ITU-R Study Group 6

Workshop
Terrestrial Multimedia Mobile Broadcasting (TMMB)

Planning and implementation

8 March 2024, 0930-1200 hours (CET)

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Terrestrial Multimedia
Mobile Broadcasting (TMMB)

Planning and implementation

Draft time management plan

Time (CET)	Title	Speaker	Affiliation
0930-0935	Welcome and opening	Mr Amir NAFEZ Mr Thiago SOARES	WP 6A Acting Chair/Moderator SG 6 Chair
0935-1020	TMMB System L network planning	Mr Walid SAMI	EBU
1020-1040	*Break*		
1040-1110	TMMB System L compatibility with DTT in the sub-700 MHz band	Ms Elena PUIGREFAGUT	EBU
1110-1125	TMMB System L Case Study: Germany	Dr Ronald LORENZ	BNE
1125-1140	TMMB System L Case Study: UK	Mr Mark JORDAN	BNE
1140-1200	Questions and Answers and Closing	Mr Amir NAFEZ	WP 6A Acting Chair/Moderator

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TMMB SYSTEM L NETWORKS PLANNING

WALID SAMI, EBU T&I

ITU WEBINAR 8TH MARCH 2024

PROGRAMME

1. Introduction
2. What questions are we answering ?
3. 5G Broadcast network planning
4. Ongoing studies
5. Q/A

1. INTRODUCTION

Introduction

- TMMB System L: ETSI LTE-based 5G Terrestrial broadcast System ETSI TS 103 720 V1.2.1 (2023-06) – Called 5G Broadcast in the context of this presentation.
- 5G Broadcast features:
  - Solution for the difficult reach of personal devices with broadcast content
  - Standalone Downlink-Only System
  - Meeting PSM requirements
  - Global system (3GPP-based)
- For standardization and market related aspects, see EBU TR 054 “5G for the Distribution of Audiovisual Media content and services”

2. What questions are we answering ?

- On the network planning side
  - Which network topologies for 5G Broadcast ?
  - How can existing broadcasting infrastructure be used ?
  - What is the expected capacity of 5G Broadcast networks ?
  - What frequency usage would 5G Broadcast networks require ?
  - What should be further studied ?

3. 5G Broadcast network planning

5G Broadcast system parameters

- OFDM – (same as DVB-T/T2)
- Allows use of SFNs (insertion of Guard Interval, GI)

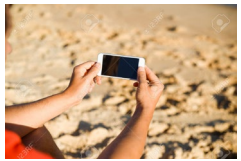
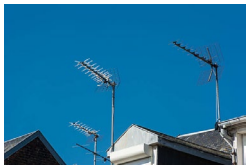
Carrier Spacing delta fd [kHz]	Tu (µs)	Tcp / GI (µs)	Ts (µs)	GI Ratio	GI Distance [km]	Approx. Max speed at 600 MHz @C/N 15 dB [km/h]
15.00	66.7	4.7	71.40	5/71		
15.00	66.7	16.7	83.40	1/4	5km	
7.50	133.3	33.3	166.60	1/4	10km	700
2.50	400	100	500.00	1/4	30km	370
1.25	**800**	**200**	**1000.00**	**1/4**	**60km**	**180**
0.37	2700	300	3000.00	1/9	90km	70

Compromise Between SFN size and mobile reception

Reception Modes

Scenario	1	2	3	4	5	6
Reception parameters	Car mounted (CM)	Handheld In-Car	Handheld portable outdoor	Fixed Rooftop (FRT)	Portable indoor (PI)	Handheld portable indoor (P-H/Internal Antenna)
Type of reception	Mobile	Mobile	Portable	Fixed	Portable	Portable



SINR to capacity mapping for 200 µs CP

MCS Index	MOD	COD	Capacity (Mbit/s) In 5 MHz channel	Fixed SINR (dB)	Portable SINR (dB)	Mobile SINR (dB)
..						
5	QPSK	0.369	2.161	4	4	**4.6**
6	QPSK	0.433	2.535	**4.8**	**5**	5.6
..						
11	16-QAM	0.366	4.282	8.4	8.4	**9.2**
12	16-QAM	0.414	4.844	**9.2**	**9.2**	10.2
..						
15	16-QAM	0.602	7.043	12.4	12.4	**14**
16	16-QAM	0.645	7.543	13.2	13	15.2
17	64-QAM	0.430	7.543	13.8	13.4	15.8
18	64-QAM	0.444	7.792	**14.4**	**14.4**	17
19	64-QAM	0.508	8.915	15.6	15.4	**19.6**
20	64-QAM	0.551	9.664	16.8	16.4	22.8
21	64-QAM	0.593	10.413	17.8	17.2	
22	64-QAM	0.636	11.162	**19.4**	**18.2**	
23	64-QAM	0.699	12.262	22.8	21.8	

5G Broadcast planning levels for SINR of 10 dB

Reception parameters	Car mounted (CM)	Handheld In-Car	Handheld portable outdoor	Fixed rooftop (FRT)	Portable indoor (PI)	Handheld portable indoor (P-H/Internal Antenna)
Type of reception	**Mobile**	Mobile	**Portable**	**Fixed**	Portable	Portable
Path type	**Land**	Land	**Land**	**Land**	Land	Land
Receiver antenna gain, including possible body loss and receiver diversity gain (dBi)	**3**	-5.8	**-5.8**	**13**	1.7	-5.8
Entry loss (dB) – Building/vehicle	**0**	9	**0**	**0**	11	11
Standard deviation associated with entry loss (dB)	**0**	5	**0**	**0**	6	6
Receiver height (m)	**1.5**	1.5	**1.5**	**10**	1.5	1.5
Receiving installation feeder loss (dB)	**0**	0	**0**	**4**	0	0
Other losses (dB)	**1**	1	**1**	**1**	1	1
Receiver strategy for signals from the same SFN	**Maximum C/I**					
Location variation standard deviation (dB)	**5.5**					
Receiver Noise Figure (dB)	**6**	9	**9**	**6**	9	9
Usual criteria in terms of percentage of locations to protect in a small area	**95%**	95%	**95%**	**95%**	95%	95%
Minimum median FS at reception height (dBµV/m)	**47 (@1.5m)**		**60 (@1.5m)**	**41(@10m)**		

Network type and site density

- High Power High Tower sites

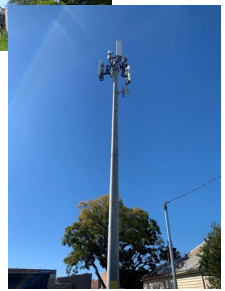
Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
HPHT	80	300	80 dBm / 100 kW	1.8

- Medium Power Medium Tower sites

Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
MPMT	20	80	59.5 dBm/900 W	28.9

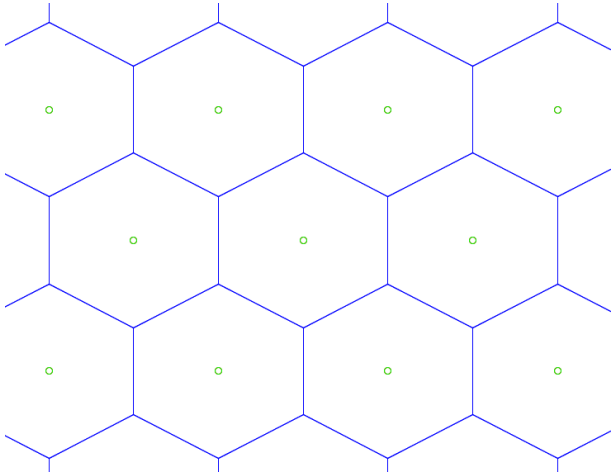
- Low Power Low Tower sites

Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
LPLT	3	30	57 dBm/500 W	1283



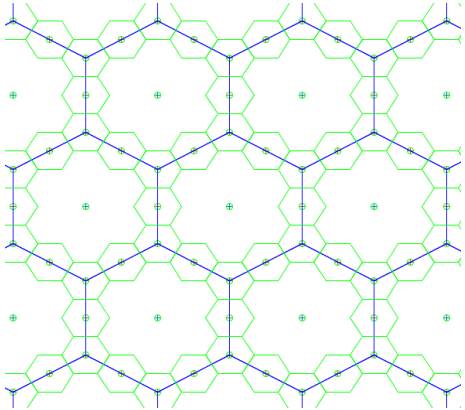
Single topology networks

- High Power High Tower (HPHT)
- Medium Power Medium Tower (MPMT)
- Low Power Low Tower (LPLT)

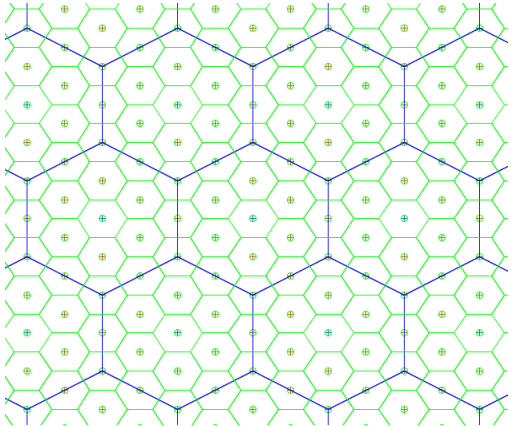


Mixed topology networks

HPHT
+ 1 row MPMT



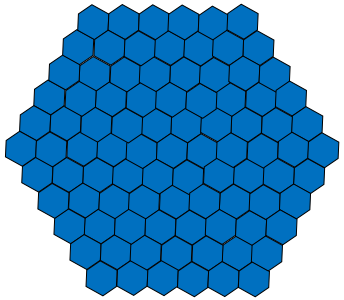
HPHT
+ 2 rows MPMT



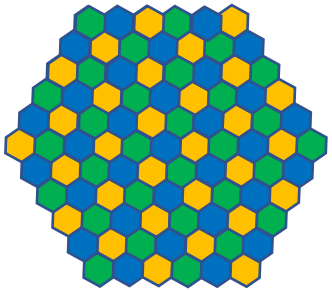
Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
HPHT	80	300	80 dBm/100 kW	1.8
MPMT	23.1	80	67 dBm/5 kW	10.8 (1 row) 21.6 (2 rows)

Frequency reuse

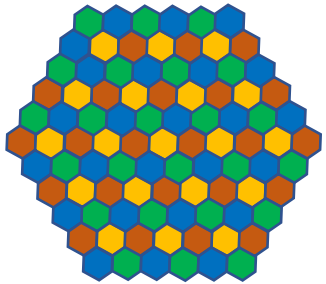
- Reuse 1 (SFN)



- Reuse 3

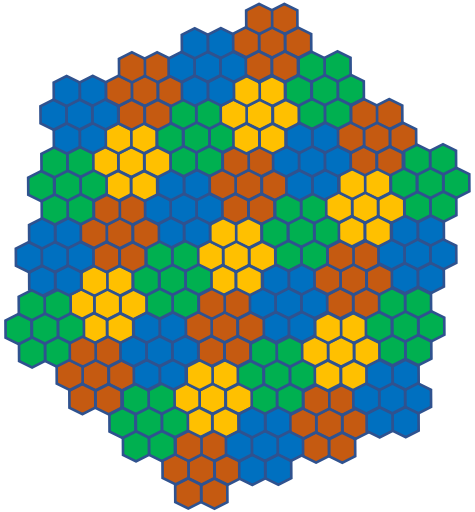


- Reuse 4



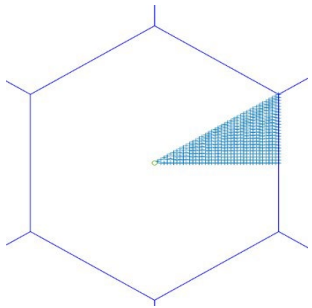
- Reuse 3 MFN clusters of 7-site SFNs

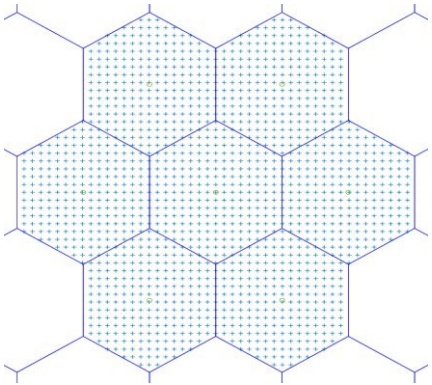
- Reuse 4 MFN clusters of 7-site SFNs

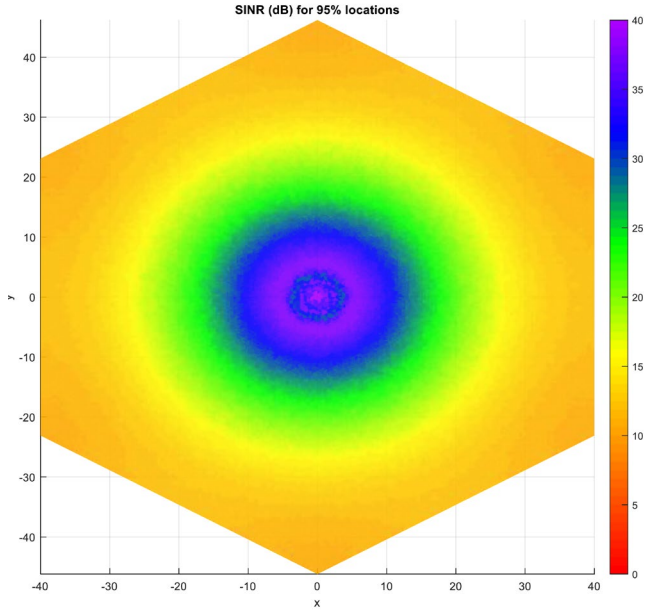


Simulation method

- Monte Carlo method used to avoid approximation of wanted and interfering signal summation in SFN networks

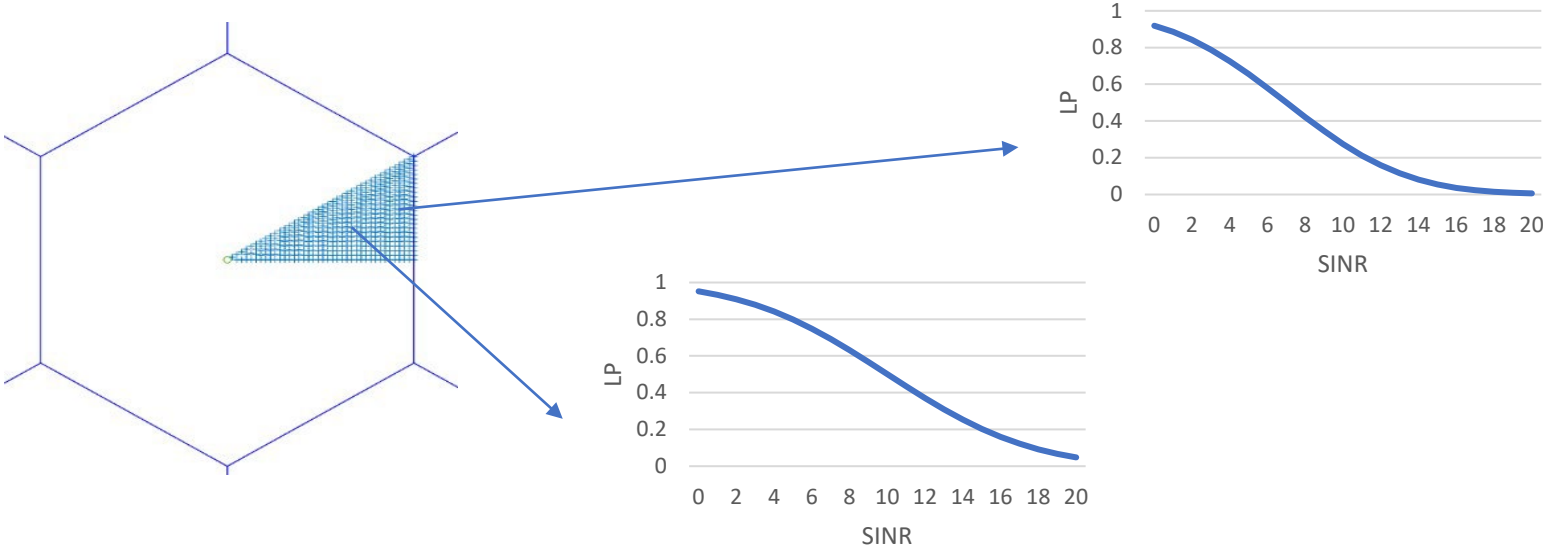






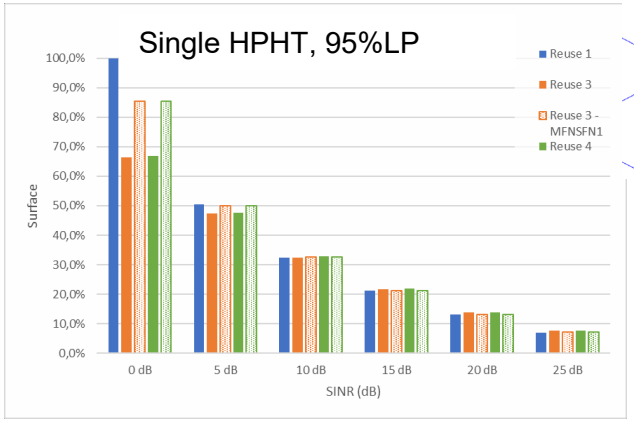
Simulation method

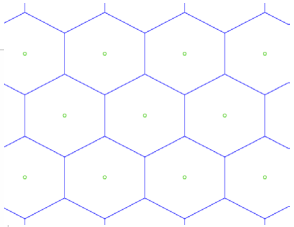
- Calculates a CDF for SINR at each pixel, so we can derive:
  - the SINR corresponding to a fixed target Location Probability (LP), or
  - the Location Probability (LP) corresponding to a fixed target SINR

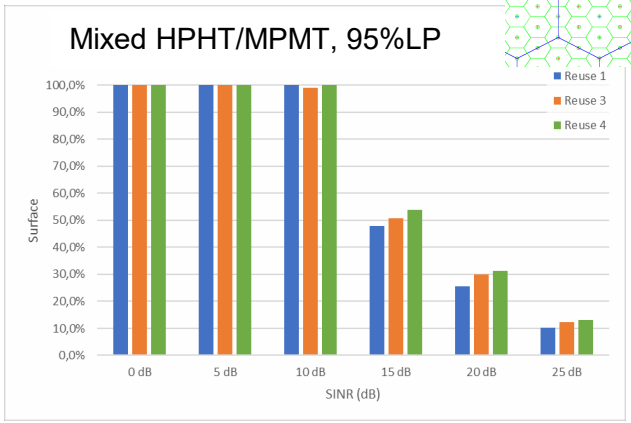


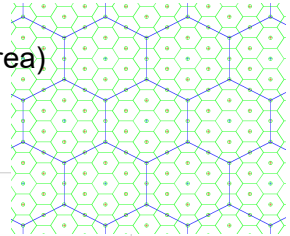
Standalone Broadcast Networks (HPHT/MPMT)

- Objective: Full area coverage (all pixels) with 95% LP in each pixel
- Result below for Handheld Portable outdoor
- Still require a relatively dense network (Mixed HPHT and 2 rows of MPMT sites inside an HPHT coverage area)





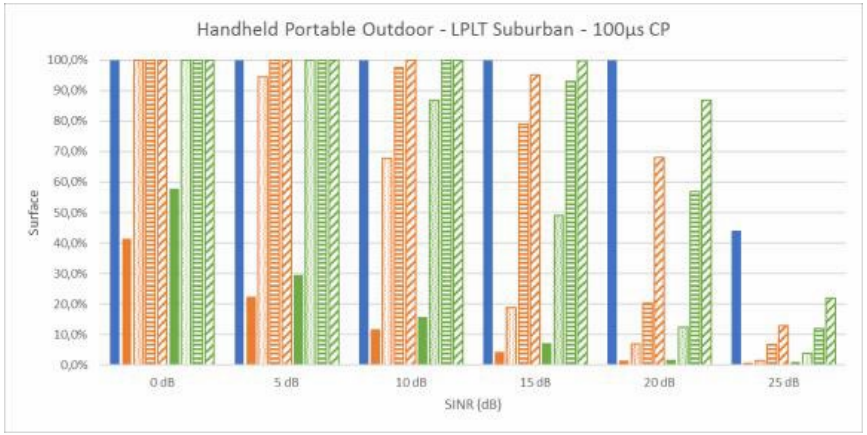


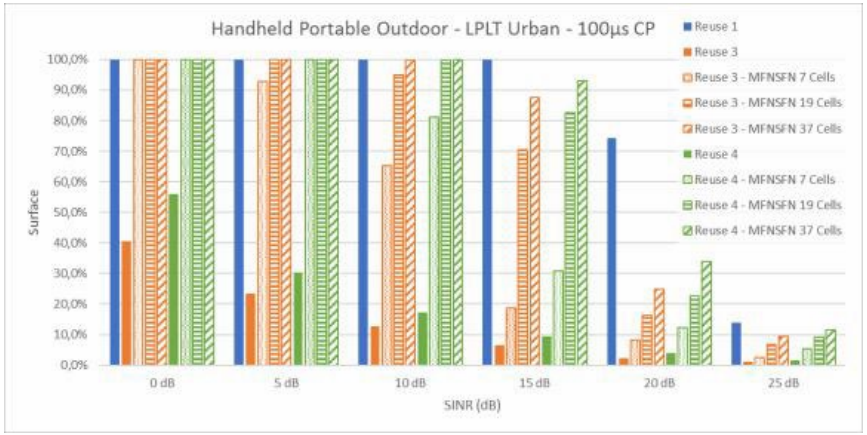


Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
HPHT	80	300	80 dBm/100 kW	1.8
MPMT	23.1	80	67 dBm/5 kW	21.6 (2 rows)

Standalone Broadcast Networks (LPLT)

- Objective: Full area coverage (all pixels) with 95% LP in each pixel
- Result below for Handheld Portable outdoor
- Reuse 1 and reuse 4 with MFN of 37 SFN clusters maximize the SINR
- Requires very dense network (1283 LPLT sites per 10000 km²)





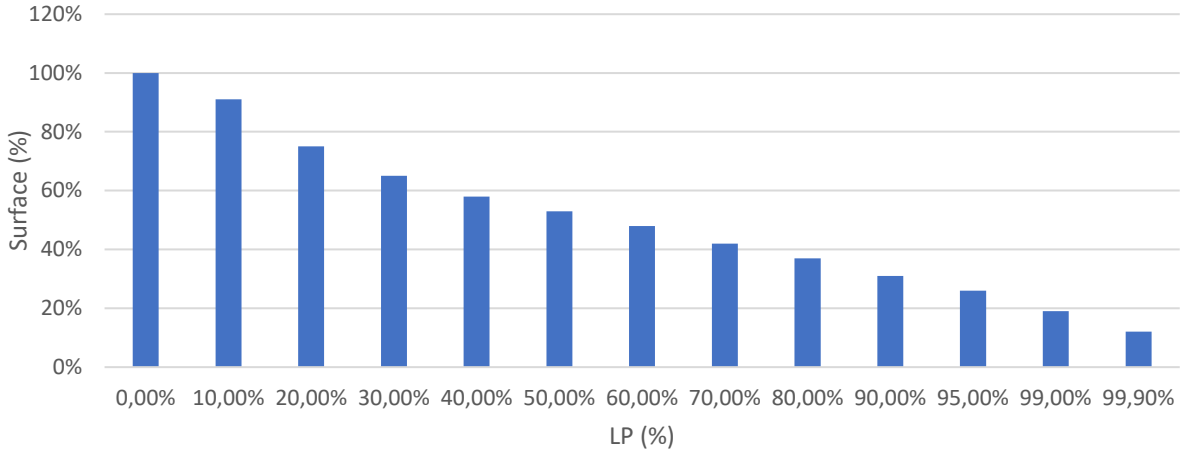
Layer	ISD (km)	Antenna height a.g.l. (m)	EIRP (in a 5 MHz channel)	Site density (per 10000 km²)
LPLT	3	30	57 dBm/500 W	1283

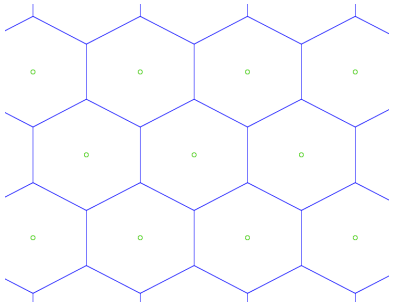
Hybrid Broadcast/Broadband Networks with seamless switchover in the receivers

- Objective: Ensure an acceptable distribution of the Location Probability (LP) across the coverage area for a fixed target SINR
- The possibility of switching seamlessly to Unicast allows
  - Reducing the target LP to less than the 95% required in the standalone Broadcast network → less number of sites required
  - Improving the quality of reception be avoiding interruptions → The unserved locations by the broadcast network can be served by the Unicast Mobile network using the seamless switchover in the receivers
- There is a need for a criteria to define the acceptable reduced LP
  - In real networks, the criteria could be the population coverage
  - In theoretical network, it could be the average LP across the network.

Hybrid Broadcast/Broadband networks

- Results for a single HPHT network for Handheld Portable outdoor reception
- Fixed target SINR of 13 dB
- Average LP 56% - insufficient

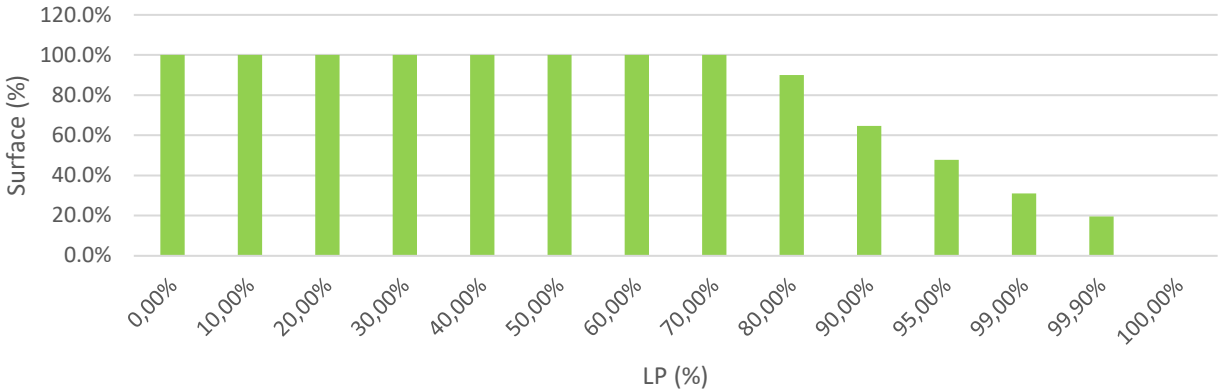


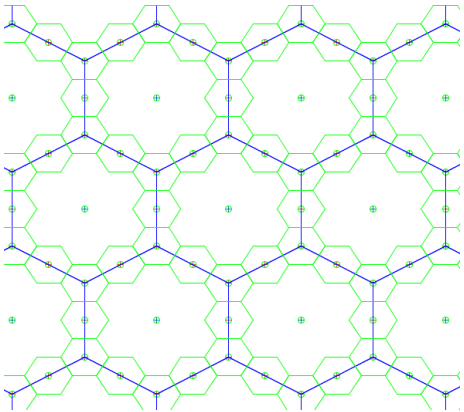


Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
HPHT	80	300	80 dBm/100 kW	1.8

Hybrid Broadcast/Broadband networks

- Results for a mixed HPHT/MPMT network for Handheld Portable outdoor reception
- Same fixed target SINR of 13 dB
- Average LP = 91.3 %
- Reduced density, using only one row of MPMT sites at the edge of each HPHT coverage area.

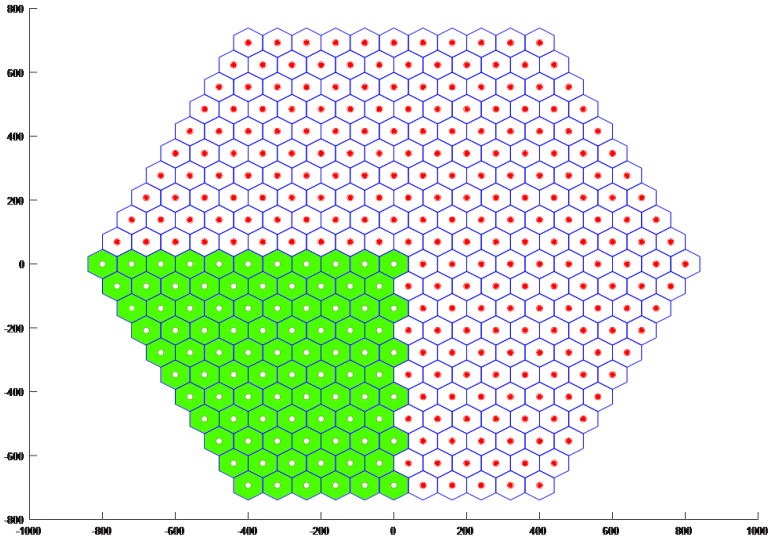


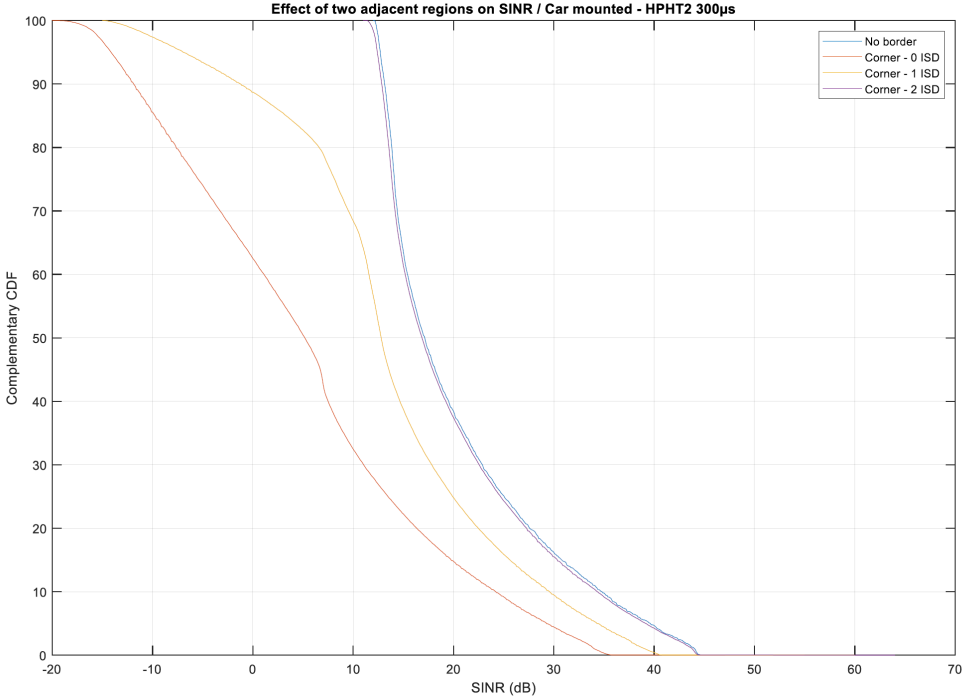


Layer	ISD (km)	Antenna height a.g.l. (m)	ERP (in a 8 MHz channel)	Site density (per 10000 km²)
HPHT	80	300	80 dBm/100 kW	1.8
MPMT	23.1	80	67 dBm/5 kW	10.8 (1 row)

SFN versus MFN

- Regional and national boundaries
- Regulatory constraints

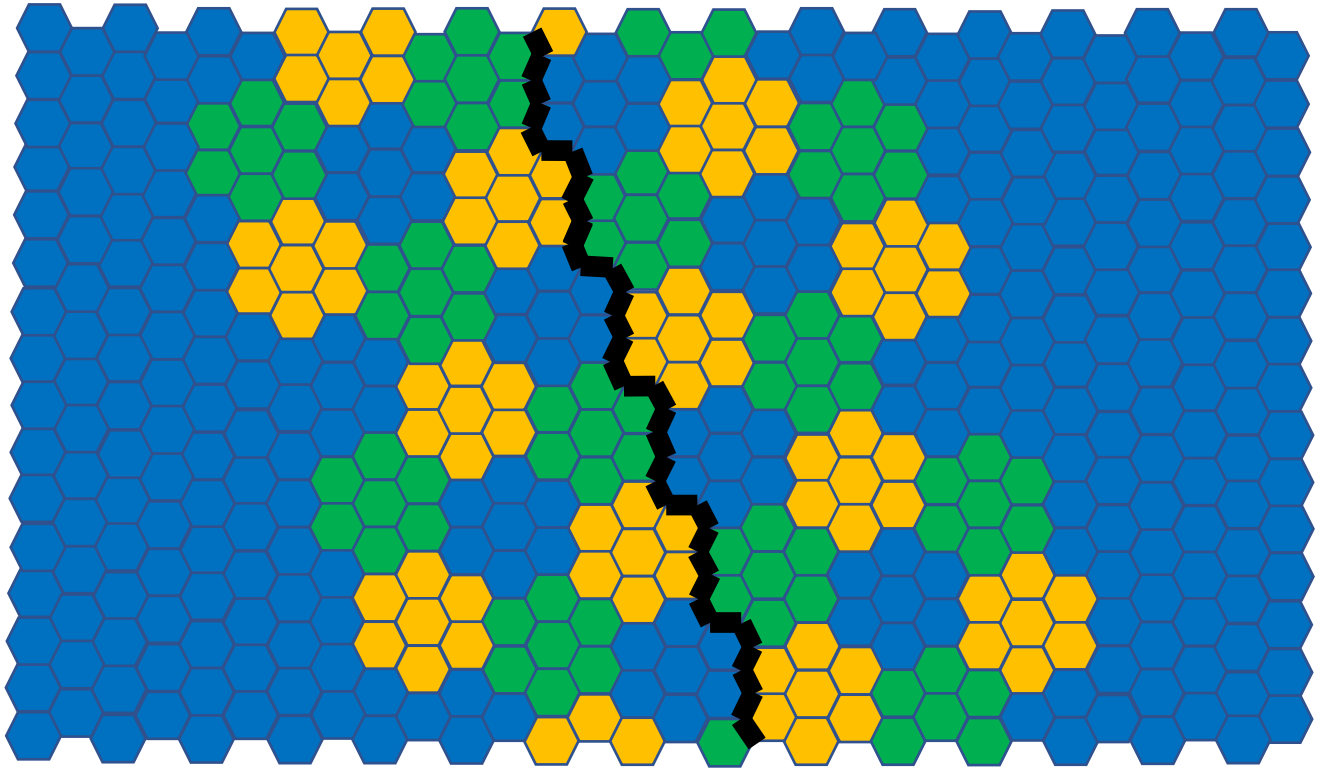




For further details, see section 1.5 “Coverage of national or regional border areas” of Annex 6 to 6A/484

SFN versus MFN

Possible solution



4. Ongoing studies

On the regular networks

- Further simulations on MFN scenarios and other network characteristics
- Aim is to reduce the site density by optimizing the various networks and planning parameters

On case studies (using real Network data)

- Continue studying ways to optimize the broadcast networks by making use of broadcast / Unicast seamless switchover at the receiver.
- Validation with field trials

5. QUESTIONS & ANSWERS

MANY THANKS !

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