, DVB-H L-Band, T-DBM L-Band, DVB-H 16QAM VHF, DVB-H 16QAM UHF, DVB-H 16QAM L-Band
UHF is Optimal Band and DVB-H Optimal Technology for Mobile TV

- **CAPEX**
  - DVB-H VHF: Low
  - T-DBM VHF: Medium
  - DVB-H UHF: High
  - DVB-H L-Band: Low
  - T-DBM L-Band: Medium
  - DVB-H 16QAM VHF: High
  - DVB-H 16QAM UHF: Medium
  - DVB-H 16QAM L-Band: High

- **Cost (eur/bit/s)**
  - DVB-H VHF: Low
  - T-DBM VHF: Medium
  - DVB-H UHF: High
  - DVB-H L-Band: Low
  - T-DBM L-Band: Medium
  - DVB-H 16QAM VHF: High
  - DVB-H 16QAM UHF: Medium
  - DVB-H 16QAM L-Band: High
UHF is Optimal Band and DVB-H Optimal Technology for Mobile TV

DVB-H offers more capacity for similar or smaller investment.

And DVB-H with 16QAM gives opportunities for future growth.
## Network Cost Comparison

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1, T-DMB VHF III network</td>
<td>42.7</td>
<td>1.06</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>2, T-DMB L-band network</td>
<td>56.7</td>
<td>1.06</td>
<td>53.49</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>3, DVB-H VHF III network</td>
<td>49.3</td>
<td>3.28</td>
<td>15.03</td>
<td>122.4</td>
<td>6.56</td>
<td>18.65</td>
</tr>
<tr>
<td>4, DVB-H UHF network</td>
<td>22.4</td>
<td>3.75</td>
<td>5.97</td>
<td>58.2</td>
<td>7.5</td>
<td>7.76</td>
</tr>
<tr>
<td>5, DVB-H L-band network</td>
<td>58.2</td>
<td>2.81</td>
<td>20.71</td>
<td>138.1</td>
<td>5.62</td>
<td>24.57</td>
</tr>
</tbody>
</table>
Conclusions

The price of service for T-DMB in L band is almost 10 times that of DVB-H in UHF

The price of a T-DMB network at any band is about twice (or more) that for a DVB-H UHF network