DVB C2: Ready for Service

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Customers continue to ask for more bandwidth and new compelling services

- Current status: Digital Cable can provide up to 5 Gbit/s downstream capacity already today using DVB-C technology
  - Cable is a shared medium; transmission capacity is shared by all customers connected to a fibre node
  - Cisco forecasts for Europe 32% annual growth of IP traffic over the next four years
  - The ratio of downstream traffic to upstream IP traffic is permanently increasing and currently already higher than 5 : 1
  - Access to video is key for our customers
  - **Efficient usage of the limited frequency resources is key for cable operators**
The DVB-X2 Family Approach

**DVB-S2**
- Development 2003
- Single Carrier Modulation (up to 32 APSK)
- LDPC Forward Error Correction
- Physical Layer Pipe (PLP) concept

**DVB-T2**
- Development 2007/2008
- OFDM Modulation (up to 256 QAM)
- LDPC Forward Error Correction
- Physical Layer Pipe (PLP) concept

**DVB-C2**
- Development 2008/2009
- OFDM Modulation (up to 4096 QAM)
- LDPC Forward Error Correction
- Physical Layer Pipe (PLP) concept

- **DVB-T2 & DVB-C2 share:**
  - Common frequency range
  - Common channel raster
  - Common signal level range
### DVB-C2: Milestones of the DVB project

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter</th>
<th>Milestone Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Q1</td>
<td>Study Mission</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>Commercial Requirements</td>
</tr>
<tr>
<td></td>
<td>Q3</td>
<td>Call for Technologies</td>
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<tr>
<td></td>
<td>Q4</td>
<td>Development of Specification</td>
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<tr>
<td>2008</td>
<td>Q1</td>
<td>ETSI Standardisation</td>
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<tr>
<td></td>
<td>Q2</td>
<td>Software Validation &amp; Verification</td>
</tr>
<tr>
<td></td>
<td>Q3</td>
<td>DVB-C2 modulator</td>
</tr>
<tr>
<td></td>
<td>Q4</td>
<td>Consumer-Type DVB-C2 demodulator</td>
</tr>
<tr>
<td>2009</td>
<td>Q1</td>
<td>Approval of the standard</td>
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<tr>
<td></td>
<td>Q2</td>
<td>First hardware demo</td>
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<tr>
<td></td>
<td>Q3</td>
<td>First launch planned</td>
</tr>
<tr>
<td>2010</td>
<td>Q1</td>
<td>CPE Development</td>
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<tr>
<td></td>
<td>Q2</td>
<td>Field Trial</td>
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</table>
Superb performance of COFDM/LDPC

- Close to the theoretical Shannon Limit
- Broad range of solutions for all kind of CATV networks characteristics
- Headroom for optimized HFC networks
- Hooks for future extensions
- Service related QoS possible
- Adaptation of modulation parameters on frame by frame basis possible
Criteria for the cable operator’s choice

- Increased robustness: 7 dB
- Increase of spectral efficiency: 36 %
- Gain of spectral efficiency in modern HFC networks: up to 63.5 %
The process from a specification to silicon

- Software implementation of DVB-C2 in the Verification & Validation Task Force
- Start of a development project for an DVC-C2 FPGA (Sony)
- September 2010: First 4096-QAM transmission in a fully loaded CATV
- October 2010 Evaluation and performance testing of the FPGA
- Sony starts the final chip design process
- April 2011: First samples of the demodulator chip are available
- Mai 2001: First prototype CPE presented at ANGACable in Cologne
Sony is in mass production with both DVB-C2 and DVB-C2/T2 chips

50% of the Sony 2012 cable iDTV product line has DVB-C2 integrated

Broadcom presents samples of a receiver demod chips at ANGA Cable for the first time

4 manufacturers of professional equipment are presenting DVB-C2 modulators

Both a professional Signal generator (R&S) as well as a Measurement receiver (PROMAX) are commercially available
First DCV-C2 Plug Fest on 27th – 29th February

5 Measurement sessions

• Session 1: Interoperability
  • 99 test configurations based on V&V test cases

• Session 2: Receiver implementation loss
  • Overall performance testing

• Session 3: Receiver noise sensitivity + input system load testing

• Session 4: Frequency linearity testing

• Session 5: Adjacent channel interference testing
  • Selectivity requirements
  • DVB-C2 versus DVB-C2, versus DVB-C, versus Analogue TV (PAL)
The diagram gives SNR for error free picture processing, measured with professional spectrum analyser

- Key findings:
  - Minimum implementation loss within 2 dB up to 1024-QAM
  - At 4086-QAM phase noise characteristics seem to be a very critical parameter for receivers
  - Average performance far better than expected
First 4096-QAM transmission in fully loaded CATV network in Berlin, September 2010

4096-QAM:
64 horizontal x 64 vertical constellational points

Provides high spectrum efficiency:
12 bit/s / Hz (gross)
10.8 bit/s / Hz (net)

Requires high Signal-to Noise ratio:
>32 dB
Integration of DVB-C2 into the Kabel Deutschland VOD architecture

- Customer visits the VOD portal
- VOD catalogue data is transferred via IP (DOCSIS)
- Customer makes his choice and requests a film

- The Transaction Server starts a VOD Session
- The Resource Manager decides the downstream channel: DVB-C2 or DVB-C depending on the CPE of the customer
- The VOD server starts to play the film
- The Transaction Server acts according to the customer’s commands: pause, fast forwards, fast backwards,……
- The Transaction Server finally closes the Session
DVB-C2 Migration for HDTV

- New tiers of HDTV products are an opportunity for the introduction of DVB-C2 for European cable operators
- Today DVB-C @256-QAM (50 Mbit/s) allows to transport 4 HDTV services using H.264 encoding
- DVB-C2 @4096-QAM, 9/10 FEC, 32 MHz modulator bandwidth (330 Mbit/s) would allow to transport 32 HDTV services using H.264 encoding and providing the same HD picture quality
- Benefit of this solution:
  1. about 63% higher spectrum efficiency
  2. about 20% higher statistical multiplexing gain
  - Resulting in an overall 100% efficiency gain
- This solution still works with standard DVB-C2 compatible receivers with a 8 MHz receiver bandwidth
Growing interest for integration of DVB-C2 into the Euro-DOCSIS system

- Euro-DOCSIS is currently based on the DVB-C physical layer system
- Cable modems with DVB-C2/DVB-C capabilities would allow to improve the spectrum efficiency for IP-based EuroDOCSIS services
- Comparable to VOD, EuroDOCSIS-Traffic is customer individual traffic, allowing to run DVB-C and DVB-C2 compliant modems in the same network
- The Provisioning System will register the type of the modem a customer is equipped with and ensure that requested IP-packets are delivered with the appropriate modulation scheme (DVB-C or DVB-C2)
The HFC structure is definitely not ‘End of Life’; Options and future extensions of standards

<table>
<thead>
<tr>
<th>System configuration</th>
<th>Bandwidth</th>
<th>Payload Capacity</th>
<th>Total Payload Capacity</th>
<th>Gain ref. to DOCSIS 3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>KDG field trial EuroDOCSIS 3.0</td>
<td>96 x 8 MHz</td>
<td>96 x 50.7 MBit/s</td>
<td>4.870 Mbit/s</td>
<td>-</td>
</tr>
<tr>
<td>Option 1: DVB-C2 basic (1024-QAM)</td>
<td>96 x 8 MHz</td>
<td>96 x 66.3 Mbit/s</td>
<td>6.365 Mbit/s</td>
<td>+31 % (+1.5 Gbit/s)</td>
</tr>
<tr>
<td>Option 2: DVB-C2 optimized (4k-QAM)</td>
<td>3 x 256 MHz</td>
<td>3 x 2.670 Mbit/s</td>
<td>8.010 Mbit/s</td>
<td>+64 % (+3.1 Gbit/s)</td>
</tr>
<tr>
<td>Future Option 3: DVB-C2 (ext. to 16k-QAM)</td>
<td>3 x 256 MHz</td>
<td>3 x 3.150 Mbit/s</td>
<td>9.450 Mbit/s</td>
<td>+94 % (+4.6 Gbit/s)</td>
</tr>
<tr>
<td>Future Option 4: DVB-C2 (ext. to 16k-QAM, 1.2 GHz)</td>
<td>4 x 256 MHz</td>
<td>4 x 3.150 Mbit/s</td>
<td>12.600 Mbit/s</td>
<td>+158 % (+7.7 Gbit/s)</td>
</tr>
<tr>
<td>Future Option 3: DVB-C2 (ext. to 64k-QAM, 1.2 GHz)</td>
<td>4 x 256 MHz</td>
<td>4 x 3.600 Mbit/s</td>
<td>14.400 Mbit/s</td>
<td>+195 % (+9.5 Gbit/s)</td>
</tr>
<tr>
<td>Future Option 3: DVB-C2 (ext. to 64k-QAM, 2 GHz)</td>
<td>6 x 256 MHz</td>
<td>6 x 3.600 Mbit/s</td>
<td>21.600 Mbit/s</td>
<td>+344 % (+9.5 Gbit/s)</td>
</tr>
</tbody>
</table>
The HFC Structure will be able to meet the customer demand for quite some time

- Cable operators will continue to bring fibre closer to the customers
- Cluster sizes will be reduced and signal quality will increase
- Further higher order modulation schemes and extension of downstream bandwidth will be possible
- 10 Gbi/s and even more will be feasible
Conclusions: DVB-C2 efficiency and flexibility combined

- DVB-C2 meets the targeted efficiency enhancement and provides sufficient headroom for high performance cable networks

- Implementations of DVB-C2 modulators and receivers are evaluated:
  - One DVB-C2 demod chip is already in mass production and a second demod implementation is introduced here at ANGA Cable 2012
  - DVB-C2 compliant iDTV device are already available in the shops
  - 4 different modulator implementations are shown at ANGA Cable 2012
  - Measurement equipment is presented by two vendors at ANGA Cable 2012

- VOD has been identified as a very attractive service to start the migration from DVB-C to DVB-C2

- There is interest of operators to make the improvements of DVB-C2 also available for the EuroDOCSIS system

- **DVB-C2 is ready for service**
Thank you for your interest.