Technologies and Prospects of a 'Next Generation Handheld' (DVB-NGH) System

Jukka Henriksson
DVB AHG TM-H chairman
Nokia

TUBS.city Symposium

July 1-3, 2009

Content

- History
- DVB study mission on NGH
- User needs & Commercial requirements
- Technology comments
- Challenges
- “Wild” guess
- Schedule

Brief history of mobile TV

- Nothing comes from vacuum
- DVB-T is the solid basis for mobile TV – DVB-H and also (partly) DVB-SH
- Fairly long history exists

From DVB-T to DVB-H
(Nokia view ☺)

DVB-T ratified

First Commercial DVB-T Networks

Nokia MediaScreen Concept

Nokia 7700

Nokia 7710

Commercial DVB-H handsets N92

1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006

DVB-T networks in UK 1998

DVB-H work started

ETSI standard

N77

NOKIA
Connecting People

History continues

- DVB later produced **DVB-SH** (from satellite to handhelds)
  - Published as ETSI standard July 2007
- **DVB-T2** standard, successor of DVB-T, was created in DVB and published by ETSI in 2008

SO

Is there need for anything new? What is the reasoning?

NOKIA

DVB study mission on NGH

- A study mission (NGH- next generation handheld) to probe these issues was launched in DVB June 2007

- SM Conclusions:
  - The new standard should address all relevant market segments (terrestrial, terrestrial-satellite hybrid) in order to avoid market fragmentation.
  - If significant capacity increase is needed, feasibility and available performance using multiantenna techniques (MIMO) in handheld terminals should be carefully assessed
  - The new standard NGH, among other things listed above, should be capable of using multiple bands of spectrum and have flexible spectrum use.

NOKIA

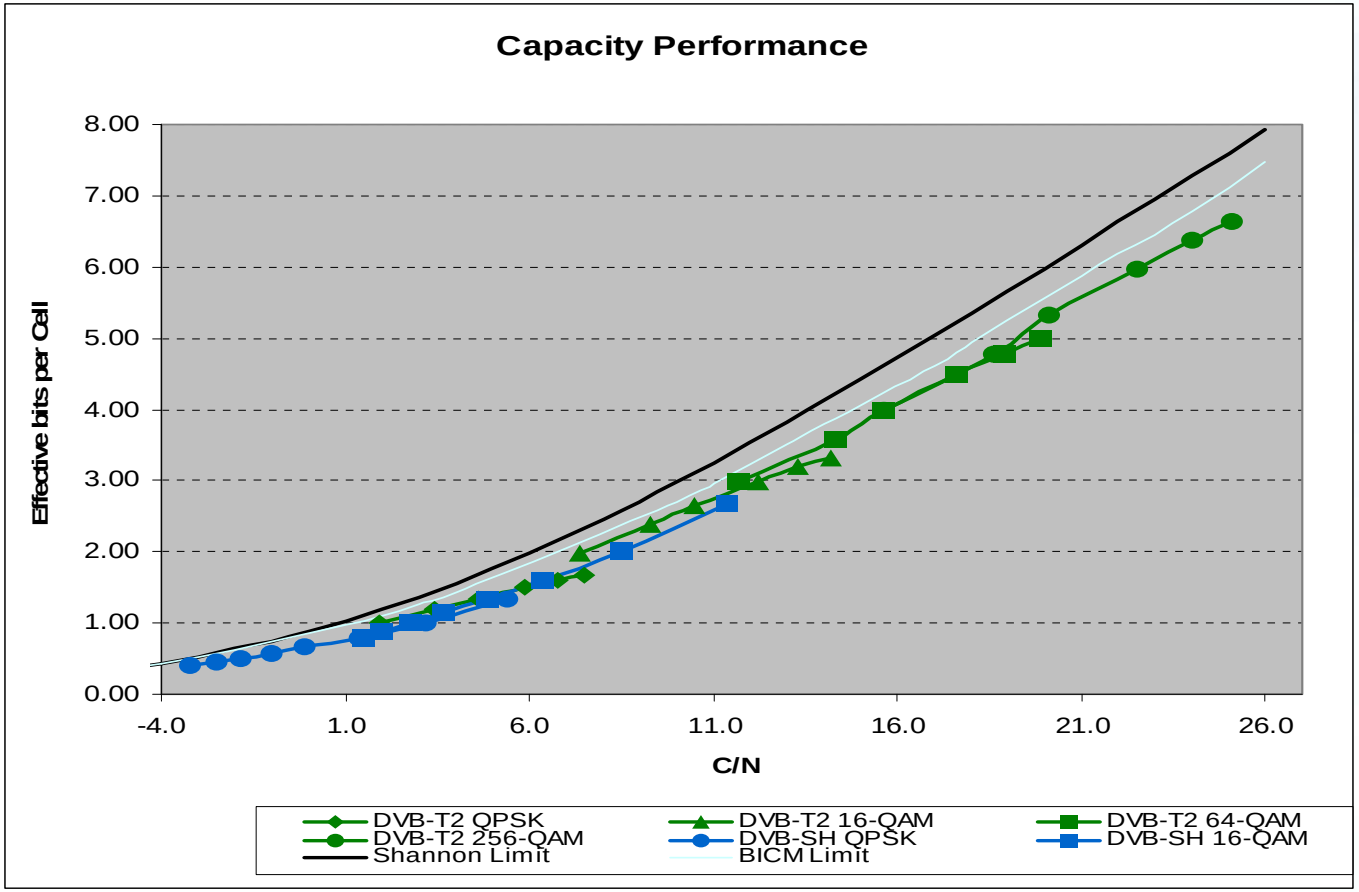
Further comments from study mission

- **DVB-T2** includes a new Frame structure (Flexible Pilots structure, Preamples, PLP concept, MISO, Rotated constellations, etc) as well as a state of the art coding with LDPCs
- LDPCs and Turbo Codes have very similar performance a very close to Shannon Limits at low C/N.
- **Taking the best from T2 and SH** we can have a very good starting point for NGH.
- To obtain a “significant improvement” we should analyze mainly *MIMO and Overhead reduction*

NOKIA

Compared capacity of SH and T2
against Shannon limit

Please be aware that only constellations and coding is considered for the simulations. Perfect channel estimation is used.



TU-6 @ 100 Hz

Please note this capacity simulations only consider Coding Rates, but no Guard Intervals, Preambles, TPS, Pilots … overheads.

2x2 MIMO promise vs. Alamouti 2x2

SIDSA, study mission have computed this capacity for a perfect MIMO 2x2 system, and for the Alamouti system used in diversity 2, which is a particular implementation of 2x2 MIMO.

	Capacity for Alamouti 2x2 (bit/cell)	Capacity for optimal MIMO 2x2 (bit/cell)
SNR = 0 dB	1.44	1.59 (+10.1 %)
SNR = 4 dB	2.36	2.73 (+15.6 %)
SNR = 8 dB	3.46	4.22 (+22.1 %)
SNR = 12 dB	4.68	5.04 (+29.2 %)
SNR = 16 dB	5.96	8.12 (+36.1 %)

Note: very preliminary, overview result

The result depends strongly on the channel model and actual implementation

BBC channel model: overview of results

- All results relative to SISO

- Sidsa +35% throughput at 10^{-4} BER at 15dB SNR
- RAI with *modified BBC* model
- +100% 1% outage & +4-5dB indoor (K=0.1)
- +100% 1% outage & +2-3dB urban outdoor (K=1)
- +33-50% 1% outage rural outdoor (K=10)
- BBC + 57% in ergodic capacity @ 15dB SNR and + 45% @ 10dB SNR

Jury is still out!

NOKIA

But is there REAL need?

- DVB set up **CM group CM-NGH** in 2008 to define commercial requirements
- The key findings
  - Technology has progressed and significant improvement in performance is available
  - Robustness and indoor reception are the main points
  - The business environment changes due to T2, LTE etc
- CM listed several general requirements (24.6.2009) like
  - NGH must be sufficiently flexible to deliver content types that match the varying amounts of attention a user might want to devote: e.g. radio, radio with slideshow, high quality (SD) TV
  - Must integrate with 'back channel' technologies to offer a truly immersive, two-way experience
  - Must be able to offer extended viewing sessions therefore extended ***battery life*** is important
  - Must offer fast access to services therefore ***fast start up and channel switching*** are important
  - Should be able to act as a 'second screen' by offering content that complements and synchronises with content on DVB-T(2) and other platforms
  - Should be possible to offer ***location specific content***

NOKIA

Highlights of the commercial requirements

7	The DVB-NGH specification shall be optimized for outdoor and deep indoor portable and slow mobile reception (pedestrian ≤15 km/h).
8	The DVB-NGH specification shall also be optimized for in-vehicle and outdoor mobile vehicular reception (15 to 350 km/h).

Keep mobility

11	The DVB-NGH specification shall be designed to operate at least in the frequency bands III, IV and V, L-band and S-band.
12	DVB-NGH shall be designed to operate in RF channel bandwidths of **1.7**, 5, 6, 7,and 8, **10**, 15 and **20** MHz.

New bands & bandwidths

15	The system shall be designed for terrestrial use and it may also contain ***a satellite component.***

Avoid market fragmentation!

18	The system should support for the transport of the whole stream to transmitters over non synchronous networks such as **IP**.
19	**Individual quality for service components** should be possible.
22	The NGH standard should allow for a NGH service to be offered in different qualities. The lower quality being more robust, e.g. based on the use of **scalable video coding**.

IP support and individual & different service quality; possibly SVC

24	The video, audio or data **net throughput shall be maximized** for a given reception condition (e.g. C/N), i.e. overheads such as packet headers and metadata should be minimized, without losing functionality.

Reduce overheads!

Highlights of the commercial requirements 2

28	**The preference, in terms of performance improvement, is on robustness and indoor coverage. Recognizing that capacity can be traded for robustness, the overall capacity improvement, for a given robustness, shall be at least 50% compared to DVB-H.**
29	The DVB-NGH specification should allow for the re-use of DVB-H RF network structures mixing several sites profiles (e.g. from high power/high broadcast towers to low power/low sites similar to 3G sites) and distribution networks as far as possible.
30	**It shall be possible to combine DVB-NGH and DVB-T2 signals in one RF channel**
31	The DVB Technical Module is requested to complete the DVB-NGH technical specification(s) by the end of 2011.

Major motivation!

Guard existing (and future) investments

Could be major competitive edge!

Commercial launch 2012

Notes & disclaimers:

1) based on draft document from CM (accepted by DVB SB 2.7.2009)

2) Selection of certain requirements here does not mean any preference or indication of importance; purely personal interest ☺

Technology comments

- **Overhead reduction**
  - DVB-H has several layers of coding + IP overhead
  - Changing the base code (like in DVB-T2) to LDPC (or equivalent), significant reduction is available
  - IP overhead can be reduced (e.g. header compression)

- **Performance increase**
  - Changing coding ; RS => LDPC
  - Additional low code rates for robustness (e.g. rate ¼ …)
  - Longer interleaving
    - Beware zapping time, maybe solutions like MPE-IFEC could be used
  - Two tuner approach
    - Use 2x2 or (distributed) 4x2 MIMO (probably in crosspolarized form)
    - Use diversity (polarization or spatial?)
    - Or even TFS (time-frequency slicing)?!!
  - Rotated constellations (from T2)

NOKIA

Technology comments 2

- **New bands**
  - MIMO probably not feasible in VHF, UHF still unclear
  - VHF requires external antennas
  - Above 1 GHz MIMO is feasible
    - However: No feedback info about the channel to the Tx is available => MIMO is not as efficient as in p-t-p connections
  - Satellite option requires very long interleavers (ca 10 s!) => large memory needed

- Big uncertainty in MIMO performance and feasibility in UHF
  - Measurement campaign was run in Helsinki may 2009
  - Sponsored by 10 “NGH Hero” companies
  - Analysis of the data started
  - New channel model expected by the end of 2009

Goals for channel modelling

- To obtain channel models representative of MIMO delivery to a handheld device (or laptop)
- Terrestrial and Satellite
- VHF,UHF, L-Band; dimensionality up to 4x2
- Probably cross-polar receive antennas (+ wired headset)

$$\begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix}$$

$$\begin{pmatrix} \tilde{h}_{11} & \tilde{h}_{12} \\ \tilde{h}_{21} & \tilde{h}_{22} \end{pmatrix}$$

Thanks for slide to P Moss, BBC

Challenges for NGH system

- How to deal with MIMO question?
  - Obligatory for UHF and above or optional (e.g. in UHF)?
  - Receiver complexity and cost issue
  - Can we always assume two tuners?
- How to tackle adaptivity MIMO vs Diversity in BC environment
  - Any reasonable solutions? (diversity seems to be more beneficial at low SNR than MIMO)
- How to deal with long interleaver issue?
  - Zapping time & delay
  - Memory
  - Cost - how to support satellite services without unreasonable burden to all receivers?
- How to build a good solution to include SCV (via physical layer pipes (PLP) or…?)
- How to share T2 & NGH in one RF channel?
  - Using Future extension frames (FEF) of T2?
  - Defining suitable method to use different physical layer pipes?
  - Something else? Or all of these?
- How to handle upper layer issues?
  - TS, IP etc transport
  - Seamless/easy service handover via various bearers
- How to increase signaling robustness and capacity?
- **How to simplify – not only adding features??!!**

NOKIA

What could it be?

Wild, (educated?) guess – very personal view

- T2 based system with some additions/modifications
  - More (and less!) coding rates
  - Long time interleaving (at least as option)
  - At least some support for 2x2 and possibly 4x2 MIMO
  - Less overhead
  - Streamlined to allow various service handover
  - Scalable video coding playing some role
  - Allowing flexible use together **with T2 and within T2**

Hope that this does not disturb anybody nor block innovations!

NOKIA

NGH work scheduling (draft)

- CM approval - CM 1062 - 24June 2009
- SB approval – 2 July 2009
- Start of technical work (CfT) – Sept 2009
- Draft Specification – Sept 2010
- Draft IG and other documents – June 2011
- Publication of Specification(s) – End 2011


Thank You!