Implementation of DVB-S2 into DVB-RCS systems

SatLabs DVB-RCS Symposium
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Contents of this presentation

- The Big Picture
- Intro to DVB-S2
- Integration of DVB-S2 into DVB-RCS systems
  - Constant Coding and Modulation (CCM)
  - Variable Coding and Modulation (VCM)
  - Adaptive Coding and Modulation (ACM)
- DVB-S2 & RCS: Impact on the business case
  - Large scale networks
  - Small & Mid scale networks
- Current Status of DVB-S2 and integration with RCS systems
- Conclusions
- Q&A
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  - Variable Coding and Modulation (VCM)
  - Adaptive Coding and Modulation (ACM)

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The Big Picture

*BUT: most of all an important positive impact on the DVB-RCS Business Case*
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  - Variable Coding and Modulation (VCM)
  - Adaptive Coding and Modulation (ACM)
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What is DVB-S2?

- New DVB standard for digital satellite communications
- Meant to replace DVB-S & DVB-DSNG (in the future)

What is new?

- Much better spectral efficiency than DVB-S
  - Up to 30% bandwidth saving
  - or up to 2.5 dB margin gain!
  - So close to the theoretical limit (Shannon) that it could be the last DVB-S standard!

- New modulation schemes (16APSK and 32APSK)
- More roll-off factors (20, 25 and 35%)
- New features
  - Support of multiple streams on a single carrier
  - Variable and Adaptive Coding and Modulation
  - Generic Mode
How is this drastic performance increase achieved?

-> New Forward Error Correction codes:
   - BCH (Bose-Chaudhuri-Hocquenghem) replaces Reed Solomon outer coding
   - LDPC (Low Density Parity Check) replaces Viterbi inner coding

- LDPC was selected among 7 advanced error correction codes, after extensive simulation tests (equivalent of 40,000 days simulations)
- LDPC uses very big block size (16200 and 64800 bits)
- More Inner code rates: 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
- LDPC was invented in the 60’s by Gallager but its actual implementation was only possible with today’s ASIC technology (<10mm² with 0.09µm technology)
Performance comparison with DVB-S/DSNG:

Spectrum efficiency versus required C/N on AWGN channel

- Less than 1dB from Shannon Limit
- More than 2dB better than DVB-S/DSNG
Encapsulation
What it was

- In DVB-S the data format was exclusively the MPEG Transport Stream (TS)
- The size of the MPEG transport stream packet (188 bytes) was optimised for the Reed Solomon error correction code, which is no longer used by DVB-S2
- For IP data, the overhead due to TS and MPE was typically 4 to 15%
Encapsulation

What’s new: DVB-S2 Generic Mode

**DVB-S2 includes a new Generic Mode for continuous or packetized data**

**Advantages:**
- Compatible with any type of data (IP, ATM, ...)
- No Transport Stream overhead (2%)
- For IP, the efficiency gain could be more than 4%

DVB-S2 does not define an encapsulation mechanism for IP data such as MPE, but it is being studied by another standardisation group (TM-GBS)
Multiple streams on single carrier

- A DVB-S2 modulator can have several physical or logical inputs:
  - The data of each input is processed in separated Base Band frames.
  - The BB frames are time-multiplexed at the Physical Layer on the same carrier (no TS multiplexing).
  - When no data is present the modulator can pad incomplete BB frames or insert dummy PL frames.
  - Demodulators can receive and decode individual streams independently from the other streams.
Variable coding and modulation

In DVB-S2 each BB frame can be encoded and modulated with its own set of parameters - on the same carrier!

3 modes of operation

- **CCM Constant Coding and Modulation**
  All frames use the same (fixed) parameters

- **VCM Variable Coding and Modulation**
  Different streams/services are coded with different (fixed) parameters

- **ACM Adaptive Coding and Modulation**
  Each frame is coded with its own set of parameters. Parameters are modified dynamically according to the reception conditions for each receiver
### Applications: DVB-S2 targets 4 application profiles:

<table>
<thead>
<tr>
<th>Application Type</th>
<th>System Configurations</th>
<th>Broadcast Services</th>
<th>Interactive Services</th>
<th>DSNG Services</th>
<th>Professional Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK</td>
<td>1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10</td>
<td>O</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>8PSK</td>
<td>3/5, 2/3, 3/4, 5/6, 8/9, 9/10</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>16APSK</td>
<td>2/3, 3/4, 4/5, 5/6, 8/9, 9/10</td>
<td>O</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>32APSK</td>
<td>3/4, 4/5, 5/6, 8/9, 9/10</td>
<td>O</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CCM</td>
<td></td>
<td>N</td>
<td>N(*)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>VCM</td>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>ACM</td>
<td></td>
<td>NA</td>
<td>N(**)</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>FECFRAME (normal)</td>
<td>64800 (bits)</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>FECFRAME (short)</td>
<td>16200 (bits)</td>
<td>NA</td>
<td>N(*)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Single Transport Stream</td>
<td></td>
<td>N</td>
<td>N(*)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Multiple Transport Streams</td>
<td></td>
<td>O</td>
<td>O(**)</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Single Generic Stream</td>
<td></td>
<td>NA</td>
<td>O(**)</td>
<td>NA</td>
<td>O</td>
</tr>
<tr>
<td>Multiple Generic Streams</td>
<td></td>
<td>NA</td>
<td>O(**)</td>
<td>NA</td>
<td>O</td>
</tr>
<tr>
<td>Roll-off 0.35, 0.25 and 0.20</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Input Stream Synchroniser</td>
<td></td>
<td>NA (***)</td>
<td>O(*** )</td>
<td>O(*** )</td>
<td>O(*** )</td>
</tr>
<tr>
<td>Null Packet Deletion</td>
<td></td>
<td>NA</td>
<td>O(*** )</td>
<td>O(*** )</td>
<td>O(*** )</td>
</tr>
<tr>
<td>Dummy Frame insertion</td>
<td></td>
<td>NA(***)</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

N=normative, O=optional, NA=not applicable

* Interactive Service receivers shall implement CCM and Single Transport Stream
** Interactive Service Receivers shall implement ACM at least in one of the two options: Multiple Transport Streams or Generic Stream (single / multiple input)
*** Normative for ACM/VCM or for multiple TS input stream(s) combined with CCM
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Typical DVB-RCS Network
DVB-S based

E.g. **DVB-S**: fixed QPSK 2/3 => total bit rate = **36.87 Mbps**
Typical DVB-RCS network: DVB-S based

Forward Link Subsystem (FLSS):
- IP Encapsulator: IP / MPE /MPEG
- DVB-S modulator

Return Link Subsystem (RLSS):
- Burst Demodulator Bank
- Return link Scheduler
- IP Routing & Valued Added Services

Integrating DVB-S2 in RCS

Internet Cloud

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DVB-RCS & CCM implementation

With **DVB-S2 CCM**: all sites with QSPK 4/5

=> total bit rate = **47.61 Mbps** + 29.1%

**Zoom in on next slide**

**DVB-S2 demodulation** (broadcast CCM version)
DVB-RCS & CCM implementation

- Hub:
  - DVB-S2 modulator

Forward Link Subsystem : FLSS

- IP Encapsulator
  - IP / MPE / MPEG

Return Link Subsystem : RLSS

- Return link Scheduler

- Valued Added Services

- Burst Demodulator Bank

- IP Routing &
DVB-RCS & VCM implementation

With **DVB-S2 VCM**: between QPSK 4/5 and 16APSK 2/3

=> total bit rate > **61 Mbps**

> +65 %

**Integrating DVB-S2 in RCS**

**DVB-S2**
Multiple streams with different Modulation/Coding

**8PSK 3/5**

**8PSK 2/3**

**QPSK 4/5**

**DVB-S2 demodulation**

Internet

**Hub & NOC**

Zoom in on next slide
DVB-RCS & VCM implementation

- Requires fixed configuration of terminals into different coding and modulation streams

**MODCOD signalling**
Forward Link Subsystem : FLSS

IP Routing & Valued Added Services

IP Encapsulator – DVB-S2 modulator

Return link Scheduler

Burst Demodulator Bank

Return Link Subsystem : RLSS

NCR timing
Integrating
DVB-S2 in RCS

DVB-RCS & ACM implementation

- ACM gain in Ka is up to 100%
- Combined with DVB-S2 error coding efficiency, this is up to 2.6 times the efficiency of DVB-S

DVB-S2
Multiple streams with different Modulation/Coding

Internet

Hub & NOC

DVB-S2 demodulation ACM signalling

Zoom in on next slide

16APSK 5/6
6ASK 3/4
8PSK 3/4
QPSK 4/5

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DVB-RCS & ACM signalling

Forward Link Subsystem: FLSS

Return Link Subsystem: RLSS

MODCOD signalling

NCR timing

Integrating DVB-S2 in RCS

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Upgrading existing DVB-RCS systems

- **Hub upgradability**
  - Increase in complexity: upgrade to DVB-S2 CCM or ACM
  - DVB-S2 implementation not Backward compatible
  - Newtec’s DVB-RCS HUB architecture already allows smooth upgrade to DVB-S2

- **Terminal Upgradability to DVB-S2**
  - Requires HW change or swap for current installed base
  - Newtec’s New Terminal NTC/2107 architecture already allows smooth upgrade to DVB-S2
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DVB-RCS business case - outlines

- Two scenarios:
  - Large scale networks (> 10 K terminals)
  - Smaller & Mid Sized networks (1000 terminals)

- Cost elements areas
  - Capex for IDC, Hub and terminals
  - Opex for IDC, Hub and Internet connectivity
  - Satellite bandwidth costs
Large scale networks

- Cost Assumptions

![Pie chart showing cost assumptions for large networks](chart.png)
Business Case  impact of introducing DVB-S2 ACM for large networks

- Given:
  - Ratio forward/return traffic => 10 to 1 (for SOHO networks)
  - => efficiency DVB-S2 impact is on 54% of overall cost
  - DVB-S2 ACM results in 100 % to 130% efficiency increase (Ku – Ka band dependent)
  - => Reduction of **27 % to 33 %** of the overall cost
DVB-RCS & ACM

- Each user operates at very low C/N margin
- ACM gain in Ka is up to 100%
- Combined with DVB-S2 error coding efficiency, this is up to 2.6 times the efficiency of DVB-S
- ACM is necessary to maintain competitiveness with ADSL:

  Ka 72MHz transponder costs 3M$/year
  -> With DVB-S: 10,000 users => 300$/year
  -> With DVB-S2 ACM: 26,000 users => 115$/year

  ADSL Service in Europe is ~ 500 $ / year and decreasing rapidly!

=> DVB-S2 + ACM is key factor to the success of Interactive Services via satellite
Small & Midsized networks

- Cost Assumptions

![Pie chart showing cost assumptions for small & midsized networks]

- 35% Capex Network
- 30% Opex Network (excl. Satellite cap)
- 35% Satellite Capacity

Impact on the Business Case
Business Case impact of introducing DVB-S2 ACM for midsized networks

- Given:
  - Ratio forward/return traffic => 4 to 1 (for Corporate and SME networks)
  - => efficiency DVB-S2 impact is on 26% of overall cost
  - DVB-S2 ACM results in 100 % efficiency increase
  - => Reduction of 13 % of the overall cost
Impact on the Business Case

Business Case impact of introducing DVB-S2 CCM for midsized networks

- Given:
  - Ratio forward/return traffic => 4 to 1 (for Corporate and SME networks)
  - => efficiency DVB-S2 impact is on 26% of overall cost
  - DVB-S2 CCM results in 29% efficiency increase
  - => Reduction of 6 % of the overall cost
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DVB-S2 into DVB-RCS
Standardisation Status

- DVB-S2 EN 302 307 V1.1.1 (2005-03)
- DVB-RCS EN 301 790 V1.4.1 (2005-04) (final draft)
- DVB-GBS IP encapsulation in Generic Mode
  - Standardsation of Generic mode (on going)
  - Current request for proposals
Current Status of DVB-S2

- DVB-S2 (de)modulators (broadcast) are commercially available on the Market (basic version) e.g.

NTC/2280 & NTC/2263 DVB-S2 Modulator & Demodulator

- Single Transport stream (CCM)
- ASI, SPI, G703, HSSI inputs
- Max 30 Mbauds
- 16Kbits frames
- available from Q2 2005

Next releases

- Multiple Transport Streams (CCM & VCM)
- GbE
- 60 Mbauds
- 64 Kbits frames
DVB-S2 integration into DVB-RCS Project Line

- DVB-RCS with DVB-S2 (in forward link)
  - CCM or ACM solutions
  - Available early 2006 (with VCM)
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DVB-RCS & DVB-S2
Conclusions:

- Full DVB-S2 implementation (incl. ACM) is highly beneficial for the DVB-RCS business case

- Customers/Prospects should check roadmap and upgradability path towards DVB-S2 when selecting 2 Way-Sat systems