Terrestrial DMB System Development in Korea

June 17, 2004
Soo In Lee, Sammo Cho

Electronics and Telecommunications Research Institute, Korea
Contents

- ETRI, Digital Broadcasting Research Division
- Eureka-147 DAB and DMB
- DMB Standard in South Korea
- DMB Development in ETRI
- Applications of DMB
  - Mobile TV
  - Traffic Information
ETRI, Digital Broadcasting Division

- Electronics and Telecommunications Research Institute
  - Located in Daejon Science Town
  - CDMA, Mobile, Telecom, Semiconductor, Home network, ...
- Digital Broadcasting Research Division
  - Digital Broadcasting, Satellite Communication, Advanced radio
Eureka-147 and DAB

- **Eureka-147 Project**: Consortium of broadcasters, network providers and consumer electronics related manufacturers for DAB standard (started with 16, currently, more than 50)
  - CD-quality audio and variable bit-rate data service
  - **Terrestrial SFN**, Satellite and Cable network
  - Interoperability with GSM, GPS and Internet
  - Robust mobile and handheld reception
  - Flexible Service Multiplex

DAB: Digital Audio Broadcasting
SFN: Single Frequency Network
EBU: European Broadcasting Union
# Eureka-147 System Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>COFDM</td>
</tr>
<tr>
<td>Modulation</td>
<td>DQPSK</td>
</tr>
<tr>
<td>Channel Coding</td>
<td>Convolutional : variable rate, constraint length=7</td>
</tr>
<tr>
<td>Time Interleaving</td>
<td>ms Depth = 384</td>
</tr>
<tr>
<td>Frequency Interleaving</td>
<td>MHz Width = 1.536</td>
</tr>
<tr>
<td>Effective Data Rate</td>
<td>Mbps 0.8 ~ 1.7 Mbps</td>
</tr>
<tr>
<td>System Bandwidth</td>
<td>MHz 1.536 MHz</td>
</tr>
</tbody>
</table>

## MODE

<table>
<thead>
<tr>
<th>MODE</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Terrestrial (SFN)</td>
<td>Terrestrial</td>
<td>Satellite/Cable</td>
</tr>
<tr>
<td>Application</td>
<td>GHz</td>
<td>&lt; 0.375</td>
<td>&lt; 1.5</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>Frequency Band</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub carriers</td>
<td>MHz</td>
<td>1,536</td>
<td>384</td>
<td>192</td>
</tr>
<tr>
<td>Sub carrier interval</td>
<td>KHz</td>
<td>1</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Guard interval</td>
<td>μs</td>
<td>246</td>
<td>62</td>
<td>31</td>
</tr>
<tr>
<td>Symbol length</td>
<td>μs</td>
<td>1,000</td>
<td>250</td>
<td>125</td>
</tr>
<tr>
<td>Frame length</td>
<td>ms</td>
<td>96</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

**COFDM**: Coded Orthogonal Frequency Division Multiplexing  
**DQPSK**: Differential QPSK
Mobile Multimedia Broadcasting in Korea

Digital Multimedia Broadcasting

- High-quality audio with video service through DAB framework
  
  Listening → Watching while listening

- Small sized TV → PDA type receivers → Mobile phone

Data Capacity

- Maximum multimedia application data rate is 1.7 Mbps/block
- 3 video or 10 audio channels are possible in one TV channel (6 MHz)

Services

- Mobile TV
- LBS, Telematics
- Many applications
  - News, weather, stock, etc.
DMB history in Korea

TTA: Telecommunications and Technology Association
Service and Standard

AVC: Advanced Video Coding, PAD: Program Associated Data, TDC: Transparent Data Channel, BWS: Broadcasting Web Site, BSAC: Bit-sliced Arithmetic Coding
DMB Standards in Korea

- TTAS.KO – 07.2004
  “Radio Broadcasting Systems; VHF Digital Multimedia Broadcasting (DMB) to mobile, portable and fixed receivers”
  - DSCTy, Korean Characters

- TTAS.KO – (TBD)
  “Radio Broadcasting Systems; Specification of the video services for VHF Digital Multimedia Broadcasting (DMB) to mobile, portable and fixed receivers”
  - Video encoding, Channel coding

- TTAS.KO – (TBD)
  “Radio Broadcasting Systems; Specification of the data services for VHF Digital Multimedia Broadcasting (DMB) to mobile, portable and fixed receivers”
  - PAD, NPAD, TDC, IP-tunneling, Slideshow, BWS, EPG, …
DMB Spectrum Plan

- Three blocks in one TV channel

```
6 MHz TV Channel

Block A  Block B  Block C

1.536 MHz/block
```
DMB Service Structure
DAB/DMB Frame Structure (Mode I)

Sync. Symbol

FIC Symbol #2
Symbol #3
Symbol #4
Symbol #5

MSC Symbol #n
Symbol #76

Guard Interval

1.246 ms

to 1.297 ms symbol duration

1.536 x 3 x 2 bits / 96 ms = 96 kbps for FIC

1.536 x 72 x 2 bits / 96 ms = 2,304 kbps for MSC

FIC: Fast Information Channel, FIB: Fast Information Block, MSC: Main Service Channel, TFPR: Time-Frequency-Phase Reference, CIF: Common Interleaved Frame
DMB Ensemble Structure

DMB Ensemble in 1.5 MHz band

Services

Alpha 1 Radio  |  Beta Radio  |  Alpha 2 Radio

Components

Audio  |  Alpha TMC  |  Alpha SI  |  Video 1  |  Video-sub  |  Video 2

Subch 1  |  Subch 2  |  Subch 3  |  Subch 4  |  ...  |  Subch 64

MCI  |  SI  |  FIDC  |  FIC  |  MSC

TMC: Traffic Message Channel, MCI: Multiplex Configuration Information, FIDC: Fast Information Data Channel
Media Multiplexing

- Eureka-147 Stream Mode
- FEC:
  - RS + Convolutional Interleaving
- Transport: MPEG-2 TS
- Adaptation: MPEG-4 SL
- Video:
  - MPEG-4 AVC Baseline Profile
- Audio: MPEG-4 BSAC
- Graphics & Data:
  - MPEG-4 System Core2D Profile

AVC: Advanced Video Coding, BSAC: Bit Sliced Arithmetic Coding, FEC: Forward Error Correction
MPEG-4 AVC

- Advanced Video Coding (ISO/IEC 14496-10)
- ITU-T H.264
- JVT from December 2001
  - ITU-T VCEG (Video Coding Expert Group)
  - ISO/IEC JTC1 SC29 WG 11 MPEG Video Group
- H.26L as a starting point
- High encoding complexity
- 3 profiles
  - Baseline
  - Main
  - Extended
MPEG-4 BSAC

- Bit Sliced Arithmetic Coding
- ISO/IEC IS 14496-3:2001
- Fine Granular Scalability
  - 16kbps/ch (base layer) ~ 64kbps/ch (top layer)
  - step size : 1 kbps/ch
- Change of noiseless coding tool from AAC-LC
- Comparable coding performance with AAC

Digital Audio Signal (PCM) → Transform → Quantization → Psychoacoustic Model → BSAC → Arithmetic Coding → Huffman Coding → Encoded Audio Bitstream
FEC for Mobile Reception

- Eureka-147 is designed basically for Audio Service
  → BER level of $10^{-4}$
- Required BER is under $10^{-8}$ for Mobile Video Service
  → Additional RS code and Convolutional Interleaver

Source data → RS encoder → Convolutional Interleaver → Energy dispersal scrambler → Convolutional encoder → Time Interleaver → FIC and MSC (frequency interleaved) symbol generator → OFDM signal generator → Synch. channel generator
Reed-Solomon Code

- Shortened RS (204, 188, t=8), derived from RS (255, 239, t=8)
- Code generator polynomial
  \[ g(x) = (x + \lambda^0)(x + \lambda^1)(x + \lambda^2)\cdots(x + \lambda^{15}), \quad \text{where } \lambda = 02_{\text{HEX}} \]
- Field generator polynomial
  \[ p(x) = x^8 + x^4 + x^3 + x^2 + 1 \]

RS error protected packet (204 bytes)
MPEG-TS packet (188 bytes)
- Sync byte
- 187 bytes Randomized Data
- 16 Parity bytes
Convolutional Byte Interleaver/Deinterleaver

- Interleaving depth: $I = 12$
- Unit size of FIFO shift register: $M = N/I = 17$, $N=204$
- Sync byte always passes through branch ‘0’
Simulation Result

- Target BER = 10^{-8}
- TU (Typical Urban), TH (typical Hilly)
- 3-A(1/2)
- Fc = 230 MHz
- V = 72 km/h
DMB Test System (ETRI)

- MPEG-4 Broadcasting Server
- DMB Multiplexers
- DMB Transmitters
- Channel Emulator + Speaker left
- Signal Interferer + Speaker right
- DMB Receivers
Transmission of DMB

DMBcaster

Media Processor

Ensemble Remultiplexer
Terrestrial DMB Network

Service Providers
- Audio Service
- Data Service
- Service Multiplexer

Collection Network
- Audio Service Providers
- Data Service Providers

Mobile-TV Service Providers

Ensemble Multiplexer
- Data Service
- Audio Service

Ensemble ReMUX

Transmission Network Provider
- Transmitter

STI: Service Transport Interface (ETSI ETS 300 797)
ETI: Ensemble Transport Interface (ETSI ETS 300 799)
DMB Applications

- Mobile TV
  - Mobile TV for high speed vehicle and cellular phones
- Telematics
  - TPEG for TTI and Navigation
  - DGPS Services
  - Location Based Services
- Data Services
  - Broadcasting Website
  - Slide show

TPEG: Transport Protocol Expert Group
TTI: Traffic and Traveler Information
DGPS: Differential GPS
Mobile TV

- Mobile TV for high speed vehicle and cellular phones
- Speed up to 120 km/h
- Robust reception in central city

NTSC vs. Mobile TV (Apr. ’03)

Mobile TV Field Test (Nov. ’03)
LBS and Telematics

- User friendly navigation service
  - PDA or Notebook
  - Mobile phone Solution
- Live Traffic Information
- Massive Traveler/Location Information

Live Traffic Information

Weather

Stock

News
Conclusion

- Change of the Digital Broadcasting Environment
  - High data rate, Mobile reception requirement
  - Harmonious service of Broadcasting and Communication
- Terrestrial DAB in Europe
  - High-quality audio and flexible rate data services
- DMB in Korea
  - Mobile multimedia broadcasting through terrestrial DAB
  - Regional, as well as nation-wide networks of high-quality mobile multimedia services
- As well as Mobile TV, DMB is strong and powerful candidate for delivering data for telematics and LBS service
Thank You!

silee@etri.re.kr, semo@etri.re.kr