

***Reception Survey for assessment of
coverage area for satisfactory
reception of DVB-T2 transmitter
located at Mumbai***

**Reception survey for
assessment of coverage area
for satisfactory reception of
DVB-T2 Transmitter**

Located

At

Mumbai

(Survey period 12/12/16 to 19/12/16)

Field Strength Measurement/Reception Survey Team

PROPAGATION LAB

Research Department

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Introduction

DVB-T2 is the second generation standard for digital terrestrial TV, offering significant benefits as compared to the older version of DVB-T.

The emergence of DVB-T2 is motivated by the higher spectral efficiency. It means that with the same amount of spectrum a larger number of programmes can be broadcast or the same number of programmes broadcast with a higher audio / video quality or coverage quality.

Like its predecessor, DVB-T2 uses OFDM (orthogonal frequency division multiplex) modulation with a large number of subcarriers, delivering a robust signal, and offers a range of different modes, making it a very flexible standard. DVB-T2 uses the same error correction coding as used in DVB-S2 and DVB-C2: LDPC (Low Density Parity Check) coding combined with BCH (Bose-Chaudhuri-Hocquengham) coding, offering a very robust signal. The number of carriers, guard interval sizes and pilot signals can be adjusted, so that the overheads can be optimised for any target transmission channel. Additional new technologies used in DVB-T2 are as follows:

- Multiple Physical Layer Pipes allow separate adjustment of the robustness of each delivered service within a channel to meet the required reception conditions (for example in-door or roof-top antenna). It also allows receivers to save power by decoding only a single service rather than the whole multiplex of services.
- Alamouti coding is a transmitter diversity method that improves coverage in small-scale single-frequency networks.
- Constellation Rotation provides additional robustness for low order constellations.
- Extended interleaving, including bit, cell, time and frequency interleaving.
- Future Extension Frames (FEF) allow the standard to be compatibly enhanced in the future.

As a result, DVB-T2 can offer a much higher data rate than DVB-T OR a much more robust signal.

Objectives of Survey

Main objectives of this survey are given below:

- Determination of service range of Mumbai DVB-T2 TV transmitter, operating on 474 MHz in QPSK (SD) (Channel # 21) in fixed reception mode (Reception antenna at a height of 10 meters).
- Determination of service range of Mumbai DVB-T2 TV transmitter, operating on 522 MHz on 256 QAM (HD) (Channel # 27) in fixed reception mode (Reception antenna at a height of 10 meters).
- Determination of service area of channel 21 on Smart phones using "TV on GO" dongle.
- Identifying areas of poor reception of the transmission, in the coverage areas of Mumbai DVB-T2 transmitter.

Equipment Used

1. Field strength cum Spectrum Analyzer, Anritsu MS 2035B & MS 2013E.
2. UHF standard Dipole Antenna, Anritsu MP663A.
3. Rhode & Schwarz make UHF log periodic antenna HL 223
3. GPS Navigator, Garmin Montana 650.
4. DVB-T2 STB.
5. Sony LCD TV receiver.
6. IRD, Ericsson RX-8200
7. TV on Go DVB-T2 dongle for Android phones.
7. Tata Safari Survey van equipped with 10 meter pneumatic mast and 3 KVA Honda generators.
8. Other accessories as per requirements.

Planning Criteria

Antenna diagram for fixed reception

The antenna diagram characterizes the relative output level of an antenna when the signal is received under different angles. Recommendation ITU-R BT.419 defines the directivity of a standard antenna used for fixed broadcast reception as in Fig. 1. To reproduce the actual receiving conditions of a customer installation, measurements for fixed coverage have been made with a measurement antenna having the same directivity.

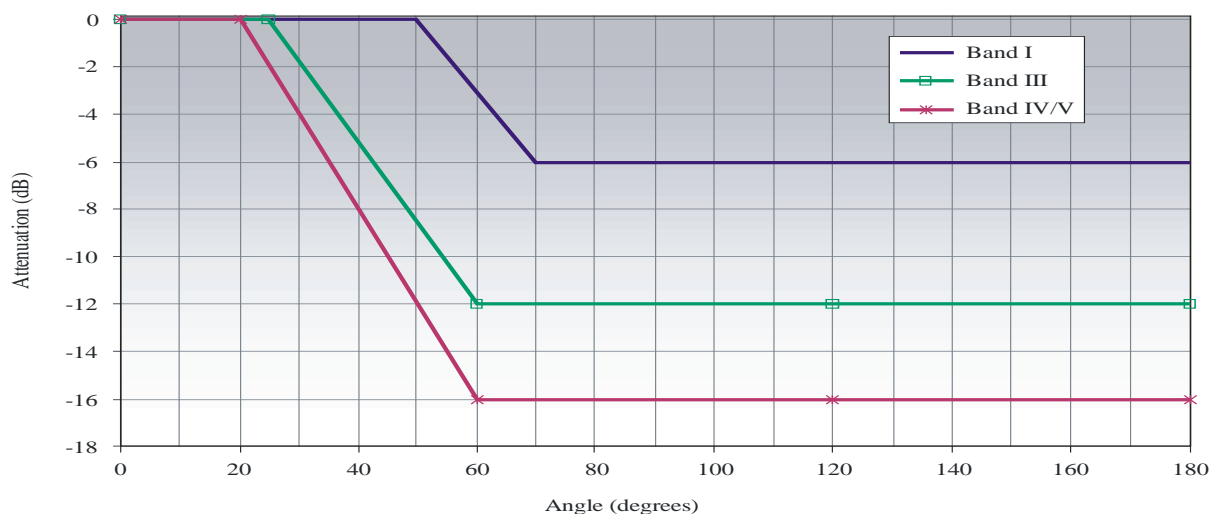


Figure-1

The term “covered”

A certain area is regarded as being “covered” by DVB-T2, when the median field strength for the particular receiving situation in a specified height above ground (often 10 m) and the protection ratio reach or exceed the values given in the relevant planning documents (e.g. ITU doc).

The fact of a certain area to be covered or not is a result of the calculation process done with a coverage survey that assumes defined conditions and/or values for:

- The receiving condition (e.g. fixed or portable reception);
- The field strength loss with distance due to topography and morphology;
- The receiver model (e.g. sensitivity and selectivity);
- The receiving antenna (height, gain and directivity);
- The reception channel (Gaussian, Rice or Rayleigh).

Attached to the attribute “covered” is also a certain probability in time and location. Using planning tools, the coverage area was calculated for this probability (e.g. 50% of the time and 50% of the locations).

It can therefore not be assumed that DVB-T2 reception with a standard receiver is possible at every single location inside the area defined as being covered.

Verification of coverage cannot be done with a standard DVB-T2 receiver by simply checking whether it works at a certain location. Instead, the technical parameters such as field strength have been measured, under the same receiving conditions as assumed in the planning tool.

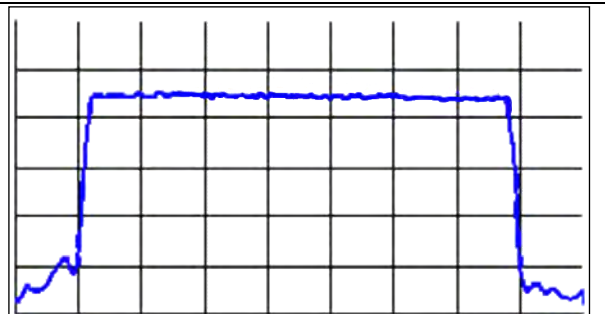
Reception Channel

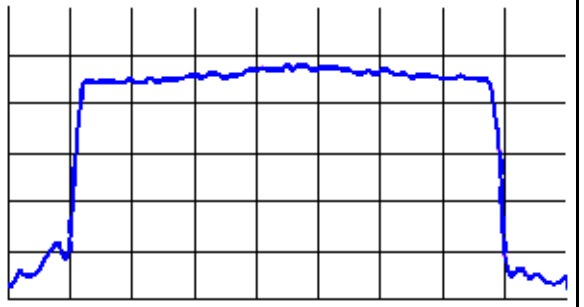
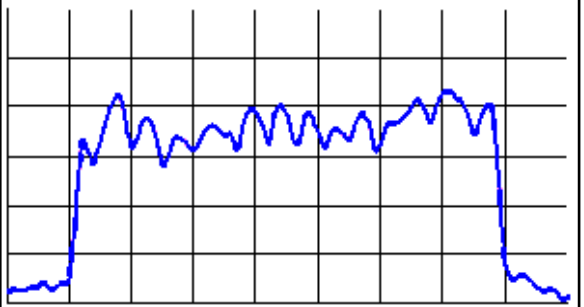
Due to reflections, shading and reception of signals from multiple transmitters of an SFN, the received spectrum can be degraded. The order of this degradation determines the reception channel

The standard deviation of the spectral amplitudes σ_{sp} has an influence on the minimum receiver input level necessary to decode the DVB-T2 signal.

Gauss channel:

Only the direct signal from a transmitter within line-of-sight is received. No reflections and co-channel emissions are received. As a result, the OFDM spectrum is rectangular. The standard deviation of the spectral amplitudes over the channel bandwidth σ_{sp} is between 0 and 1 dB.



<p>Rice channel: In addition to the direct signal, several smaller co-channel signals and reflections are received. The OFDM spectrum shows slight variations in amplitude over frequency. The standard deviation of the spectral amplitudes over the channel bandwidth σ_{sp} is between 1 and 3 dB.</p>	
<p>Rayleigh channel: The received signal is composed only of reflections and components from various co-channel transmitters. No dominant direct signal is received. The OFDM spectrum shows heavy distortion. The standard deviation of the spectral amplitudes over the channel bandwidth σ_{sp} is higher than 3 dB.</p>	

Measurement Set-Up

The field trial was carried out by utilizing mobile survey van of Research department having 10 meter pneumatic telescopic mast. Field strength measurement was carried out, using Anritsu make spectrum analyzer & UHF band standard dipole antenna with known correction factor already loaded in the analyzer for different channels. To record digital parameters, Ericsson made IRD was used. In addition to this Garmin make GPS was used for the determination of the co-ordinates and LOS distance.

ITU Parameters for reception of DVB-T2 transmission (BT. 2254-2)

DVB-T2 in Band IV/V			Fixed	Portable outdoor/urban	Portable indoor/urban	Mobile/rural	Handheld portable outdoor	Handheld mobile Class H-D/integrated antenna
Frequency	Freq	MHz	650	650	650	650	650	650
Minimum C/N required by system	C/N	dB	19.7	17.8	18.2	10.0	9.6	10.0
System variant (example)			256-QAM FEC 2/3, 32k, PP7 Extended	64-QAM FEC 2/3, 32k, PP4 Extended	64-QAM FEC 2/3, 16k, PP1 Extended	16-QAM FEC 1/2, 8k, PP1 Extended	16-QAM FEC 1/2, 16k, PP3 Extended	16-QAM FEC 1/2, 8k, PP2 Extended
Bit rate (indicative values)		Mbit/s	35-40	26-29	23-28	11-14	12-15	11-14
Receiver noise figure	F	dB	6	6	6	6	6	6

DVB-T2 in Band IV/V			Fixed	Portable outdoor/urban	Portable indoor/urban	Mobile/rural	Handheld portable outdoor	Handheld mobile Class H-D/integrated antenna
Equivalent noise bandwidth	B	MHz	7.77	7.77	7.77	7.71	7.77	7.71
Receiver noise input power	P_n	dBW	-129.1	-129.1	-129.1	-129.1	-129.1	-129.1
Min. receiver signal input power	$P_{s_{min}}$	dBW	-109.4	-111.3	-110.9	-119.1	-119.5	-119.1
Min. equivalent receiver input voltage, 75 Ω	U_{min}	dB μ V	29.4	27.5	27.9	19.6	19.3	19.6
Feeder loss	L_f	dB	4	0	0	0	0	0
Antenna gain relative to half dipole	G_d	dB	11	0	0	0	-9.5	-9.5
Effective antenna aperture	A_a	dBm ²	-4.6	-15.6	-15.6	-15.6	-25.1	-25.1
Min power flux-density at receiving location	θ_{min}	dB(W)/m ²	-100.8	-95.7	-94.3	-103.5	-94.4	-94.0
Min equivalent field strength at receiving location	E_{min}	dB μ V/m	45.0	50.1	50.5	42.3	51.4	51.8
Allowance for man-made noise	P_{mmn}	dB	0	1	1	0	0	0
Penetration loss (building or vehicle)	L_b, L_v	dB	0	0	11	0	0	8
Standard deviation of the penetration loss		dB	0	0	6	0	0	2
Diversity gain	Div	dB	0	0	0	0	0	0
Location probability		%	70	70	70	90	70	90

DVB-T2 in Band IV/V			Fixed	Portable outdoor/urban	Portable indoor/urban	Mobile/rural	Handheld portable outdoor	Handheld mobile Class H-D/integrated antenna
Distribution factor			0.5244	0.5244	0.5244	1.28	0.5244	1.28
Standard deviation			5.5	5.5	8.1	5.5	5.5	5.9
Location correction factor	C_l	dB	2.8842	2.8842	4.24764	7.04	2.8842	7.552
Minimum median power flux-density at reception height ¹ ; 50% time and 50% locations	θ_{med}	dB(W)/m ²	-97.9	-91.8	-79.1	-96.5	-91.5	-78.5
Minimum median equivalent field strength at reception height ¹ ; 50% time and 50% locations	E_{med}	dB μ V/m	47.9	54.0	66.7	49.3	54.0	67.3
Location probability		%	95	95	95	99	95	99
Distribution factor			1.6449	1.6449	1.6449	2.3263	1.6449	2.3263
Standard deviation			5.5	5.5	8.1	5.5	5.5	5.9
Location correction factor	C_l	dB	9.04695	9.04695	13.32369	12.79465	9.04695	13.72517

DVB-T2 in Band IV/V			Fixed	Portable outdoor/urban	Portable indoor/urban	Mobile/rural	Handheld portable outdoor	Handheld mobile Class H-D/integrated antenna
Minimum median power flux-density at reception height ¹ ; 50% time and 50% locations	θ_{med}	dB(W)/m ²	-91.8	-85.7	-72.4	-90.8	-85.4	-72.3
Minimum median equivalent field strength reception height ¹ ; 50% time and 50% locations	E_{med}	dB μ V/m	54.0	60.1	75.8	55.0	60.4	73.5

⁽¹⁾ 10 m for fixed reception and 1.5 m for the other reception modes.

Basic Data and Transmitter details

Transmitter Details:

1. Name of the Station	:	DDK Mumbai
2. GPS data of TV transmitter tower	:	N 19.00722° & E 72.82000°
3. Terrain around Transmitter	:	Urban, Populated Residential
	:	Tx-1(474 MHz) Tx-2(522 MHz)
4. Rated power of the transmitter	:	6.0 KW 6.0 KW
5. Forward radiated power	:	5.98 KW 6.03 KW
6. Reflected Power	:	3W 3 W
7. Transmission mode	:	QPSK 256 QAM
8. Make	:	HARRIS HARRIS
9. Model	:	MAXIVA MAXIVA ULX6500T2 ULX6500T2

- 10. Frequency of operation : 474 MHz 522 MHz
- 11. Date of commissioning : 25/2/16

Transmitting Antenna Details

- 1. Make : SIRA SISTEMI RADIO
- 2. Type/Model : UTV-01/24(6x4)
- 3. Antenna Gain : 12.9 dBd (Nominal)
- 4. Effective height of antenna (Midbay) : 300 meters.
- 5. Polarization : Horizontal

Transmission Parameters of DTT transmission at DDK, MUMBAI

CH # 21	CH# 27
474 MHz (SD)	522 MHz (HD)

- | | | |
|----------------------|--------------|------------------|
| 1. Constellation: | QPSK | 256QAM |
| 2. PLP: | | |
| 3. PILOT PATTERN: | PP2 | --- |
| 4. CODE RATE: | 1/2 | 3/4 |
| 5. FFT: | 8K EXT | 8K EXT |
| 6. OFDM SYMBOL RATE: | 992 SYM /S | --- |
| 7. BW: | 8 MHz | 8 MHz |
| 8. GUARD INTERVAL: | 1/8 | 1/8 |
| 9. SISO/MISO: | SISO | SISO |
| 10. PLP BIT RATE: | 4.858 MBIT/S | 28.3 MBIT/S |
| 11. FREQUENCY: | 474 MHz | 522 MHz |
| 12. CONTENT: | SD Channels | HD & SD Channels |

Measurement Method

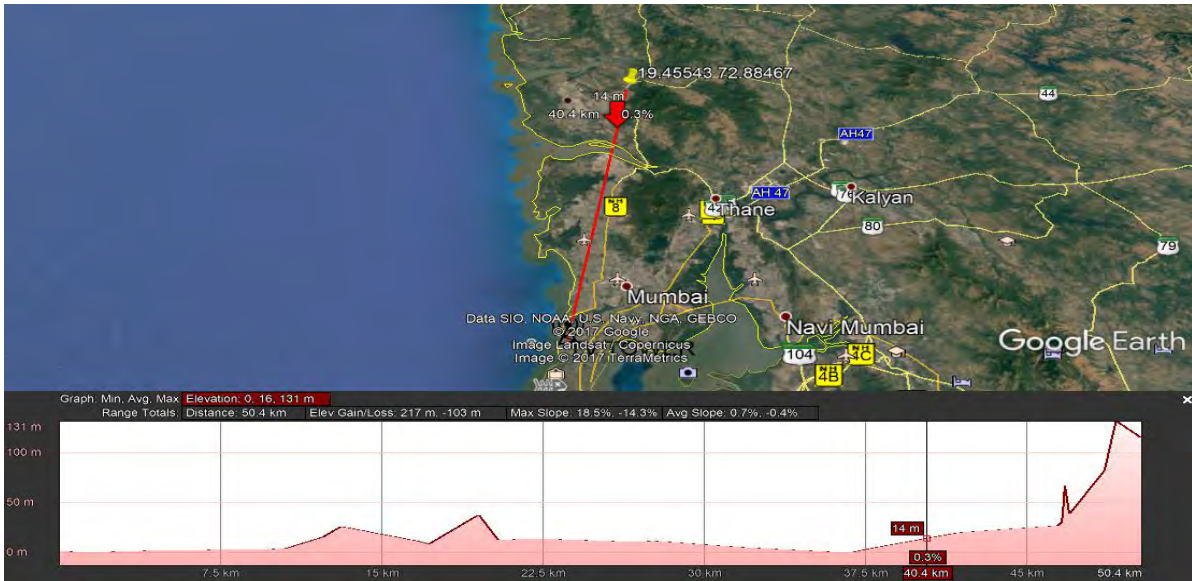
Google and Garmin maps were used throughout the survey for making different routes. Location of the transmitter tower was marked using GPS for reference purpose. Using this reference all the routes and survey points (Map-6) were decided keeping in consideration the type of terrain encountered. Since the purpose of the survey was to determine the fixed primary coverage area for satisfactory reception, the measurement was carried out in static condition along the motor able roads along particular route. ITU recommendation BT.2254-2 was used for determining coverage area on the basis of field strength at a height of 10 meters above ground using standard antenna. As per ITU recommendation the receiving antenna for subjective assessment of picture and sound quality must be checked using directional Yagi antenna having gain of 11 db (Nominal) under fixed roof top mode. Accordingly necessary corrections were made where ever required. Digital television service coverage is characterized by a very rapid transition from near perfect reception to no reception at all and it thus becomes critical to be able to define which areas are going to be covered and which not. Accordingly coverage definition of "Excellent "has been selected as the case where 95 % of the locations within a small area are covered.

For coverage assessment of reception on Android smart phone using "TV on GO" DVB-T2 dongle, the height of smart phone is kept at 1.5 meters above normal ground level. All the available content were observed and recorded along with data. After attending all the routes, the field strength data and subjective assessment were tabulated.

Route Analysis

1. North: Table-1&6 and MAP-1

This route lies in the north direction from TV tower located in Worli area of Mumbai. The main cosmopolitan areas like Bandra, SV Road, Andheri(W) , Goregaon, lokhandwala complex and Meera road lies in this route. The entire area consists of high rise buildings and dense population. The movement of vehicular traffic was very high. As more and more buildings are now using electronic ballast for lighting and other RF source for different uses, the overall man made noise was very high in this area.

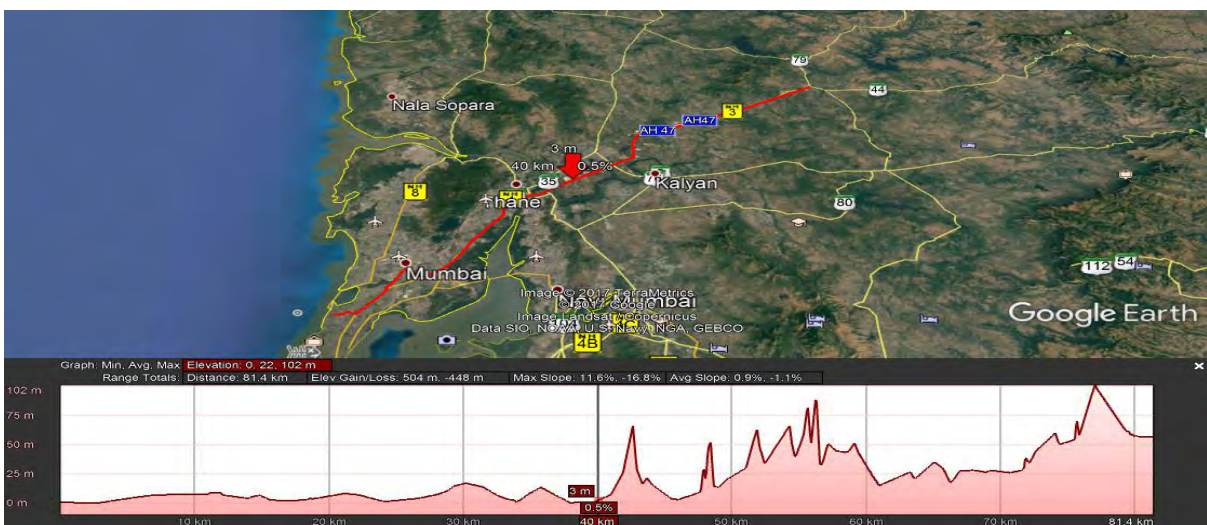


MAP-1

If we check the terrain profile, it looks very normal up to the LOS distance of 40 to 50 Km. Afterwards it increases from 23 meter to 131 meter at LOS distance of just 50 Km or more. This prevents propagation of DTT signal and it becomes very low. The effective range in this route was found up to 40 Km only with respect to minimum signal requirement which is 54db μ v/ m only (ITU BT.2254-2). Similarly for Smart phone reception, excellent quality was found up to a LOS distance of 10 Km only. For SD channel 21, bad spots were also observed within the primary coverage at LOS distance of 20 & 25 Km. Channel 27 DTT signal in HD mode was also available at a LOS distance of 40 Km only.

2. North-East 1: Table-2&7 and Map-2

This route goes up to Bhiwandi and up to NH# 160 near Vasind. The minimum signal requirements were available up to a LOS distance of 30 Km only. Here the MER on Ericsson T2 IRD was 23.5 db.

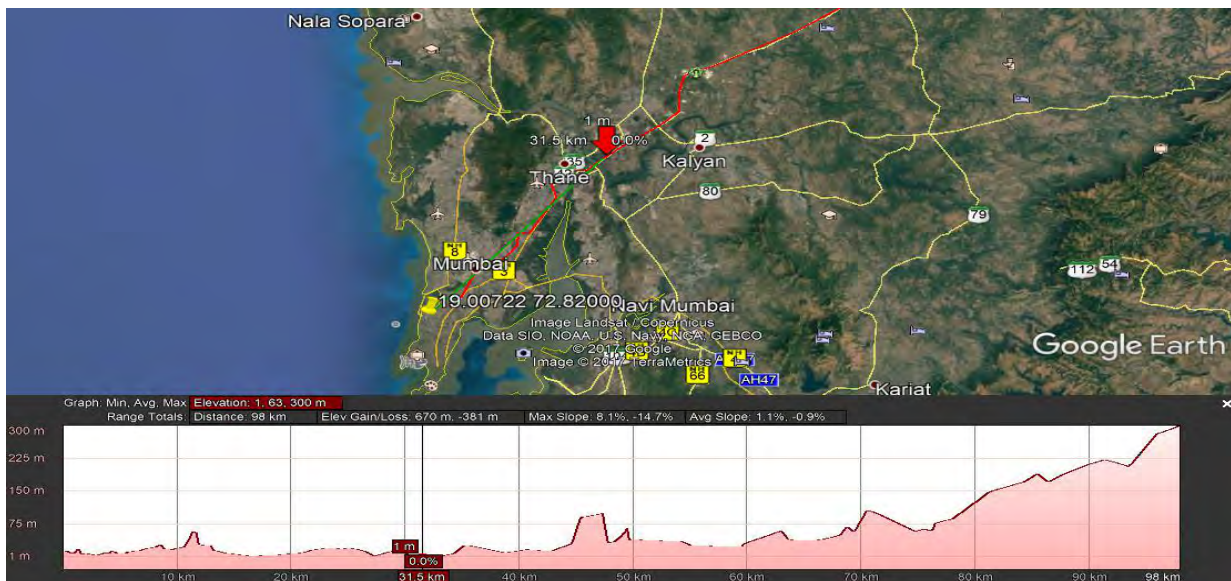


MAP-2

As evident from MAP-2, hillocks lie in this route from road distance of 45Km to 80 Km with height fluctuating from 70 meter to 102 meters. Afterwards there is a regular increase in height. The hillock at 80 Km was reflecting signals of DTT which severely impaired the MER of receiver. Accordingly field strength of 30 Km was considered as primary coverage with exceptions at few bad spots within the coverage route. Again Smart phone reception was excellent up to a LOS distance of 10 Km only.

3. North-East-2: Table-3&8 and Map-3

This route was similar to earlier one with change in direction from Bhandup East. We checked the DTT signals up to POTGAON which was at a LOS distance of 71 Km. The minimum required signal was



MAP-3

available up to a LOS distance of 31.9 Km at Nilje Gaon location. If we take curvature of earth as a perfect sphere then for a DTT transmitter antenna height of 300 meters, horizon will be at a distance of 61 Km. However even at a LOS distance of 60 Km, field strength was very low. Here comes the high rise buildings (30 floor or more) in Thane area, which was creating obstacle for DTT transmission. For HD transmission the coverage range was only up to 15 to 20 Km. As field strength was 81 db μ V/ m at a LOS distance of 10 Km and 39 db μ V/ m at a LOS distance of 32 Km, the figure of 45 db μ V/m has been considered for HD channel coverage.

4. East: Table 4&9 and Map-4

Prominent, locations in this route was Mumbai port trust road, Trombay, Chembur (E), Elephanta caves, Panvel east etc. The minimum signal required for coverage purpose was located on NH#48 near Toll road at a LOS distance of 34.7 Km. Similarly for HD channel of 27, the coverage was up to LOS distance of 31.8 Km. In HD channel, field strength drops to 47 from 64 db μ V/m within a distance of 3 Km.

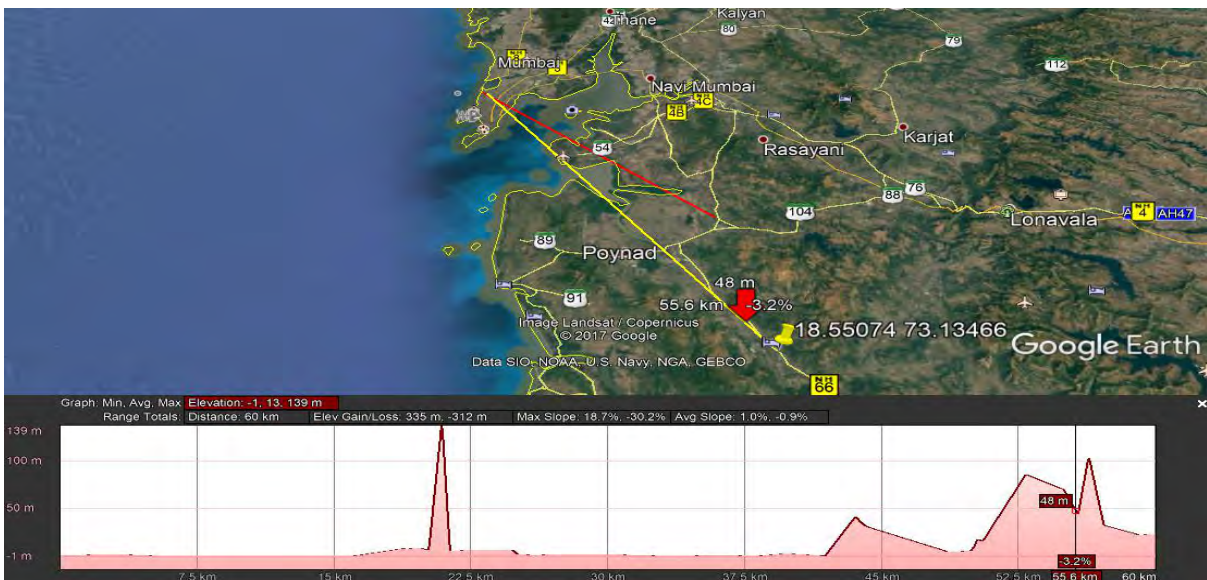


MAP-4

The terrain profile shows few peaks of 260 meter height along the route. The working of Smart phone using "TV on Go" DVB-T2 dongle was observed up to a LOS distance of 35 Km.

5. South: Table 5&10 and Map-5

This route was the longest one as minimum required signal was available at LOS distance of 60 Km for SD channels 21 and 40 Km for HD channel of 27. Tall buildings or structure was not there. The entire stretch was without any physical obstacle except long trees in Colaba & Malabar hills at initial range of 10 Km.



Map-5

The DTT signal strength reduced to below 54 dBμV/m, due to the free space attenuation, Earth's horizon and one small hillock. The Smart phone worked well up to the LOS distance of 40 Km

Conclusion:

Based on the field strength and other related factors, the coverage in different direction are as follows (Map-7 & 8).

Direction from Antenna tower	Coverage in Kilometers		
	CH#21/SD As per ITU Reco. BT2245-2	CH#27/HD As per ITU Reco. BT2245-2	SMART PHONE As per good reception basis.
NORTH	40	40	20
NORTH-EAST 1	30	30	25
NORTH-EAST 2	32	15	20
EAST	35	32	35
SOUTH	60	60	40

The remaining three directions namely South-West, West and North-West areas lies in Arabian Sea, and due to the non availability of proper means of transport, cannot be checked. Few randomly selected locations were also checked for reception quality. The same is available in table-11.

Acknowledgement:

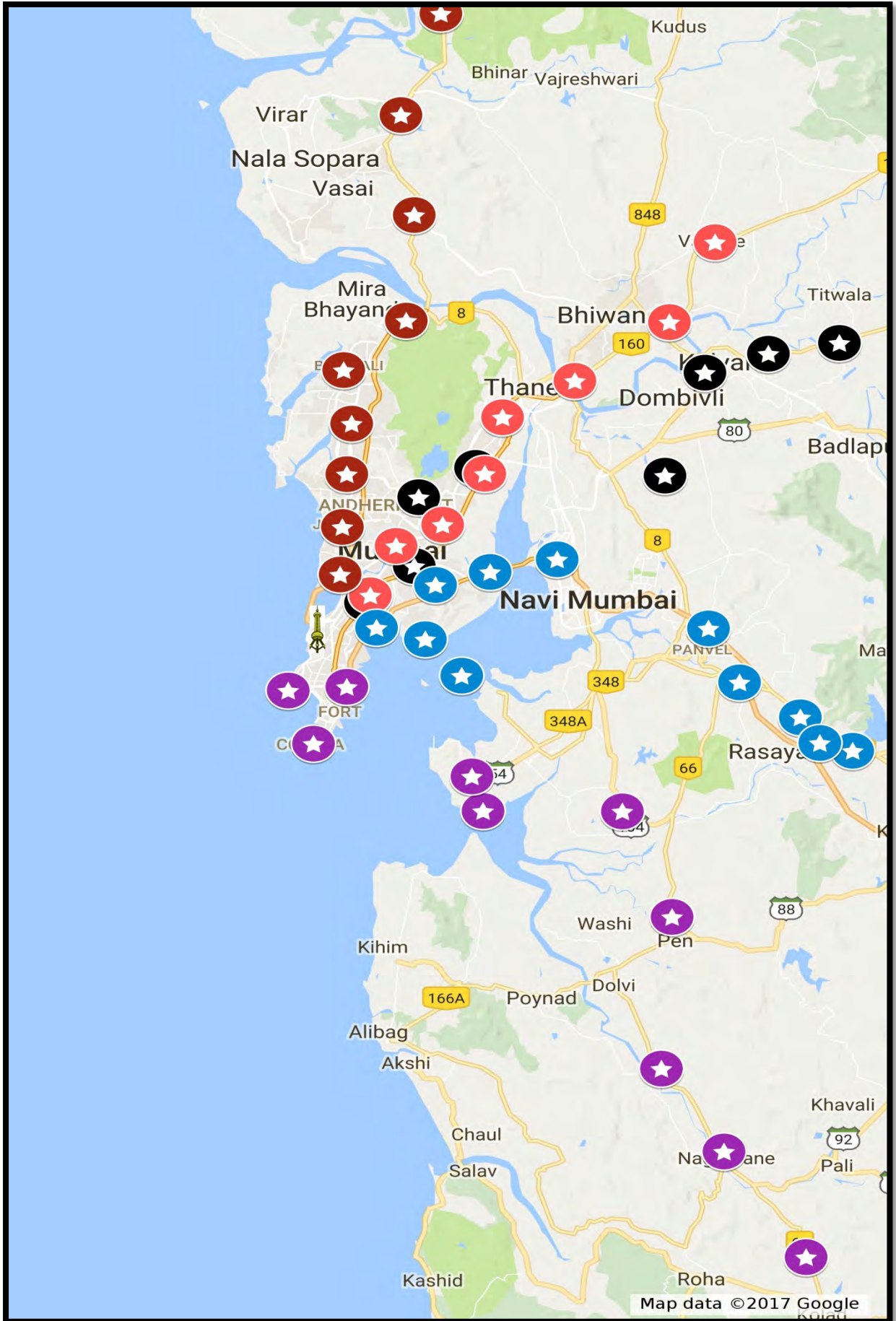
The DTT coverage survey of DDK, Mumbai was carried out by the Propagation labs of The Research department of AIR & DD, New Delhi. The field trial was successfully done with the sincere support of Engineers of DDK, Mumbai. The survey team also extends their gratitude to Mr.Satyajit Dash, DDG (E), Mrs. Ujjawal Chandramore, DE and Mr. Zende, AE of DDK Mumbai for necessary support. We are thankful to Mr. B Soni, DDG (E), O/o ADG (E) WZ for providing all logistic support.

Further study:

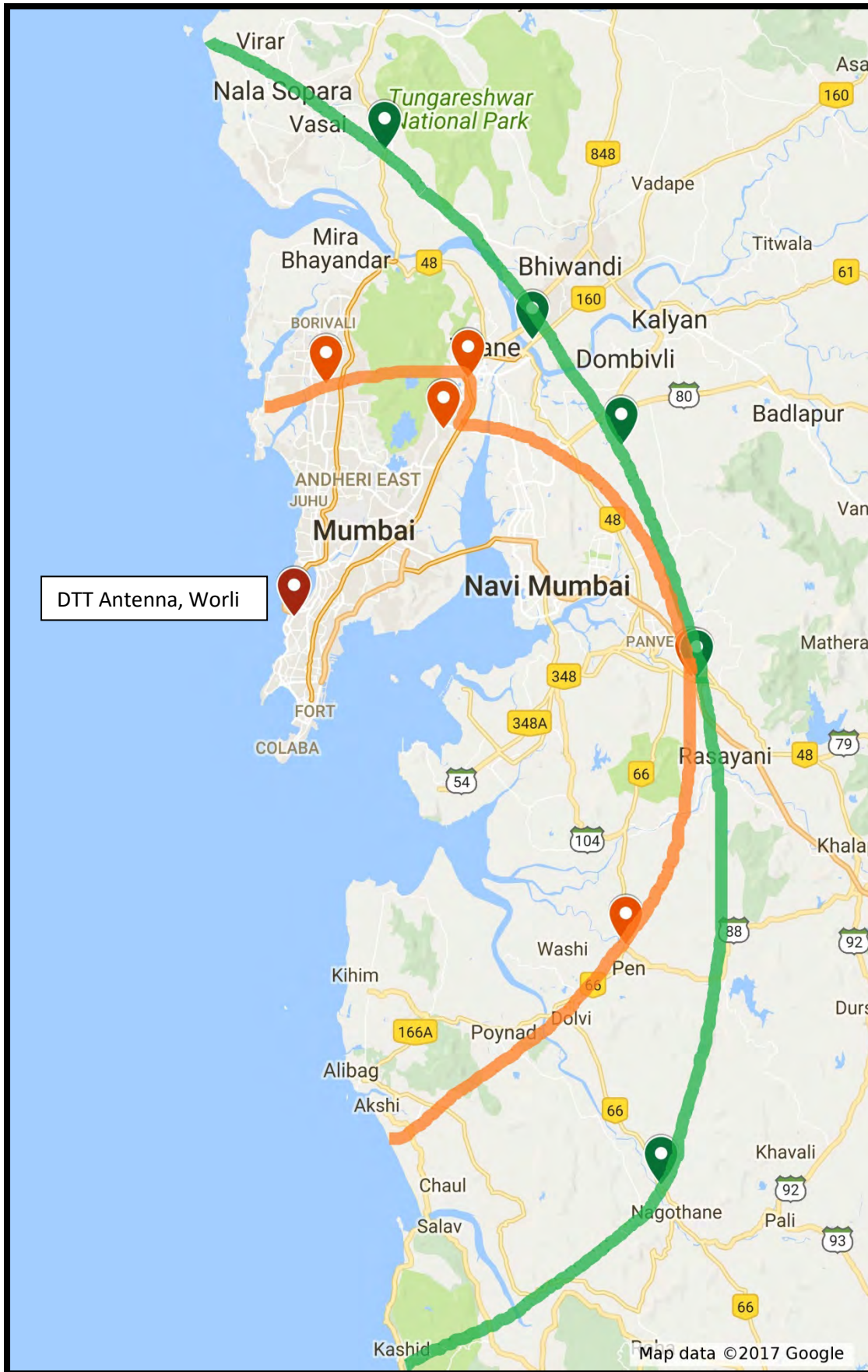
Mumbai is a very big city surrounded by tall buildings and dense population and very high vehicular traffic. Reception of DTT on smart Mobile Phone requires street by street survey using latest software based instruments like ETL with unidirectional calibrated antennas mounted on vehicle top. Automatic recording of data with GPS marking will provide excellent report on such coverage. Doordarshan Directorate may explore the possibility of such surveys in metropolitan cities.

SURVEY LOCATIONS IN MUMBI

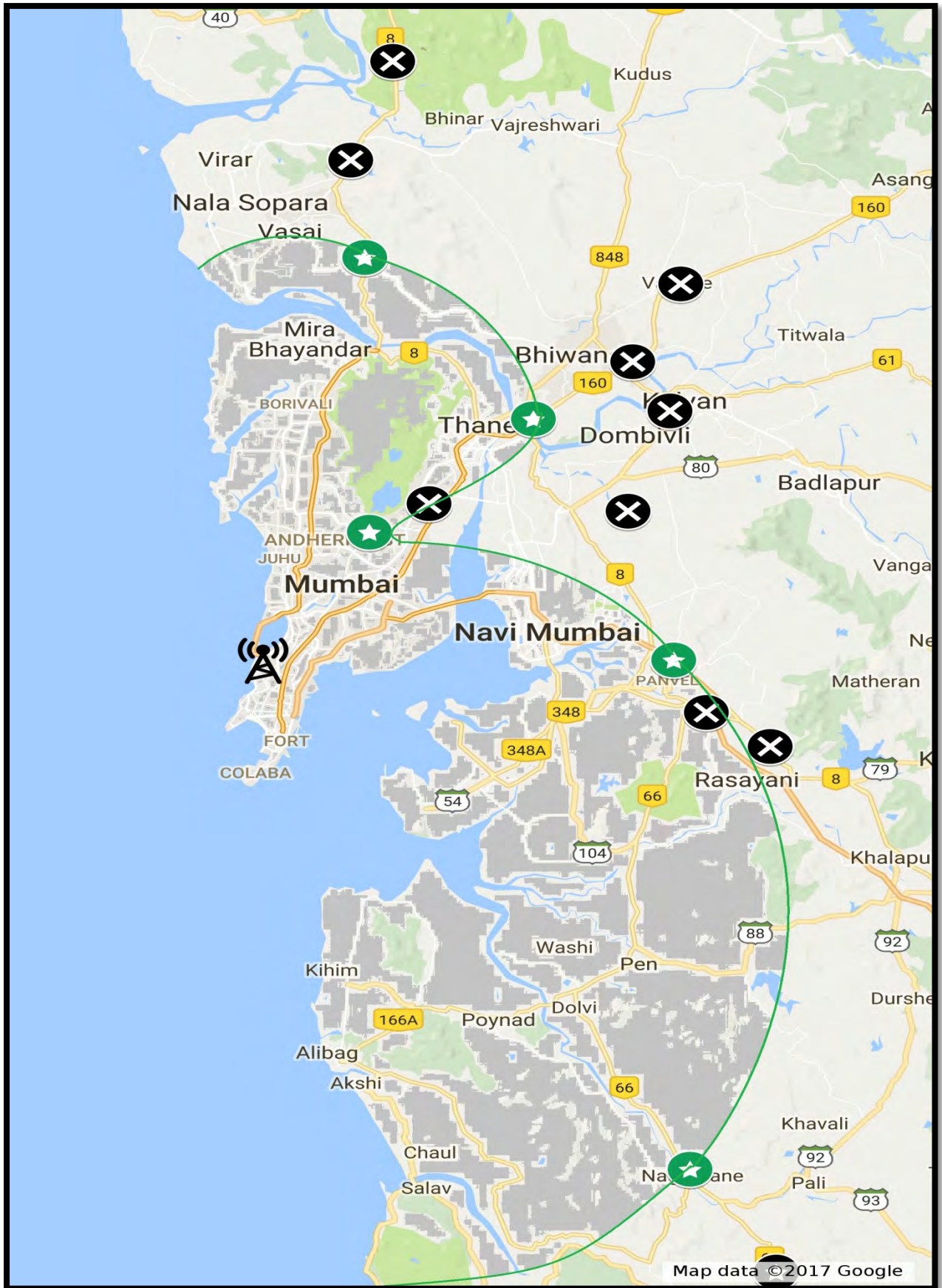
MAP-6



BROWN-NORTH, PINK-NORTH-EAST1, BLACK-NORTH-EAST2, BLUE-EAST, PURPLE-SOUTH



Legends: Thick green lines denotes boundary of fixed reception coverage of channel 21 (474 MHz), where as thick orange lines denotes boundary of Smart phone reception coverage of channel 21 at low heights(1.5 to 2 meters) without consideration of ITU recommended field strength values.



Reception Survey of DTT from DDK-Mumbai transmitter on Channel 21 (474 MHz)

DIRECTION: NORTH
 ROUTE: TV TOWER-BANDRA-SV ROAD-MEERA ROAD-VASAI-NH#48

TABLE: 1
 DATE: 13-14/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			Subjective Assessment		Terrain	Remarks
						MER (dB)	BER(Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
1630	SV ROAD, BANDRA	19.05492 72.83762	8	5.6	69	22	1.5 E-3	1.0 E-8	EXCELLENT	EXCELLENT	HT/HDP/MRB	
1750	JUHU APPT SV ROAD	19.09651 72.83948	9	10	81	24	7.5 E-4	4.5 E-8	---DO---	---DO---	MT/LRB/VEG/	
1950	GAUTAM NGR SV ROAD	19.14273 72.84296	10	15	50	19.1	2.4 E-3	3.0 E-5	---DO---	---DO---	HT/HRB/	WIDE ROAD
2115	NEAR MALAD RS SV RD	19.18658 72.84661	19	20	39	3	2.3 E-2	1.9 E-6	---DO---	---DO---	MT/HRB/VEG	
2150	NEW LINK RD BORIVALI(W)	19.23342 72.84055	10	25	41	18	2.1 E-3	1.0 E-8	---DO---	DROPS	MT/MRB/VEG/O A	
1115	MEERA RD EAST WESTERN EXPRESSWAY	19.27634 72.88868	12	30	NT	NT	NT	NT	NT	NT	OA/HT/HILLOCK	NEARBY HILL
1210	NH#48 VASAI	19.36856 72.89481	23	40	62	25.9	1.3 E-3	1.0 E-8	EXCELLENT	EXCELLENT	HT/NHW/OA	MULTI PATH
1240	NH#48	19.54402 72.91560	30	60	NT	NT	NT	NT	NT	NT	LT/NHW/VEG	BETWEEN HILLS OF 300M
1300	NH#48 NEAR SAPHALE XING	---	---	65	NT	NT	NT	NT	NT	NT	LT/NHW/VEG	BETWEEN HILLS OF 300M
1345	NH#48 VIRAR EAST	19.45543 72.88467	38	50	42	20.4	2.4 E-3	3.0 E-8	EXCELLENT	NT	HT/NHW/OA/ VEG	BETWEEN HILLS

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 21 (474 MHz)

DIRECTION: NORTH-EAST-1

TABLE: 2

ROUTE: TV TOWER-SION-BHANDEP-BHIWANDI-NAGPADA

DATE: 14/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			Subjective Assessment		Terrain	Remarks
						MER (dB)	BER(Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
2120	SION CIRCLE-SION EAST	19.03686 72.86095	11	5	74	24	8.0 E-4	1.5 E-8	EXCELLENT	EXCELLENT	HT/MRB	WIDE ROAD FS@3M-67db μ v
2045	LBS MARG NEAR KISMAT NAGAR	19.08008 72.88078	5	10	77	25.2	8.2 E-4	1.0 E-8	---DO---	---DO---	HT/MRB/POP	FS@3M-73
2000	LBS MARG VIKROLI WEST	19.09830 72.91685	16	15	55	26	9.5 E-4	1.0 E-8	---DO---	---DO---	HT/HRB/NOISY	FS@3M-59
1920	BHANDUP EAST EASTERN EXPRESSWAY	19.14297 72.94973	7	20	63	25.5	1.0 E-3	1.0 E-8	---DO---	---DO---	VHT/OA/NOISY	FS@3M-60
1850	NAUPADA EASTERN EXPRESSWAY	19.19205 72.96317	18	25	53	24.5	5.2 E-6	1.0 E-8	EXCELLENT	NT	HT/HRB/NOISY	FS @3M- 37db μ v/m
1600	NH# 160 NEAR THANE	19.22408 73.01912	11	30	59	24.9	4.4 E-3	2.1 E-5	---DO---	---DO---	HT/OA	
1700	NH#160 NEAR BHIWANDI	19.27529 73.09238	13	41	43	17.5	2.5 E-3	1.5 E-8	---DO---	NT	HT/OA	
1750	NH#160	19.34476 73.12764	46	50	18	NT	NT	NT	NT	NT	HT/OA	NEARBY HILLS

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 21 (474 MHz)

DIRECTION: NORTH-EAST-2

TABLE: 3

ROUTE: TV TOWER-TROMBAY-NAVIMUMBAI-PANVEL-LONAVALA

DATE: 17/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			Subjective Assessment		Terrain	Remarks
						MER (dB)	BER(Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
1030	NEAR KING CIRCLE	19.03037 72.85725	7	4.8	61	24	1.1 E-3	1.5 E-8	EXCELLENT	EXCELLENT	MRB/LWR/POP	
1055	AMAR MAHAL JN EASTERN EXP FLYOVER	19.06245 72.89483	17	9.9	85	25	7.1 E-4	7.5 E-8	---DO---	---DO---	MRB/HWR/POP /OA	
1135	POWAI LAKE	19.12236 72.89844	45	15	50	16.8	2.9 E-3	4.5 E-8	---DO---	---DO---	HT/HWR/POP MRB/OA	
1220	BHANDUP EAST	19.14805 72.94230	11	20.2	47	17.2	2.6 E-3	2.7 E-6	---DO---	---DO---	MRB/LT/RAIL TRACK/LWR	
1355	NEAR NILJE GAON RS	19.14116 73.08904	16	31.9	52	18.8	2.7 E-3	1.0 E-8	---DO---	---NT---	OA	
1440	KALYAN EAST	19.23125 73.11994	20	40	32	0	6.5 E-2	4.0 E-4	---NT---	---NT---	MT/LRB/POP	
1600	KALYAN MILLS NEAR CENTURY RAYON	19.24747 73.16893	18	45	33	0	9.3 E-2	4.0 E-4	---NT---	---NT---	VEG/LT	
1630	BHIWANDI-MURBAD ROAD	19.25689 73.22376	18	50	32	1.6	7.1 E-2	6.3 E-3	EXCELLENT	---NT---	MT/VEG/NHW	
1735	NH# 61 POTGAON	19.25373 73.32173	50	59.4	35	13.8	3.1 E-3	1.0 E-7	---DO---	---NT---	VEG/MT/NHW	
1805	---DO---	19.26687 73.44115	81	71.3	28	6.1	1.3 E-2	1.5 E-8	---DO---	---NT---	VEG/MT/OA	

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 21 (474 MHz)

Direction from Tx: EAST
Route: TV TOWER-EASTERN FWY-NH#48-LONAWALA-PUNE ROAD

Table: 4
DATE: 16-12-16

Time	LOCATION	GPS CO ORDINATES	Ground Height above MSL in meters	Line of Sight distance in Km.	Field strength in dB μ V/m	DVB-T2 Parameters			SUBJECTIVE ASSESSMENT		Terrain Profile	Remarks
						MER	BER (Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
1125 15/12/16	MPT ROAD	19.00861 72.86575	11	4.8	78	24.3	8.4 E-4	1.8 E-7	EXCELLENT	EXCELLENT	OA/LRB/SEA_SIDE	
1205 15/12/16	KALACHANKI NEAR TROMBAY	18.99851 72.90363	10	8.84	77	27.3	3.6 E-3	1.4 E-5	---DO---	---DO---	OA/SEA_SIDE	
1300 15/12/16	CHEMBUR EAST	19.04588 72.91143	27	10.5	54	21.4	2.7 E-3	1.5 E-7	---DO---	---DO---	HT/LRB/VEG	
1300 18/12/16	ELEPHANTA CAVES	18.96680 72.93041	6	12.5	75.6 @3METER	----	----	----	---	---DO---	OA/HILLOCK/SEA SIDE	WITHOUT IRD & TV
1330 15/12/16	MUMBAI-NAVI MUMBAI ROAD	19.05740 72.95361	12	15.1	84	26.3	9.6 E-6	9.0 E-8	---DO---	---DO---	OA/SEA SIDE/HT	
1355 15/12/16	SECTOR-18 NAVI MUMBAI	19.06817 73.00540	14	20.6	55	21.3	1.9 E-3	1.0 E-8	---DO---	---DO---	VHT/MRB/OA	
1805	NEW PANVEL EAST	19.00788 73.12274	10	31.8	62	26	5.0 E-6	1.0 E-8	---DO---	---DO---	VHT/VEG/OA/NHW	
2050	NH#48 NEAR TOLL ROAD	18.96072 73.14660	18	34.7	54	24.7	1.6 E-3	1.9 E-3	---DO---	EXCELLENT	HT/VEG	
2020	NH#48 OLD ROAD	18.93038 73.19351	40	40.2	42	8	---	---	---DO---	NT	HT/VEG/NHW/OA	
1845	NH#48 PUNE ROAD	18.90113 73.23428	40	42	41	17.3	3.4 E-6.3	1.0 E-8	EXCELLENT	NT	HT/VEG/NHW/OA	
2000	NH#48 KARJAT XING	18.90113 73.23428	37	45	41	9	6.2 E-3	6.0 E-8	---DO---	NT	HT/VEG/NHW/OA	

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 21 (474 MHz)

Direction from Tx: SOUTH

Table: 5

Route: TV TOWER-EASTERN FWY-NH#48-LONAWALA

DATE: 15-12-16

Time	LOCATION	GPS CO ORDINATES	Ground Height above MSL in meters	Line of Sight distance in Km.	Field strength in dB μ V/m	DVB-T2 Parameters			SUBJECTIVE ASSESSMENT		Terrain Profile	Remarks
						MER	BER (Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
1520 16/12	MALABAR HILL	18.95375 72.79759	21	6.4	67	25.3	1.6 E-3	1.5 E-8	EXCELLENT	EXCELLENT	HRB/MT/POP/LRW	
1620 16/12	COLABA	18.90722 72.81691	15	11	44	11	2.8 E-3	3.0 E-8	---DO---	OK/F	HRB/LRB/LT/VEG	FS@3M- 41db μ v/m
1045	P D MELLO ROAD NEAR PRINCESS DOCK	18.95694 72.84270	12	6.08	74	24.8	1.3 E-3	1.0 E-8	---DO---	EXCELLENT	LRB/MT/NP/VEG	
1555	URAN MARKET	18.87882 72.93961	7	19	45	16	3.4 E-3	1.3 E-7	---DO---	---NT---	LRB/MKT	
1635	KARANJA NAVAPARA	18.84849 72.94824	6	22	47	9.1	2.1 E-3	1.0 E-8	---DO---	---NT---	OA/SEA_SIDE/LRB	
1720	SH# 104 NEAR DIGHATI	18.84810 73.05605	68	30	48	21	2.5 E-3	1.0 E-8	---DO---	---NT---	LT/VEG/HILLOCKS ONE SIDED OA	
1810	NH# 66 BEFORE PEN	18.75598 73.09435	10	40	65	27	9.9 E-4	1.0 E-8	---DO---	EXCELLENT	HT/OA/VEG	
1957	NH# 66 NEAR AMTEM	18.62308 73.08624	6	51	63	27	8.6 E-4	1.0 E-8	---DO---	---NT---	HT/NHW/OA/VEG	
2205	BEFORE KOLAD	18.55074 73.13466	17	60	66	27	8.7 E-4	1.0 E-8	---DO---	---NT---	OA/VEG/MT	
2130	BEFORE KOLAD	18.45809 73.19809	22	72.7	35	10.5	4.2 E-3	1.5 E-8	---DO---	---NT---	OA/VEG/MT	

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 27 (522 MHz)

Direction from Tx: NORTH

ROUTE: TV TOWER-BANDRA-SV ROAD-MEERA ROAD-VASAI-NH#48

TABLE: 6 (HD)

DATE: 13-14/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			Subjective Assessment	Terrain	Remarks
						MER (dB)	BER(Pre)				
							LDPC	BCH	TV DISPLAY HD & SD CHANNELS		
1630	SV ROAD, BANDRA	19.05492 72.83762	8	5.6	61	21	1.2 E-3	2.1 E-5	EXCELLENT	HT/HDP/MRB	
1750	JUHU APPT SV ROAD	19.09651 72.83948	9	10	81	24	7.5 E-4	4.5 E-8	---DO---	MT/LRB/VEG/	
1950	GAUTAM NGR SV ROAD	19.14273 72.84296	10	15	52	21	1.8 E-2	2.1 E-5	---DO---	HT/HRB/	WIDE ROAD
2115	NEAR MALAD RS SV RD	19.18658 72.84661	19	20	39	7-8	--	--	---NT---	MT/HRB/VEG	
2150	NEW LINK RD BORIVALI(W)	19.23342 72.84055	10	25	40	0-8	---	---	---NT---	MT/MRB/VEG/OA	
1115	MEERA RD EAST WESTERN HWY	19.27634 72.88868	12	30	NOISE FLOOR	---	---	---	---NT---	OA/HT/HILLOCK	NEARBY HILL
1210	NH#48 VASAI	19.36856 72.89481	23	40	62	27.1	3.6 E-3	1.8 E-5	---OK---	HT/NHW/OA	MULTI PATH
1345	NH#48	19.45543 72.88467	38	50	42	21.2	3.6 E-2	3.0 E-8	---OK---	HT/NHW/HILLOCK	
1240	NH#48	19.54402 72.91560	30	60	NOISE FLOOR	---	---	---	---NT---	LT/NHW/VEG	BETWEEN HILLS OF 300M
1300	NH#48 NEAR SAPHALE XING	---	---	65	---DO---	---	---	---	---NT---	LT/NHW/VEG	BETWEEN HILLS OF 300M

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 27 (522 MHz)

DIRECTION: NORTH-EAST-1
 ROUTE: TV TOWER-SION-BHANDEP-BHIWANDI-NAGPADA

TABLE: 7(HD)
 DATE: 14/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			SUBJECTIVE ASSESMENT	Terrain	Remarks
						MER (dB)	BER(Pre)				
							LDPC	BCH	TV DISPLAY HD & SD CHANNELLS		
2120	SION CIRCLE-SION EAST	19.03686 72.86095	11	5	71	24.7	3.5 E-3	1.4 E-5	EXCELLENT	HT/MRB	
2045	LBS MARG NEAR KISMAT NAGAR	19.08008 72.88078	5	10	75	27.3	2.8 E-3	1.8 E-5	EXCELLENT	HT/MRB/POP	
2000	LBS MARG VIKROLI WEST	19.09830 72.91685	16	15	55	27	3.2 E-3	1.9 E-5	EXCELLENT	HT/HRB/NOISY	
1920	BHANDUP EAST EASTERN EXPRESSWAY	19.14297 72.94973	7	20	57	24.3	5.3 E-3	1.9 E-5	EXCELLENT	VHT/OA/NOISY	
1850	NAUPADA EASTERN EXPRESSWAY	19.19205 72.96317	18	25	47	19.1	4.1 E-2	1.9 E-5	EXCELLENT	HT/HRB/NOISY	
1600	NH# 160 NEAR THANE	19.22408 73.01912	11	30	56	23.5	1.4 E-3	1.0 E-8	EXCELLENT	HT/OA	
1700	NH#160 NEAR BHIWANDI	19.27529 73.09238	13	41	45	21.7	2.6 E-2	2.1 E-5	EXCELLENT	HT/OA	
1750	NH#160	19.34476 73.12764	46	50	18	---	---	---	---NT---	HT/OA	NEARBY HILLS

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 27 (522 MHz)

DIRECTION: NORTH-EAST-2
 ROUTE: TV TOWER-TROMBAY-NAVIMUMBAI-PANVEL-LONAVALA

TABLE: 8(HD)
 DATE: 17/12/16

Time (Hrs.)	Spot/Location	Location Co-ordinates	Ht Above MSL (Mtrs)	Radial Distance (kM)	Field Strength (dB μ V/m)	COFDM (IRD) Parameter			Subjective Assessment	Terrain	Remarks
						MER (dB)	BER(Pre)				
							LDPC	BCH	TV DISPLAY HD & SD CHANELLS		
1030	NEAR KING CIRCLE	19.03037 72.85725	7	4.8	59	25	5.7 E-3	1.8 E-5	EXCELLENT	MRB/LWR/POP	
1055	AMAR MAHAL JN EASTERN EXP FLYOVER	19.06245 72.89483	17	9.9	81	26.3	2.2 E-3	1.8 E-5	EXCELLENT	MRB/HWR/POP /OA	
1135	POWAI LAKE	19.12236 72.89844	45	15	45	13.7	4.9 E-2	2.7 E-5	EXCELLENT	HT/HWR/POP MRB/OA	
1220	BHANDUP EAST	19.14805 72.94230	11	20.2	45	18.5	3.6 E-2	2.6 E-5	EXCELLENT	MRB/LT/RAIL TRACK/LWR	
1355	NEAR NILJE GAON RS	19.14116 73.08904	16	31.9	39	22	2.4 E-2	2.6 E-4	---NT---	OA	
1440	KALYAN EAST	19.23125 73.11994	20	40	32	---	---	---	---NT---	MT/LRB/POP	
1600	KALYAN MILLS NEAR CENTURY RAYON	19.24747 73.16893	18	45	33	---	---	---	---NT---	VEG/LT	
1630	BHIWANDI-MURBAD ROAD	19.25689 73.22376	18	50	32	4.9	1.1 E-1	2.6 E-4	---NT---	MT/VEG/NHW	
1735	NH# 61 POTGAON	19.25373 73.32173	50	59.4	36	6.2	8.6 E-2	2.6 E-4	---NT---	VEG/MT/NHW	
1805	---DO---	19.26687 73.44115	81	71.3	32	7	1.0 E-1	2.6 E-4	---NT---	VEG/MT/OA	

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 27 (522 MHz)

Direction from Tx: EAST
Route: TV TOWER-EASTERN FWY-NH#48-LONAWALA-PUNE ROAD

Table: 9 (HD)
DATE: 16-12-16

Time	LOCATION	GPS CO ORDINATES	Ht Above MSL (Mtrs)	Line of Sight distance in Km.	Field strength in dB μ V/m	DVB-T2 Parameters			SUBJECTIVE ASSESSMENT	Terrain Profile	Remarks
						MER	BER (Pre)		TV DISPLAY HD & SD CHANELLs		
							LDPC	BCH			
1125 15/12/16	MPT ROAD	19.00861 72.86575	11	4.8	75	24.3	2.3 E-2	1.5 E-5	EXCELLENT	OA/LRB/SEA_SIDE	
1205 15/12/16	KALACHANKI NEAR TROMBAY	18.99851 72.90363	10	8.84	77	27.3	3.6 E-3	1.4 E-5	EXCELLENT	OA/SEA_SIDE	
1300 15/12/16	CHEMBUR EAST	19.04588 72.91143	27	10.5	58	19.2	9.2 E-3	1.9 E-9	EXCELLENT	HT/LRB/VEG	
1300 18/12/16	ELEPHANTA CAVES	18.96680 72.93041	6	12.5	77	---	---	---	---	OA/HILLOCK/SEA SIDE	WITHOUT IRD & TV
1330 15/12/16	MUMBAI-NAVI MUMBAI ROAD	19.05740 72.95361	12	15.1	82	26.8	3.3 E-3	1.5 E-5	EXCELLENT	OA/SEA SIDE/HT	
1355 15/12/16	SECTOR-18 NAVI MUMBAI	19.06817 73.00540	14	20.6	56	18.4	1.8 E-2	1.9 E-5	EXCELLENT	VHT/MRB/OA	
1805	NEW PANVEL EAST	19.00788 73.12274	10	31.8	64	28	3.0 E-3	1.8 E-5	EXCELLENT	VHT/VEG/OA/NHW	
2050	NH#48 NEAR TOLL ROAD	18.96072 73.14660	18	34.7	47	17	1.9 E-2	2.1 E-5	EXCELLENT	HT/VEG	
2020	NH#48 OLD ROAD	18.93038 73.19351	40	40.2	39	13.8	2.9 E-2	2.6 E-4	---NT---	HT/VEG/NHW/OA	
1845	NH#48 PUNE ROAD	18.90113 73.23428	40	42	37	15	2.0 E-2	2.6 E-4	---NT---	HT/VEG/NHW/OA	
2000	NH#48 KARJAT XING	18.90113 73.23428	37	45	36	12	2.8 E-2	2.4 E-4	---NT---	HT/VEG/NHW/OA	

Reception Survey of DTT from DDK-Mumbai transmitter on Channel 27 (522 MHz)

Direction from Tx: SOUTH
Route: TV TOWER-EASTERN FWY-NH#48-LONAWALA

Table: 10(HD)
DATE: 15-12-16

Time	LOCATION	GPS CO ORDINATES	Ground Height above MSL in meters	Line of Sight distance in Km.	Field strength in dB μ V/m	DVB-T2 Parameters			SUBJECTIVE ASSESSMENT	Terrain Profile	Remarks
						MER	BER (Pre)		TV DISPLAY HD & SD CHANELLs		
							LDPC	BCH			
1520 16/12	MALABAR HILL	18.95375 72.79759	21	6.4	68	28.5	2.4 E-3	1.9 E-5	EXCELLENT	HRB/MT/POP/LRW	
1620 16/12	COLABA	18.90722 72.81691	15	11	41	9.8	2.8 E-2	2.6 E-4	---NT---	HRB/LRB/LT/VEG	FS@3M- 41db μ v/m
1045	P D MELLO ROAD NEAR PRINCESS DOCK	18.95694 72.84270	12	6.08	71	25.3	3.3 E-3	2.0 E-5	EXCELLENT	LRB/MT/NP/VEG	
1555	URAN MARKET	18.87882 72.93961	7	19	48	8.8	2.7 E-2	2.6 E-4	---NT---	LRB/MKT	
1635	KARANJA NAVAPARA	18.84849 72.94824	6	22	41	12.6	3.8 E-2	2.6 E-4	---NT---	OA/SEA_SIDE/LRB	
1720	SH# 104 NEAR DIGHATI	18.84810 73.05605	68	30	45	16.2	4.4 E-2	2.2 E-5	EXCELLENT	LT/VEG/HILLOCKS ONE SIDED OA	
1810	NH# 66 BEFORE PEN	18.75598 73.09435	10	40	66	27.9	3.1 E-3	1.6 E-5	EXCELLENT	HT/OA/VEG	
1957	NH# 66 NEAR AMTEM	18.62308 73.08624	6	51	61	28	3.1 E-3	1.8 E-5	EXCELLENT	HT/NHW/OA/VEG	
2205	BEFORE KOLAD	18.55074 73.13466	17	60	64	22	2.8 E-3	1.7 E-5	EXCELLENT	OA/VEG/MT	
2130	BEFORE KOLAD	18.45809 73.19809	22	72.7	32	---	---	---	---NT---	OA/VEG/MT	

Direction: Random

DATE: 18-19/12/16

Time	LOCATION	GPS CO ORDINATES	Ground Height above MSL in meters	Line of Sight distance in Km.	Field strength in dBμV/m	DVB-T2 Parameters			SUBJECTIVE ASSESSMENT		Terrain Profile	Remarks
						MER	BER (Pre)		TV DISPLAY	SMART PHONE		
							LDPC	BCH				
1745 18/12	KHAR	19.06627 72.82990	17	6.65	74	24.6	1.1 E-3	1.0 E-8	EXCELLENT	EXCELLENT	HRB/LWR/MT/POP	HD-OK
1840	JUHU TARA ROAD	19.10442 72.82921	18	10.85	64	21.8	2.4 E-5	6.0 E-8	EXCELLENT	EXCELLENT	HRB/HT/LRW/POP	HD-OK
2000	LOKHANDWALA COMPLEX	19.14694 72.82397	3	15.5	45	14.4	1.8 E-3	1.5 E-8	EXCELLENT	EXCELLENT	MT/HRB/POP	HD-DROPS
2110	CHARKOP	19.20202 72.82317	10	21.5	73	26.4	8.2 E-4	1.5 E-8	EXCELLENT	EXCELLENT	MT/ONE SIDE HRB/OA	HD-OK
1145 19/12	FRONT OF VT STATION	18.95691 72.83224	11	7.75	62	16.9	6.4 E-5	1.7 E-4	EXCELLENT	EXCELLENT	HT/HRB/POP/WRW	HD-OK
1212	MOHAMMAD ALI RD/BELOW FLYOVER	18.95691 72.83224	7	5.77	77	26.4	9.0 E-4	1.5 E-8	EXCELLENT	EXCELLENT	HT/HRB/POP/MRW	HD-OK
1250	DADAR(E)	19.01740 72.84399	12	2.76	79	22.6	1.7 E-3	1.0 E-8	EXCELLENT	EXCELLENT	HT/MRB/POP/RS	HD-OK
1430	ST. ANTHONY RD SANTA CRUZ(E)	19.08026 72.85661	31	8.9	67	23.8	7.3 E-6	7.0 E-5	EXCELLENT	EXCELLENT	LT/MRB/RES	HD-OK
1600	AIRPORT CARGO TERMINAL	19.09762 72.86526	22	11.12	69	22.8	3.8 E-4	1.5 E-8	EXCELLENT	EXCELLENT	LT/AIRPORT	HD-OK
1655	FILM CITY GOREGAON	19.16312 72.88799	62	18.6	47	19.2	7.8 E-5	1.5 E-8	EXCELLENT	NT	LT/VEG/HILLOCK	HD-OK