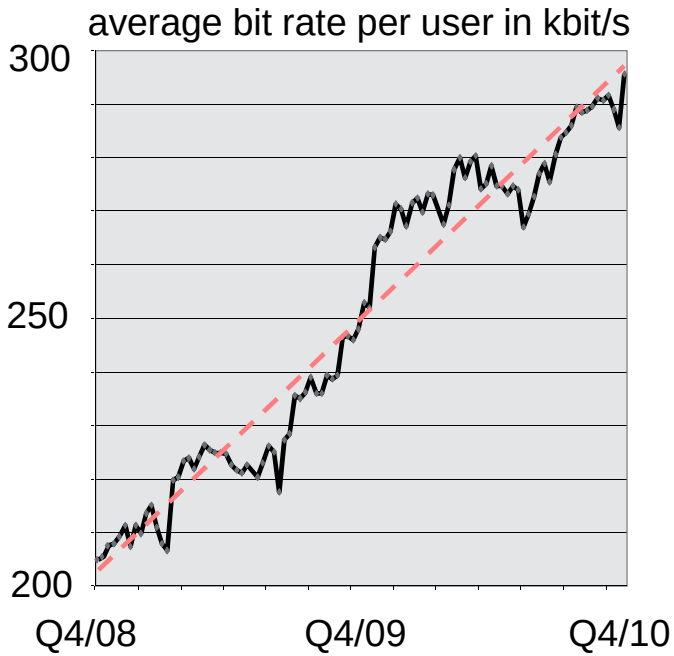
DVB C2: Ready for Service

Christoph Schaaf (chairman DVB TM-C2), Kabel Deutschland

ANGA Cable, Cologne, 12th June 2012

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

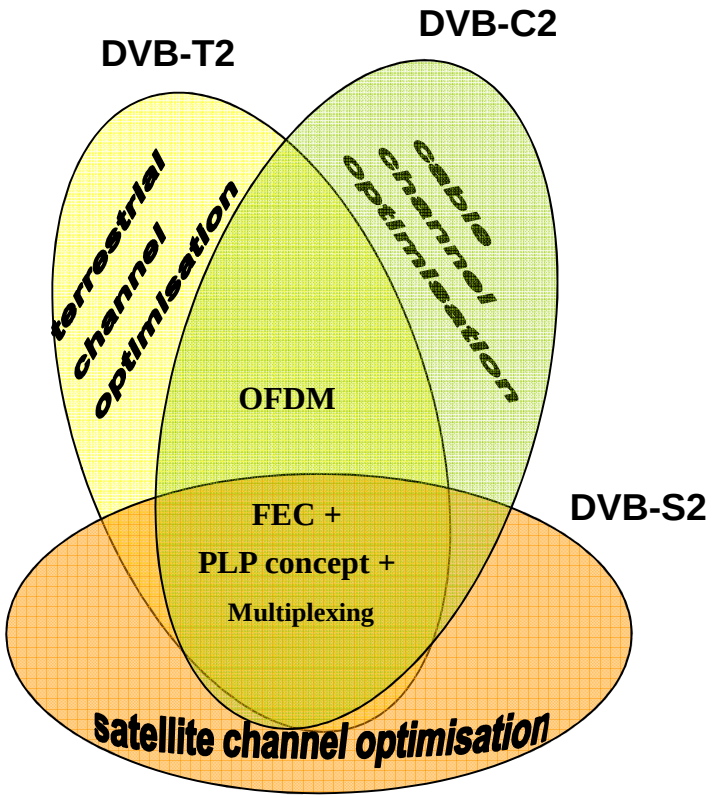
- Development 2003
- Single Carrier Modulation (up to 32 APSK)
- LDPC Forward Error Correction
- Physical Layer Pipe (PLP) concept

DVB-T2

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

DVB-C2

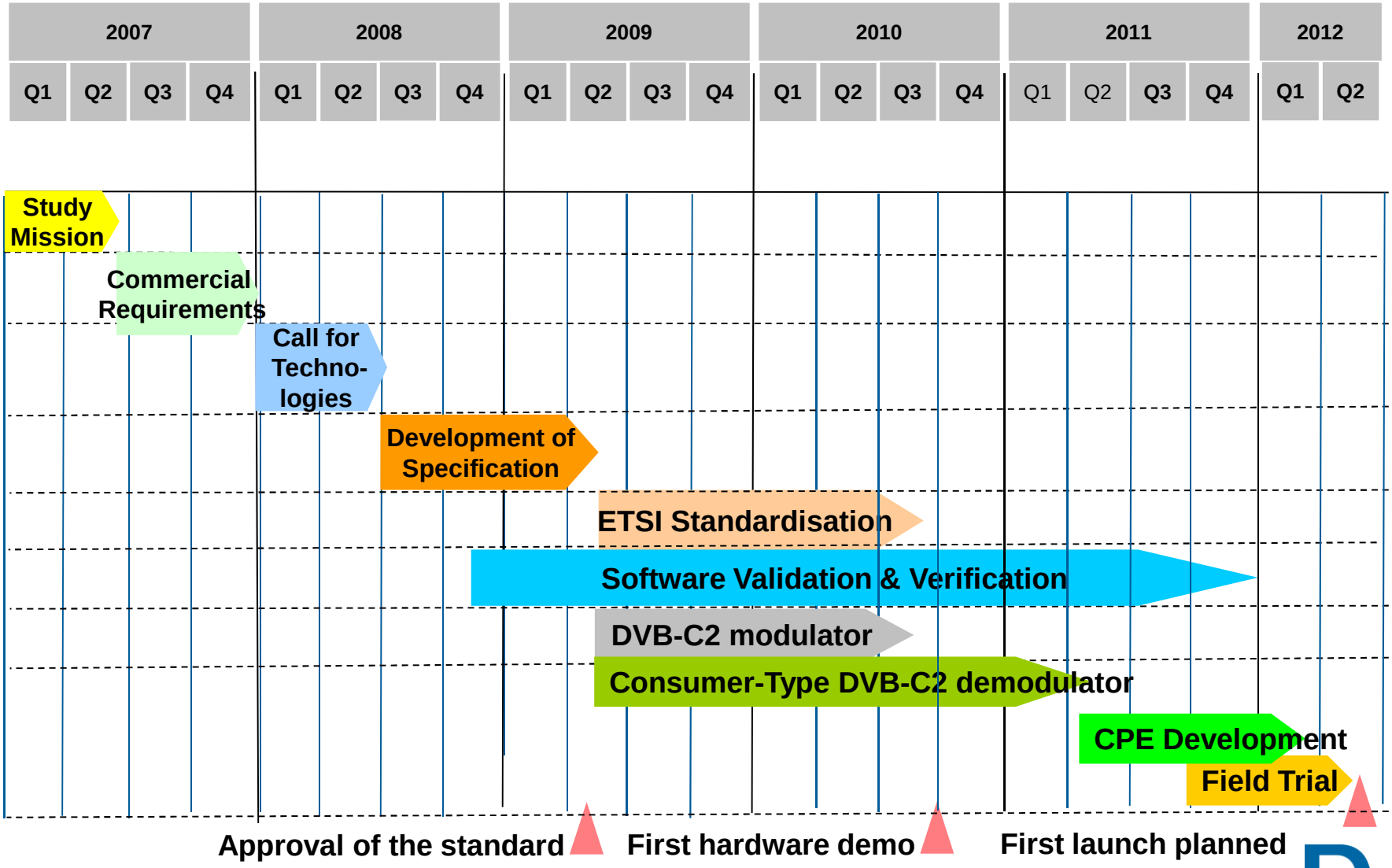
- Development 2008/2009
- OFDM Modulation (up to 4096 QAM)
- LDPC Forward Error Correction
- Physical Layer Pipe (PLP) concept



- **DVB-T2 & DVB-C2 share:**
- **Common frequency range**
- **Common channel raster**
- **Common signal level range**

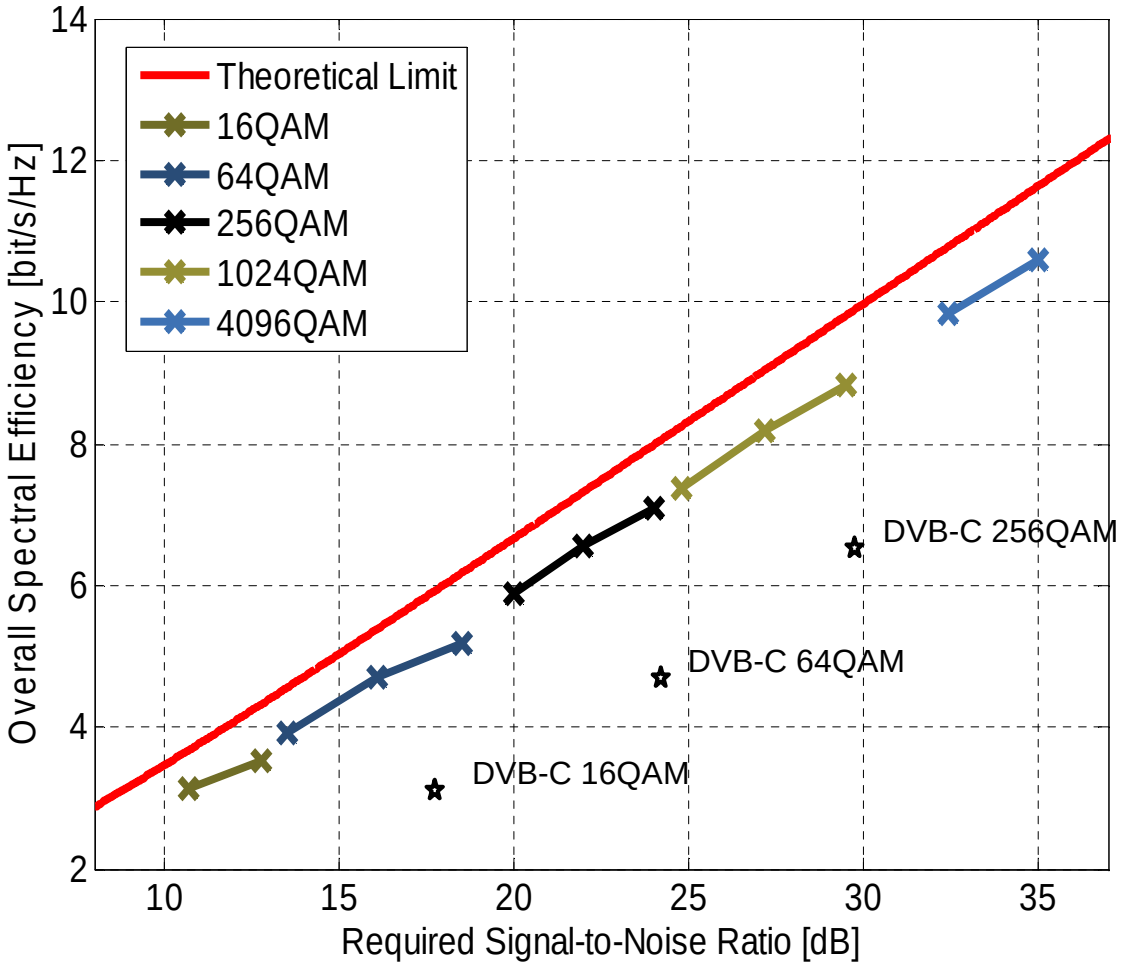
Digital Video Broadcasting

DVB-C2: Milestones of the DVB project



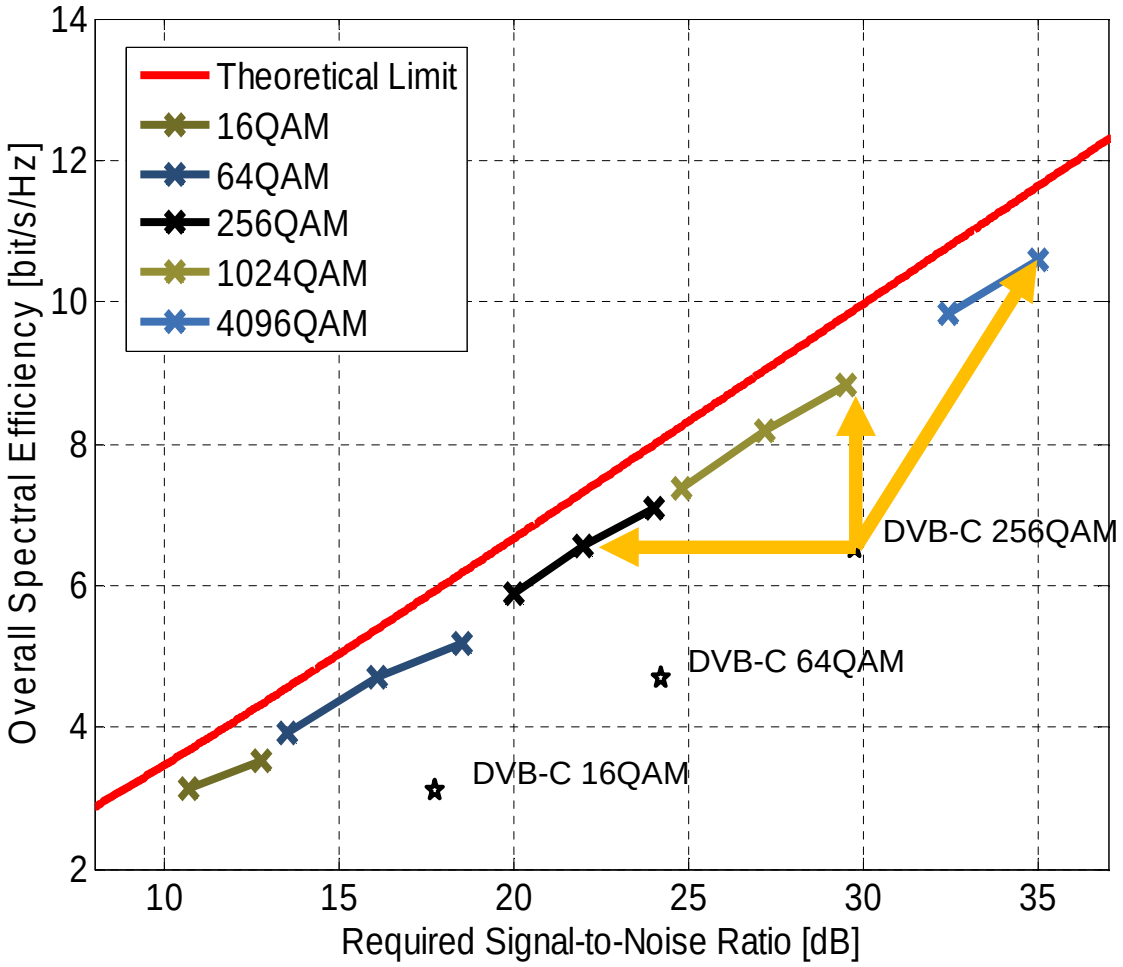
Superb performance of COFDM/LDPC

- 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



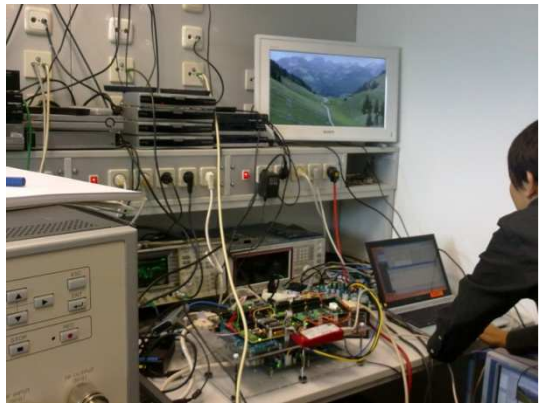
Criteria for the cable operator's choice

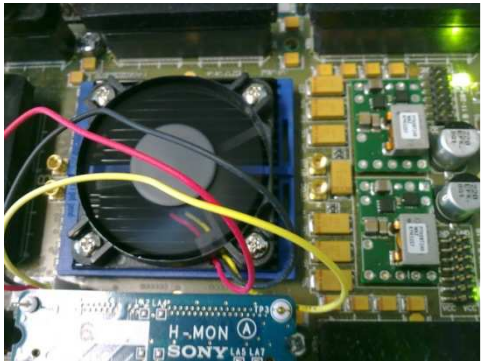
- Increased robustness:
  7 dB
- Increase of spectral efficiency:
  36 %
- Gain of spectral efficiency in modern HFC networks:
  up to 63,5 %

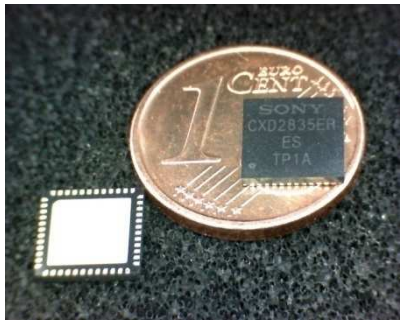


The process from a specification to silicon

- 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







Status ANGA Cable 2012

- 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

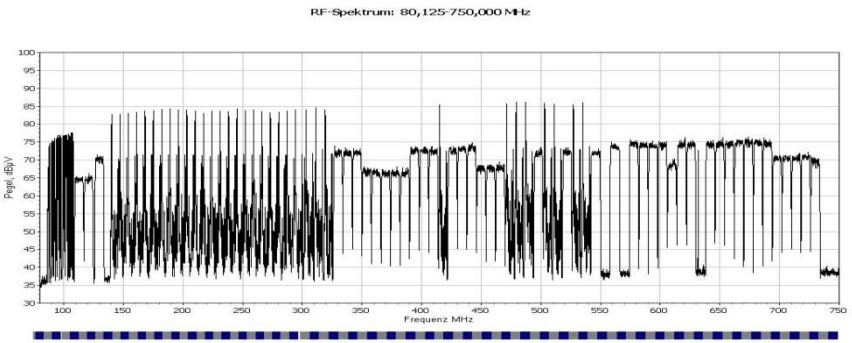
First DCV-C2 Plug Fest on 27th – 29th February

5 Mesurement sessions

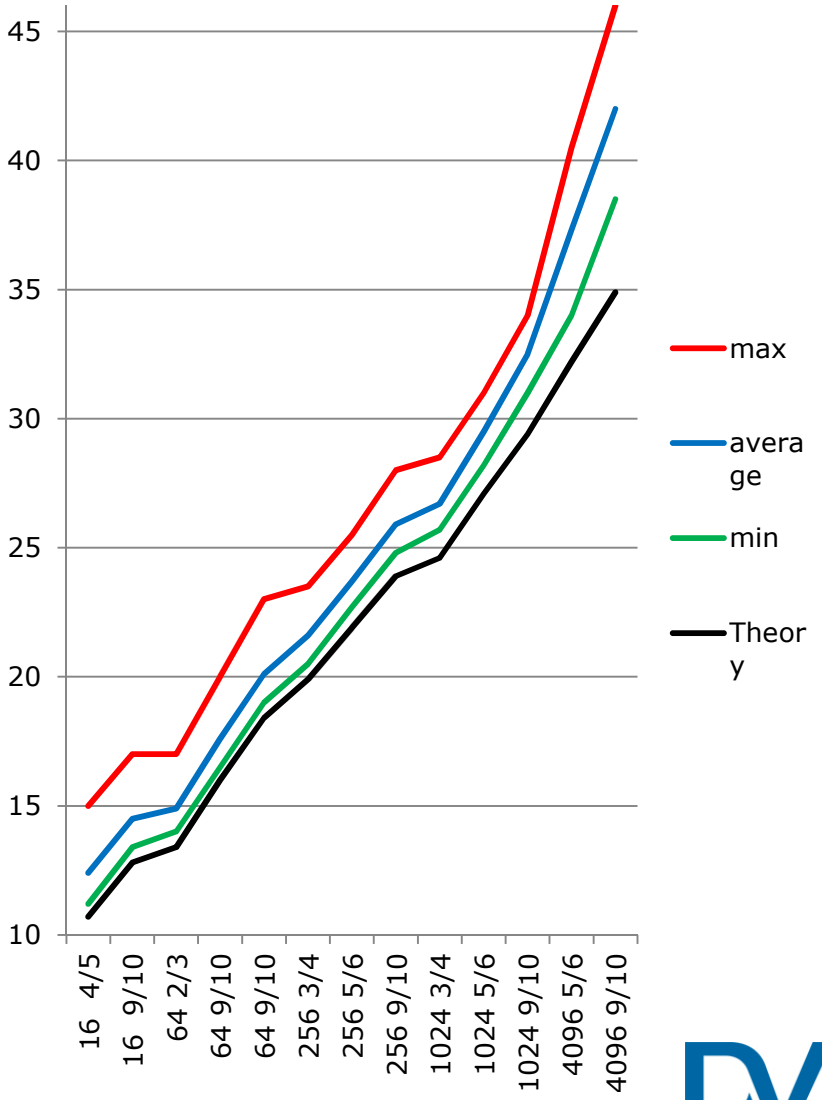
- Session 1: Interoperability
  - 99 test configurations based on V&V test cases
- Session 2: Receiver implementation loss
  - Overall performance testing
- Session 3: Receiver noise sensitivity + input system load testing
- Session 4: Frequency linearity testing
- Session 5: Adjacent channel interference testi
  - Selectivity requirements
  - DVB-C2 versus DVB-C2, versus DVB-C, versus Analogue TV (PAL)

Digital Video Broadcasting

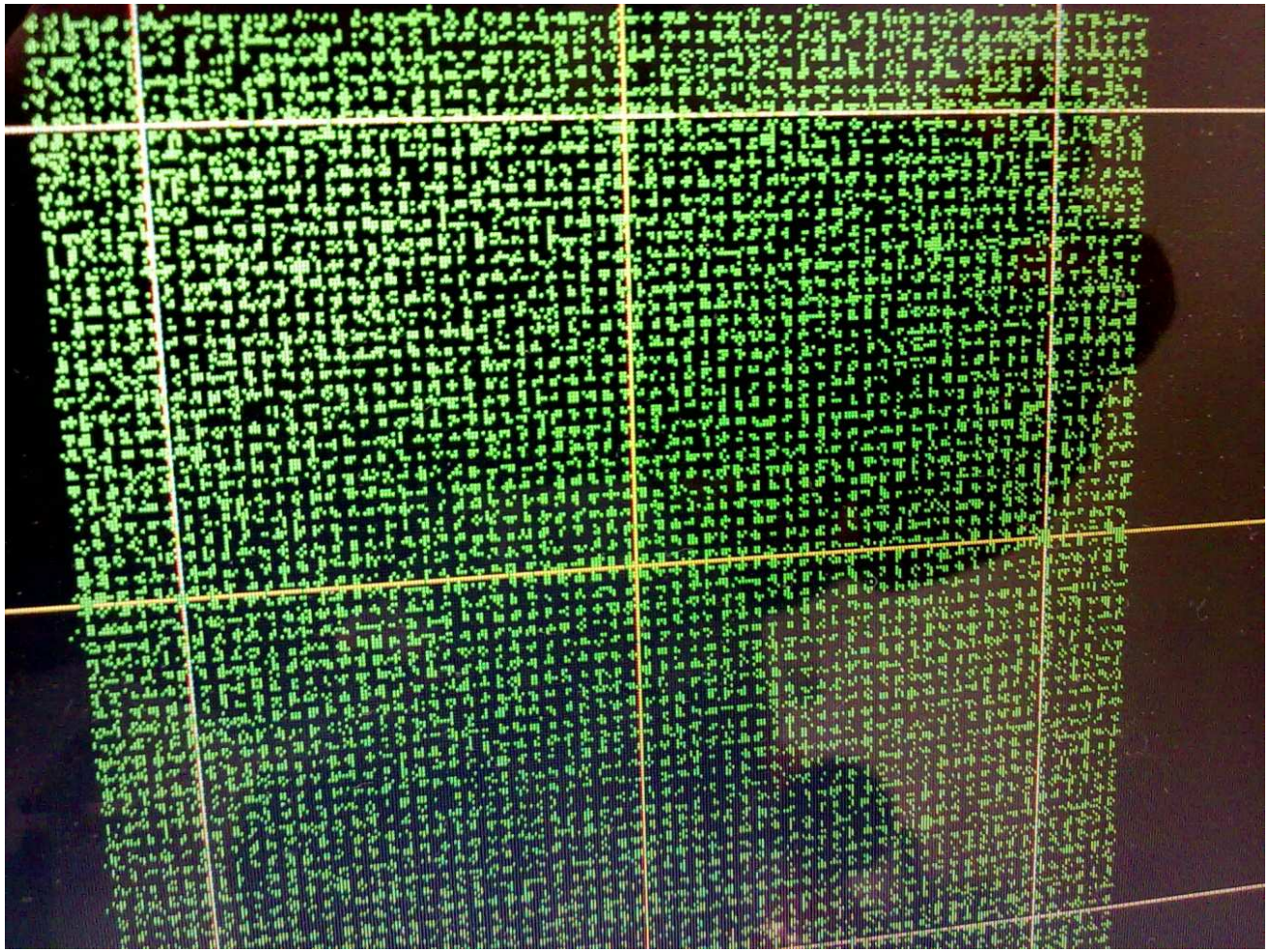
Plug Fest: Receiver performance measurements



- 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

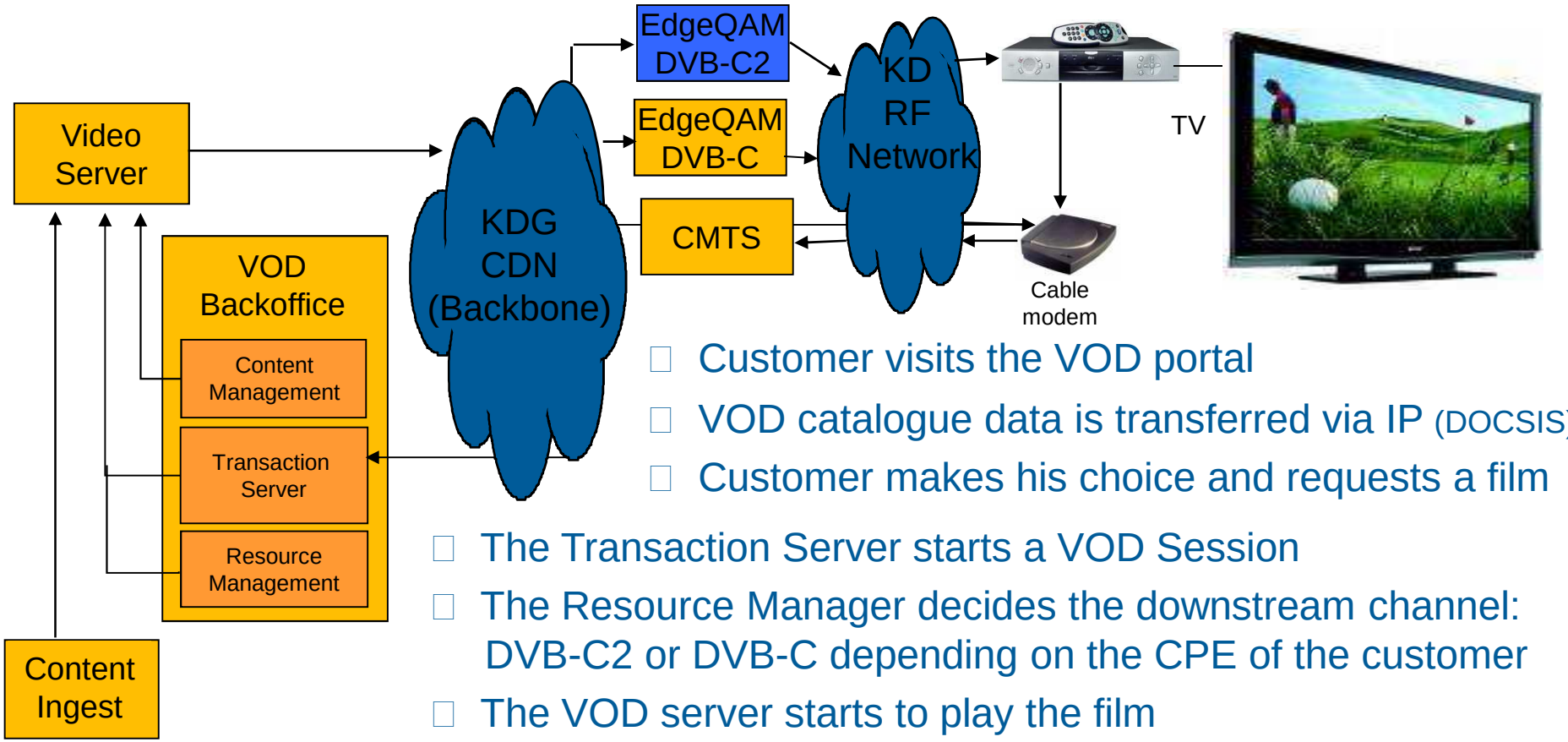


4096-QAM:
64 horizontal
x
64 vertical
constellational points

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

Requires high Signal-to Noise ratio:
>32 dB

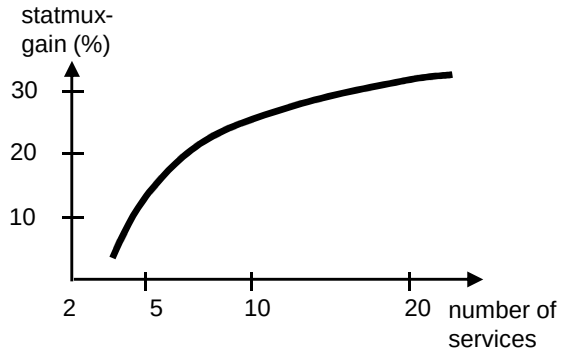
Integration of DVB-C2 into the Kabel Deutschland VOD architecture

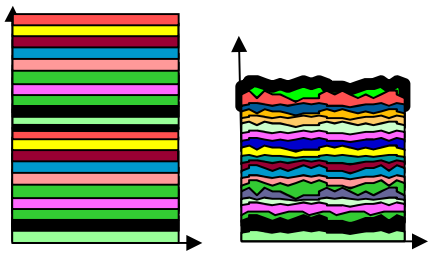


- Customer visits the VOD portal
- VOD catalogue data is transferred via IP (DOCSIS)
- Customer makes his choice and requests a film
- The Transaction Server starts a VOD Session
- The Resource Manager decides the downstream channel: DVB-C2 or DVB-C depending on the CPE of the customer
- The VOD server 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

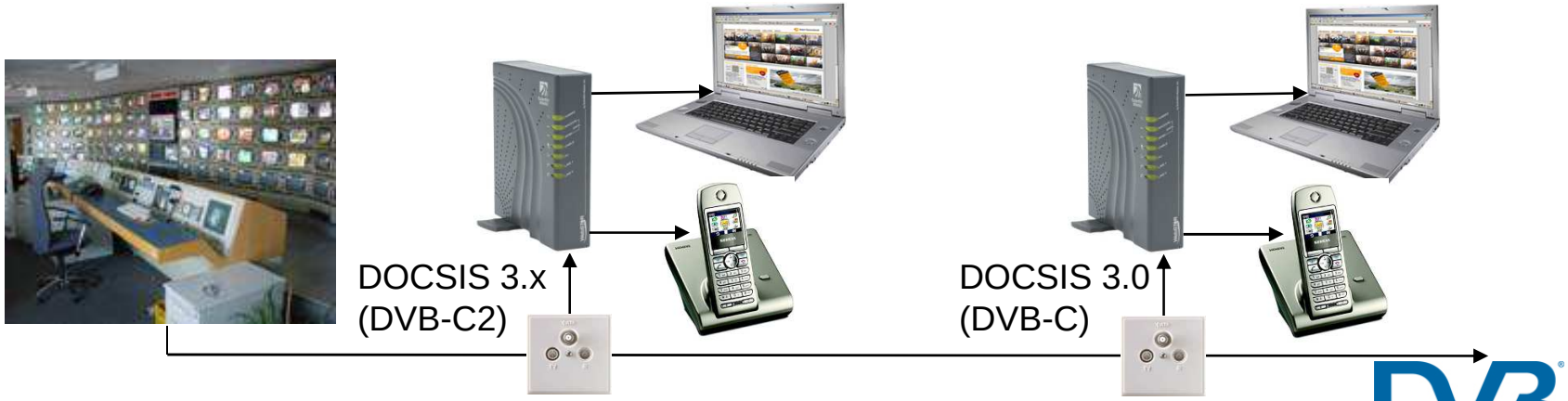
- New tiers of HDTV products are an opportunity for the introduction of DVB-C2 for European cable operators
- Today DVB-C @256-QAM (50 Mbit/s) allows to transport 4 HDTV services using H.264 encoding
- DVB-C2 @4096-QAM, 9/10 FEC, 32 MHz modulator bandwidth (330 Mbit/s) would allow to transport 32 HDTV 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)

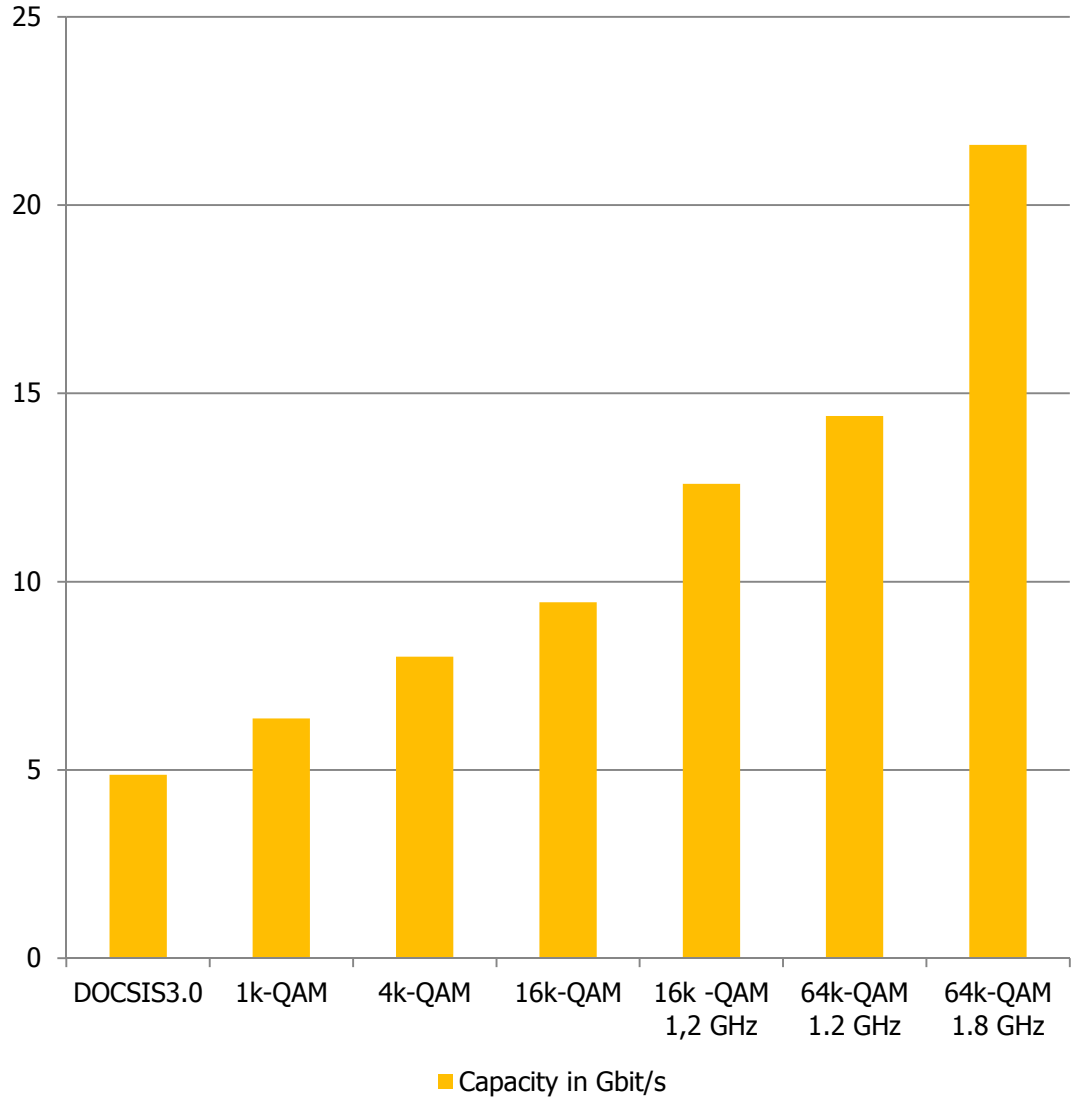


The HFC structure is definitely not 'End of Life'; Options and future extensions of standards

System configuration	Bandwidth	Payload Capacity	Total Payload Capacity	Gain ref. to DOCSIS 3.0
KDG field trial EuroDOCSIS 3.0	**96 x 8 MHz**	**96 x 50.7 MBit/s**	**4.870 Mbit/s**	**-**
Option1: DVB-C2 basic (1024-QAM)	**96 x 8 MHz**	**96 x 66.3 Mbit/s**	**6.365 Mbit/s**	**+31 % (+1.5 Gbit/s)**
Option2: DVB-C2 optimized (4k-QAM)	**3 x 256 MHz**	**3 x 2.670 Mbit/s**	**8.010 Mbit/s**	**+64 % (+3,1 Gbit/s)**
Future Option 3: DVB-C2 (ext. to 16k-QAM)	**3 x 256 MHz**	**3 x 3,150 Mbit/s**	**9.450 Mbit/s**	**+94 % (+4.6 Gbit/s)**
Future Option 4: DVB-C2 (ext. to 16k-QAM, 1.2 GHz)	**4 x 256 MHz**	**4 x 3,150 Mbit/s**	**12.600 Mbit/s**	**+158 % (+7.7 Gbit/s)**
Future Option 3: DVB-C2 (ext. to 64k-QAM, 1.2 GHz)	**4 x 256 MHz**	**4 x 3,600 Mbit/s**	**14.400 Mbit/s**	**+195 % (+9,5 Gbit/s)**
Future Option 3: DVB-C2 (ext. to 64k-QAM, 2 GHz)	**6 x 256 MHz**	**6 x 3,600 Mbit/s**	**21.600 Mbit/s**	**+344 % (+9,5 Gbit/s)**

Digital Video Broadcasting

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 ANGACable 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**

Digital Video Broadcasting

Thank you for your interest.