



ITU/EBU workshop on Digital Broadcasting
Sofia 8-10 June 2004

How many digital broadcast networks can be accommodated in the VHF and UHF bands

J. Doeven



Subjects

General considerations

Aspect regarding capacity
Possible requirements
Other services
References

Example 1

Theory
All tx equal
No country borders

Example 2

Practice
Conversion of analogue tx

Aspects regarding capacity

- Size of the coverage area
 - Heff, ERP
- Reception mode
 - Rooftop, portable, mobile
- Coverage probability
 - small area (70%, 95%)
- Pixel coverage
 - % of area coverage
- System variant
 - 64 QAM, 16 QAM (C/N)
- Network structure
 - SFN, MFN

Available
frequency band

Band III


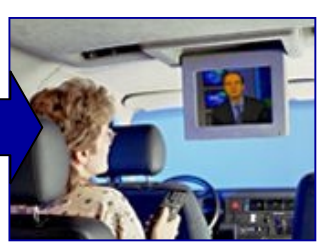


Band IV/V

Other services

General
considerations

Service Requirements

Impact on spectrum

Indoor reception		Important in each market, but requires high field strength	High	Lower coverage or less services may need to be accepted
Mobile reception		Widespread interest, but requires high field strength	High	Only few networks with reduced bitrate may be possible
Flat panels		Seen as very important, but needs 2 times higher bitrate	High	Additional demand on spectrum or less services
Return path		Essential for new interactive services	Low	Mainly via UMTS/GSM or ADSL/PSTN

General considerations

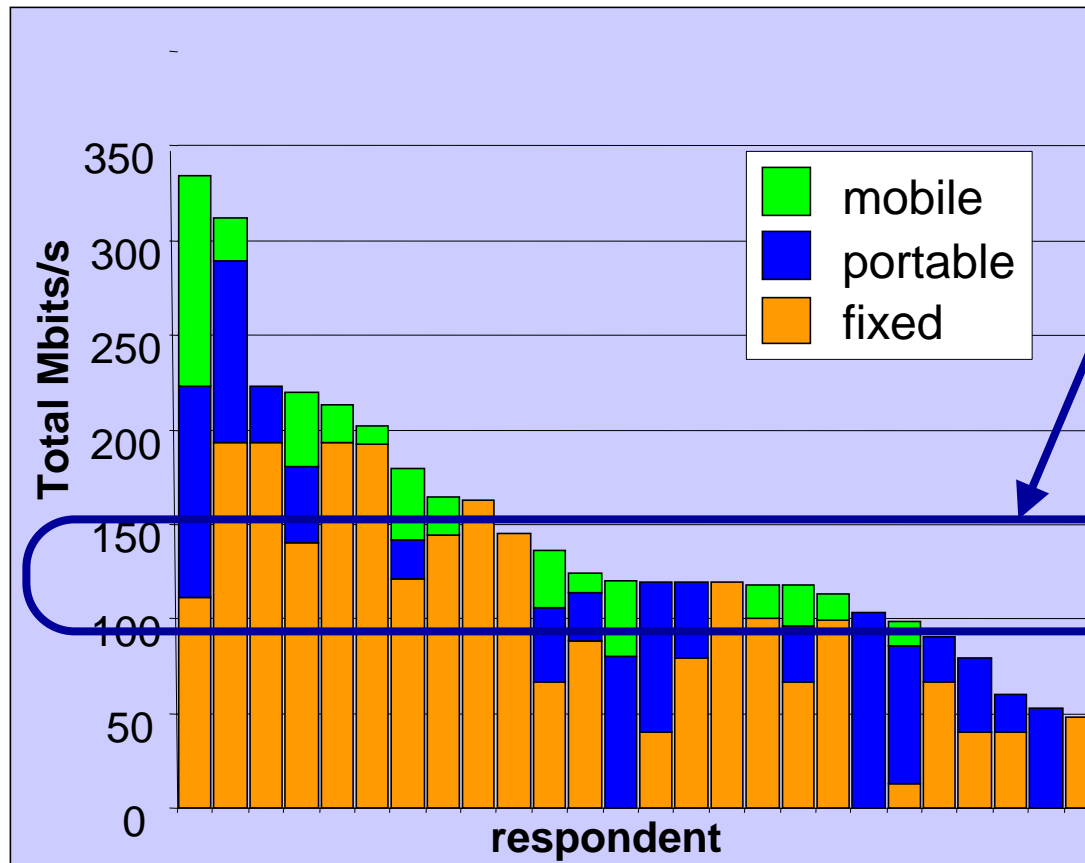


Market Conditions

Market	Characteristic	Most important	As far as possible
Cable dominated	DVB-T portable indoor is USP	Portable indoor reception	Number of services
Mixed (C, S, T)	Most competitive environment	High number of services	Extend of coverage
Terrestrial delivery dominated	Full coverage is a must	Universal coverage	Portable indoor reception

General considerations

Requested capacity



Concentration in range 100 – 150 Mb/s

- On average, need for 6-7 multiplexes for:
- Fixed
 - Portable
 - Combination
 - ⇒ Fixed
 - ⇒ Portable
 - ⇒ Mobile

General considerations

Protection of other services

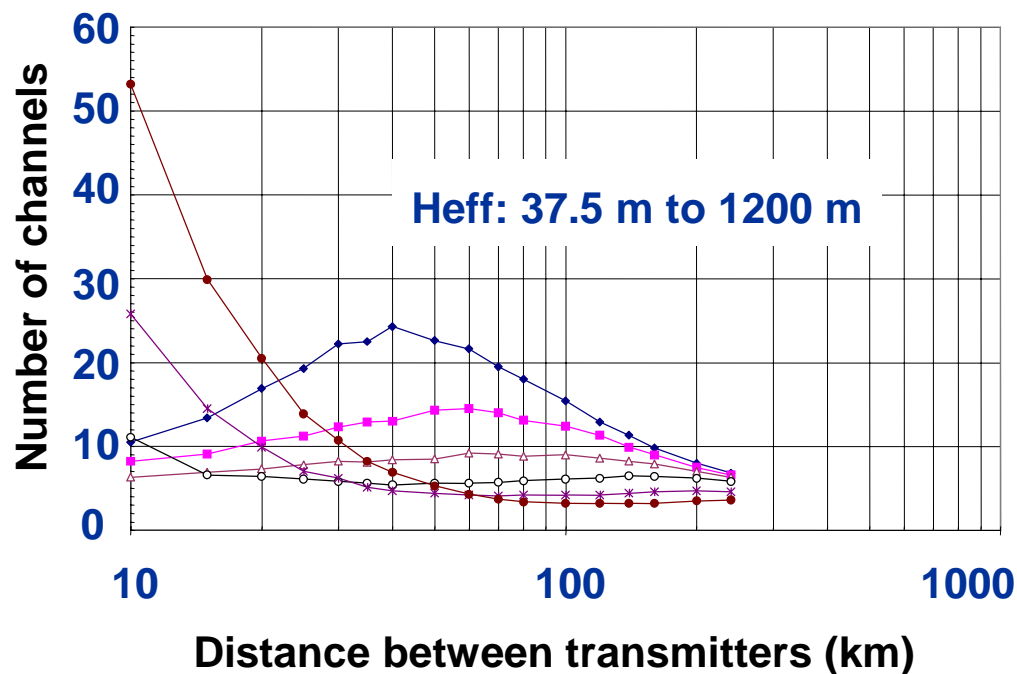
General considerations

1. In establishing the Plan	No broadcasting in related channels Accept reduced access for digital broadcasting	Other services that remain in use
2. In implementing the Plan only	Digital broadcasting in related channels in the Plan Accept temporary restrictions for digital broadcasting	Other primary services that will phase out

Band	Adm.	Services category 1	Band	Adm.	Services category 2
B III	3	Fixed/mobile	B III	5	Fixed/mobile
B V	4	Fixed/mobile	B V	13	Fixed/mobile
B V	2	Aeronautical radio navigation	B V	7	Aeronautical Radio navigation

Number of channels needed for fixed antenna reception

■ 64QAM, 95% of locations, 100% of pixels



Number of channels (equivalent number of channels)

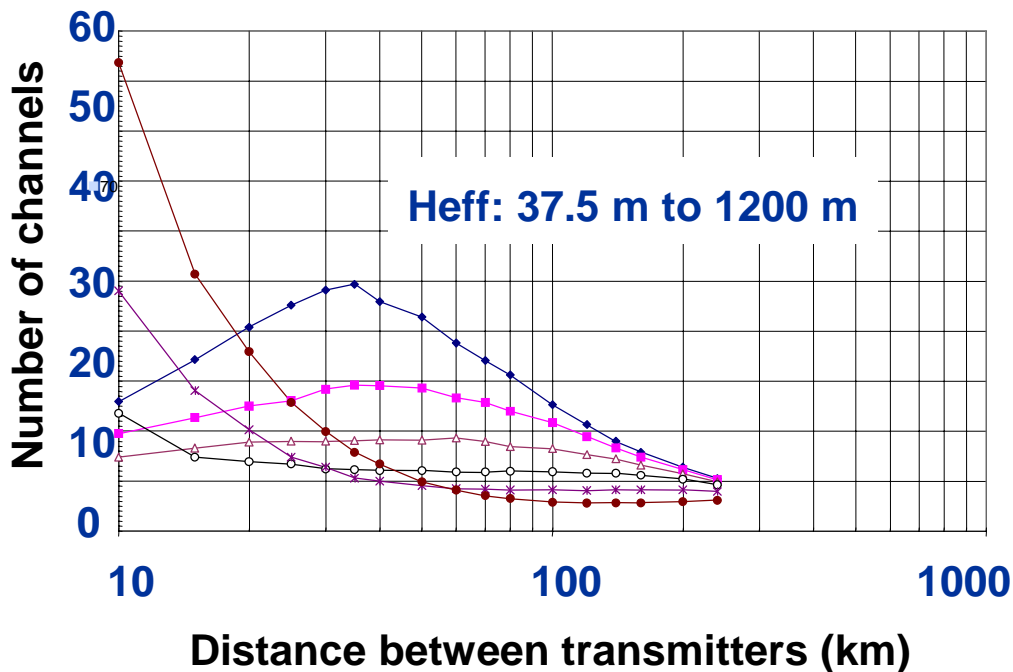
Heff (m)	64 QAM	16 QAM
150	9 (9)	6 (9)
300	6 (9)	4 (6)

- MFN
- Distance between tx: 50-100 km
- Bitrate 64QAM= 1.5 bitrate 16QAM

Theory
Example 1

Number of channels needed for indoor antenna reception

- 64QAM, 70% of locations, 100% of pixels



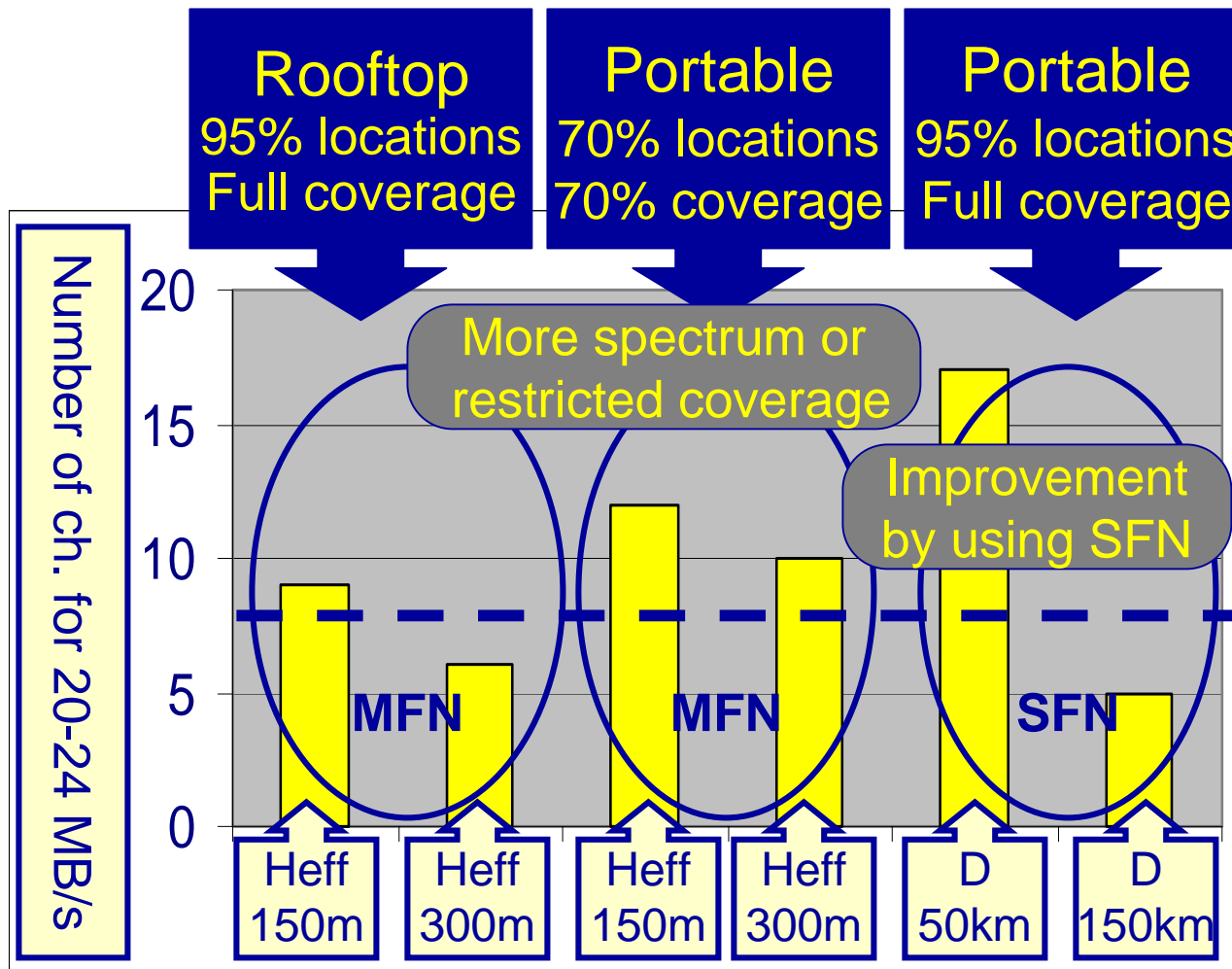
Number of channels (equivalent number of channels)

Heff (m)	64 QAM	16 QAM
150	15-18 (15-18)	10-13 (15-20)
300	24-12 (24-12)	16-9 (24-14)

- MFN
- Distance between tx: 10-60 km
- Bitrate 64QAM= 1.5 bitrate 16QAM

Theory
Example 1

Spectrum Demand



About 8 channels may be needed under practical conditions

Theory
Example 1



General conclusions (1)

- Average demand of 100 - 150 MB/s
 - Could be achieved by using the **whole** band in most countries
 - Unlikely to satisfy maximum demand (>200 Mb/s) in most areas
- Rooftop reception requires less spectrum than portable
- Spectrum requirements for portable reception can be reduced by accepting:
 - Lower location percentage
 - Lower pixel coverage
 - Use of SFNs

Example 1
Theory

General conclusions (2)

- **Small SFNs (about 50 km diameter)**
 - Require a similar amount of spectrum compared to small MFNs
- **Larger SFNs (> 100 km diameter)**
 - Require less spectrum than MFNs
 - Show better spectrum usage than small SFNs (about 50 km diameter)
- **Modulation 64QAM and 16QAM**
 - Require a similar amount of spectrum expressed in total bitrate of all multiplexes in most practical cases.

Number of channels needed in case of conversions

Albania	ALB	4	Lithuania	LTU	173
Andorra	AND	30	Luxembourg	LUX	12
Austria	AUT	1755	Macedonia	MKD	194
Belgium	BEL	73	Malta	MLT	4
Belarus	BLR	347	Moldova	MDA	349
Bosnia and Herzegovina	BIH	594	Monaco	MCO	5
Bulgaria	BUL	1354	Netherlands	HOL	72
Croatia	HRV	2175	Norway	NOR	3984
Cyprus	CYP	115	Poland	POL	1351
Czech Republic	CZE	2332	Portugal	POR	576
Denmark	DNK	280	Romania	ROU	715
Estonia	EST	71	Russian Federation	RUS	2020
Finland	FIN	782	Serbia & Montenegro	YUG	449
France	F	13254	Slovak Republic	SVK	1491
Germany	D	10174	Slovenia	SVN	911
Greece	GRC	745	Spain	E	6799
Hungary	HNG	743	Sweden	S	1608
Iceland	ISL	7	Switzerland	SUI	3023
Ireland	IRL	779	Turkey	TUR	431
Italy	I	22714	Ukraine	UKR	2344
Latvia	LVA	118	United Kingdom	G	5484
Liechtenstein	LIE	12	Vatican City	CVA	5

Practice
Example 2

90458 analogue stations;
17899 disputed

■ ITU/EBU workshop Sofia



Number of channels, optimum choice of frequency

	%location	% pixel	Abs min	N
64 QAM	95	100	60	285
	95	70	48	2
	95	50	42	
	70	100	44	
	70	70	37	
	70	50	32	
16 QAM	95	100	50	4
	95	70	39	
	95	50	35	
	70	100	38	
	70	70	33	
	70	50	32	

■ Abs min
Minimum number of channels without incompatibilities

■ N
Number of stations which could not be found a channel (49 channels available)

■ Only non-disputed stations of $\geq 10\text{kW}$

Example
Practical

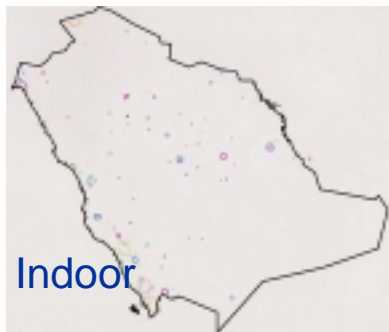
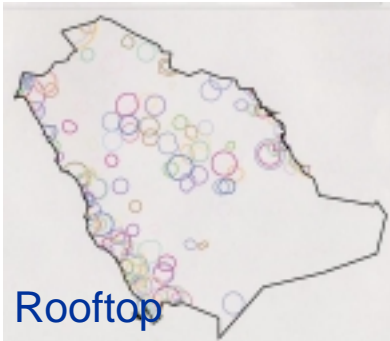
Coverage as result of conversion (1)



- Digital channel same as analogue channel
- Analogue ERP reduced by 7 dB
- Channel 21 – 38
- Only stations with ERP (analogue) >10 kW
- Given colour represents a given channel
- Where same colour appears in same area: error in data base

Example 3
Practice

Coverage as result of conversion (2)



- Example of country with few stations and low interference levels (noise limited in many cases)
- Large difference between rooftop and indoor



- Example of country with many stations and high interference levels
- Difference between rooftop and indoor not too large

Practice
Example 4

General conclusions

- First results based on conversions:
 - With 16QAM all UHF channels are needed to replace current analogue coverage
 - Full coverage (100 % pixels) or less - is important factor regarding the capacity
- Band fully occupied with replacing analogue coverage?
 - In practice digital coverage may not require 95% location probability and 100% pixel coverage
 - Results for pixel coverage of less than 100% may be more relevant
 - This may be of great importance when considering target coverage areas fro submission of requirement

Practical
examples

References

- Digitag final report on service requirements for DVB-T, October 2002
- Digitag report. Building bridges between decision makers and frequency planning experts in view of the coming RRC04/05, November 2003
- EBU report BPN 038. Report from ad-hoc group B/CAI-FM24 to B/MDT and PT24 on spectrum requirements for DVB-T implementation, March 2001
- CEPT document FM24(04)031. Initial planning exercise, 16 February 2004