Development of Mobile TV standards in DVB

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FRUCT seminar

November, 2009

Helsinki-Espoo
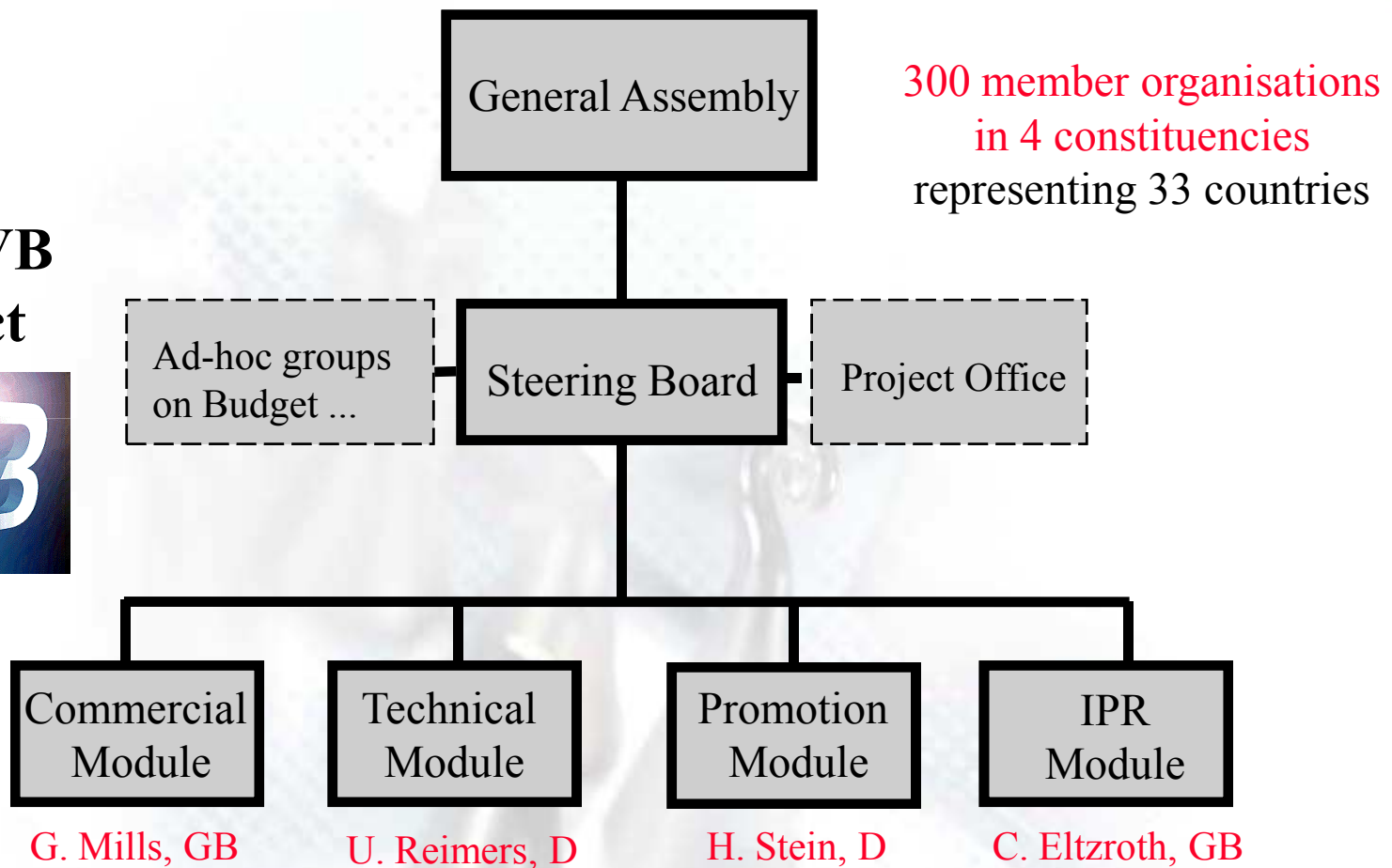
Outline

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DVB

The DVB Project

General Assembly

300 member organisations
in 4 constituencies
representing 33 countries

Ad-hoc groups on Budget ... — Steering Board — Project Office

Commercial Module — Technical Module — Promotion Module — IPR Module

G. Mills, GB — U. Reimers, D — H. Stein, D — C. Eltzroth, GB

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From DVB-T to DVB-H
(Nokia-centric view ☺)

Nokia 7710

First Commercial
DVB-T Networks

Nokia MediaScreen
Concept

Commercial
DVB-H handsets
N92

Nokia 7700

DVB-T
ratified

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006

DVB-T networks in
UK 1998

DVB-H work started

ETSI standard

N77

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From DVB-H to DVB-NGH

N96

DVB-NGH

(Or DVB-H2?) NGH/H2

NGH
Study
mission

NGH
Std work
starts

Commercial
launch

ETSI

?

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016

DVB-T2 work started

Study mission

DVB

ETSI

EN 302 755
DVB-T2

    DVB-H web /JHe

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DVB-T

    DVB-H web /JHe

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COFDM based DVB-T is the basis
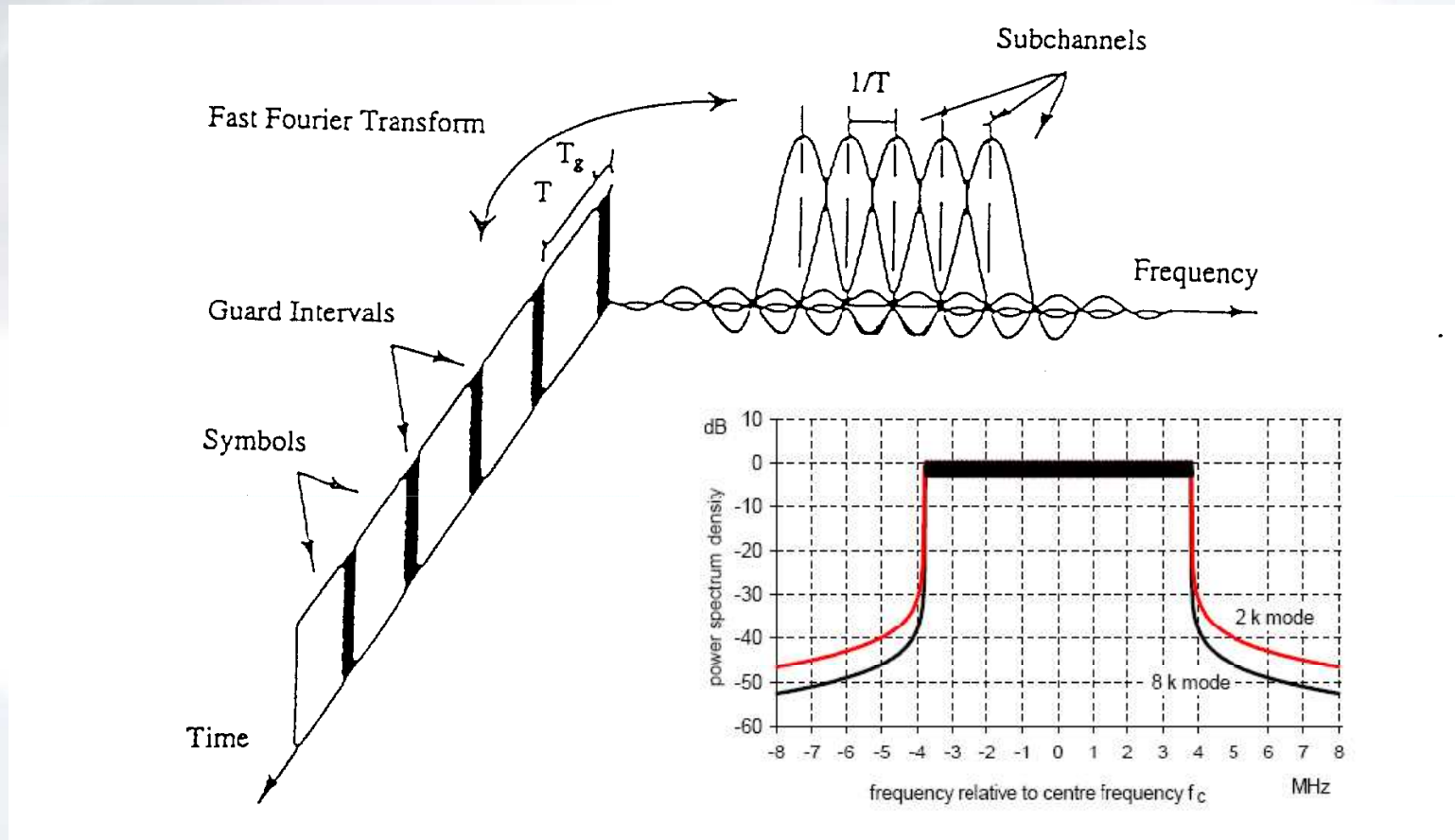
- You may want to visit, e.g., BBC web for COFDM tutorials:
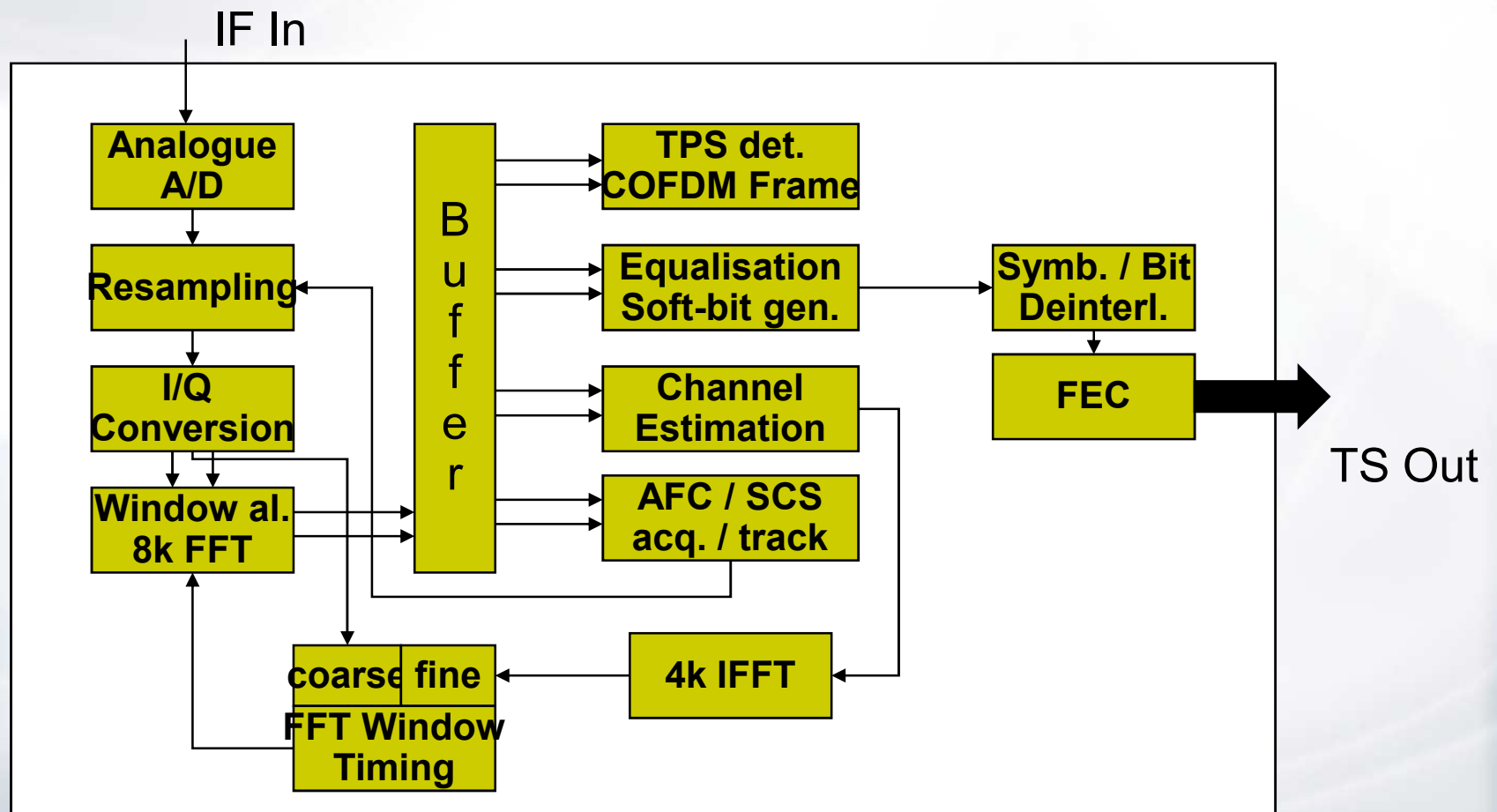
http://www.bbc.co.uk/rd/pubs/papers/index-digitalbroadcasting-comp.shtml

- Also http://www.dvb.org/ or http://www.dvb.org/index.php?id=278

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DVB-T transmitter

From DVB-H Transport Multiplexer

MPEG-TS "HP" → MUX adaptation Energy Dispersal → Outer Coder → Outer Interleaver → Inner Coder → Inner Interleaver

MPEG-TS "LP" → MUX adaptation Energy Dispersal → Outer Coder → Outer Interleaver → Inner Coder

Mapper → Frame Adaptation → OFDM → Guard Interval Insertion → D/A → Front End → To Aerial

Pilots & TPS signals

DVB-T **Terrestrial Channel Adapter**

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Pilot structure

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COFDM Channel Decoder

- Critical points:
  - Channel estimation / correction

IF In

Analogue A/D	
Resampling	
I/Q Conversion	
Window al. 8k FFT	

Buffer

TPS det. COFDM Frame

Equalisation Soft-bit gen.

Channel Estimation

AFC / SCS acq. / track

coarse fine FFT Window Timing

4k IFFT

Symb. / Bit Deinterl.

FEC

TS Out

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Features of DVB-T

- FFT sizes 2k and 8k
- Convolutional code rates ½, 2/3, ¾, 5/6, 7/8
- Reed-Solomon code (255, 239) (t=8)
- Modulations 4QAM, 16QAM, 64 QAM
- Four guard intervals 1/32, 1/16, 1/8, ¼
- Supports 6,7 and 8 MHz channels
- Intended for VHF and UHF BC bands

- By selecting various parameter combinations one can support networks from high mobility (car reception) to large (nationwide) SFNs

- SFN = single frequency network

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Why a new standard?

DVB-H

Why & how?

Why a new standard?

- **Broadcast** is the way to get cost down (cf. cellular systems, point-to-point)

- **DVB-T is existing and known to have good mobile performance**

- The **displays on handheld devices smaller** than on fixed reception
  - MPEG2 is probably too heavy, something else could be used

- DVB-T based IP-data broadcasting (IPDC) could be the solution

BUT…

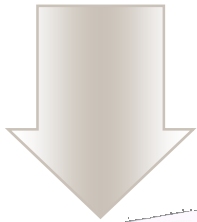NOKIA
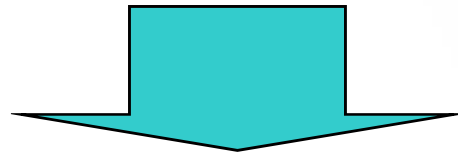
…3 MAIN PROBLEMS REMAIN

- **1. Power consumption**
- **2. Performance in cellular environment**
-     - C/N in mobile channel
-     - Doppler in mobile channel
-     - Impulse interference
- **3. Network design flexibility for mobile**
-     - Single antenna mobile reception in medium to large SFN

AND DVB-H SHOULD BE BASED ON DVB-T FOR EASY CO-EXISTENCE

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Solution: DVB-H based on DVB-T

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Making TV mobile

MPEG-2 over DVB-T

IP Datacast over DVB-H

(MPEG-4)

Indoor reception

Power saving

Optimal use of capacity

4-5 Mbps/program

3 - 5 TV channels on big screen
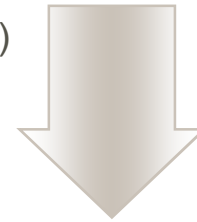
200 - 500 kbps/program

10 – 55 channels on small screen

Nokia Research Center

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Solution: DVB-H System
(When Sharing the Multiplex with MPEG-2)

MPEG-2 TV Service
MPEG-2 TV Service
MPEG-2 TV Service
MPEG-2 TV Service

MUX → TS → DVB-T Modulator

| 8K | 4K | 2K | DVB-H TPS |

RF

IP →

DVB-H
IP- Encapsulator

| MPE | MPE-FEC | Time Slicing |

New to DVB-H

Existing

Channel

Transmitter
- -
Receiver

RF

DVB-T Demodulator

| 8K | 4K | 2K | DVB-H TPS |

TS →

DVB-H
IP- Decapsulator

| Time Slicing | MPE-FEC | MPE |

→ IP

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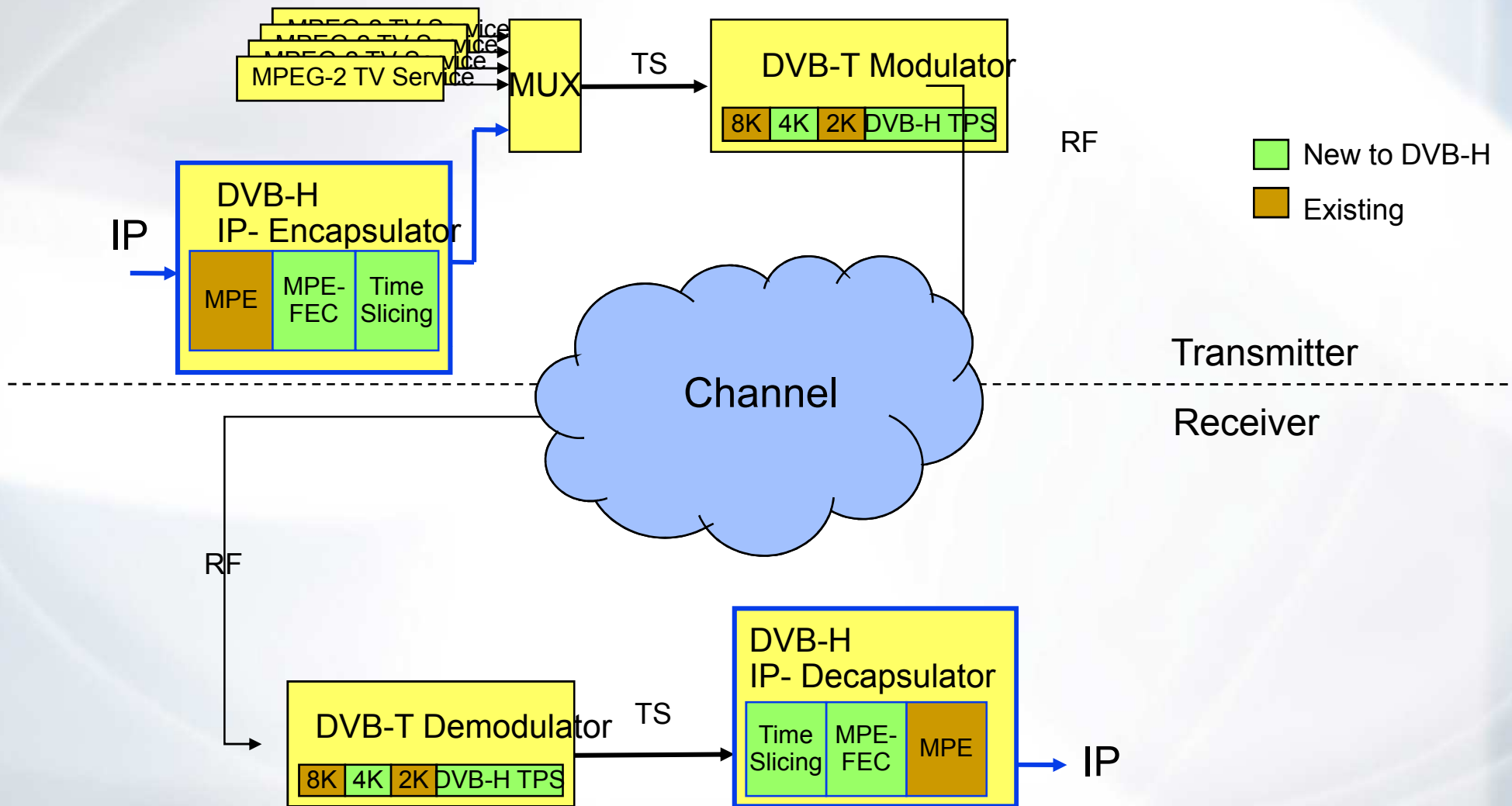
Solution elements

- **Based on DVB-T**,
  - can share multiplex with DVB-T services (backwards compatible)
  - can share frequency band with DVB-T (spectrally compatible)
- **IP-based solution**, Multi Protocol Encapsulation (MPE) used over DVB-T

- New 1: Time Slicing for power saving

- New 2: MPE-FEC (with virtual time-interleaving) for mobile performance and tolerance to impulse noise

- New 3: features to DVB-T PHY
  - Optional 4K mode and 4K symbol interleaver
  - Optional in-depth interleaver (= short time-interleaving) for 2K and 4K
  - 5 MHz channels for non-broadcasting bands
 - + something else…

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Time Slicing 1

- In normal DVB-T MPEG-2 and data transmissions the transport streams from the services are multiplexed together with high frequency on the TS-packet level.

- This means that the services are transmitted practically in parallel.

Channel capacity

Service 1

Service 2

Service 3
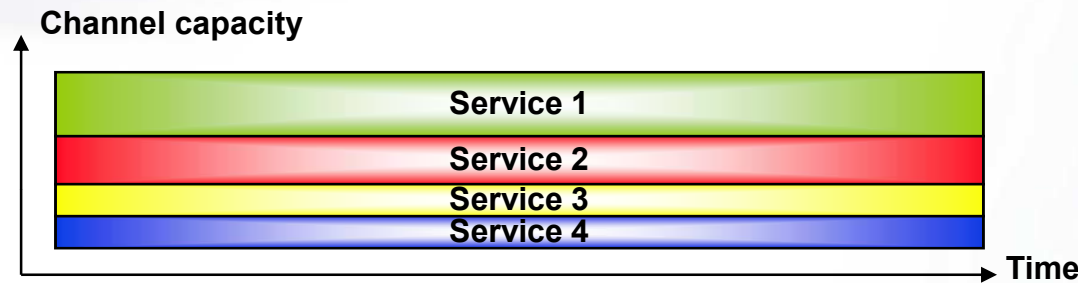
Service 4

Time

- For a DVB-T receiver it is impossible to receive only the wanted TS-packets due to the high multiplexing rate. All data must be received -> high power consumption.

    DVB-H web /JHe

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Time Slicing 2

- In time slicing IP-services within a MPE data service are organised:

  - One service will use the full DVB-H data capacity for a while, say 200 ms.
  - After that comes the next service and so on…
  - After longer period, say 2-4s, the first service is again in the air
  - There might be some 20-50 H –services depending on MUX and service properties
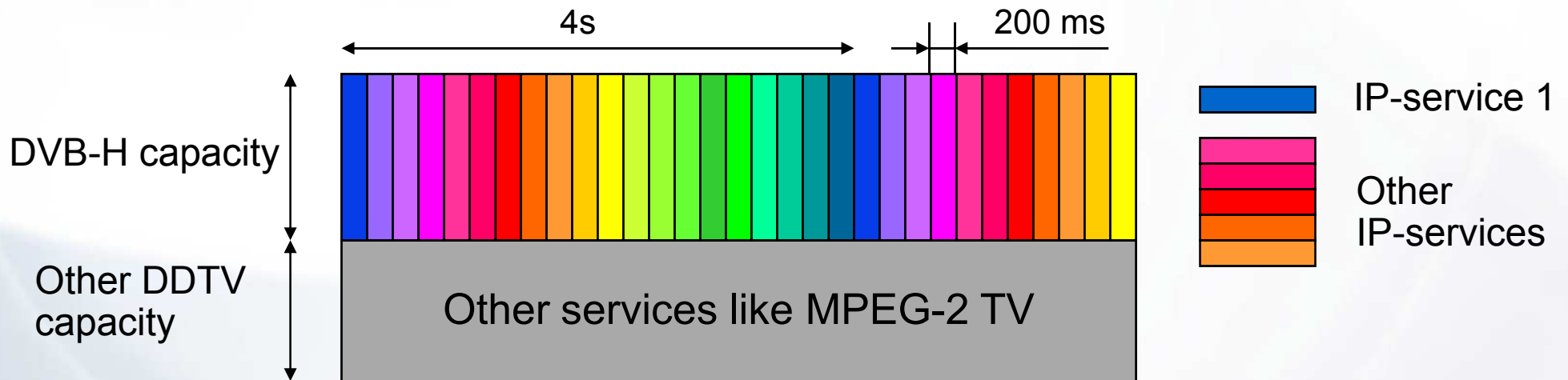
- The DVB-H service is just another "MPE-data pipe" for the DVB-system and can be freely multiplexed with other transport streams.
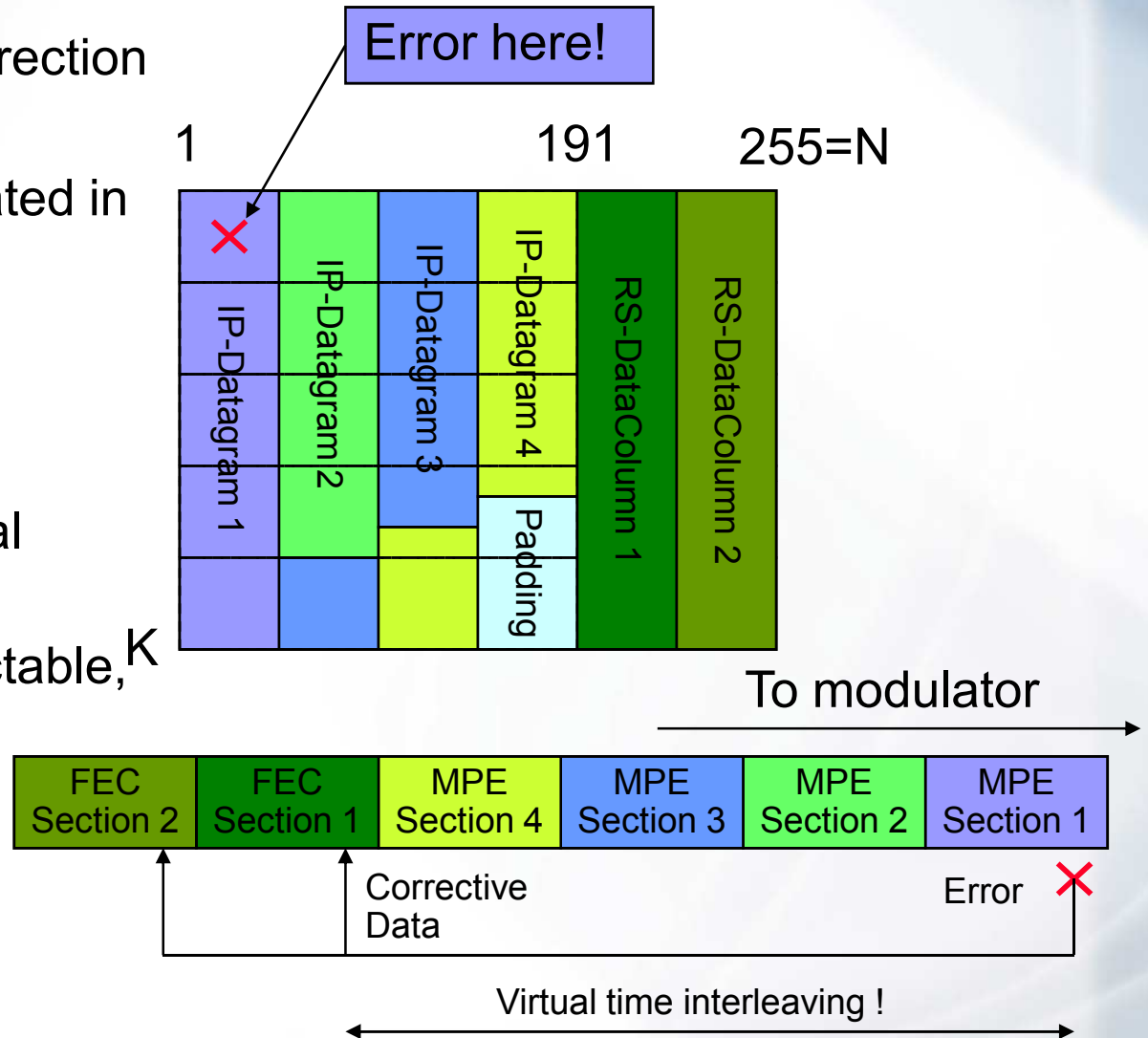
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Best invention since sliced bread?

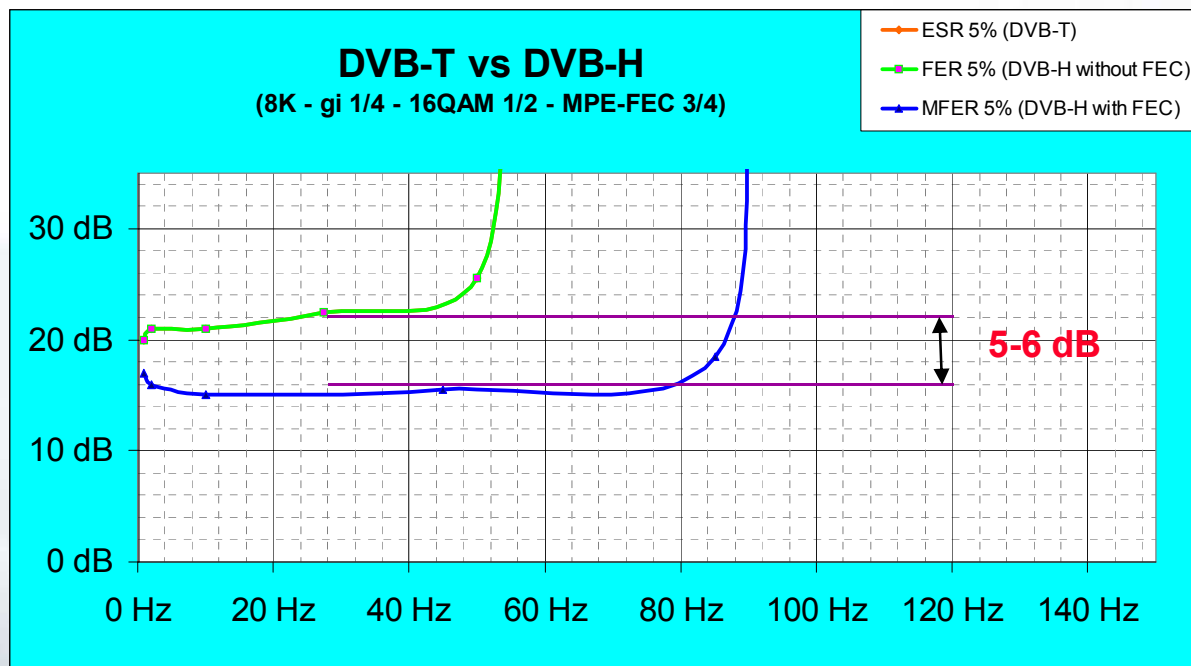**At least we have time slicing!**

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MPE-FEC

- IP-Data is filled in vertical direction

- RS-Code words are calculated in horizontal direction

- Data is transmitted in vertical direction

- The number of rows K selectable, max 1024

- The code may be punctured or shortened => selectable robustness

Error here!

1   191   255=N

| IP-Datagram 1 | IP-Datagram 2 | IP-Datagram 3 | IP-Datagram 4 / Padding | RS-DataColumn 1 | RS-DataColumn 2 |

K

To modulator

| FEC Section 2 | FEC Section 1 | MPE Section 4 | MPE Section 3 | MPE Section 2 | MPE Section 1 |

Corrective Data

Error

Virtual time interleaving !

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Performance of DVB-H

- Virtual interleaving provided by FEC gives a real improvement to tolerance to Doppler by 50% and more.

- MPE-FEC gives several dB improvement in tolerance to impulse interference

- General improvement in tolerance to noise.

DVB-T vs DVB-H
(8K - gi 1/4 - 16QAM 1/2 - MPE-FEC 3/4)

Legend:
- ESR 5% (DVB-T)
- FER 5% (DVB-H without FEC)
- MFER 5% (DVB-H with FEC)

5-6 dB

Notice the flatness from low mobility to high mobility!

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Why a new standard?

DVB-T2

Why & how?

Motivation & background

- HDTV is a new service that is coming – already via satellite
  - More capacity needed in terrestrial network

- Technology progress in semiconductors
  - More complexity can be allowed for receiver

- Technology progress in theory & algorithms
  - MISO , MIMO
  - Coding
  - Etc

- DVB had developed second generation DVB-S2 standard with extreme efficiency
  - Wish to repeat the same in terrestrial

- **Capacity increase, robustness and flexibility** were the main drivers

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T2 work

- Starting point for T2 work was to take as much as reasonable from existing DVB-T
  - OFDM with guard intervals
  - QAM modulated carriers
  - …

- But many things were changed
  - TDM structure with synch symbols
  - Possibility of time slicing
  - Service specific robustness
  - LDPC coding
  - Extended modulation
    - => 256QAM
    - Rotated constellations
 - Interleaving
  - etc

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Closer Summary of Techniques (1)

- S2 LDPC (Rates: ½, 3/5, 2/3, ¾, 4/5, 5/6)

- Compatible S2 system layer (Baseband Frames)

- Classical GI-OFDM
  - FFT sizes: 1K, 2K, 4K, 8K, 16K, 32K
  - GI sizes: 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, ¼
  - Bandwidths 1.7, 5, 6, 7, 8, 10 MHz

- 8 Scattered Pilot patterns

- Time interleaving at physical layer to improve impulse noise robustness

- Time slicing at physical layer
  - Different PLPs can have different levels of robustness
  - Enables power saving

- Sub-slicing within frame
  - Increases time diversity/interleaving depth without increasing de-interleaver memory

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Closer Summary of Techniques (2)

- P1 symbol for frame sync. and for rapid T2 signal detection

- P2 symbol carrying frame construction data and PSI/SI information

- Three main levels of interleaving
  - Bit interleaving, Time interleaving and Frequency interleaving

- Rotated constellations

- MISO capability (Alamouti-based transmit diversity)

- Peak-to-average-power reduction via tone reservation and constellation distortion

- Future Expansion Frames

- Signalling and compatibility with future implementations of Time Frequency Slicing

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# Key features: BB Frames and LDPC

- Data packaged into BaseBand Frames

- BaseBand Frames protected by the S2 LDPC FEC
  - With an additional small BCH code to mop up any residual errors after LDPC decoding
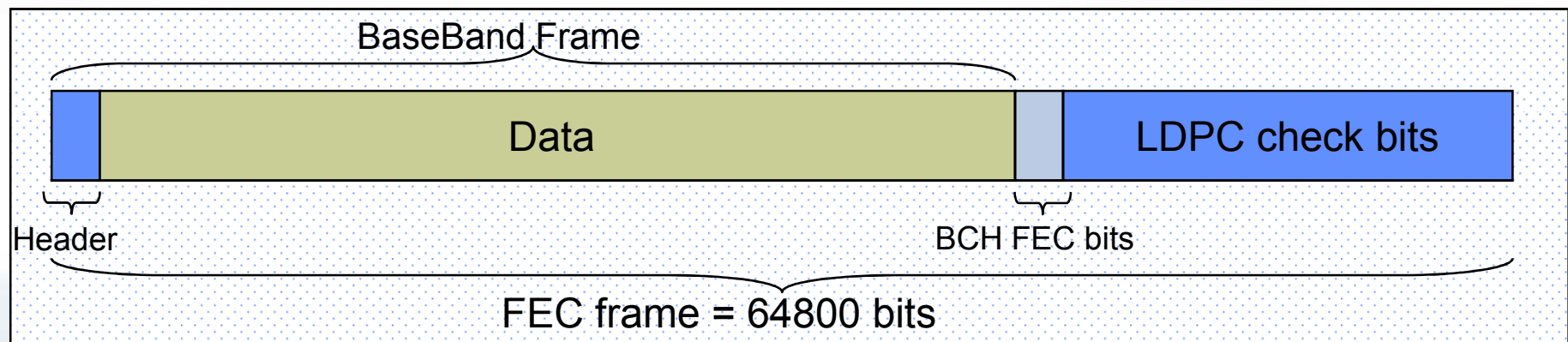
- This FEC frame, of length 64800 bits, is a fundamental unit within T2
  - Code rates: 1/2, 3/5, 2/3, 3/4, 4/5, 5/6
  - A shorter FEC frame of 16200 bits also provided for low data rate services

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Key Features: Modulation (1)

- T2 uses conventional Guard-Interval OFDM (GI-OFDM)
  - as in DVB-T
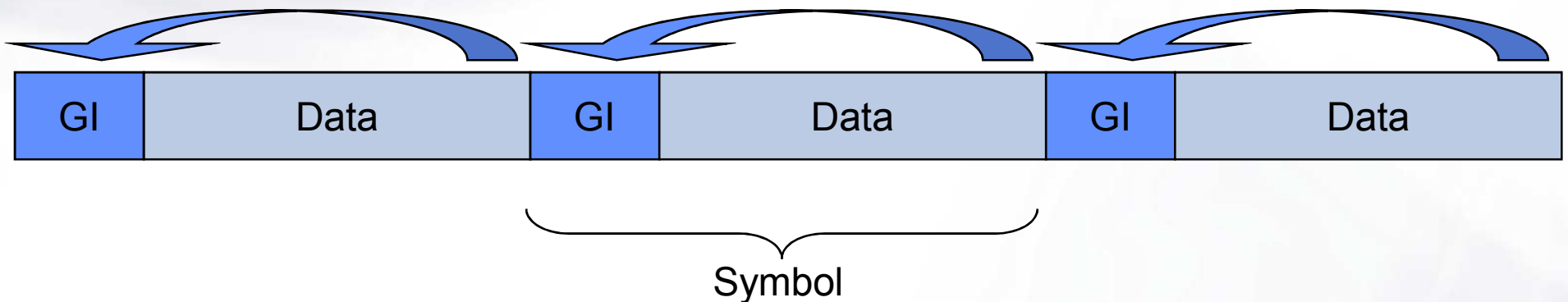
- Each symbol carries data on a large number of separate carriers
  - 1K, 2K, 4K, 8K, 16K, 32K options are available in T2
    - 16K and 32K: to give improved SFN performance
    - 1K for bandwidth and frequency flexibility
  - Increasing the number of carriers increases the symbol period

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Key Features: Modulation (2)

- Increasing the symbol period
  - Can reduce guard interval overhead for given size of SFN
  - Can increase SFN capability for a given fractional GI

GI	8K symbol

25% overhead

GI	32K symbol
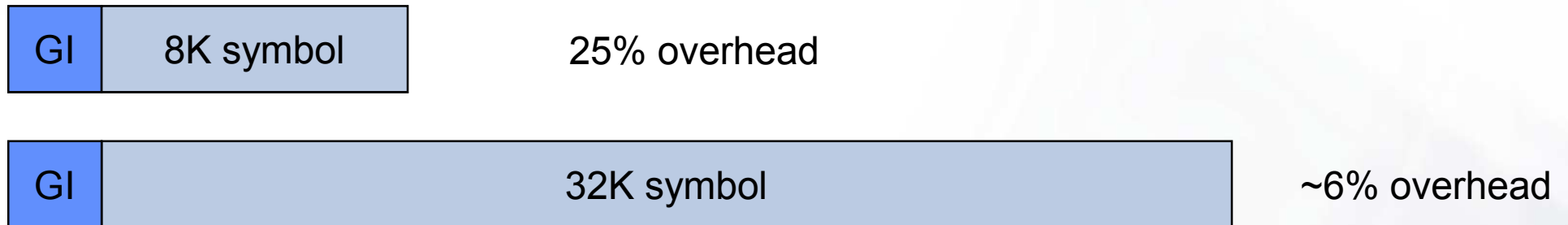
~6% overhead

- T2 extends guard interval range to allow reduced overhead and additional flexibility
 - GIs in T2: 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4

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Key Features: Modulation (3)

- T2 includes 256 QAM mode
  - Carries 8 bits/ data cell
    - (c.f 6 bits / data cell for 64 QAM)

  - Enables greater capacity, exploiting improved FEC performance of LDPC

  - Studies show that typical tuner phase noise should not be a problem


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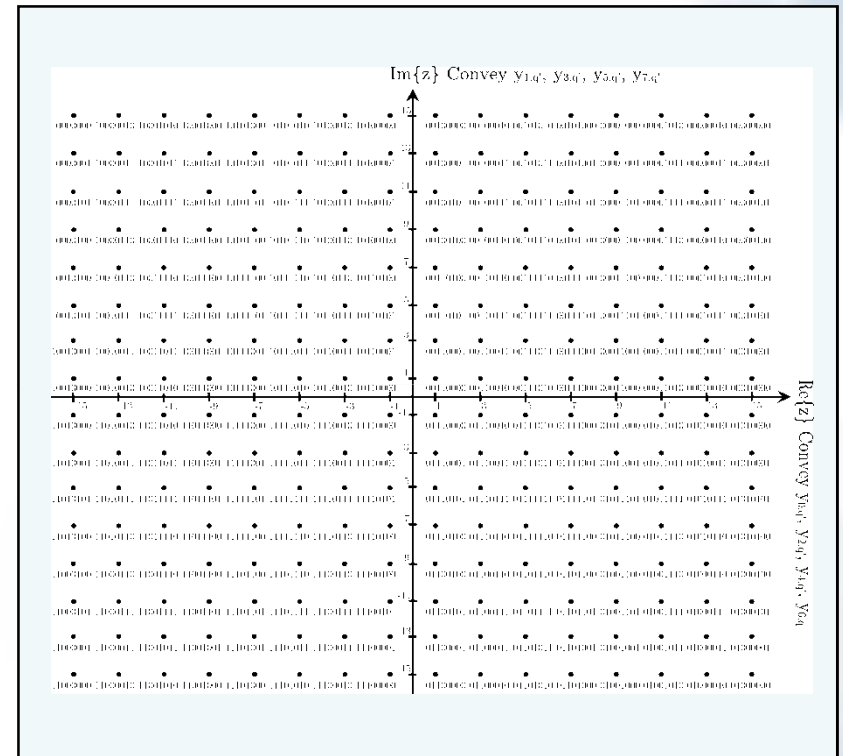
Scattered Pilot Patterns (1)

- Scattered pilots are OFDM cells of known amplitude and phase
  - Receiver uses these to compensate for effects of channel changing in frequency and time.

- In DVB-T, 1 in 12 OFDM cells is a scattered pilot
  - 8% overhead
  - Independent of guard-interval fraction

Frequency →

Time ↓

8%

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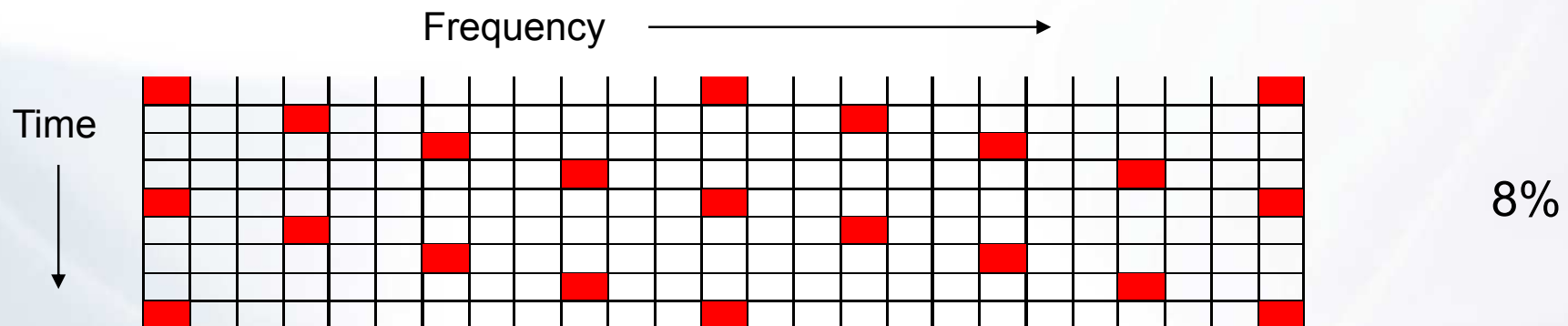
Scattered Pilot Patterns (2)

- T2 has 8 different scattered pilot pattern options
  - Aim: to minimise pilot pattern overhead for a given fractional guard interval; e.g. ….

Time

2%

4%
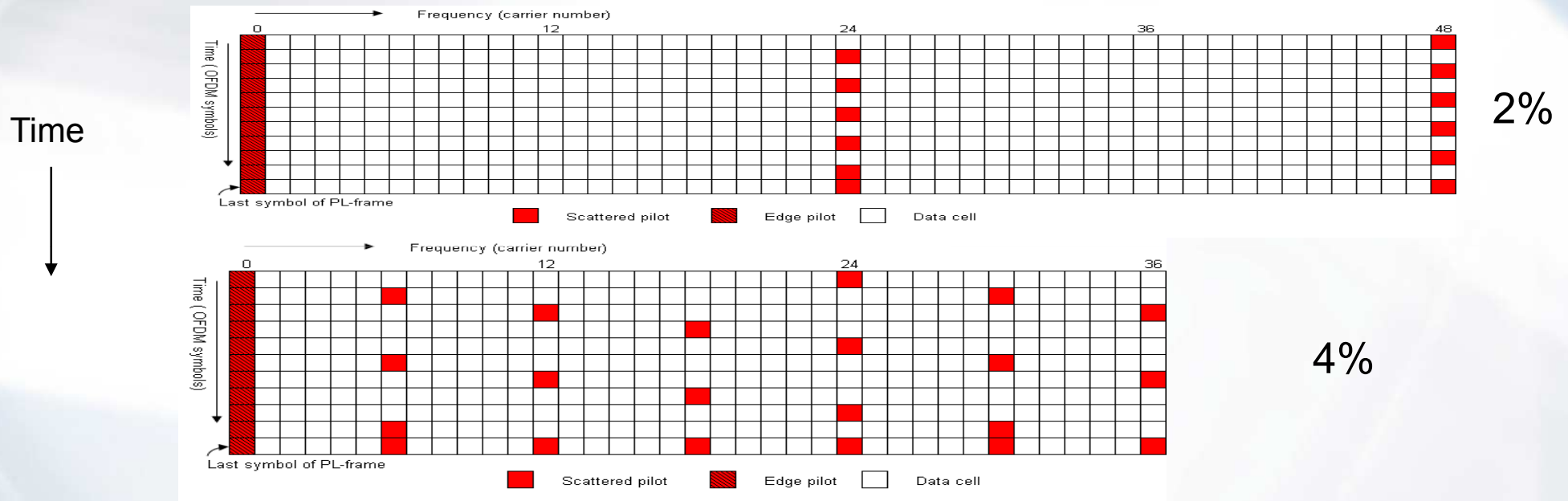
- Pilot cells are boosted by up to 7 dB depending on density
  - Improves signal to noise on channel estimate
- Pilot pattern modulated by pseudo-random sequence
  - Can be used for improved time synchronisation algorithms
- Pilot pattern modified for edge carriers and for last symbol of frame

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Key features: Service Specific Robustness

- Each service can be given its own modulation mode (e.g. 256QAM, 16 QAM) and FEC coding rate (e.g. rate 3/5, rate 3/4)
  - Different applications: roof-top reception/portables

Carriers

(freq)

Symbols
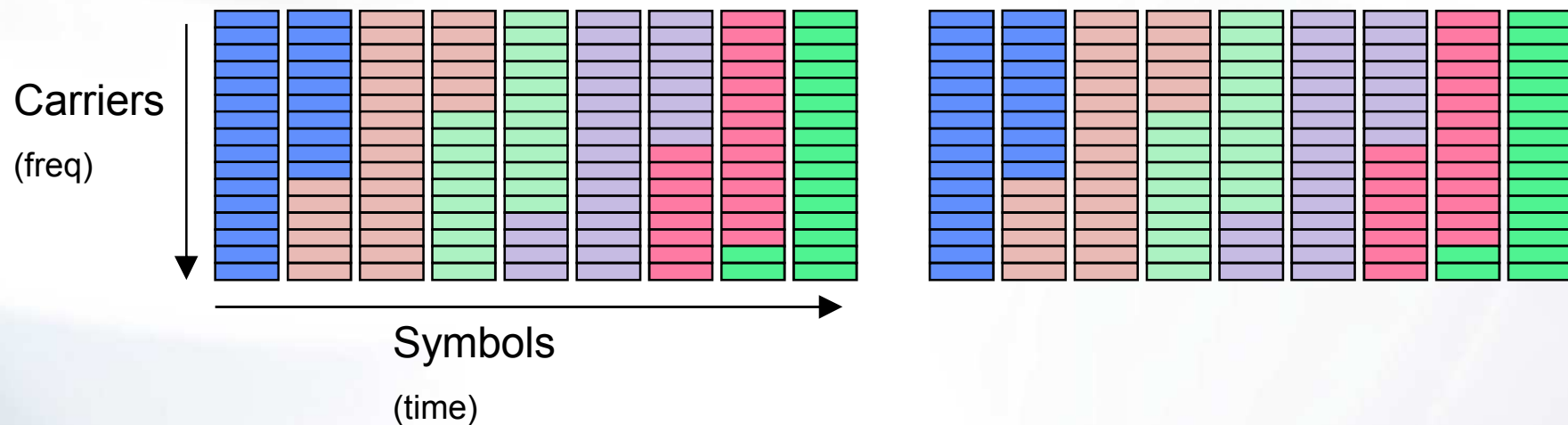
(time)

- Each service is given a slice of data cells within a frame
  - Each slice is part of a *Physical Layer Pipe* for that service
  - Also enables power saving in the receiver
  - Slices can be sub-divided into sub-slices within frame in order to give more time diversity

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Key features: Frame Structure

- Start of frame is signalled by a short P1 symbol
  - Based on **1K OFDM** symbol with frequency shifted repeats at front and rear of symbol
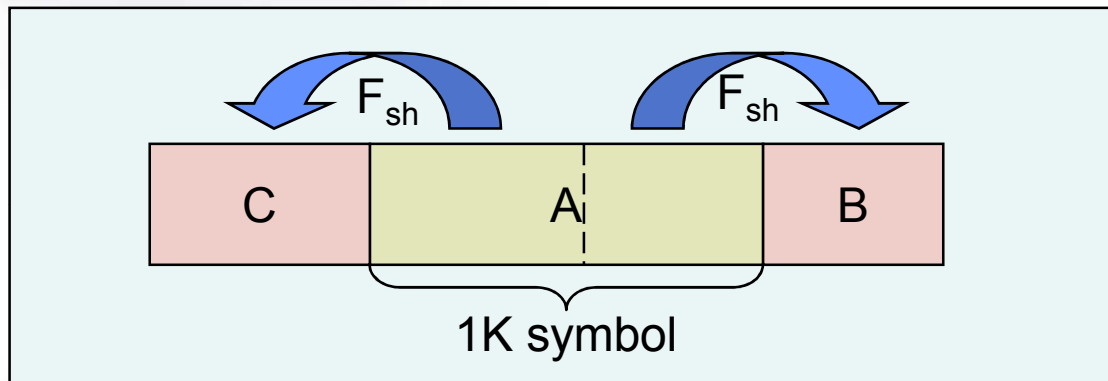

- Only a sparse proportion of 1K carriers occupied
  - Carrying carefully chosen data patterns
- Lengths of segments carefully chosen

- This format of P1 symbol provides
  - Simple and robust mechanism for rapid detection of T2 signal
  - Fast frequency lock mechanism
  - 7 bits of signalling (e.g. for FFT size in main frame)

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Frame Structure (2)

- Structure of frame must be signalled at beginning of frame
  - Start address and length of individual PLPs
  - This data is carried in P2 symbols which follow P1 symbol
    - Number of P2 symbols depends on FFT size
  - Frame structure data must be carried robustly
    - Use strong FEC and modulation modes within P2
  - Channel equalisation must be rapid and robust
    - Use a greater density of scattered pilots

● Scattered pilot cell   Frequency   ○ Data cell

Time

2 x P2 symbols are used in 8K mode

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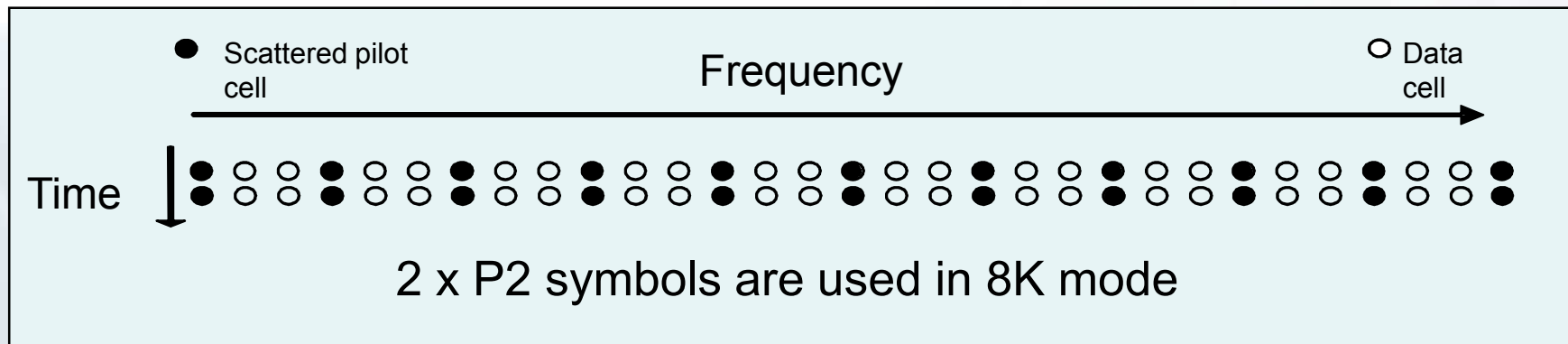
Frame Structure (3)

- Typical frame duration: 150 -250 ms
  - P1 & P2 overhead typically less than 1%

```
                          T2 Frame
  ┌────┬──────────┬──────────────────────────────────┐
  │ P1 │    P2    │            Payload               │
  └────┴──────────┴──────────────────────────────────┘
         ┌──────────────────┬──────────────┐
         │   L1 signalling  │  Other data  │
         └──────────────────┴──────────────┘
```
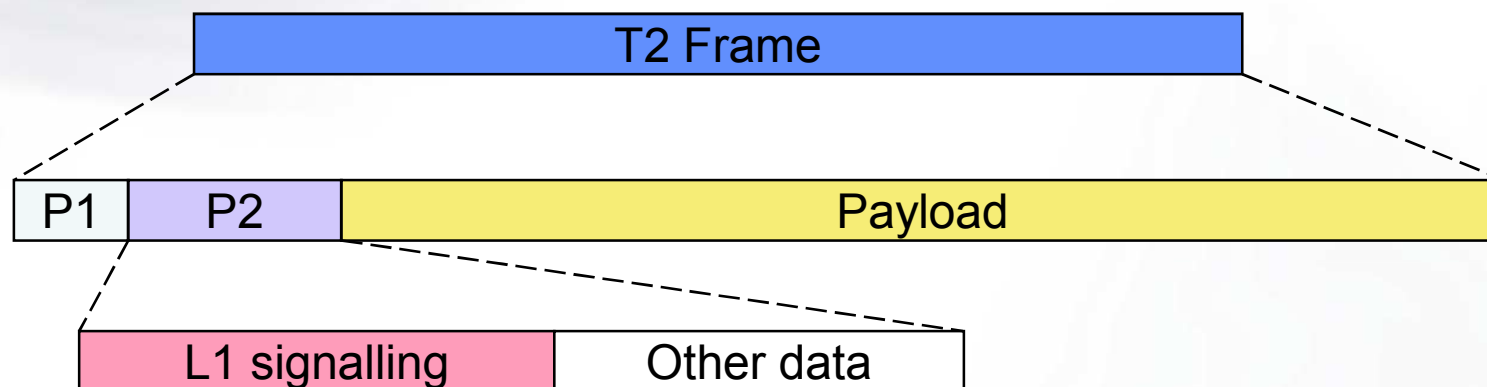
- L1 signalling carries frame structure data
  - L1 data must be carried more robustly than payload data
  - L1 data split into 2 parts: L1-pre (very robust); L1-post (quite robust)
- Other data carried in P2 can include common PSI/SI data for services carried in payload

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Frame Structure (4)

- Typical use – single PLP
  - Complete transport stream is contained within single PLP
    - Including all PSI/SI

- Typical use – multiple PLP
  - Each PLP carries a transport stream

  - Frame structure for all PLPs is contained in L1 data - which is
    - carried in P2 symbols at beginning of frame
    - And normally carried 'in-band' with each PLP – for that PLP (to reduce need to decode P2 symbols)

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Interleaving

- LDPC works well only for randomly distributed bit errors
  - Must avoid regular patterns of errors and bursts of errors
  - Must randomise mapping of bits from FEC block into constellation points

- T2 uses three main interleavers – applied per PLP

  - Bit Interleaving within an FEC block
    - Randomises errors from single errored data cells
    - Based on a row/column block interleaver - with a 'twist'
  - Time Interleaver
    - Disperses data cells from FEC blocks of a given service throughout slice (/subslices) for that service
  - Frequency Interleaving
    - Causes randomisation of possibly-damaged adjacent data cells within an OFDM symbol
    - Provides robustness against a frequency-selective channel
    - T2 uses twin interleavers (based on DVB-T interleaver)

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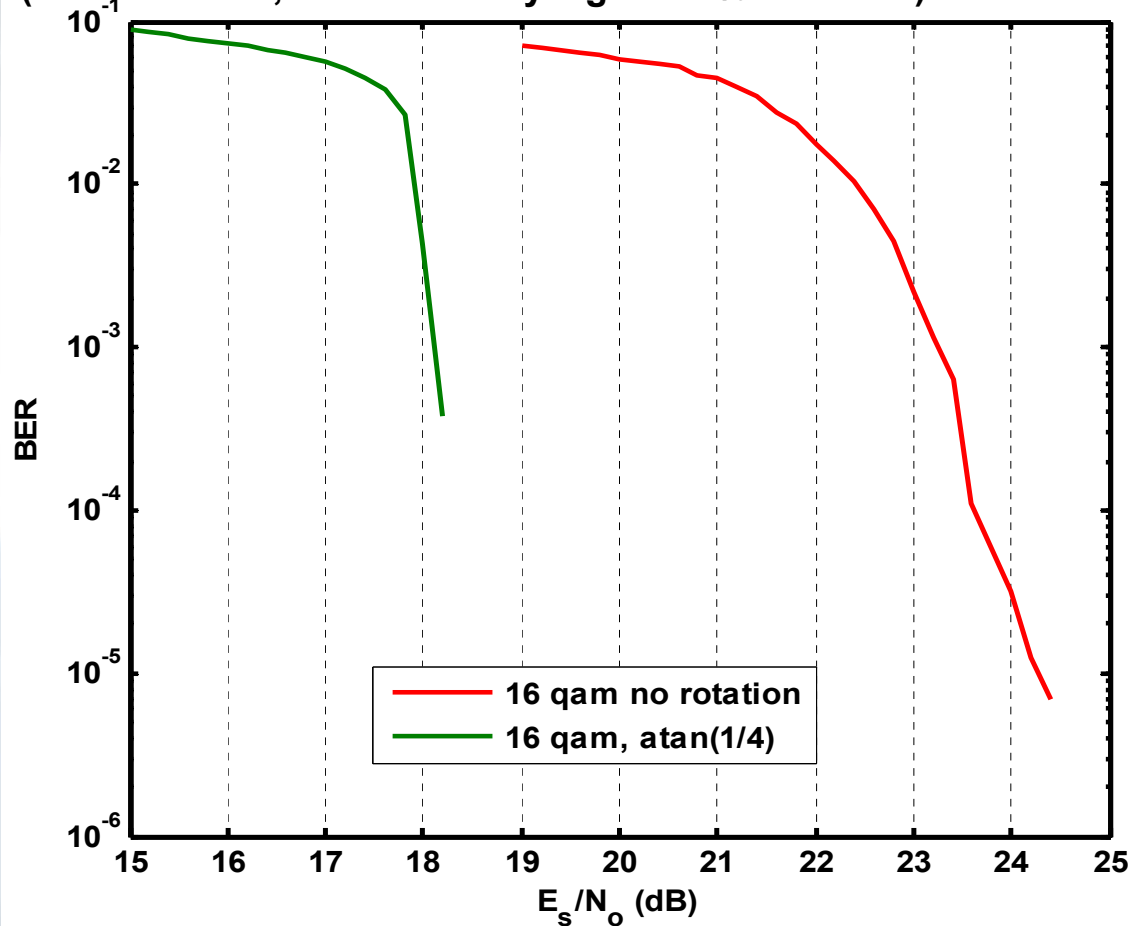# Rotated Constellations (1)
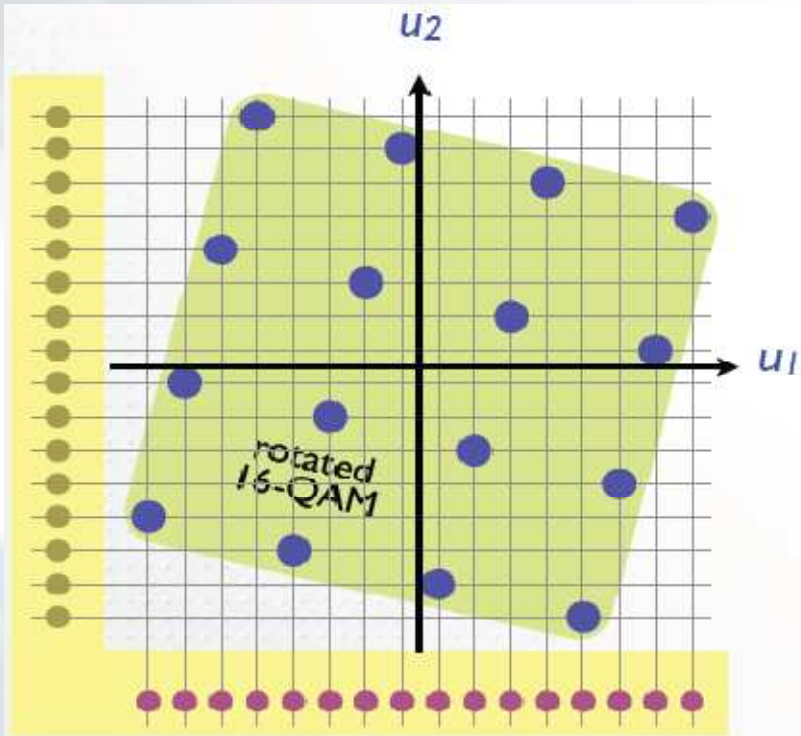
- Map data onto a normal QAM (x,y)

- Rotate constellation (axes now (u_1, u_2)

- Ensure u_1 and u_2 travel in different cells
    - So that they fade independently
    - Gather together in receiver

- Each of u_1, u_2 carries all of the info of original x,y
    - So can decode (less ruggedly) if one is erased completely

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Rotated Constellations (2)

**Comparison of performance for rotated/non-rotated constellations (code rate=4/5; channel = Rayleigh + 15% erasures)**

- Rotated constellations provide significantly improved robustness against loss of data cells
  - Can achieve gains of up to 5 dB on difficult channels
    - e.g. 15% cell loss channel
  - Can translate into increased bit rate by choosing less robust FEC with lower overhead

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Transmit Diversity (1)

- T2 includes Alamouti coding mode for simple SFNs
  - While Tx1 transmits pair of data cells S_0, S_1, Tx2 transmits $-S_1^*, S_0^*$
  - Also involves modification of pilot patterns to measure *h1 and h2*
  - This prevents possibility of 'flat fading' at receiver

S_o, S_1 *h1*   *h2* $-S_1^* S_0^*$
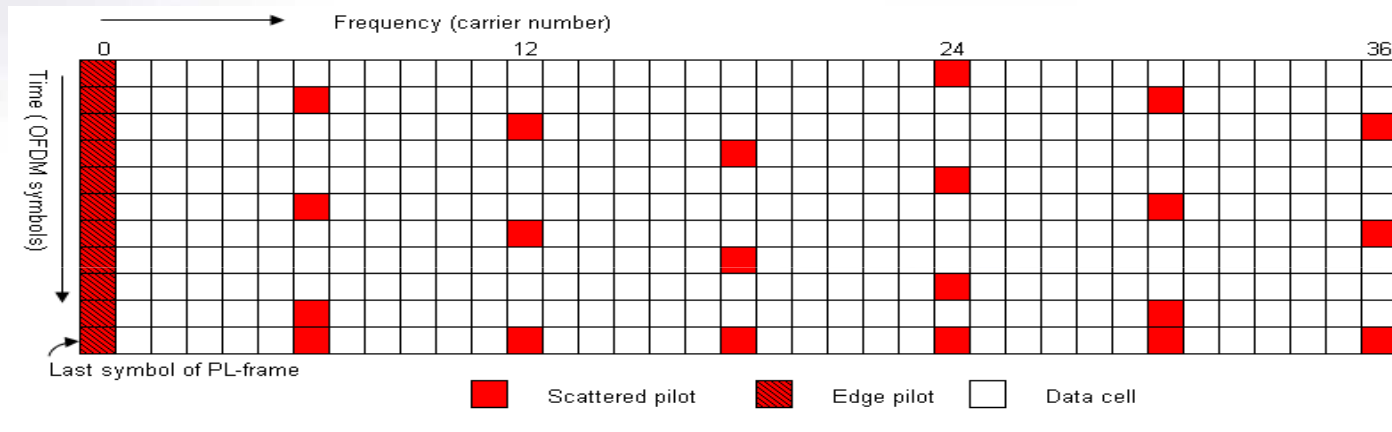
TX1   RX   TX2
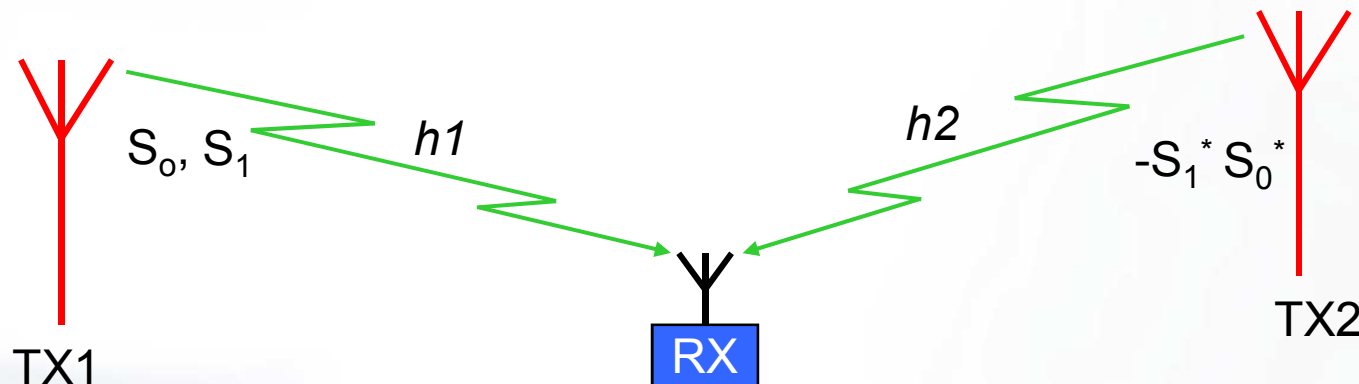
- Initial planning studies predict 30% increase in coverage area for simple SFNs
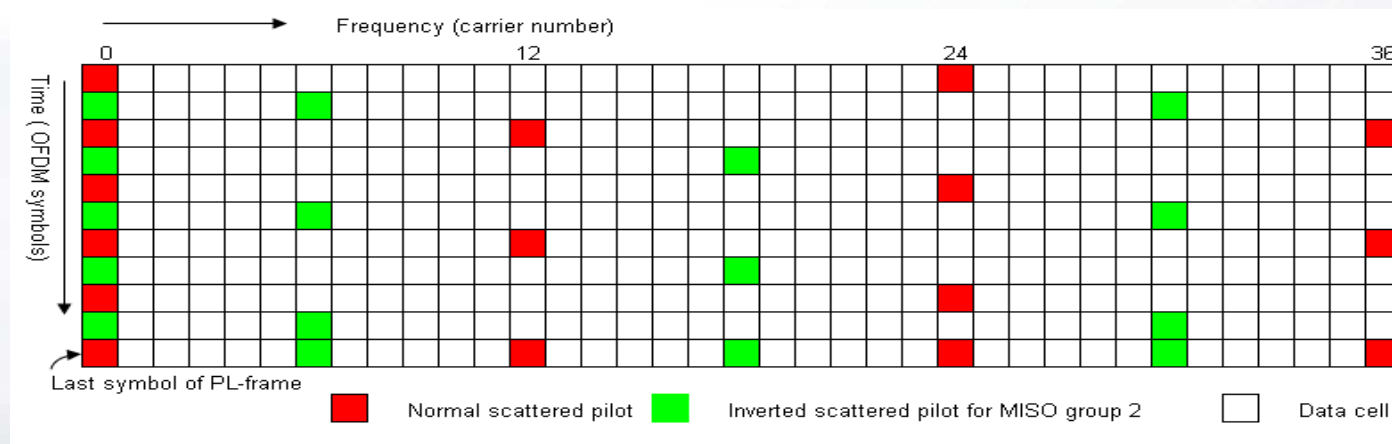
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Transmit Diversity (2)

- Scattered pilot patterns are modified (for second transmitter) to enable measurement of channels h1 and h2; e.g. -

Transmitter 1

Transmitter 2

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Additional Features

- Future Extension Frames (FEFs)
  - Provide a mechanism for future compatible enhancements – e.g. MIMO
  - Only requirement is for FEF to start with P1 symbol

T2	FEF	T2	T2	FEF	T2

P1   P1   P1   P1   P1   P1
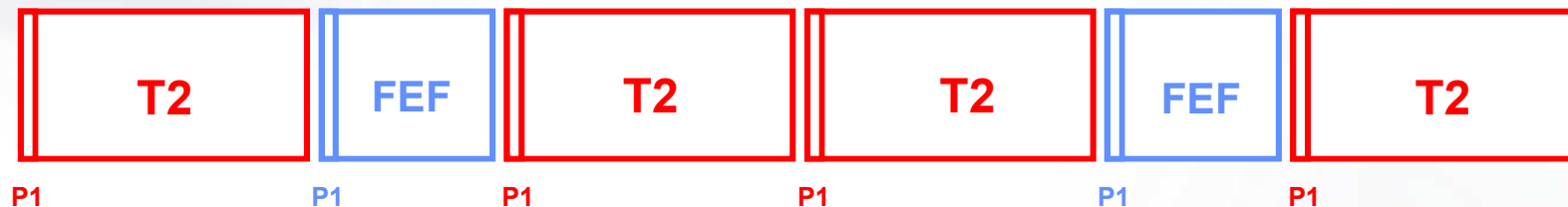
- Time Frequency Slicing
  - Multiplex of signals is spread across several linked frequencies
    - Can give significant Stat Mux gain (20%) and frequency planning gain (5dB)
  - T2 signalling and system is compatible with Time Frequency Slicing system provided receivers have 2 tuners

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Modulation and Coding performance

- Capacity limits for simple Gaussian noise channel
  - With LDPC can get close to theoretical limit

- Typically 30% gain in capacity compared with DVB-T codes.
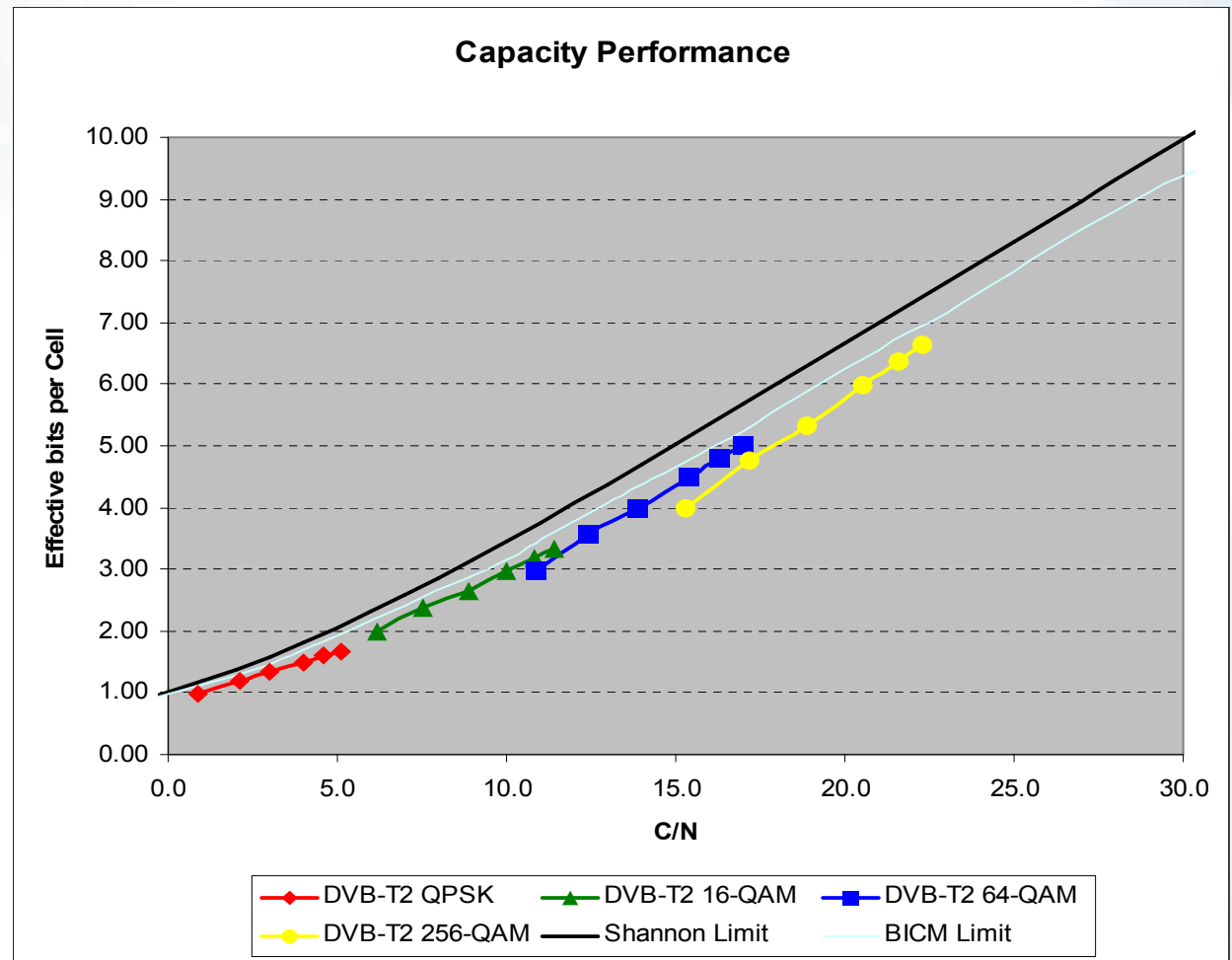
Capacity Performance

Legend:
- DVB-T2 QPSK
- DVB-T2 16-QAM
- DVB-T2 64-QAM
- DVB-T2 256-QAM
- Shannon Limit
- BICM Limit

X-axis: C/N
Y-axis: Effective bits per Cell

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Why STILL a new standard?

Future NGH

Why & how?

Motivation & background

- Technology progress
  - Various new things possible

- Business environment changes
  - New standards competing with DVB-H or otherwise changing the situation
    - LTE, T2 etc

- Room for improvement
  - Robustness and indoor reception are the main points
  - There exists reasonable and realistic means to address this within a couple years time frame

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DVB study mission on NGH

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

- SM Conclusions Spring 2008:
  - 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.

     DVB-H web /JHe

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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

"Real" MIMO seems to provide substantial benefit

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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*

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Technology comments

- **Overhead reduction**
  - 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 (like in T2)
  - Additional low code rates for robustness (e.g. rate ¼ …)
  - Longer interleaving
  - 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)

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Technology comments 2

- **New bands**

  - MIMO probably not feasible in VHF, UHF still unclear

  - 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 bands: Satellite option requires very long interleavers (ca 10 s!) => large memory needed

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Challenges for NGH system

- How to deal with MIMO & diversity question?
  - Obligatory for UHF and above or optional (e.g. in UHF)?
  - Receiver complexity and cost issue

- 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 share T2 & NGH in one RF channel?
  - Using Future extension frames (FEF) of T2?

- How to handle upper layer issues?
  - TS, IP etc transport
  - Seamless/easy service handover via various bearers

How to simplify – not only adding features??!!

What could it be?

Wild, (educated?) guess

- 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
  - Allowing flexible use together with T2 and within T2
    - e.g. using future extension frames

Hope that this does not block anybody to make innovations!

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NGH work scheduling (draft)

- CM approval – 24. June 2009
- SB approval – 2 July 2009
- Start of technical work (CfT) – November 2009 (probably)
- Draft Specification – 2H 2010
- Draft IG and other documents – Mid 2011
- Publication of Specification(s) – End 2011/2012

Draft NGH STD

ETSI

NGH STD

Draft IG & others

24.6.09

2.7.09

CfT in TM

CfT deadline

| 2009 | 2010 | 2011 |

work ongoing

Commercial launch

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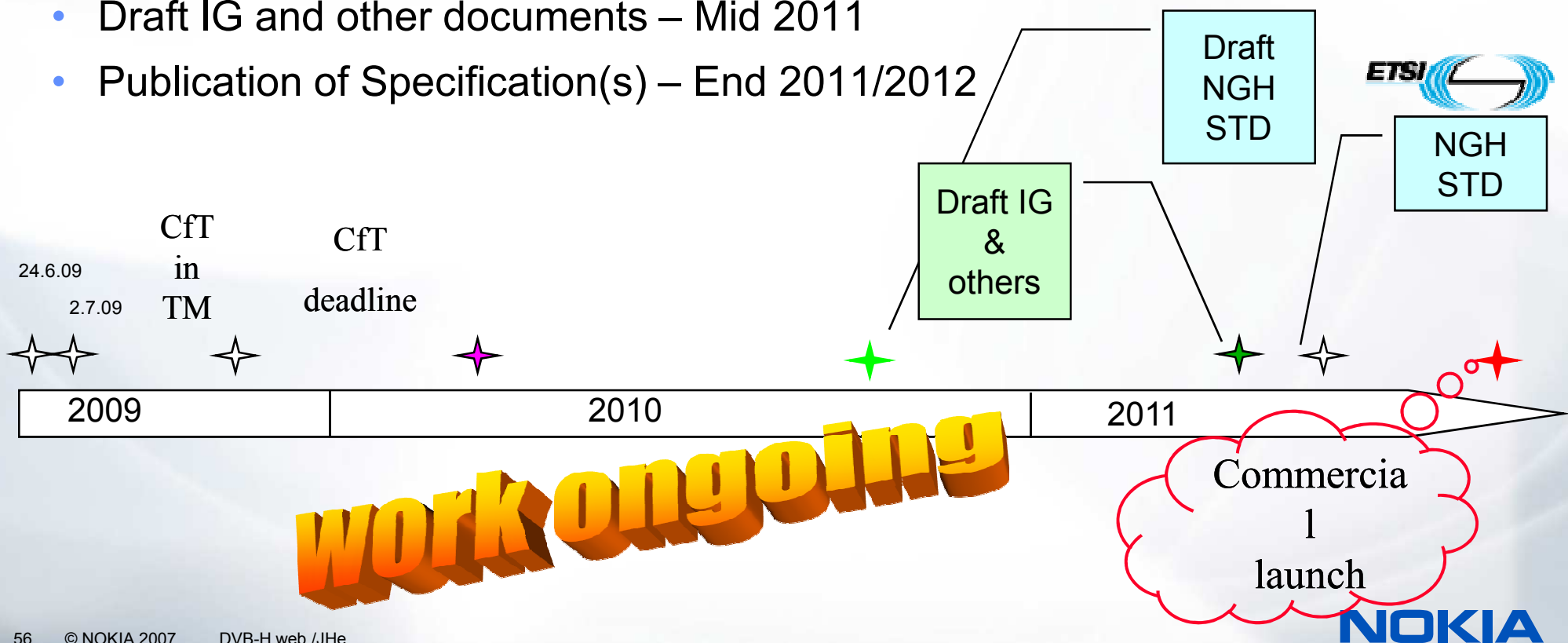
Conclusions

- DVB is a living organization that has been successful in creating broadcast standards over ten years

- DVB-T => DVB-H => DVB-T2 => DVB-NGH form a natural evolution path for fixed and mobile handheld broadcasting

- The future may provide more tightly knitted family of terrestrial broadcasting standards (T2-NGH)
  - Serving all segmets – home rooftop reception, portable, mobile (vehicular) and handheld receivers

- The performance is (will be) very close to Shannon limits
  - One cannot significantly improve spectral efficiency after this by defining a new physical layer standard
  - Other improvement might be possible
    - (e.g. areal/temporal etc spectral efficiency)
    - ???

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Thank You!

Special thanks for many slides to

several collegues

from Nokia and DVB community

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References

[1] ETSI EN 302 304 V1.1.1 (2004-11), Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H)

[2] ETSI EN 301 192 V1.4.1 (2004-11); Digital Video Broadcasting (DVB); DVB specification for data broadcasting

[3] ETSI EN 300 468 V1.6.1 (2004-11), Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems

[4] ETSI EN 300 744 V1.5.1 (2004-11), Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television

[5] ETSI TS 101 191 V1.4.1 (2004-06), Digital Video Broadcasting (DVB); DVB mega-frame for Single Frequency Network (SFN) synchronization

[6] ETSI TR 102 401 V1.1.1 (2005-04), Digital Video Broadcasting (DVB); Transmission to Handheld Terminals (DVB-H); Validation Task Force Report VTF

[7] ETSI TR 102 377 V1.2.1 (2005-11), Digital Video Broadcasting (DVB); DVB-H Implementation Guidelines

[8] Reimers Ulrich, "DVB- the Family of International Standards for Digital Video Broadcasting, 2nd ed., Springer, 2005, 408 pp.

[9] Henriksson, Talmola: "Coach potato - meet the standard… DVB-H", IEE Communications Engineer, AugSept 2004, p.28-32.

[10] Faria, Henriksson, Stare, Talmola: DVB-H: Digital Broadcast Services to Handheld Devices, Proc. IEEE vol 94, no1, pp. 194-209, Jan 2006

[11] ETSI EN 302 755 V1.1.1 Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)
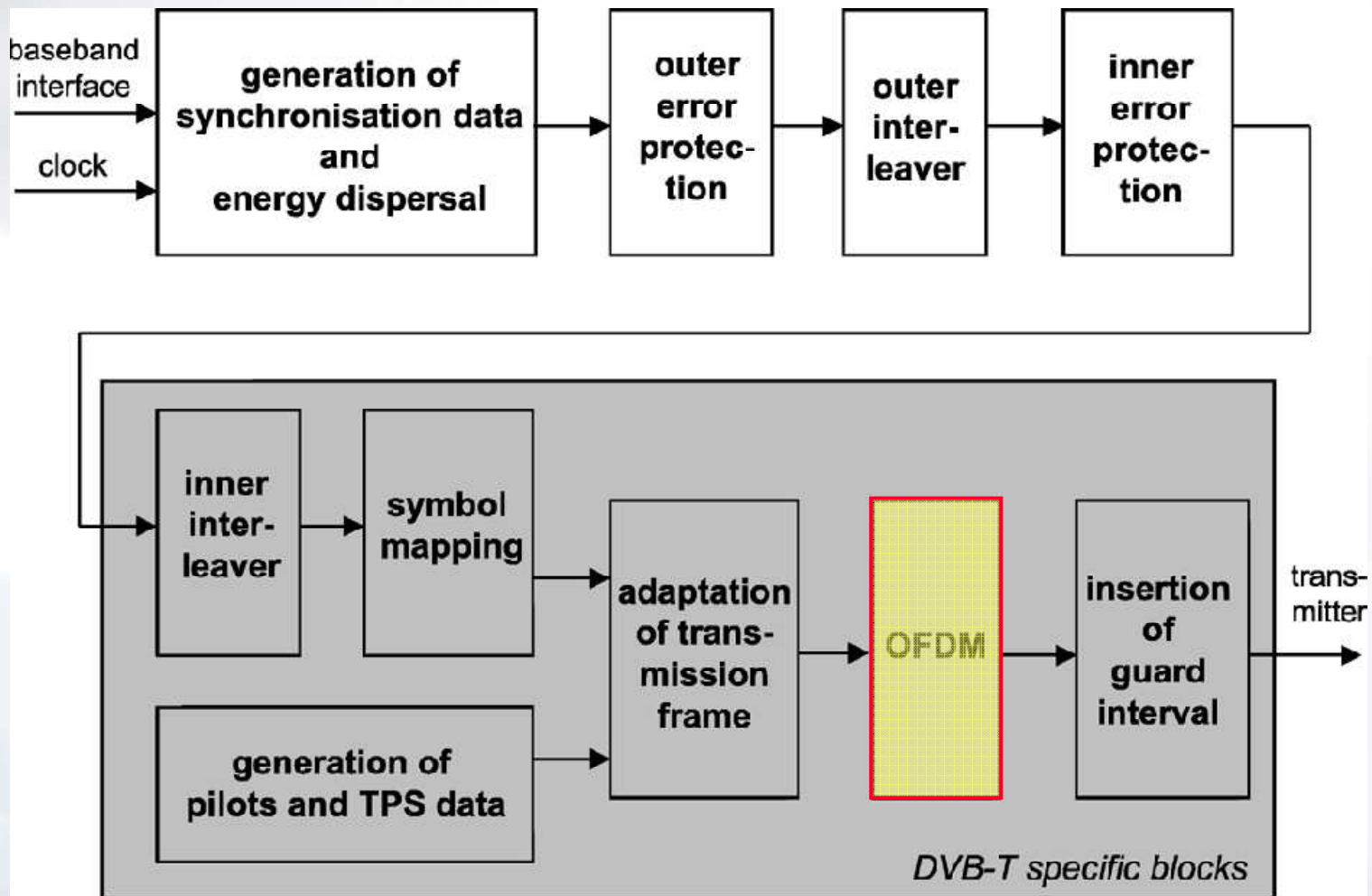
http://www.dvb-h.org/

www.nokia.com/mobiletv

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Competition & future

- Several competing standards exist
  - Japanese one segment ISDB-T
  - Korean DMB-T
  - Qualcomm MediaFlo
  - Chinese CMMB
  - (MBMS)

- New evolutions emerging
  - DVB-T2
  - US evolution of ATSC
  - Etc

Digital broadcast is strongly & rapidly evolving area

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# DVB-T encoding block diagram

     DVB-H web /JHe

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Power saving

- Assuming only two services available, same bitrate, both Time Sliced
  -> On Time is 50% of the Cycle Time
  -> Power Saving nearly 50% (Synchronization Time decreases the achieved level)

- Time Slicing always saves power on a receiver

- The greater the Off Time / On Time relation, the greater power saving achieved
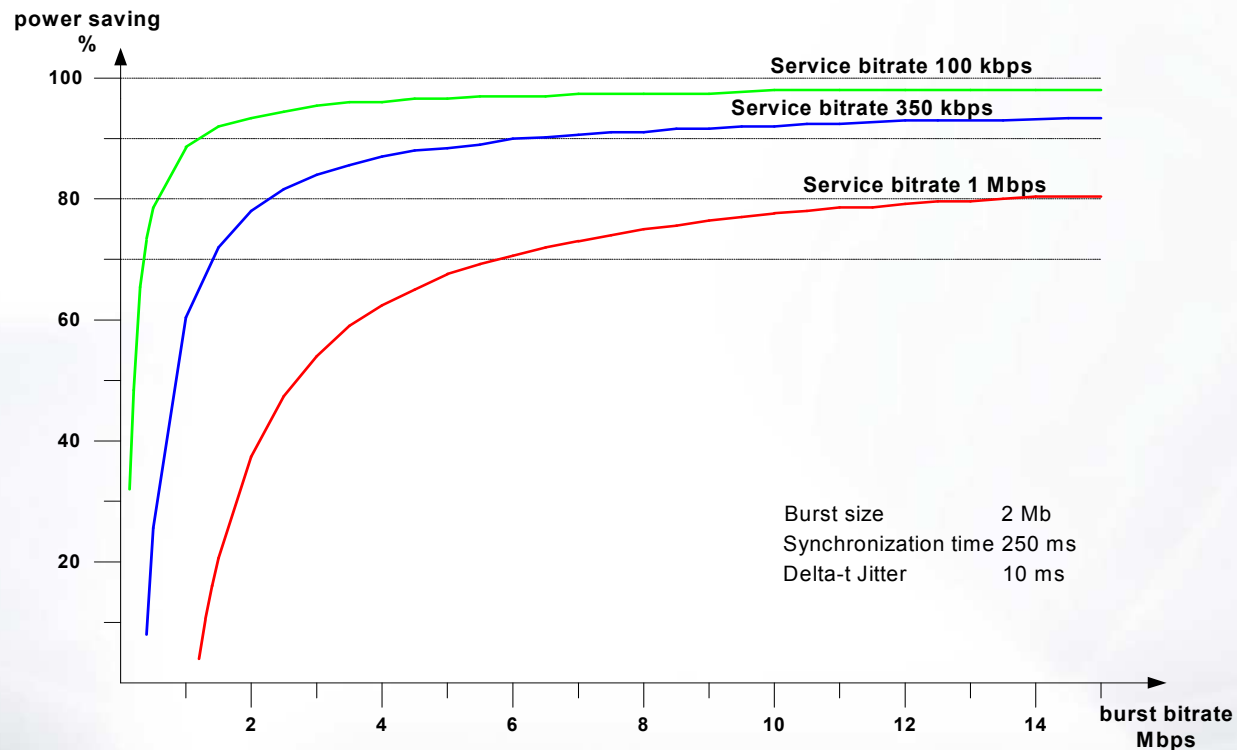
Handover Support
due to time-slicing

- In normal DVB-T systems smooth handovers would require two front ends in a single terminal

- Time Slicing offers, as an extra benefit, the possibility to use the same receiver to monitor neighbouring cells during the off-time

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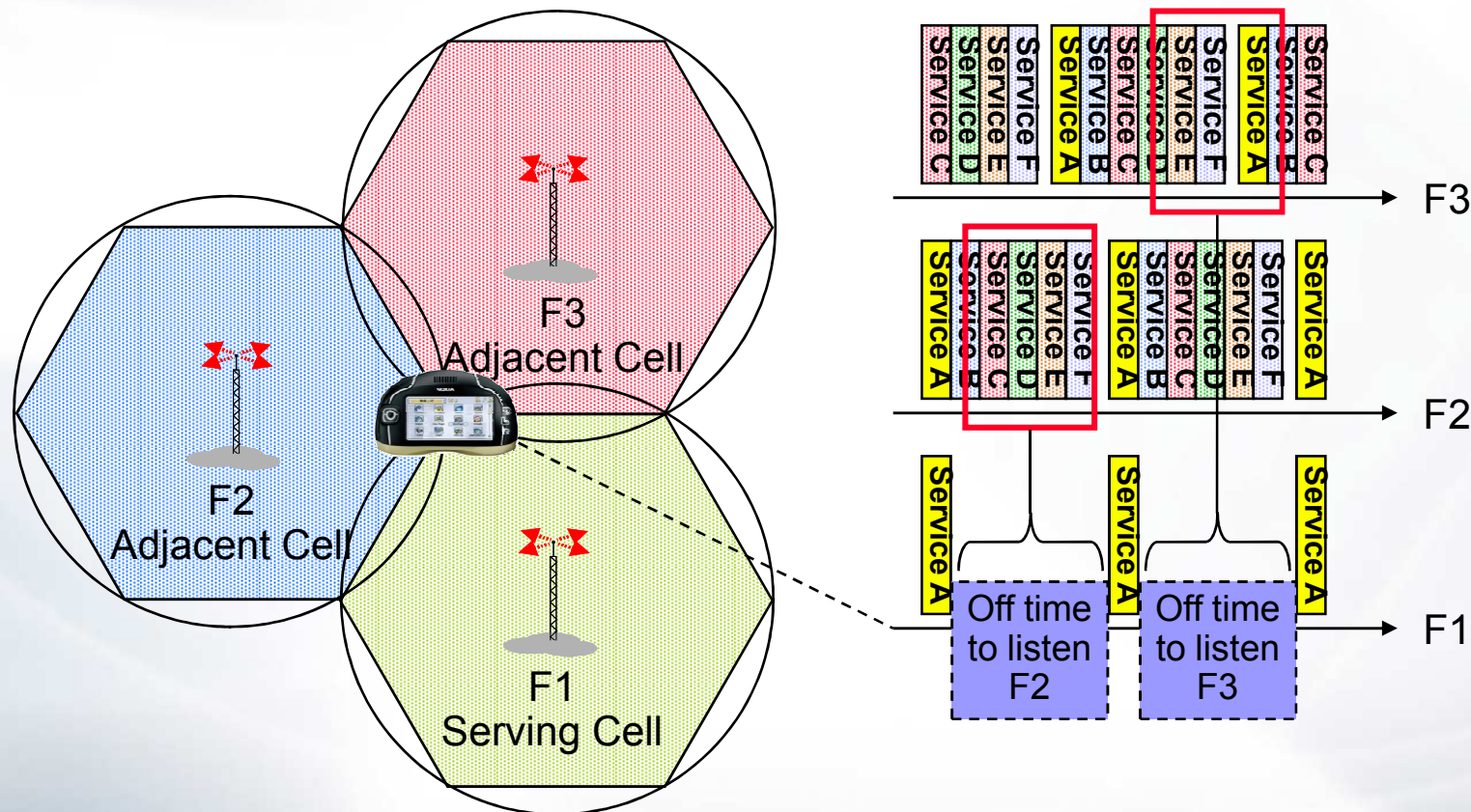
Benefits for all players

- **Consumers:** good, understandable service

- **New revenue opportunities for all industry players**

- **Media & broadcasters:** re-use of popular content and new distribution platform

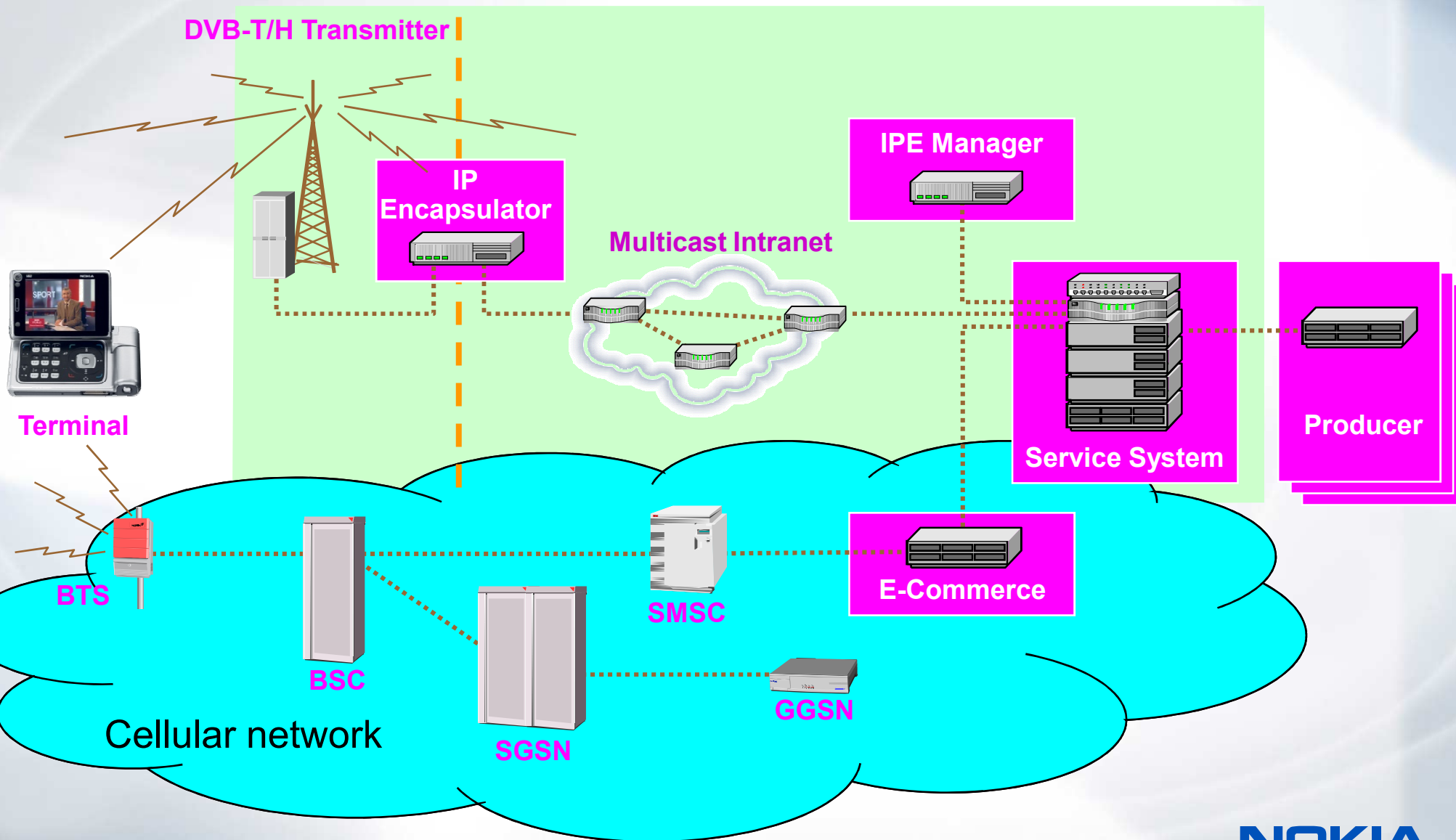- **Broadcast network operators:** operating new DVB-H networks

- **Mobile operators:** Offering Mobile TV services to customers and additional opportunities for interactive services

- **Regulators:** good use for the spectrum released in digital switchover

- **Equipment vendors:** new DVB-H network elements, DVB-H enabled mobile phones

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Conclusions on DVB-H

- Based on DVB-T, **backwards fully compatible**

- Gives additional features to support **Handheld** reception
  - Battery saving
  - Mobility with high data rates, single antenna reception, SFN networks
  - Increased general robustness, improved impulse noise tolerance
  - Support for seamless handover

- The above have been achieved by adding options
  - Time-slicing for power saving
  - MPE-FEC for additional robustness and mobility
  - 4k mode for mobility and network design flexibility

- DVB-H **can share DVB-T multiplex** with MPEG2 services

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The System Architecture in a Nutshell

DVB-T/H Transmitter

IP Encapsulator

IPE Manager

Multicast Intranet

Terminal

Service System

Producer

BTS

BSC

SGSN

SMSC

GGSN

E-Commerce

Cellular network

    DVB-H web /JHe

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Solution DVB-H (receiver part)
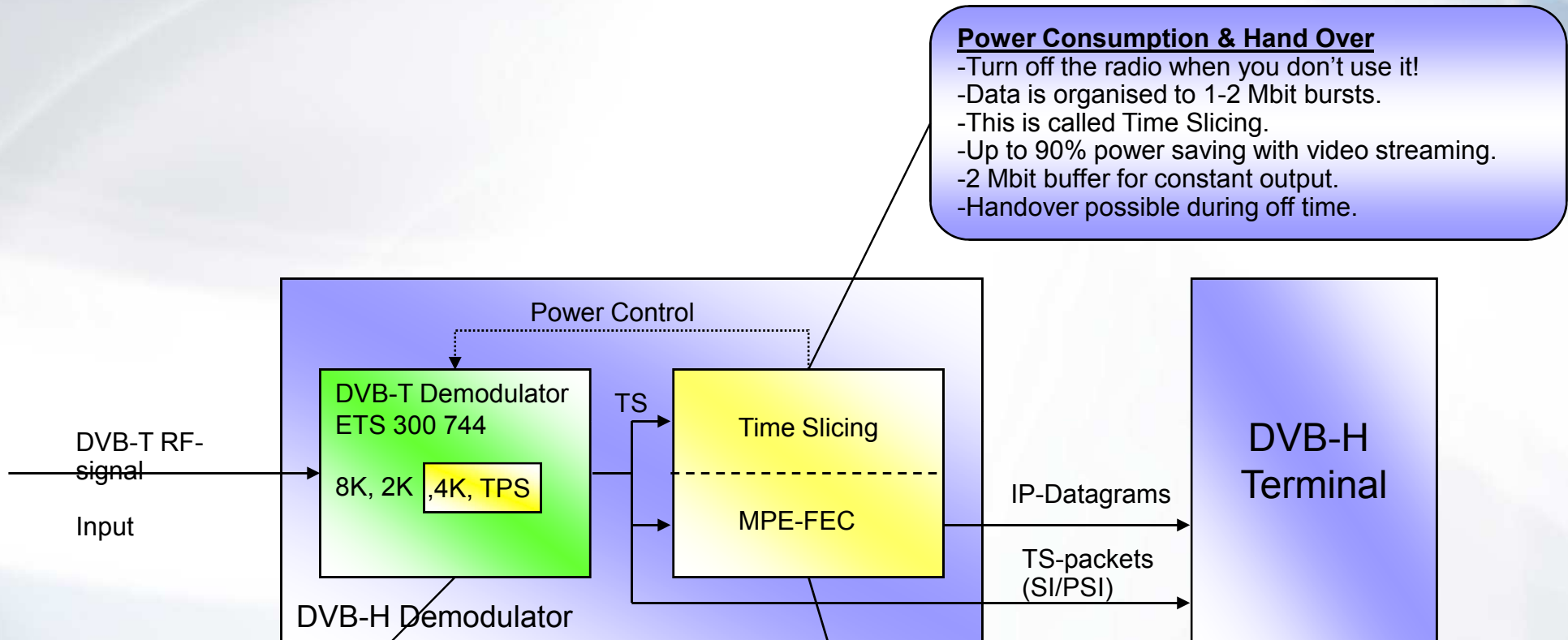
Power Consumption & Hand Over
-Turn off the radio when you don't use it!
-Data is organised to 1-2 Mbit bursts.
-This is called Time Slicing.
-Up to 90% power saving with video streaming.
-2 Mbit buffer for constant output.
-Handover possible during off time.

Power Control

DVB-T Demodulator
ETS 300 744

8K, 2K ,4K, TPS

DVB-T RF-signal

Input

TS

Time Slicing

MPE-FEC

DVB-H Demodulator

IP-Datagrams

TS-packets
(SI/PSI)

DVB-H
Terminal

Network Design Flexibility and Signalling
-With 4k practical SFN is still possible with very good mobile performance.
-Flexible use of interleavers [8k in 4k or 2k].
-New TPS bits to signal Time Sl. and MPE-FEC.
-Cell id is mandatory.
-Very low additional complexity.

Mobile Performance
-New error correction (RS) for the MPE-sections.
-Virtual interleaver re-using Time Slice buffer.
-Doppler and CN-improved in mobile&portable.
-Impulse interference tolerance improved.
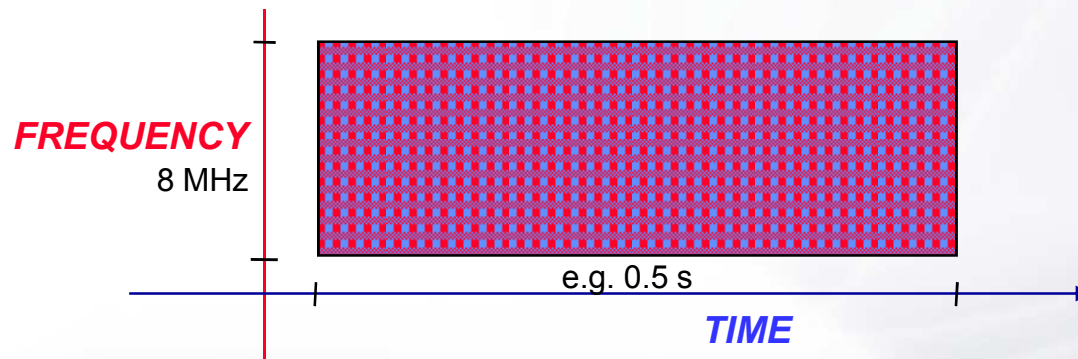-Possibility to vary the level of robustness.

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MPE-FEC

- Additional data link layer Reed-Solomon coding for IP datagrams
- RS data delivered in special FEC sections (*virtual interleaving*)
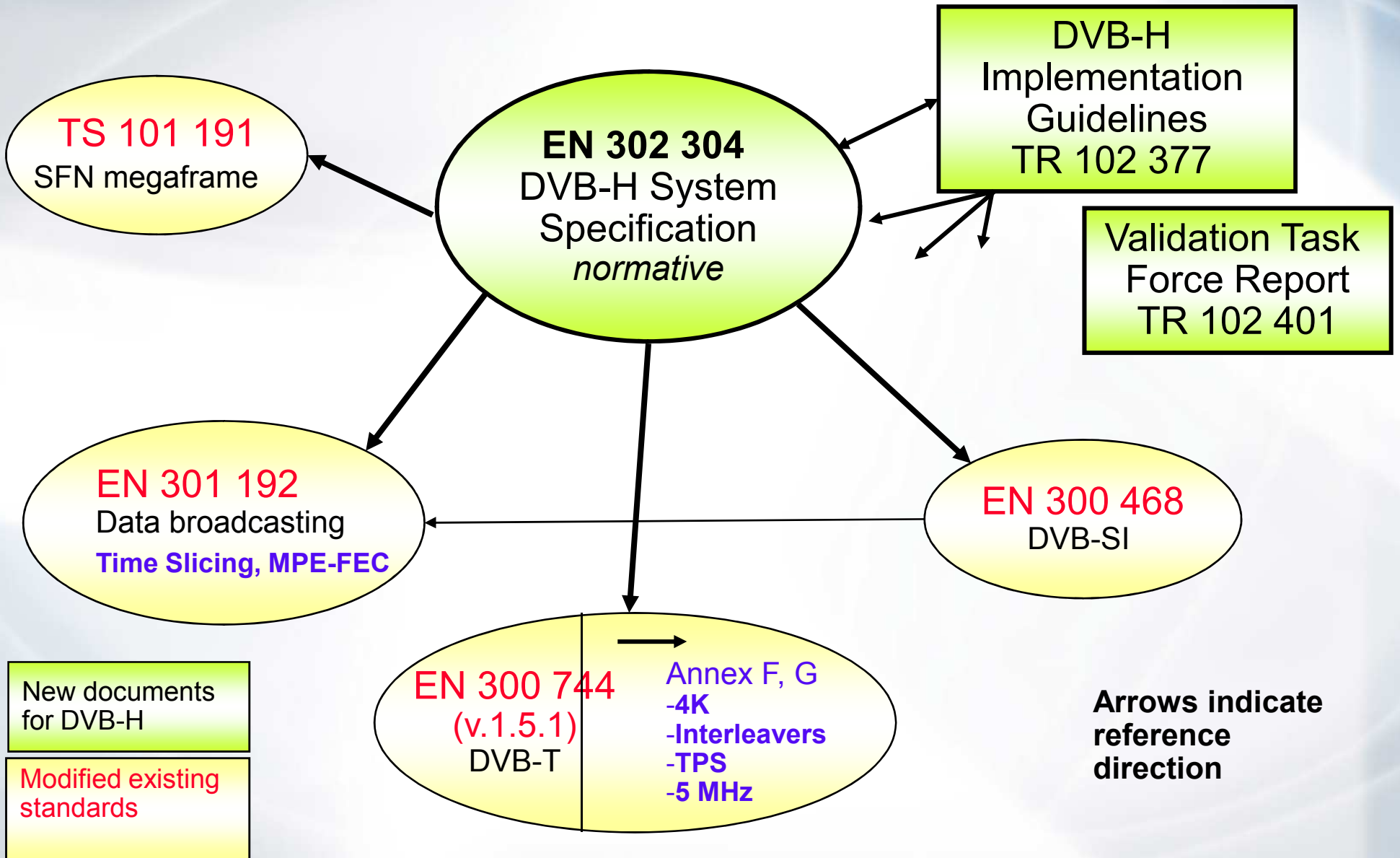- Reuses Time Slicing buffer (max 2 Mbit)
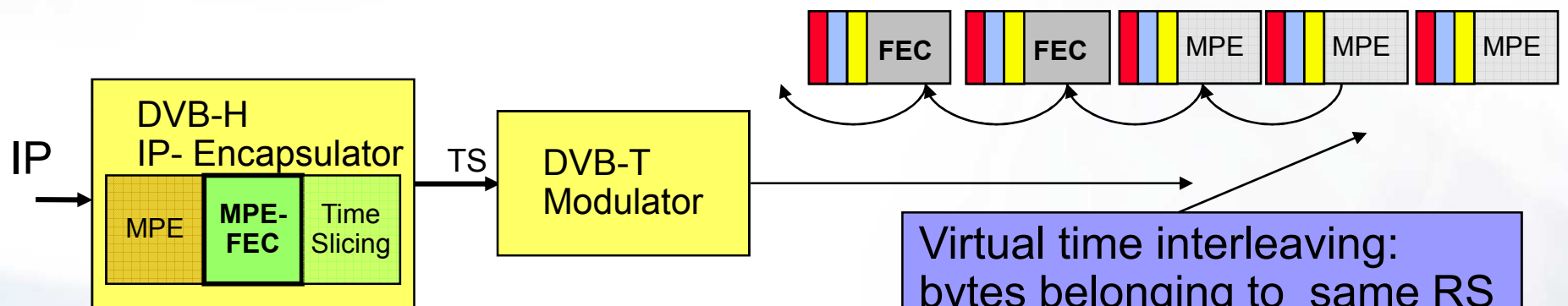
Virtual time interleaving: bytes belonging to same RS codeword distributed in time; *length can be of the order of 0.5 s or even more*

Time slicing 3

- The parameters can be selected from a large range of values: the burst lengths may be shorter or longer; the same with burst intervals

- The power savings in the receiver front-end can typically be of the order of 90 % or higher

- **NOTICE**: Bytes belonging to one service will be spread both in *TIME* and *FREQUENCY*
  - MPE-FEC virtual time-interleaving spreads in time (see later)
  - Time-slicing gives the **whole DVB-T bandwidth** in use (even when sharing with DVB-T!)

FREQUENCY
8 MHz

e.g. 0.5 s

TIME

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DVB-H Standards Family

EN 302 304
DVB-H System
Specification
normative

TS 101 191
SFN megaframe

DVB-H
Implementation
Guidelines
TR 102 377

Validation Task
Force Report
TR 102 401

EN 301 192
Data broadcasting
Time Slicing, MPE-FEC

EN 300 468
DVB-SI

EN 300 744
(v.1.5.1)
DVB-T

Annex F, G
-4K
-Interleavers
-TPS
-5 MHz

New documents
for DVB-H

Modified existing
standards

**Arrows indicate
reference
direction**

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Highlights of the NGH 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!

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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.**

Major motivation!

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.

Guard existing (and future) investments

30	**It shall be possible to combine DVB-NGH and DVB-T2 signals in one RF channel**

Could be major competitive edge!

31	The DVB Technical Module is requested to complete the DVB-NGH technical specification(s) by the end of 2011.

Commercial launch 2012

Notes & disclaimers:

1) based on draft document from CM

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

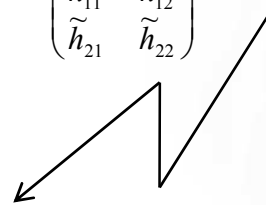**NOKIA**

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)

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

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

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Thank You!

Special thanks for many slides to
Pekka Talmola, Jussi Vesma
& others from Nokia and DVB community

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