

IEEE 1900.7 White Space Radio

A broadcaster's view: use cases/requirements

Date: **2011-09-29; Berlin**

Authors:

Name	Company	Address	Phone	Email
A. Murphy	BBC R&D	Centre House, London. W12 7SB. UK		andrew.murphy@rd.bbc.co.uk
S. Thilakawardana	BBC R&D	Centre House, London. W12 7SB. UK		Shyamalie.Thilakawardana@bbc.co.uk

Notice: This document has been prepared to assist IEEE DYSPAN SC. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release: The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE DYSPAN SC.

Patent Policy and Procedures: The contributor is familiar with the IEEE Patent Policy and Procedures <<http://iee802.org/guides/bylaws/sb-bylaws.pdf>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <harada@nict.go.jp> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within IEEE DYSPAN SC. **If you have questions, contact the IEEE Patent Committee Administrator at <patcom@ieee.org>.**

Contents

- ➔ Introduction
- ➔ Use Cases
- ➔ Requirements
 - Physical Layer
 - DVB-T2
 - Geo-location vs Sensing
 - MAC Layer
 - TDMA vs CSMA
- ➔ Conclusions

Why is White Space Important?

- ➔ Broadband Internet connectivity is essential for people to access BBC's new services



Possible Use Cases

➔ Broadband Wireless Access

- Rural Area Networks (IEEE 802.22)
- “ADSL-like” wireless broadband networks operated by an ISP

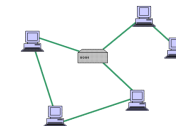


➔ In Home Networks / Business Campus Networks

- Improved WiFi (better range)
- Femtocells
- Multimedia streaming and VOD
 - High bit rates required
- Internet sharing (e.g. BT FON model)

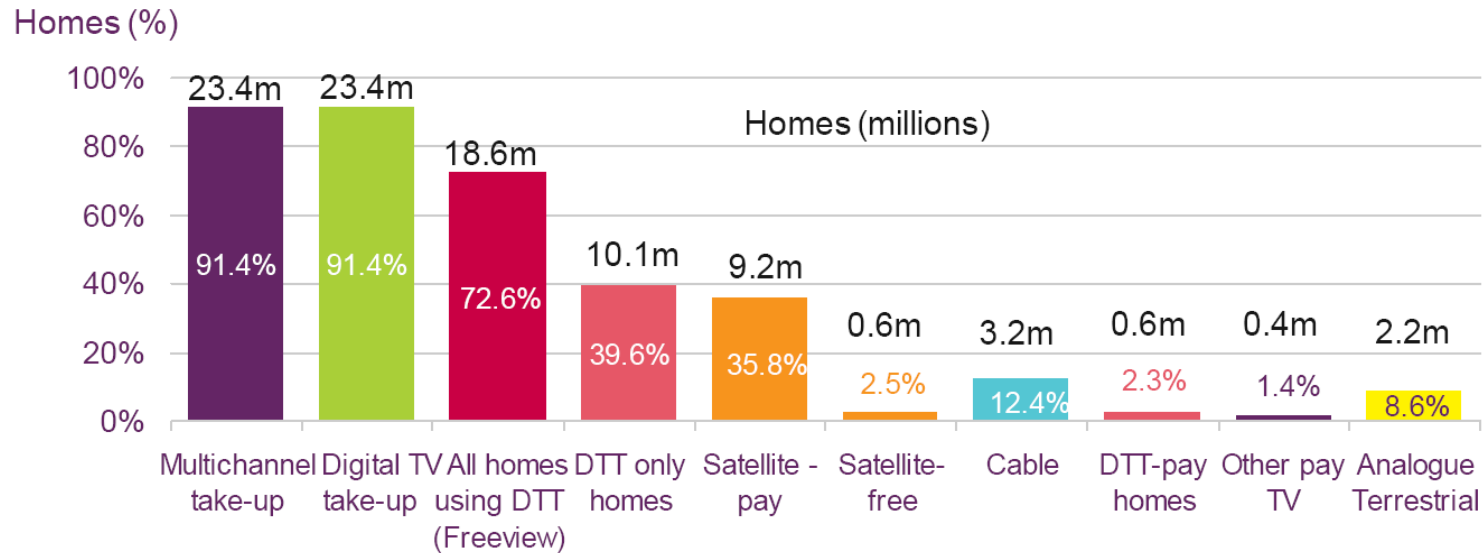


➔ Helping to meet national broadband connectivity objectives



Why protect terrestrial TV?

- ➔ Why not just use Cable, Satellite or IPTV?
 - 10.1 million homes (40%) use DTT as main Digital TV service (Ofcom Dec 2009)
 - 8.5 million (32.6%) homes use DTT for 2nd and 3rd Digital TV services
 - 2.2 million analogue homes, likely to use DTT after DSO



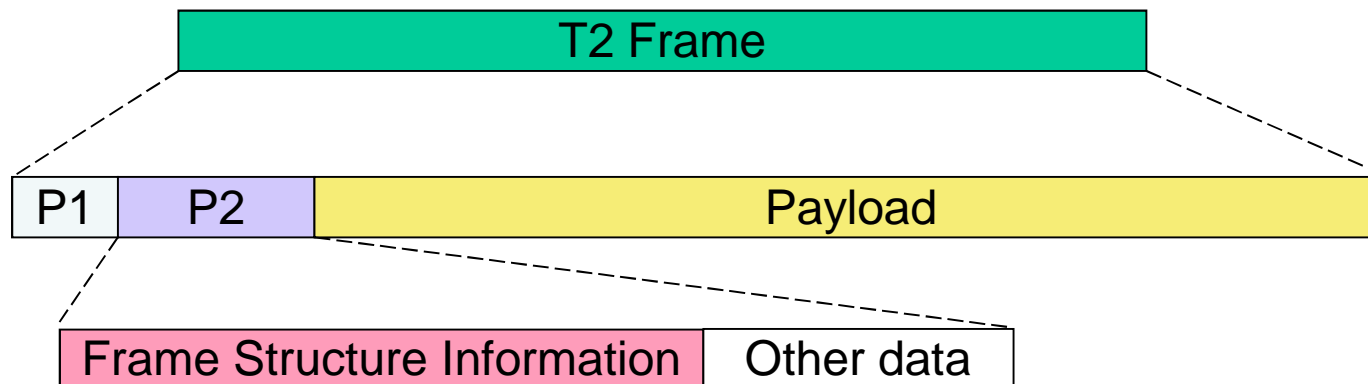
PHY: DVB-T2 (i)

- ➔ Second generation Digital Terrestrial TV broadcasting standard
- ➔ ‘Classical’ Guard Interval OFDM (as DVB-T)
 - FFT sizes: 1K, 2K, 4K, 8K, 16K, 32K
 - Guard Intervals: 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4
 - Constellations: QPSK, 16-QAM, 64-QAM, 256-QAM
 - Bandwidths: 1.7, 5, 6, 7, 8, 10 MHz
- ➔ Error coding uses LDPC + BCH; 16200 & 64800 bit FEC blocks
 - Rates (1/3, 2/5), 1/2, 3/5, 2/3, 3/4, 4/5, 5/6
- ➔ Rotated Constellations
 - Offer improved performance in highly-selective channels
- ➔ Flexible Time Interleaving (multi-frame and multiple TI block)
- ➔ MISO (Alamouti-based transmit diversity)

PHY: DVB-T2 (ii)

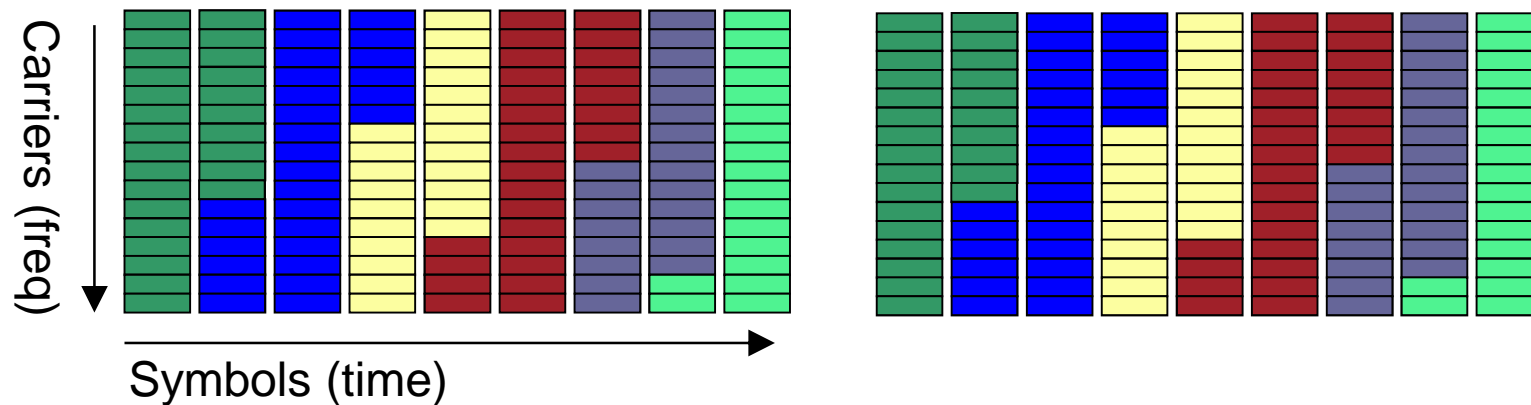
➔ Frame structure

- P1 symbol
 - Coarse synchronisation and initial configuration
- P2
 - Layer 1 signalling information – configuration of payload symbols
- Payload
 - Data symbols carrying content

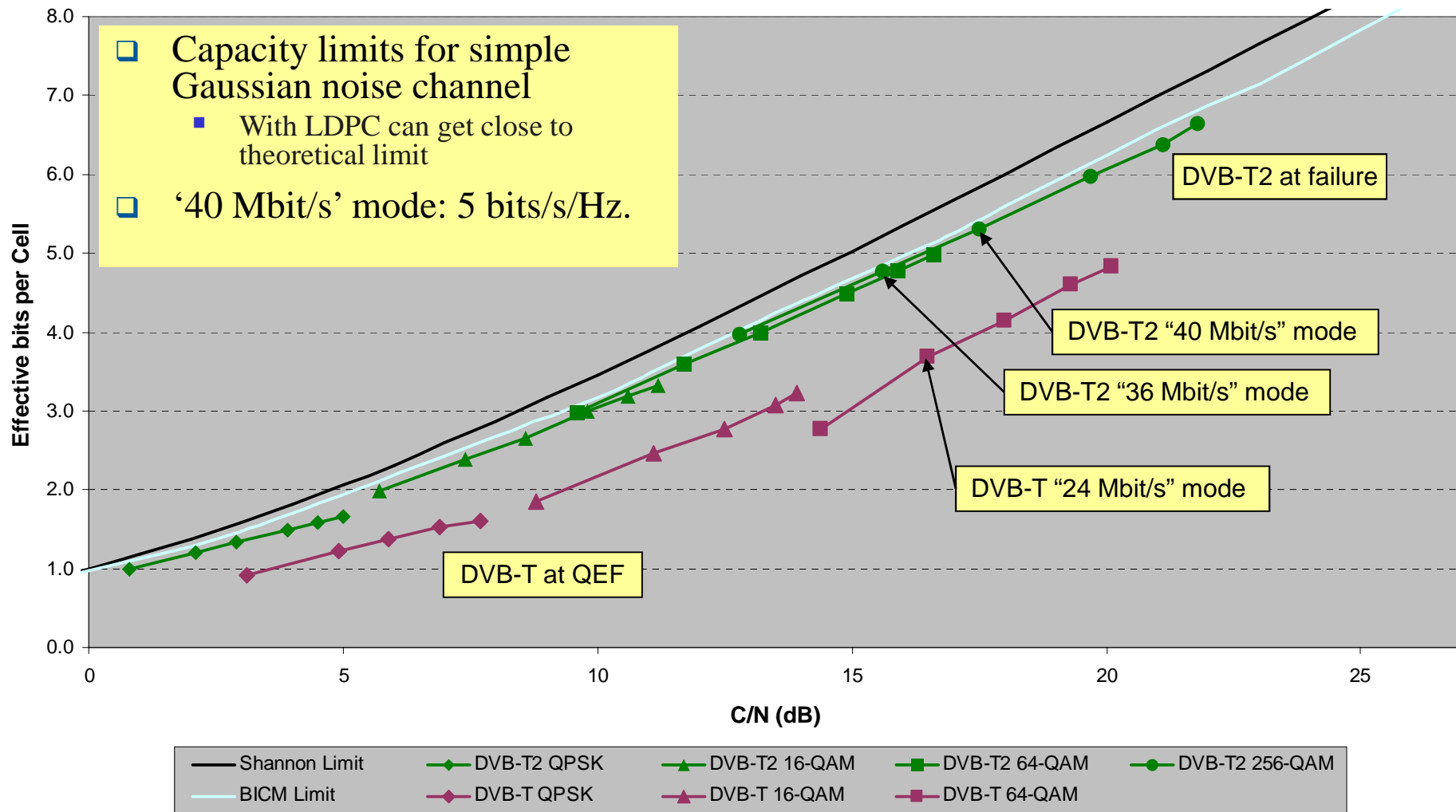


PHY: DVB-T2 (iii)

- ➔ Highly flexible frame structure: Physical Layer Pipes (PLPs)
 - Service specific robustness
 - Time-slicing at physical layer



PHY: DVB-T2 Performance



PHY: Spectral Efficiency Comparison

System (#UE Cat)	Modulation	Number of Codes (CDMA)	FEC Code Rate	Data Rate [Mb/s]	Spectrum Efficiency [bit/s/Hz]
3G HSDPA #6	16-QAM / SISO	5	0.76	3.6	0.72
3G HSDPA #8	16-QAM / SISO	10	0.76	7.2	1.44
3G HSDPA #10	16-QAM / SISO	15	0.97	14.0	2.80
4G LTE (20MHz)	64-QAM / SISO	-	1.00	100.0	5.00
4G LTE (20MHz)	64-QAM / MIMO	-	1.00	172.8	8.64
4G LTE (20MHz)	64-QAM / MIMO 4x4	-	1.00	326.4	16.32
3G HSDPA #14	64-QAM / SISO	15	0.98	21.1	4.22
802.11g	64-QAM SISO	-	0.75	54	2.7
DVB-T	64-QAM SISO	-	0.67	24.1	3.01
DVB-T2	256-QAM SISO	-	0.67	40	5.00
DVB-NGH	256-QAM MIMO	-	0.67	80	10.00

PHY: Geo-location vs Sensing

➔ Sensing

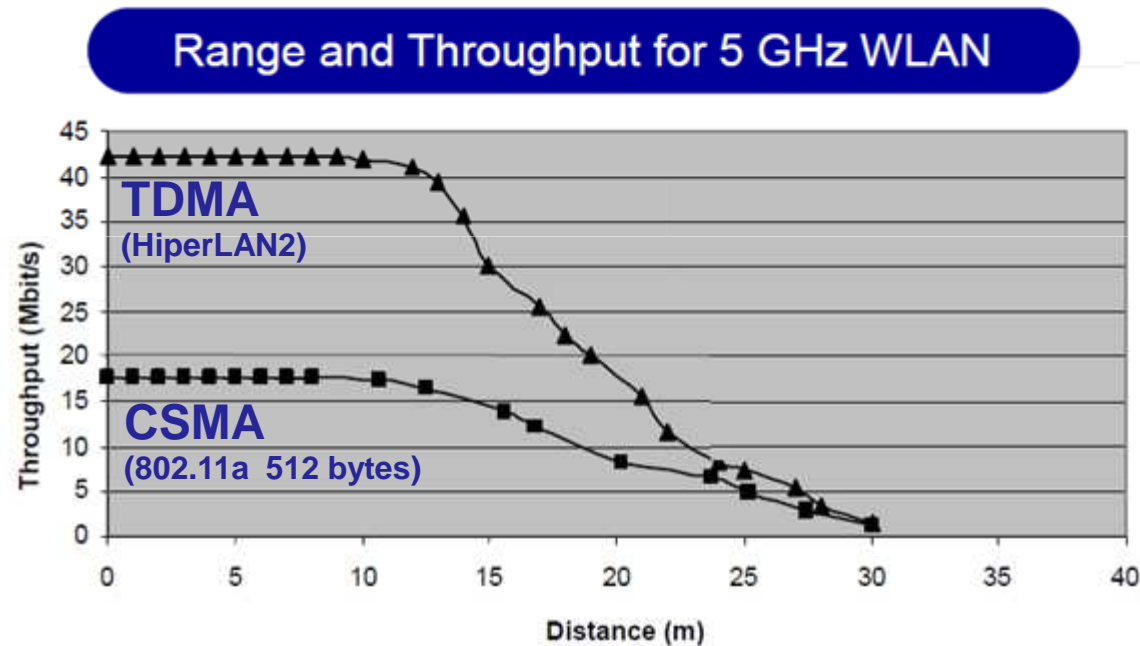
- Concern over accuracy of sensing within devices
- Time taken for sensing to take place
 - Difficulties of sensing at ground level
- Complexity of modelling required by device
 - How can a device simply model what effect it might have kms away?
 - Antenna patterns
 - Topography
 - Knowledge of services consumed locally
 - Sensing of future standards?

➔ Geo-location database

- Issues around database accuracy and security
 - Certification

MAC: CSMA vs TDMA

- ➔ Motivation is to avoid loss of throughput cf. PHY layer capacity
 - Deliver PHY layer performance to application layers



- CSMA vs TDMA graph indicates potential gain of scheduled MAC layer
 - 802.11a (2.7 bit/s/Hz reduced to 0.9 bit/s/Hz)
- Backwards compatibility not a strong requirement in new WS spectrum

Conclusions

- ➔ White Space important to BBC
 - But must protect existing terrestrial TV services used by millions of people
- ➔ Use cases
 - Broadband wireless access: Rural area networks
 - In-home networks: Distribution of content
- ➔ Requirements
 - Efficient PHY layer
 - Highest possible bit rates needed e.g. DVB-T2: 5 bit/s/Hz
 - Concern about viability of device sensing
 - Efficient MAC layer
 - Concerned about efficiency of CSMA with heavy traffic
 - Time division system would solve this
 - Whitespace is new spectrum
 - Backwards compatibility with existing CSMA (as @ 2.4 GHz) not a strong requirement