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

Jukka Henriksson
DVB AHG TM-H chairman
Nokia

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- 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 😊)

- **1996**: First Commercial DVB-T Networks
- **1997**: DVB-T networks in UK 1998
- **1998**: DVB-H work started
- **1999**: Nokia MediaScreen Concept
- **2000**: ETSI standard
- **2001**: Commercial DVB-H handsets N92
- **2002**: DVB-H work started
- **2004**: Nokia 7710
- **2005**: Nokia 7700
- **2006**: Commercial DVB-H handsets N92

(Nokia view 😊)
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?*
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.
Further comments from study mission

- **DVB-T2** includes a new Frame structure (Flexible Pilots structure, Preambles, 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.
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.

| SNR = 0 dB | Capacity for Alamouti 2x2 (bit/cell) | 1.44 |
| SNR = 4 dB | 2.36 |
| SNR = 8 dB | 3.46 |
| SNR = 12 dB | 4.68 |
| SNR = 16 dB | 5.96 |
| SNR = 0 dB | Capacity for optimal MIMO 2x2 (bit/cell) | 1.59 (+10.1 %) |
| SNR = 4 dB | 2.73 (+15.6 %) |
| SNR = 8 dB | 4.22 (+22.1 %) |
| SNR = 12 dB | 5.04 (+29.2 %) |
| SNR = 16 dB | 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!**
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**
### Highlights of the commercial requirements

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Notes</th>
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<tbody>
<tr>
<td>7</td>
<td>The DVB-NGH specification shall be optimized for outdoor and deep indoor portable and slow mobile reception (pedestrian ≤15 km/h).</td>
<td><strong>Keep mobility</strong></td>
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<tr>
<td>8</td>
<td>The DVB-NGH specification shall also be optimized for in-vehicle and outdoor mobile vehicular reception (15 to 350 km/h).</td>
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<td>11</td>
<td>The DVB-NGH specification shall be designed to operate at least in the frequency bands III, IV and V, L-band and S-band.</td>
<td><strong>New bands &amp; bandwidths</strong></td>
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<tr>
<td>12</td>
<td>DVB-NGH shall be designed to operate in RF channel bandwidths of 1.7, 5, 6, 7, and 8, 10, 15 and 20 MHz.</td>
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<td>15</td>
<td>The system shall be designed for terrestrial use and it may also contain a satellite component.</td>
<td><strong>Avoid market fragmentation!</strong></td>
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<tr>
<td>18</td>
<td>The system should support for the transport of the whole stream to transmitters over non synchronous networks such as IP.</td>
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<td>19</td>
<td><strong>Individual quality for service components</strong> should be possible.</td>
<td><strong>IP support and individual &amp; different service quality; possibly SVC</strong></td>
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<td>22</td>
<td>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.</td>
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<tr>
<td>24</td>
<td>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.</td>
<td><strong>Reduce overheads!</strong></td>
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## Highlights of the commercial requirements 2

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<th>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.</th>
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<tbody>
<tr>
<td>28</td>
<td>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.</td>
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<td>29</td>
<td>It shall be possible to combine DVB-NGH and DVB-T2 signals in one RF channel</td>
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<td>30</td>
<td>The DVB Technical Module is requested to complete the DVB-NGH technical specification(s) by the end of 2011.</td>
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### 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 \( \frac{1}{4} \ldots \))
  - 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)
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)

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

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\begin{pmatrix}
  \tilde{h}_{11} & \tilde{h}_{12} \\
  \tilde{h}_{21} & \tilde{h}_{22}
\end{pmatrix}
\]
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??!!
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!
NGH work scheduling (draft)

- CM approval - CM 1062 - 24 June 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

Subject to SB, TM & CM decisions

Commercial launch