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AIR & DDI

Reception survey for assessment of coverage area for satisfactory reception of DVB-T2 Transmitter *Located at Cuttack Odisha*

PRASAR BHARATI

RESEARCH DEPARTMENT

ALL INDIA RADIO & DOORDARSHAN

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

Located at Cuttack

Odissa

(Survey Period: 14/05/2017 to 20/05/2017)

Field Strength Measurement/Reception Survey Team

PROPAGATION LAB

Team Leader	**:**	**Sh. G.P.Srivastava (AE)**
Team Members	**:**	**Sh. Naeem Khan (Sr.Tech.)**
		Sh. O.P.Upadhay (Tech)
Assisted By	**:**	**Md. Javed Shams (AE)**
Staff Car Driver	**:**	**Sh. H.N.Mishra**
Guided By	**:**	**Sh. S.Hyder (DDG)**
Supervised By	**:**	**Sh.V.K.Verma (DDE)**
Inspired By	**:**	**Smt. Anuradha Agarwal (ADG)**

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Transmitting Antenna Tower

6kW DVB-T2 Transmitter

Transmitter Control Unit, DVB-T2 Transmitter, HPT (TV) Tower, Tulsipur, Cuttack, Odisha

Introduction:

Digital technology has already made its way into vast areas of the information and communications landscape. In all areas of application, the conversion of information into strings of zeroes and ones allows data to be compressed on modern storage media without sacrificing its quality. The transition to digital technology results in an improved spectrum efficiency, where more program channels can be broadcast within the same bandwidth. It allows the simultaneous transmission of multiple services, each one with a different configuration, and thus, with different robustness and quality. This permits new type of reception scenarios for these digital terrestrial signals, like mobile and handheld pedestrian reception scenarios. DVB-T2 has been designed to fulfill these requirements, increasing spectral efficiency and robustness in a flexible way so that a variety of reception scenarios can be covered, with the same system by choosing the best configuration options available. So DVB-T2 can be used for providing both fixed and mobile services within the same channel with number of configurations supported. Although, this new standard has been fundamentally designed for fixed reception (receiver devices with rooftop and set-top antennas) but now the DVB-T2 reception is also feasible in portable and mobile devices (Smart Mobile Phones, PCs, laptops or in-car receivers).In the process of modernization, Doordarshan India has established DVB T2 Transmitters in its network with future plan to replaced analogue transmitters with such DVB-T2 Transmitters. One of such transmitter is being established at Cuttack(Odissa) & commissioned for DD National Transmission on UHF Band Ch#29(538MHz). The HPT (TV) DVB-T2 Transmitter, Cuttack is situated in an urban area (MSL-70 Meter) at Tulsipur area surrounded by Mahanadi river belt. Its topography consist of irregular mixed terrain, large hill forest ranges along North, North-West, West, & South-West directions & mostly low populated rural areas whereas far end region confined along East, South-East & South direction are bounded by sea bitch(Bay of Bengal). In this context Research Department is involved in carrying out propagation studies on DVB-T2 transmission to assist fixing of planning parameters/transmission configuration under existing terrain condition. The scope of work for the survey team of Research Department is to carry out field trial for prediction of coverage area for satisfactory reception. For this work a four member survey team carried out field strength survey during the period 14/05/2017 to 20/05/2017 along eight radials around the location of DVB-T2 Transmitter. The survey was carried out for fixed antenna reception mode mounted at a height of 10 Meters

Objective:

1. Ascertaining the coverage area for satisfactory reception of DVB-T2 Transmission.
2. To envisage minimum field strength value for satisfactory reception.

Equipment Used:

1. Spectrum Analyzer(Make: Anritsu, Model: MS 2035B & MS 2013E)
2. Log Periodic antenna(Make: Rhode & Schwartz, Model: HL-223)
3. GPS Navigator(Make: Garmin, Model: Montana 650)
4. DVB-T2 Set Top Box & IRD(Make: Ericsson)
5. LED TV Receiver(Make: Sony) & Smart Phone (Samsung Galaxy J7 Prime)
6. HD Ranger(TV Analyzer)(Make: Promax)

Basic Data and Transmitter details

Transmitters Details:

1.	Name of Station	:	HPT(TV) Tower, Cuttack Orissa
2.	Location of the Transmitters (In 6 figure coordinates)	:	Tulsipur LAT- N 20° 29'05.7" LON- E 85° 51'07.4" MSL-70 Meter
3.	Description of terrain around the Transmitters	:	Urban, Vegetation,
4.	Classification(Large city/urban/rural)	:	Urban
5.	Rated power of the Transmitter	:	6.0kW
6.	Forward radiated Power	:	5.89kW
7.	Reflected Power	:	9.0W
8.	VSWR	:	1.12
9.	Transmission Mode	:	SDTV
10.	Make	:	Harris
11.	Model No.	:	MAXIVA ULX-6500 T2
12.	Frequency of operation	:	538**MHz (Ch#29)**
13.	Date of Commissioning	:	25/02/ 2016

:

Transmitting Antenna Details:

1.	Make	:	SIERA
2.	Type /Model of Antenna	:	Panel Type /UTV-01/16(6X4)
3.	Antenna Gain	:	12.59dB
4.	PAPR	:	13dB
5.	Height of Tower	:	150 Meter
6.	Type of Tower	:	Steel structure Tower
7.	Effective height of antenna(Midbay)	:	Not available
8.	Type of Polarization	:	Horizontal

DVB-T2 Broadcast System:

DVB-T2 is the world's most advanced digital terrestrial transmission (DTT) system, offering more robustness, flexibility and at least 50% more efficiency than any other DTT system. It supports SD, HD, mobile TV, or any combination thereof. Like its predecessor, DVB-T2 uses OFDM (orthogonal frequency division multiplex) modulation with a large number of sub-carriers 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 optimized for any target transmission channel. The key new technologies in DVB-T2 are:

- 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) allows 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. For comparison, the two bottom rows show the maximum data rate at a fixed C/N ratio and the required C/N ratio at a fixed (useful) data rate.

Transmission Parameter	DVB-T	DVB-T2(New improved option in Red)
FEC	Convolutional Coding + Reed Solomon(1/2,2/3,3/4,5/6,7/8)	LDPC + BCH(1/2,3/5,2/3,3/4,4/5,5/6)
Modes	QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM, 256QAM
Guard Interval	1/2, 1/8, 1/16, 1/32	1/4,19/128,1/8,19/256,1/16,1/32,1/128
FFT Size	2k, 8k	1k, 2k, 4k,8k,16k,32k
Scattered Pilot	8% of Total	1%,2%,4%,8% of total
Continual Pilot	2.6% of total	0.35% of total
Bandwidth	6,7,8 MHZ	1.7,5,6,7,8,10MHz
Typical data rate(UK)	29 Mbit/second	40 Mbit/second
Max data rate @20dB C/N	29 Mbit/Second	47.8 Mbit/second
Required C/N Ratio @ 22	16.7 dB	8.9dB

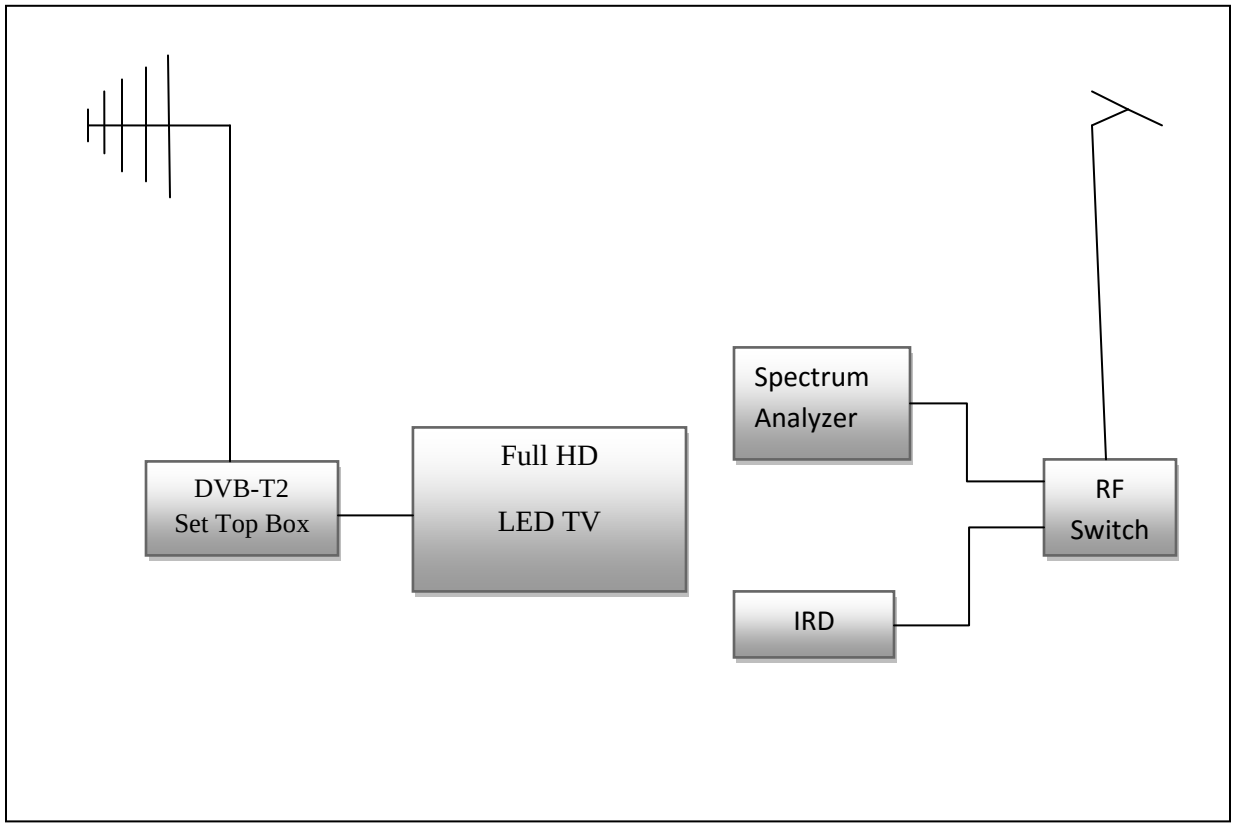
Modulation Parameters:

DVB-T2 standard offers a bigger choice of the OFDM parameters and modulation schemes depending upon application & reception mode. Combining various modulation schemes with FFT sizes and guard intervals allows construction of MFN and SFN networks designed for different applications: from low bit-rate but robust mobile reception to the high bit-rate fixed reception for domestic and professional use. Currently DVB-T2 transmitter, Cuttack operating with following set of Modulation parameters targeted for fixed antenna & handheld portable (smart phone) reception mode.

Operating Frequency	538 MHz
Channel No.	#29(UHF, Band-IV)
Bandwidth	8 MHz
Number of Programme Content	TV : Five Services Radio: Three Services
PLP Bit Rate:	6.17 M Bit/s
FFT	8K
Guard Interval	1/8
PLP Constellation	QPSK
PLP Rotation	Rotated
PLP Code Rate	1/2
Pilot Pattern	PP3
SISO/MISO	SISO
FEC Frame Length	Normal

System configuration:

The field trials system mainly consists of field strength measuring equipment, standard calibrated UHF Dipole antenna & Yagi receiving antenna for receiving horizontally polarized TV Broadcast signal, Portable Generator, 10 Meters electromechanically operated telescopic mast housed in a customized Survey Van of Research Department. A pictorial diagram is given below.



Measurement Set Up:

The field trials were 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 & R&S make UHF Log Periodic Antenna. The whole system was assembled in a mobile van with power generating system (portable generator set). The two main components of the reception set up are DVB-T2 receiving system and field strength measuring system (Spectrum Analyzer). A calibrated UHF Log Periodic Antenna was used to receive the signal whereas for subjective assessment of the received signal was performed by using DVB-T2 set top box & a Sony make LED TV. To record Pre LDPC/BCH & MER data an Promax make HD Ranger 2 TV Analyzer was used. In addition to this Garmin make GPS navigator was used for determination of the spot/location co-ordinate in six figures & radial distance from the transmitter location.

Selection of sites for measurement:

As far as practicable an open & safe spot/ location (overhead power and telephone cables, trees and other hazards were avoided) was chosen for the measurement of received field strength. Instead of cluster measurement (measurement at four to five spot for a given location), single sample method in this survey is preferred, because of the additional time that may be taken in making cluster measurements (due to the frequent raising or lowering of the receiving antenna & insufficient space along the motorable road side), or because of the hazards in moving the survey vehicle while the antenna is fully erected. High tension overhead wires, close to high raise buildings & elevated flyovers/underpasses were avoided while collecting field strength data along a radial route.

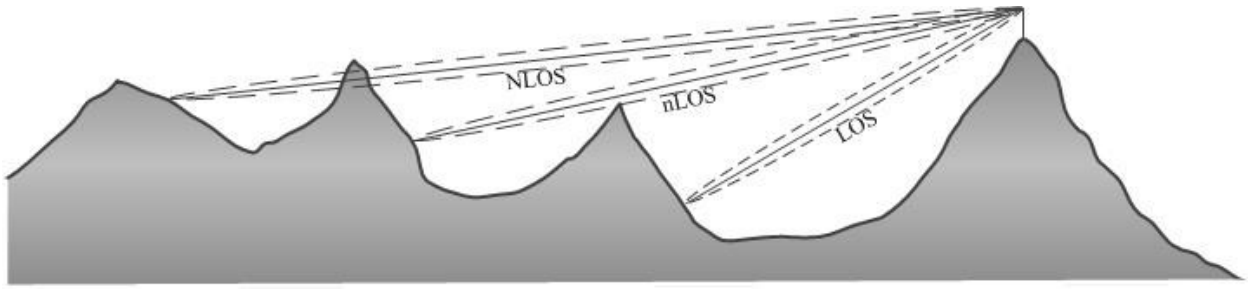
Measurement Methodology:

A map of the largest available scale may be used to mark the location of the transmitters. From the transmitter location eight radials are drawn passing through the transmitter location along North, East, South, West, North-East, North-West, South East & South West directions. For prediction of the coverage area, field strength measurement along a radial is carried out by employing mobile survey van having 10Mtrs telescopic mast with rotor & tilt facility. For field strength measurement the survey vehicle was mostly parked in open space, raising the telescopic mast up to the required height of 10 meters & then rotating the antenna to align it along the direction of transmission source for getting optimum value of field strength & MER value. While taking static reception measurement, LAT/LONG, MSL & radial distance of each & every location was also recorded. Once all measurements have been undertaken, mast is fully retracted & then drive away for the next location. Since the purpose of the survey was to determine the primary coverage area for satisfactory reception so the measurement was carried out in static condition along motorable roads. The same procedures for field strength measurement/reception survey are adopted along all other radials. After data collection is over the FSM data are tabulated & interpreted on the basis of the findings.The quality of received audio/video was also analyzed by using DVB-T2 Set Top Box & SONY make receiver under given terrain conditions. The environment classification criteria are:

Rural	Areas with scarce isolated buildings, open fields.
Suburban	Small towns; residential areas with low building density and buildings not higher than two stories; wide roads or streets between buildings.
Urban	Big to medium sized cities, residential areas with high density of buildings; areas where buildings are higher than two stories and close distances between them
Large Cities	Densely populated cities having cluster of township with high rise building & skyscrapers

TV Broadcast Signal Propagation:

TV broadcast signal propagates from the transmitter by space wave propagation mechanisms i.e. Line of sight Propagation & travel straight way in propagating medium & undergoes all optical phenomena like Reflection, Refraction, Scattering, Diffraction etc while travelling through the medium. DVB T2 reception is largely affected by multipath, which changes along time due to the receiver travelling around the buildings. It is also important to point out other factors typical of urban reception environment such as traffic, speed change due to traffic lights and pedestrian crossings, etc. The field strength level, at a given point, not only depends on its distance from the transmitter, the frequency of transmission and the antenna heights but also on the long-term and short-term interferences caused by reflections of the natural environment (terrain configuration, vegetation) and the man-made environment. Thus the received signal must be considered as the vector sum of the wanted signal and many reflected signals. Due to the effect of reflected signals, the Field Strength/MER along a route shows severe fluctuation. Since, the measurements are made on public roads the reflected signals coming from other vehicles cannot be foreseen. The field strength test results therefore very rarely match the results of measurements obtained at the same place, at a different time. In respect of the visibility between transmitting and receiving sites there are three distinct propagation scenarios.



Propagation scenarios

1. **Gaussian Channel** or Line of Sight (LOS) propagation:

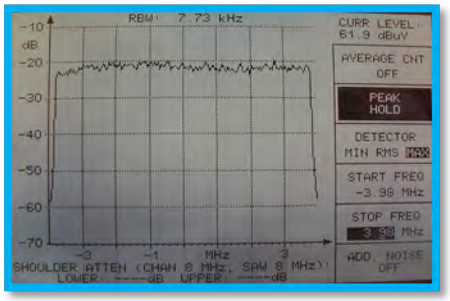
   The transmitter and the receiver have direct visibility between each other. In this case he Fresnel ellipsoid is clear. It provides best signal reception as only Gaussian noise present. Gaussian channel with high C/N ratio was used as a reference.

2. **Rice Channel or** Non Line of Sight (NLOS) propagation:

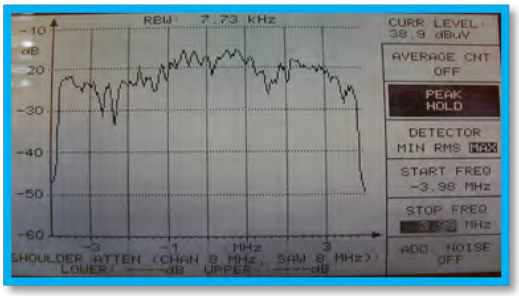
   The transmitter and the receiver do not have visibility between with each other. The signal from the transmitter undergoes several optical phenomena such as diffraction, diffusion, or both, before reaching the receiver. In this case the Fresnel ellipsoid is fully obstructed. It simulates fixed signal reception using directional antenna.

3. **Rayleigh Channel or** Near Line of Sight (NLOS) propagation:

   This case represents intermediate situation between the LOS and the NLOS case. The transmitter and the receiver have optical visibility between with each other, but part of the Fresnel ellipsoid is obstructed. In those situations the signal propagates via diffraction or multi-path reflections on building sides. It simulates portable signal reception using Omni-directional antenna.



Ricean Channel

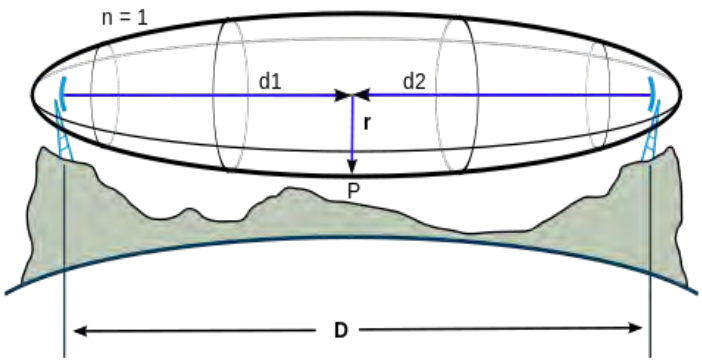


Rayleigh Channel

Concept of Fresnel Zone:

Fresnel zones are used by propagation theory to calculate reflections and diffraction loss between a transmitter and receiver. Fresnel zones are numbered and are called 'F1', 'F2', and 'F3' etc. There are an infinite number of Fresnel zones, however, only the first 3 have any real effect on radio propagation. A Fresnel zone is a cylindrical ellipse drawn between transmitter and receiver. The size of the ellipse is determined by the frequency of operation and the distance between the two sites. When a radio signal travels between transmitter and receiver, it can travel in several ways. It can go directly between transmitter and receiver (main signal). Signal can reflect off the ground and then carry on to the distant receiver (reflected signal). It can go left or right and be reflected back by a hill (another reflected signal).

The receive antenna cannot differentiate between a main and reflected signal. They are both on the same frequency. It receives both main and reflected signals. It also receives any other signals within its designed frequency range. When an antenna receives a main signal and a reflected signal, the two signals will combine and add together at the antenna. If they are 360º shifted (in phase), there is no issue. However if the signals are 180º apart (opposite phase), they will cancel and the receiver will receive nothing. For establishing Fresnel zones, first determine the RF Line of Sight (RF LOS), which in simple terms is a straight line between the transmitting and receiving antennas. Now the zone surrounding the RF LOS is said to be the Fresnel zone. The general equation for calculating the Fresnel zone radius at any point P in the middle of the link is the following:



$$F_N = \sqrt{\frac{N \times \lambda \times D_1 \times D_2}{D_1 + D_2}}$$

Where:

F_N = The nth Fresnel Zone radius in meters
D_1 = The distance of P from one end in meters
D_2 = The distance of P from the other end in meters
λ = The wavelength of the transmitted signal in meters

Fresnel Zone 1 (F1)

The first Fresnel zone radius is calculated so that the difference in path length between the main signal and a reflected signal from the F1 radius distance is 180º. A reflected signal shifted by 180º of path distance plus 180º from the actual reflection point totals 360º of phase shift. The two signals, main and reflected, arrive at the antenna 360º apart or in phase. They will add together and not affect receiver performance.

Fresnel Zone 2 (F2)

The second Fresnel zone radius is calculated so that the path length difference between the main and reflected signals from the second Fresnel zone tube is 360º. This is critical, since a reflected signal has an automatic 180º phase shift plus the path length difference of 360º equals a phase shift of 540º. 540º and 180º are the same phase shift in mathematics and the two signals will cancel, leaving no signal at the receiver.

Fresnel Zone 3 (F3)

The third Fresnel zone has a path length difference of 540º. Add this to the 180º reflection shift; the total is 720º, and the two signals are in phase.

The net result is that even numbered Fresnel zones incur a 180º signal reflection. These are detrimental to radio propagation. Odd numbered Fresnel zones incur a 360º phase shift and have no effect. Accordingly odd numbered Fresnel zones are good for radio wave propagation..

Collection of field strength data:

The field strength data were collected along eight radials routes drawn (Annexure-I) around the transmitting antenna. At each & every spot/location along the radial the telescopic mast was expanded upto10 Meters from the ground level keeping the dipole antenna horizontally as the polarization of the radiated beam is horizontally polarized. The antenna position is being continuously rotated for optimized value of field strength in the direction of line of sight with respect to the transmitting antenna. The optimum field strength values are thus recorded. In addition to this the terrain a detail of each & every spot/location was also recorded along with the subjective assessment of the received audio/video quality on the basis of watching on DVB-T2 TV receiving system (TV Receiver & Smart Mobile Phones using TV On Go Dongle). These collected data's are being tabulated in proper sequence to make it convenient for discussion & correlation with other parameters. The subjective assessment of received audio/video quality on TV receiver is graded as OK, FF-Frequent Freezing, F-Freeze & NT- Not Traceable. The field strength measurement values along with subjective assessment at each & every spot/location are recorded in a tabular form giving at an instance the trend for variation in received field strength/MER & signal reception quality with distance. In this report the received field strength & subjective assessment data collected along eight radials are tabulated accordingly in Table No.-1 to Table No.-8.In addition to this the radial distances, MER/BER & field strength value corresponding to satisfactory reception along all eight radials are compiled in tabular form (as in Table No: 9) to make it convenient to determine the primary coverage area of the said

transmission. On the basis of Table -9, a coverage contour for DVB-T2 transmission has been drawn & annexed as in Annexure-II(For TV Reception) & Annexure III(For Mobile Phone Reception). Also along the radials graph (Fig-I to VIII) represents variation of Field strength & MSL with distance.. The code used for grading of the received signal is illustrated as follows.

Criteria for grading of received signal on the basis of subjective assessment:

Signal	OK	No impairment in received audio/video quality.
	FF	Received frame simultaneously appearing-disappearing leading to irritable reception.
	F	Received frame freeze permanently.
	NT	Not Traceable or No Signal.

Broadcast Service Area:

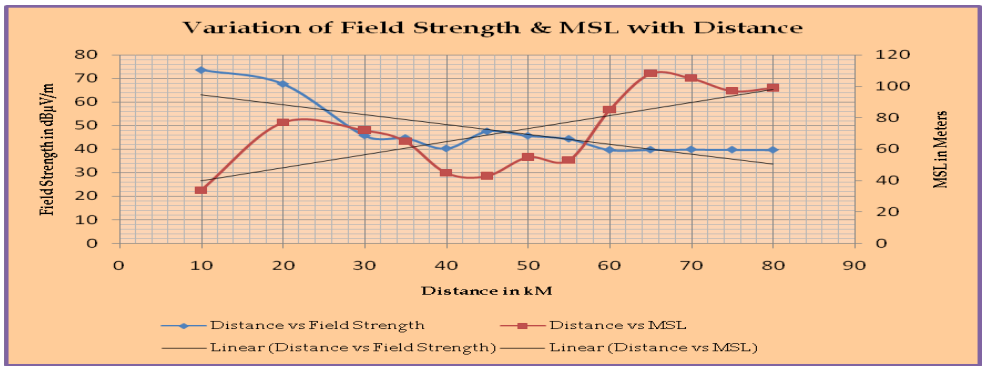
The objective of broadcasting is to provide quality reception free from interferences & noise in a commercial domestic receiver, either fixed or mobile, to as much of population and area of the country as possible, In case of analogue transmission coverage area of broadcasting is decided by the minimum required received 'field strength' at the farthest end of the coverage area for satisfactory reception with commercially available domestic receivers but in digital terrestrial transmission one more transmission parameter(MER) is required along with the minimum field strength value for prediction of the coverage area. Studied has been carried out worldwide to determine the minimum required field strength & MER value for satisfactory reception of DTT signal. Rec. ITU-R BT.2254-3 give minimum equivalent field strength at receiving location for satisfactory reception of DVB-T2 transmission are as illustrated in following table.

Mode of Reception	Rice Channel (Fixed Reception) 256QAM,FEC2/3, 32k, PP7 Normal Antenna (10 Meters)		Rayleigh Channel (Portable Reception) 16QAM,FEC ½,16k,PP3 Normal			
			Portable Device Outdoor Urban Antenna (1.5 Meter)		Hand Held Portable Device Outdoor Antenna (1.5 Meter)	
Band	III (200 MHz)	**IV/V (650 MHz)**	III (200 MHz)	**IV/V (650 MHz)**	III (200 MHz)	**IV/V (650 MHz)**
Fixed Location	36.1	**45.0**	41.4	**50.1**	48.0	**51.4**
Locations 70%	41.0	**47.9**	52.3	**54.0**	50.9	**54.0**
Locations 95%	47.1	**54.0**	58.4	**60.1**	57.0	**60.4**

Interpretation of the collected data along radials:

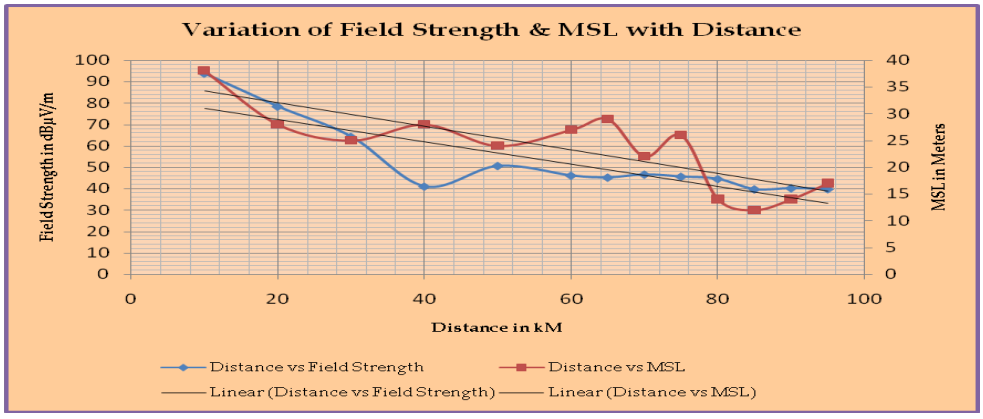
In this report efforts are being made for the interpretation & analysis of the collected FSM data along a radial & then a coverage contour based on compiled Table-9 for satisfactory reception of DVB-T2 transmission was drawn on a map.

1. **Radial-1(North)**:Along this radial field strength measurement done at thirteen location like Chaman - Karanji - Sapuajhar- Kaitha- Mandar- Bhuban – Botalanda-Gandhapal-Khandara-Tomka Forest Block- Near Bamanipal- Kendujhar & NearTangiriapal up to a radial distance of 80 kM. Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **55 kM** (Gandhapal) whereas for TV ON Go (Dongle) on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **45 kM** (Bhuban).



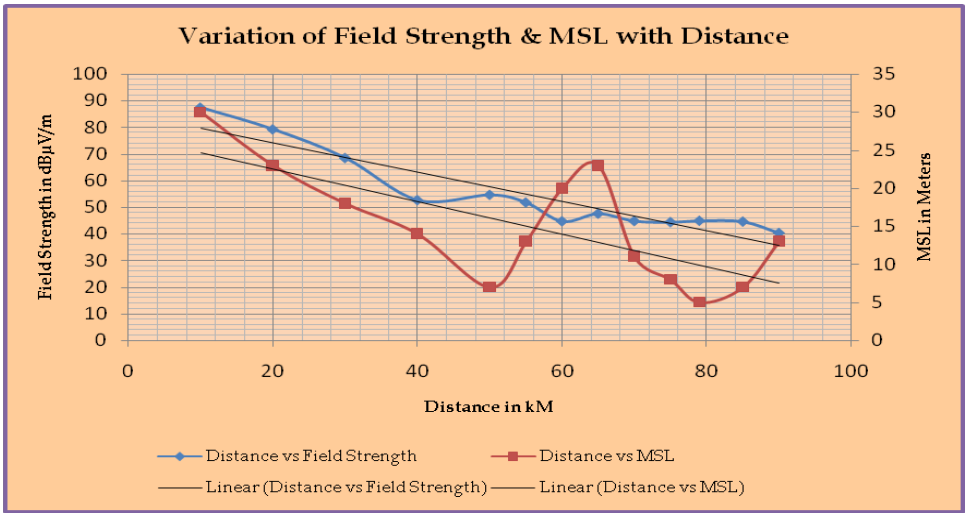
(Fig-I, Showing variation of Field Strength & MSL with Distance along North Direction)

2. **Radial-2 (North-East)**:Along this radial field strength measurement done at fourteen location like Manguli Chowk- Bainchua - Ganash - Sarei- Karajanga Chhak- Manipur - Sathipur-Puripada- Bhandari Pokhari- Piripur- Adampur- Gelpur- Charampa & Tisalpur up to a radial distance of 100 kM . Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **80 kM** (Piripur) whereas for TV ON Go (Dongle) on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **50 kM** (Karajanga Chhak)



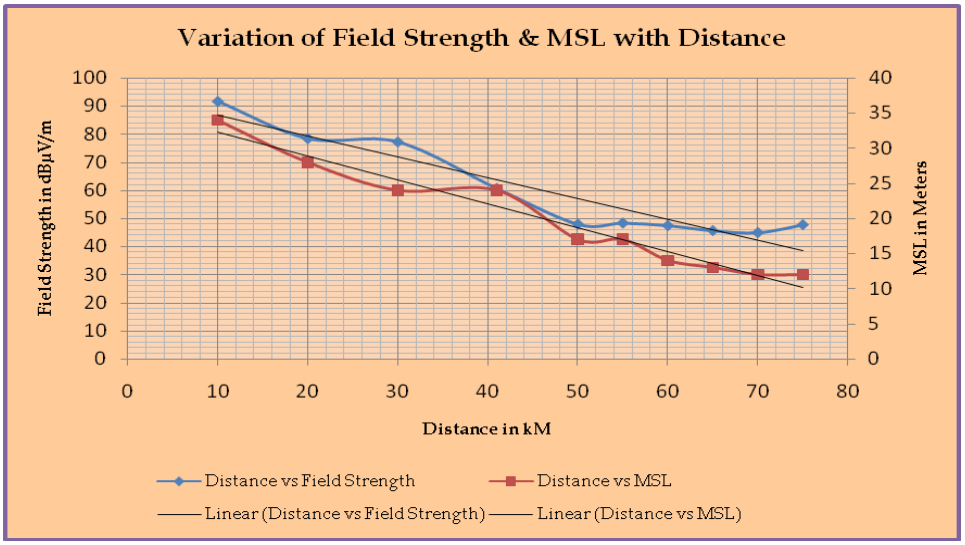
(Fig-II, Showing variation of Field Strength & MSL with Distance along North-East Direction)

3. **<u>Radial-3 (East)</u>**:Along this radial field strength measurement done at fourteen location like Jagatpur- Bhatapada- Kulia- Ranipada- Khamol -Kasoti - Kapleswar- Baro- Nasipur- Pattamundai- Sasan- Sansarfal- Rajnagar & Kurunti up to a radial distance of 95 kM . Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **85 kM** (Sansarfal) whereas for TV ON Go (Dongle) on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **55 kM** (Kasoti).



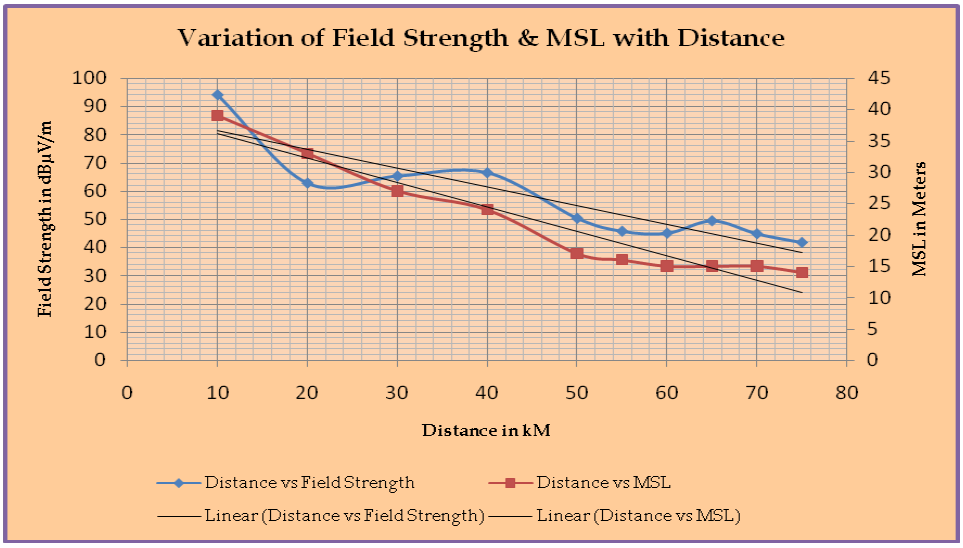
(Fig-III, Showing variation of Field Strength & MSL with Distance along East Direction)

4. **<u>Radial-4 (South- East)</u>**: Along this radial field strength measurement done at location like Bidyadharpur-Athanga-Gopinathpur-Jagatsinghpur-Aril -Badagar- Iswarpur- Chataramundi-Brahmanadehi & Kusupur (Sea Beach) up to a radial distance of 75 kM. Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **75 kM** (Kusupur)) whereas for TV ON Go (Dongle) on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **60 kM** (Iswarpur).



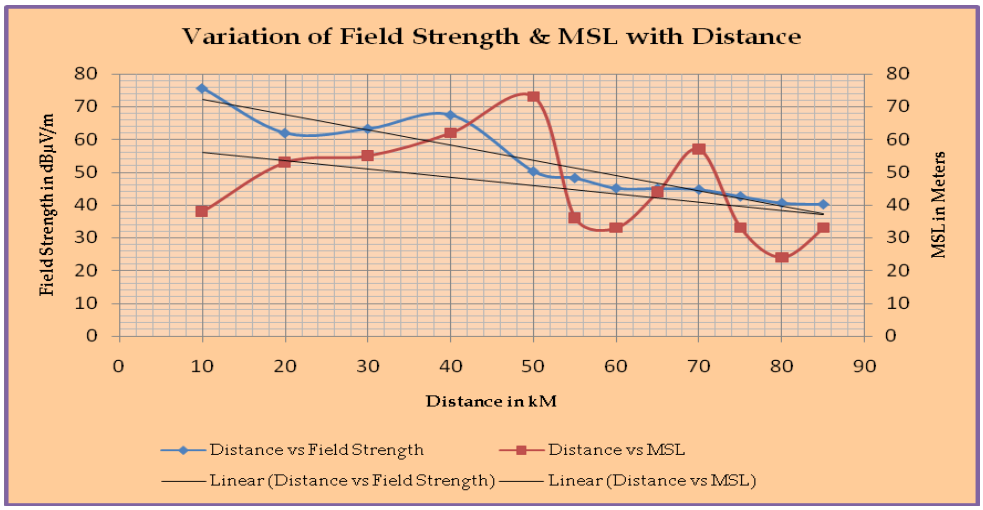
(Fig-IV, Showing variation of Field Strength & MSL with Distance along South-East Direction)

5. **Radial-5 (South)**:Along this radial field strength measurement done at Ten location like Naugarh Cricket Ground- Palasuni- Lingipur- Pipili - Thengipada - Siriapur - Sakhigopal- Jagannathpur- Alikia & Puri (beyond that there is sea bitch) up to a radial distance of 75 kM . Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **70 kM** (Alkia near Puri)) whereas for TV ON Go (Dongle) on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **50 kM** (Thengipada near Potal).



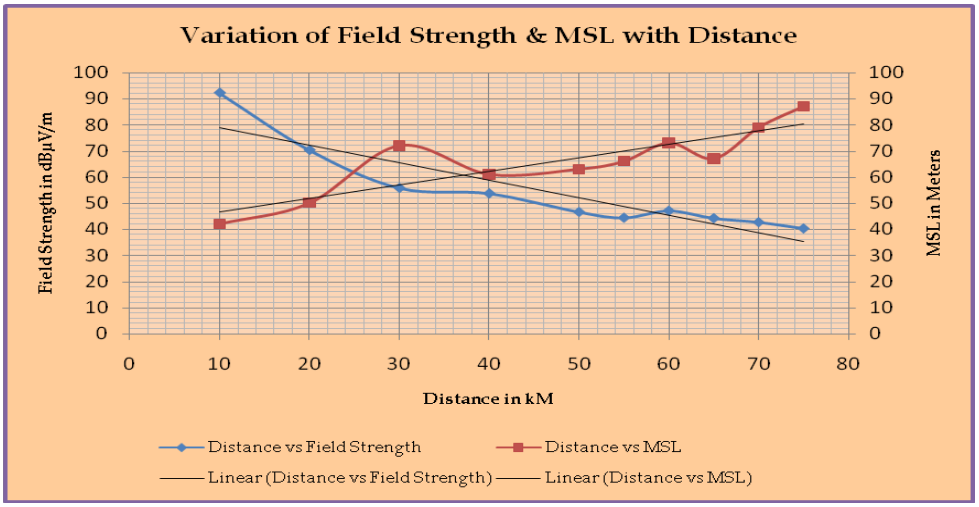
(Fig-V, Showing variation of Field Strength & MSL with Distance along South Direction)

6. **Radial-6 (South-West)**: Along this radial field strength measurement done at twelve location like Jujhagada- Andharua- Chatabar- Jagannathpur- Dadhimachhagadia- Malipada - Mundaamba - Ratamati- Patrapada- Kandhanayagarh- Nandapur (Tangi) & Nizgarhkuhudi up to a radial distance of 85 kM. Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **70 kM** (Patrapada) whereas for TV ON Go on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **50 kM** (Dadhimachhagadia).



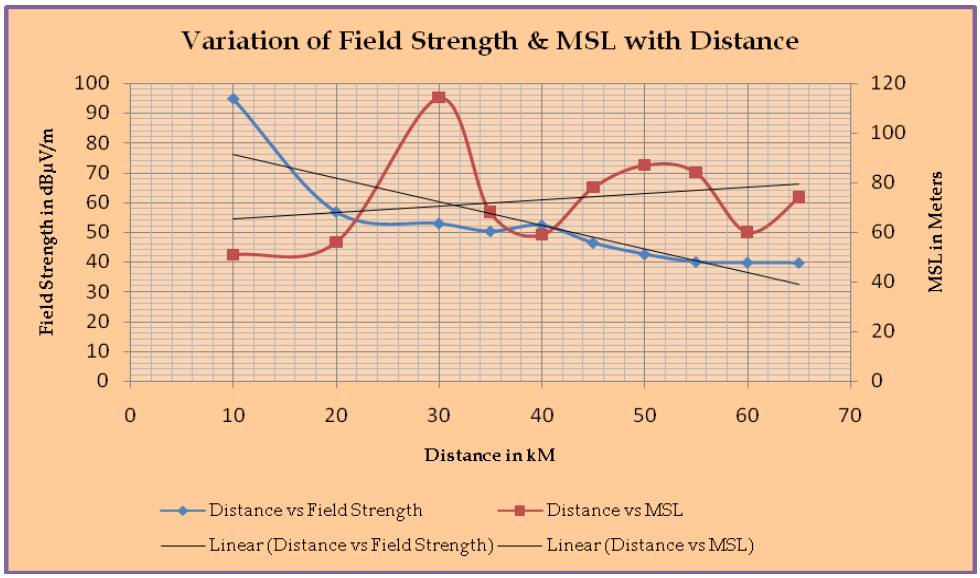
(Fig-VI, Showing variation of Field Strength & MSL with Distance along South-West Direction)

7. **Radial-7(West)**:Along this radial field strength measurement done at ten location like Talagar- Kandarpur- Nuabandha- Nuapatana- Gadapokhari- Deuli- Janisahi– Shyamsunderpur- Purunagopalpur- Padmapur up to a radial distance of 75 kM . Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **65 kM** (Shyamsunderpur) whereas for TV ON Go on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of 50 **kM** (Gadapokhari).



(Fig-VII, Showing variation of Field Strength & MSL with Distance along West Direction)

8. **Radial-8 (North-West)**:Along this radial field strength measurement done at nine location like Kapursingh- Radha Krushnapur- Dhenkanal Forest- Nachhipura- Barada- Godaribili- Mahuli- Bijadiha & Puruna Alatuma up to a radial distance of 60 kM . Satisfactory reception of DVB-T2 Transmission was observed for TV Receiver (10 meter) to be up to a radial distance of **45 kM** (Godaribili) whereas for TV ON Go on smart mobile phone at a height of 1.5 Meter it was up to a radial distance of **35 kM** (Nachhipura).



(Fig-VIII, Showing variation of Field Strength & MSL with Distance along North- West Direction)

Conclusion:

On the basis of received field strength & MER values at the spot/location along eight radials & coverage contour(Annexure-II) drawn on the basis of table prepared/compiled for satisfactory reception of DVB-T2 transmission following conclusions can be stipulated.

A. Satisfactory coverage on conventional TV receiver (Antenna at a height of 10 Meter)

1. The coverage along North & North-East region varies from 55 kM to 85 km**,** along North-East & East region it is 80 kM to 85 kM. Along East & South-East region coverage extended up to 85 kM to 75 kM. The coverage along South-East & South region is up to a distance of 75 kM to 70 Km. Coverage along South & South-West region is restricted up to a distance of 70 kM. Whereas along South-West & West region coverage is up to a distance of 70 kM & 65 kM. Along West & North-West region coverage is 65 kM to 45 kM & along North-West & North region extended up to a distance of 45 kM to 55 kM.

2. The coverage along North-West & North region was found to be minimum up to a distance of **45-55 kM**. The coverage shrinkage along this region due to existence of irregular terrain & long stretch of hill forest region (Kapilash, Karamul & Harichandanpur-Telkoi hill Forest along North & Gurudijhatia, Kapilash, Bahukhai & Dhenkanal Forest range along North-West Direction).These hill forest range lie along the radials causing random variation of field strength & MER due to multipath reflected signal & penetration/vegetation losses.

3. The coverage along North & North-East region was found to be confined up to distance of **55-80 kM**. Along the North direction the coverage is extended upto 55 km only due to existence of irregular terrain & hill forest range whereas along North-East direction it is larger upto 80 kM due to non existence of forest ranges.

4. The coverage along North-East & East region was found to be maximum up to a distance of **80-85 kM**. This is because of non-existence of any forest range along this region however there was irregular rural terrain causing significant variation in field strength & MER over the far end locations.

5. The coverage along East & South-East region was found to be confined up to a distance of **85-75 kM**. The far end region confined along these directions is bounded by sea bitch(Bay of Bengal) as such along South-East radial field strength measurement was restricted up to a distance of 75 kM(Kusupur). Along this radial coverage may be extended upto 80-85 kM distance falling inside the sea water.

6. The coverage along South-East - South & South-West region was found to be confined up to **75-70 kM**. The far end region along these directions are bounded by sea bitch (Bay of Bengal). Along south radial the terrain was urban low level land whereas South-West direction mostly rural irregular terrain with stretch of hill forest ranges (Chandaka, Tangi & Khallikote forest ranges).

7. The coverage along South-West & West region was found to be confined up to a distance of **70-65 kM**. The shrinkage in coverage along this region basically due to the existence of number of irregular hill forest ranges effectively causing vegetation & penetration losses.

8. The coverage along West & North-West region was found to be confined up to a distance of **65-45 kM**. The shrinkage in coverage along this region is also basically due to the existence of number of irregular hill forest ranges effectively causing vegetation & penetration losses. The coverage along North-West direction is restricted up to a distance of 45 km only the least coverage comparatively other directions.

B. Satisfactory coverage on smart mobile phone (Antenna at a height of 1.5 Meter)

1. The coverage for mobile reception was found to be lesser by 10-30 km respectively in all direction than the coverage stipulated for stationary reception on conventional TV receiver when receiving antenna is placed at height of 10 meters from the ground level. The coverage contour area for hand held portable device (Smart Mobile Phones) seems to be lesser than the coverage contour area drawn for TV reception. Along North, North-West region the coverage is minimum & along East, South-East region it is maximum upto a distance of 55-60 kM whereas along other regions coverage is almost the same extended upto a distance of 50 55 kM.

From the field strength & MER data collected along all eight radials, it is being observed that the reception in QPSK mode of transmission is satisfactory for minimum field strength value of 45 dBµV/m for conventional TV receivers (with DVB-T2 set top box) measured at a receiving antenna height of 10 Meters whereas for smart mobile phone reception it is ranging from 47-50 dBµV/m with MER greater than 10.0dB under existing environment condition. The predicted coverage contour itself reveals that DVB-T2 reception is satisfactory within the predicted coverage area (up to 45-85 kM) with fixed roof top antenna mounted at a height of 10Mtrs from the ground & up to 35 kM to 60 kM in case of smart mobile phone at a height of 1.5 Meters.

No interference of unwanted signal in reception of DTT transmission has been observed within its coverage area.

Scope of further study:

The purpose of this field trial is to determine the coverage contours for satisfactory reception of DVB-T2 Transmission under existing environmental condition. A comprehensive field strength survey of the said transmitter for reception in portable devices like smart mobile phone in densely populated areas, narrow lanes etc. to assess poor pocket zone & inside different types of building falling within the coverage contour & also reception on go inside moving vehicles is suggested for further propagation study under different environment conditions.

Acknowledgement:

In true sense field trial is like a bridge between theoretical & practical working & the outcome is a team effort that involves hard work, dedication & sincere interest exhibited by the team member. Before we get into thick of things survey staff would like to add a few words of appreciation for Sh.P.R.L.Rao (ADE) & the staff of HPT (TV) Cuttack who have been a part of this field trial right from its inception. Survey team owes a deep sense of gratitude to Sh.S.Hyder (DDG) & Sh.V.K.Verma (DDE) for his keen interest at every stage of this survey work. Presentation inspiration & motivation have always played a key role in the success of any project work, with this sense survey team feel to acknowledge their indebtedness & deep sense of gratitude to Smt.Anuradha Agarwal (ADG) whose encouraging guidance, elevating inspiration & kind supervision leads to successful completion of this survey.

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Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

.

Direction: North (Radial-1) Table-1

Route: TV tower (Tulsipur)-Karanji- Mandar-Khandara-Bamanipal-Tangiriapal Date: 14/05/2017

Time (Hrs.)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
							MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone		
					10M	3M			LDPC	BCH	10M	3M			
0925	Chaman (Link Road) Gurudijhatia Station Road	N20°34'24.2" E85°50'43.8"	***34***	*10*	73.6	69.3	37.8	39.9	1.0E-7	1.0E-6	OK	OK	OK	Rural, Near Kapilash Forest Range,	Near Kapilash Forest Range
1030	Karanji (Kapilash Forest Range), Tangi Road	N20°39'19.5" E85°54'57.5"	*77*	*20*	67.7	62.8	37.0	38.7	1.0E-8	1.0E-6	OK	OK	OK	Hilly, Kapilash Forest Range, No Traffic	Surrounded by Forest Ranges
1215	Sapuajhar Mandara road	N20°45'05.0" E85°47'25.1"	*72*	30	45.7	42.8	11.8	18.3	1.0E-7	5.3 E-3	OK	FF	F	Hilly, Kapilash Forest Range, No Traffic	Behind Kapilash Forest Range
1235	Kaitha Mandara road	N20°47'51.1" E85°49'18.2"	***65***	35	44.7	40.1	11,6	NT	1.0E-7	4.7E-4	OK	F	NT	Rural, No Traffic,	Between Kapilash & Karamul Hill Forest
1255	Mandar Mandara road	N20°50'53.4" E85°51'24.4"	*45*	*40*	40.2	39.8	NT	NT	NT	NT	NT	NT	NT	Hilly, Rural, No Traffic	Behind Karamul Forest Range,
1320	Bhuban Bhuban-Mangalpur Road	N20°53'13.5" E85°49'56.6"	*43*	*45*	47.5	44.5	14.2	15.6	1.0E-7	2.3E-4	OK	OK	OK	Hilly, Rural, No Traffic,	Behind Karamul Forest Range,
1345	Botalanda Bhuban-Mangalpur Road	N20°56'15.0" E85°51'11.3"	*55*	*50*	45.6	41.8	18.5	12.7	1.0E-7	1.0 E-6	OK	FF	FF	Hilly, Rural, No Traffic ,	Behind Karamul Forest Range
1410	Gandhapal Kuhika-Rankia Road	N20°58'42.2" E85°50'24.4"	*53*	*55*	44.3	39,7	13.9	10.8	1.0E-7	4.4E-4	OK	NT	NT	Rural, Near Tomka Forest Range.	
1430	Khandara Naranpur-Duburi Road	N21°00'56.9" E85°58'47.3"	*85*	*60*	39.6	39.4	NT		NT	NT	NT		NT	Rural,, Near Forest Range No Traffic	
1455	Tomka Forest Block Naranpur-Duburi Road	N21°03'58.1" E85°59'01.9"	*108*	*65*	39.7	39.6	NT		NT	NT	NT		NT	Rural, Tomka Hill Forest, Low Traffic	
1525	Near Bamanipal Naranpur-Duburi Road	N21°06'54.0" E85°56'15.4"	*105*	*70*	39.8	39.5	NT		NT	NT	NT		NT	Hilly, Rural, Behind Tomka Forest Range,	
1550	Kendujhar Naranpur-Duburi Road	N21°09'25.2" E85°55'51.9"	*97*	*75*	39.7	39.4	NT		NT	NT	NT		NT	Rural ,Surrounded by Two Forest Range	Harichandanpur-Telkoi Forest
1635	NearTangiriapal Naranpur-Duburi Road	N21°09'32.4" E85°55'48.6"	*99*	*80*	39.6	39.4	NT		NT	NT	NT		NT	Rural ,Surrounded by Two Forest Range	

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: North East (Radial-2) Table-2

Route: TV Tower (Tulsipur), Manguli Chowk-Ganash-Karajanga Chhak-Sathipur-Bhandari Pokhari-Adampur-Bhadrak-Tisalpur Date: 15/05/2017

Time (Hrs.)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
							MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone		
					10M	3M			LDPC	BCH	10M	3M			
0830	Manguli Chowk Sambalpur-Cuttack HWY	N20°31'25.3" E85°56'22.4"	*38*	*10*	93.7	89.3	37.0	51.7	1.0E-7	1.0 E-6	OK	OK	OK	Urban , Moderate Traffic,	
0900	Bainchua Badshahi Road	N20°34'20.6" E86°01'16.5"	*28*	*20*	78.3	73.1	37.0	46.7	1.0E-7	1.0E-6	OK	OK	OK	Rural , Moderate Traffic,	
0925	Ganash (Bandal) Badshahi Road	N20°38'09.1" E86°05'30.6"	*25*	30	64.2	64.1	37.0	36.0	1.0E-7	1.0 E-6	OK	OK	OK	Rural , Moderate Traffic, Vegetation	
0945	Sarei Badshahi Road	N20°43'36.9" E86°08'21.8"	*28*	*40*	41.0	40.1	8.6	2.4	1.0E-7	2.7E-2	F	F	F	Rural , Moderate Traffic, Vegetation	
1015	Karajanga Chhak Badshahi Road	N20°48'45.6" E86°11'14.1"	*24*	*50*	50.6	50.2	21.6	19.6	1.0E-7	1.0E-6	OK	OK	OK	Rural , Moderate Traffic, Vegetation	
1045	Manipur (Soti) Badshahi Road	N20°54'12.9" E86°13'13.5"	*27*	*60*	46.1	41.3	21.1	17.0	1.0E-7	1.0E-6	OK	F	F	Rural , Moderate Traffic, Vegetation	
1100	Sathipur Badshahi Road	N20°56'00.5" E86°15'46.3"	*29*	*65*	45.2	40.7	21.1	13.5	1.0E-7	1.0E-6	OK	NT	NT	Rural , Moderate Traffic, Vegetation	
1125	Puripada (Mituani) Badshahi Road	N20°56'28.3" E86°19'10.0"	*22*	*70*	46.6	40.7	22.3	17.9	1.0E-7	1.0E-6	OK	NT	NT	Rural , Moderate Traffic, Vegetation	
1140	Bhandari Pokhari Badshahi Road	N20°57'37.1" E86°22'08.7"	*26*	*75*	45.6	40.7	13.4	6.7	1.0E-7	1.1E-4	OK	NT	NT	Rural , Moderate Traffic, Vegetation	
1200	Piripur Badshahi Road	N20°59'03.6" E86°24'41.6"	*14*	*80*	44.5	40.2	8.5	6.9	1.0E-7	1.9E-2	OK	NT	NT	Rural , Moderate Traffic, Vegetation	
1225	Adampur Badshahi Road	N21°00'50.1" E86°26'51.5"	*12*	*85*	39.7	39.6	-	NT	NT	NT	NT	NT	NT	Rural , Moderate Traffic, Vegetation	
1240	Gelpur Badshahi Road	N21°02'41.5" E86°28'56.6"	*14*	*90*	40.2	39.7	6.2	3.8	1.0E-7	3.4E-2	NT	NT	NT	Rural , Moderate Traffic, Vegetation	
1255	Charampa Badshahi Road	N21°05'02.3" E86°30'57.0"	*17*	*95*	39.8	39.5	NT	NT	NT	NT	NT	NT	NT	Rural , Moderate Traffic, Vegetation	
1310	Tisalpur Badshahi Road	N21°07'01.4" E86°32'37.0"	*20*	*100*	39.8.	39.6	NT	NT	NT	NT	NT	NT	NT	Rural , Moderate Traffic, Vegetation	

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: East (Radial-3) Table-3

Route: TV tower (Tulsipur)-Jagatpur-Kulia-Khamol-Kendrapada- Baro-Pattamundai-Sasan-Rajnagar-Kurunti Date: 15/05/2017

Time (Hrs)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
							MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone		
					10M	3M			LDPC	BCH	10M	3M			
2230	Jagatpur Cuttack- Kendrapada Rd	N20°29'41.0" E85°56'57.0"	*30*	*10*	87.5	78.2	37.1	52.0	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Vegetation	
2200	Bhatapada Cuttack- Kendrapada Rd	N20°28'50.2" E86°02'35.5"	*23*	*20*	79.3	74.9	37.0	48.5	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Vegetation	
2125	Kulia Cuttack- Kendrapada Rd	N20°28'38.2" E86°08'16.1"	*18*	*30*	68.5	67.4	37.0	42.0	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Vegetation	
2055	Ranipada Cuttack- Kendrapada Rd	N20°29'01.3" E86°14'05.9"	*14*	*40*	52.6	46.7	20.4	4.5	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Vegetation	
2030	Khamol Cuttack- Kendrapada Rd	N20°30'07.2" E86°19'48.0"	*7*	50	54.6	42.1	30.4	27.5	1.0E-7	1.0 E-6	OK	FF	FF	Rural, Low Traffic Vegetation	
2005	Kasoti (Kendrapada) Cuttack- Kendrapada Rd	N20°30'55.9" E86°22'39.3"	*13*	*55*	51.7	50.3	26.6	16.4	1.0 E-7	1.0 E-6	OK	OK	OK	Urban. Low Traffic. Vegetation	
1930	Kapleswar Kendrapada - Chandabali Rd	N20°31'15.9" E86°25'24.0"	*20*	*60*	44.6	40.4	14.4	5.1	1.0E-7	2.6 E-4	OK	NT	NT	Rural, Low Traffic Vegetation	
1905	Baro Kendrapada - Chandabali Rd	N20°33'10.1" E86°28'08.8"	*23*	*65*	47.5	40.7	23.2	17.1	1.0E-7	1.0E-6	OK	NT	FF	Rural, Low Traffic. Vegetation	
1845	Nasipur Kendrapada - Chandabali Rd	N20°34'20.2" E86°30'56.1"	*11*	*70*	44.7	39.4	18.6	14.1	1.0 E-7	1.8 E-4	OK	NT	NT	Rural ,Low Traffic, Vegetation	
1820	Pattamundai Kendrapada - Chandabali Rd	N20°34'55.0" E86°33'27.4"	*08*	*75*	44.3	39.1	17.3	16.2	1.0 E-7	1.0 E-6	OK	NT	NT	Rural ,Low Traffic, Vegetation	
17.45	Sasan Pattamundai-Rajnagar Rd	N20°33'16.8" E86°37'00.6"	*05*	*79*	44.8	39.8	6.0	7.3	1.0 E-6	2.8 E-2	OK	NT	NT	Rural ,Low Traffic, Vegetation	
1710	Sansarfal Pattamundai-Rajnagar Rd	N20°34'03.8" E86°40'22.8"	*07*	*85*	44.5	40.3	12.8	13.2	1.0E-7	1.6E-5	OK	NT	F	Rural, Low Traffic, Vegetation	
1640	Rajnagar Pattamundai-Rajnagar Rd	N20°34'23.2" E86°42'44.8"	*13*	*90*	40.2	39.7	6.8	2.8	1.0E-7	2.8E-2	FF	NT	F	Forest Range, Moderate Traffic	Bhitarkanika National Park
1615	Kurunti Pattamundai-Rajnagar Rd	N20°34'13.2" E86°45'53.8"	*09*	*95*	39.6	39.5	-	-	-	-	F	NT	NT	Forest Range, Moderate Traffic	

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: South-East (Radial-4) Table-4

Route: TV tower (Tulsipur)-Bidyadharpur-Gopinathpur-Jagatsinghpur-Badagar-Chataramundi-Kusupur(Sea Beach) Date: 16/05/2017

Time (Hrs)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
							MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone		
					10M	3M			LDPC	BCH	10M	3M			
0930	Bidyadharpur Cuttack-Paradeep Rd	N20°26'46.9" E85°56'25.5"	*34*	10	91.5	83.4	37.2	51.9	1.0E-7	1.0E-6	OK	OK	OK	Rural, Moderate Traffic, Vegetation	
0955	Athanga Cuttack-Jagatsinghpur	N20°23'07.8" E86°00'48.2"	*28*	20	78.3	72.2	37.0	48.1	1.0E-7	1.0E-6	OK	OK	OK	Rural, Moderate Traffic, Vegetation	
1025	Gopinathpur Cuttack-JagatsinghpurRd	N20°19'36.2" E86°05'26.5"	*24*	*30*	77.1	51.3	37.0	50.6	1.0E-7	1.0E-6	OK	OK	OK	Rural, Moderate Traffic, Vegetation	
1055	Jagatsinghpur Cuttack-JagatsinghpurRd	N20°15'25.8" E86°09'55.7"	*24*	*41*	60.6	54.1	35.6	26.8	1.0E-7	1.0E-6	OK	OK	OK	Urban, Moderate traffic, Vegetation	
1121	Aril (Sadeipur) Machhagan Road	N20°11'59.7" E86°13'35.0"	*17*	*50*	47.9	46.2	25.1	21.5	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low traffic, Vegetation.	
1140	Badagar (Naranpur) Machhagan Road	N20°09'39.7" E86°15'07.6"	*17*	*55*	48.3	44.5	23.9	21.1	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low traffic, Vegetation.	
1200	Iswarpur Machhagan Road	N20°07'20.7" E86°16'55.6"	*14*	*60*	47.4	45.2	16.9	13.6	1.0E-7	9.0E-4	OK	OK	OK	Rural, Low traffic, Vegetation.	
1230	Chataramundi Rahan Road	N20°05'27.2" E86°19'06.2"	*13*	*65*	45.6	40.5	16.4	11.7	1.0E-7	2.8E-6	OK	FF	NT	Rural, Low traffic, Vegetation.	
1245	Brahmanadehi Rahan-Tentulibellari Rd	N20°04'04.8" E86°21'22.6"	*12*	*70*	44.9	39.8	17.6	13.5	1.0E-7	1.0E-6	OK	NT	NT	Rural, Low traffic, Vegetation	
1325	Kusupur (Sea Beach)	N20°02'41.3" E86°24'14.3"	*12*	*75*	47.7	41.2	23.3	19.3	1.0E-7	1.0E-6	OK	NT	NT	Rural, Low traffic, Vegetation	No Road Sea ahead

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: South (Radial-5) Table-5

Route: TV tower (Tulsipur)-Palasuni-Pipli-Thengipada-Siriapur-Sakhigopal-Jaganathpur-Alikia-Puri Date: 17/05/2017

Time (Hrs.)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
							MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone 1.5M		
					10M	3M			LDPC	BCH	10M	3M			
0905	Naugarh Cricket Ground Badshahi Road	N20°23'44.5" E85°52'56.5"	*39*	10	94.1	85.2	37.0	51.9	1.0E-7	1.0E-6	OK	OK	OK	Urban, Moderate Traffic, Vegetation	
0927	Palasuni Cuttack-Bhubaneswar Rd	N20°18'07.3" E85°51'53.9"	*33*	*20*	62.7	59.1	22.2	24.6	1.0E-7	5.2E-4	OK	OK	OK	Urban, Heavy Traffic,	
1010	Lingipur Bhubaneswar-Puri Rd	N20°12'50.4" E85°51'14.6"	*27*	*30*	65.2	52.2	34.1	24.7	1.0E-7	1.0E-6	OK	OK	OK	Urban, Moderate Traffic,	
1035	Pipili Bhubaneswar-Puri Rd	N20°07'16.6" E85°50'56.5"	*24*	*40*	66.4	64.7	34.2	38.7	1.0E-7	1.0E-6	OK	OK	OK	Urban, Moderate Traffic, Vegetation	
1055	Thengipada(Potal) Bhubaneswar-Puri Rd	N20°01'41.0" E85°49'19.6"	*17*	*50*	50.2	46.7	23.8	22.6	1.0E-7	2.8E-5	OK	OK	OK	Urban, Moderate Traffic,	
1110	Siriapur(Arjunsinghpur) Bhubaneswar-Puri Rd	N19°59'07.4" E85°49'29.4"	*16*	*55*	45.6	41.2	18.9	7.4	1.0E-7	1.0E-6	OK	NT	NT	Urban, Moderate Traffic,	
1145	Sakhigopal Bhubaneswar-Puri Rd	N19°56'19.6" E85°49'13.0"	*15*	*60*	44.9	41.6	20.1	12.3	1.0E-7	3.6E-6	OK	NT	NT	Urban, Moderate Traffic,	
1200	Jagannathpur Bhubaneswar-Puri Rd	N19°53'49.9" E85°48'23.4"	*15*	*65*	49.3	41.8	22.4	20.9	1.0E-7	2.4E-4	OK	FF	NT	Urban, Moderate Traffic,	
1220	Alikia Puri –Balanga Rd	N19°51'07.6" E85°50'10.4"	*15*	*70*	44.7	40.9	10.0	7.2	1.0E-7	5.4E-3	OK	NT	NT	Urban, Moderate Traffic,	
	Puri Bhubaneswar-Puri Rd	N19°48'34.6" E85°49'54.1"	*14*	*75*	41.6	39.7	-	-	-	-	NT	NT	NT	Urban, Heavy Traffic,	

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: South-West (Radial-6) Table-6

Route: TV tower (Tulsipur)-Jujhagada-ChatabarDadhimachhagadia-Mundamba-Patrapada-Nandapur (Tangi)-Nizgarhkuhudi Date: 18/05/2017

Time (Hrs.).	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
					10M	3M	MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone 1.5M		
									LDPC	BCH	10M	3M			
0900	Jujhagada Chandaka-Nandankanan Rd	N20°24'11.7" E85°48'40.6"	*38*	*10*	75.5	66.3	37.0	49.0	1.0E-6	1.0E-7	OK	OK	OK	Rural, Forest, Moderate Traffic	Nandan Kanan Forest Range
1115	Andharua Khurdha-Chandaka Rd	N20°20'09.5" E85°44'25.1"	*53*	*20*	61.9	57.7	25.2	24.3	1.0E-7	1.0E-6	OK	OK	OK	Rural, Forest, Moderate Traffic	Chandaka Forest Range
1150	Chatabar Khurdha-Chandaka Rd	N20°15'33.4" E85°41'21.9"	*55*	*30*	63.2	51.9	36.1	35.8	1.0E-7	1.0E-6	OK	OK	OK	Rural, Moderate Traffic Vegetation	Chandaka Forest Range
1215	Jagannathpur Katikata-Jaipur Road	N20°10'24.8" E85°37'55.7"	*62*	40	67.4	60.4	37.1	27.6	1.0E-6	1.0E-6	OK	OK	OK	Rural, Low Traffic. Vegetation	
1235	Dadhimachhagadia Katikata-Jaipur Road	N20°06'50.4" E85°34'38.7"	*73*	*50*	50.2	46.9	26.1	18.7	1.0E-6	1.0E-6	OK	OK	OK	Rural, Low Traffic. Vegetation	
1300	Malipada(Kanpur) Katikata-Jaipur Road	N20°04'22.4" E85°33'15.9"	*36*	*55*	48.2	42.2	24.8	17.2	1.0E-6	1.0E-6	OK	OK	NT	Rural, Low Traffic. Vegetation	
1320	Mundaamba(Jankia) Khurdha-Brahmapur Rd	N20°02'16.6" E85°31'26.8"	*33*	*60*	45.1	42.2	18.5	4.9	1.0E-7	1.0E-6	OK	OK	NT	Rural, Low Traffic. Vegetation	
1335	Ratamati Khurdha-Brahmapur Rd	N20°00'26.6" E85°29'17.0"	*44*	*65*	45.0	40.2	19.1	13.2	1.0E-6	1.0E-6	OK	OK	NT	Rural, Low Traffic. Vegetation	Tangi Forest Range
1350	Patrapada Khurdha-Brahmapur Rd	N19°58'38.3" E85°27'05.4"	*57*	*70*	44.7	42.1	17.3	14.7	1.0E-7	3.0E-5	OK	OK	NT	Rural, Low Traffic. Vegetation	Tangi Forest Range
1405	Kandhanayagarh Khurdha-Brahmapur Rd	N19°56'50.7" E85°24'46.7"	*33*	*75*	42.6	40.1	13.9	9.8	1.0E-7	1.1E-3	OK	NT	NT	Rural, Low Traffic. Vegetation	Between Tangi & Khallikote Forest Range
1500	Nandapur (Tangi) Khurdha-Brahmapur Rd	N19°54'47.5" E85°22'53.1"	*24*	*80*	40.6	39.6	-		-	-	NT	NT	NT	Rural, Low Traffic. Vegetation	Khallikote Forest Range
1515	Nizgarhkuhudi Khurdha-Brahmapur Rd	N19°53'00.3" E85°20'39.9"	*33*	*85*	40.2	39.6	-		-	-	NT	NT	NT	Rural, Low Traffic. Vegetation	

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: West (Radial- 7) Table-7

Route: TV tower (Tulsipur)-Kapursingh-Dhenkanal Forest-Barada-Mahuli-Bijadiha-Puruna Alatuma-Siarimalia Date: 20/05/2017

Time (Hrs)	Spot/Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
					10M	3M	MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone 1.5M		
									LDPC	BCH	10M	3M			
0855	Talagar Cuttack-Athgarh Rd	N20°27'17.8" E85°45'25.2"	*42*	*10*	92.2	86.4	37.0	51.6	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Vegetation,	Mahanadi River Side
0940	Kandarpur Kandarpur Road	N20°28'02.9" E85°39'20.8"	*50*	20	70.3	67.2	37.0	43.9	1.0E-7	1.0E-6	OK	OK	OK	Rural, Forest, Hilly Low Traffic	Chandaka Forest Range
1017	Nuabandha Haldia-Talabasta Road	N20°28'59.9" E85°33'51.3"	*72*	*30*	55.8	46.5	32.9	30.2	1.0E-7	1.0E-6	OK	OK	OK	Rural, No Traffic, Forest, Hilly,	Near Hindol Badamba Forest Range
1115	Nuapatana Haldia-Talabasta Road	N20°26'42.6" E85°27'30.3"	*61*	*40*	53.7	44.1	29.5	22.5	1.0E-7	1.0E-6	OK	OK	OK	Rural, Low Traffic, Hilly,	Hindol Badamba Forest
1150	Gadapokhari Haldia-Talabasta Road	N20°25'27.9" E85°22'30.6"	*63*	*50*	46.6	45.7	21.2	20.4	1.0E-7	1.0E-6	OK	OK	OK	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest
1215	Deuli Haldia-Talabasta Road	N20°24'55.9" E85°19'43.8"	*66*	*55*	44.4	40.0	17.1	11.6	1.0E-7	1.0E-6	OK	OK	NT	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest
1235	Janisahi Haldia-Talabasta Road	N20°24'27.7" E85°16'50.5"	*73*	*60*	47.1	42.9	23.1	19.2	1.0E-7	1.0E-6	OK	OK	FF	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest
1255	Shyamsunderpur Haldia-Talabasta Road	N20°24'32.3" E85°13'50.3"	*67*	*65*	44.2	41.2	13.6	10.4	1.0E-7	3.0E-4	OK	OK	NT	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest
1315	Purunagopalpur Haldia-Talabasta Road	N20°25'31.5" E85°10'56.6"	*79*	*70*	42.7	39.8	-	-	-	-	NT	NT	NT	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest
1335	Padmapur Haldia-Talabasta Road	N20°26'47.6" E85°07'53.6"	*87*	*75*	40.3	39.6	-	-	-	-	NT	NT	NT	Rural,LowTraffic, Vegetation,	Hindol Badamba Forest

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Direction: North-West (Radial- 8) Table-8

Route: TV tower (Tulsipur)-Kapursingh-Dhenkanal Forest-Barada-Mahuli-Bijadiha-Puruna Alatuma-Siarimalia Date: 20/05/2017

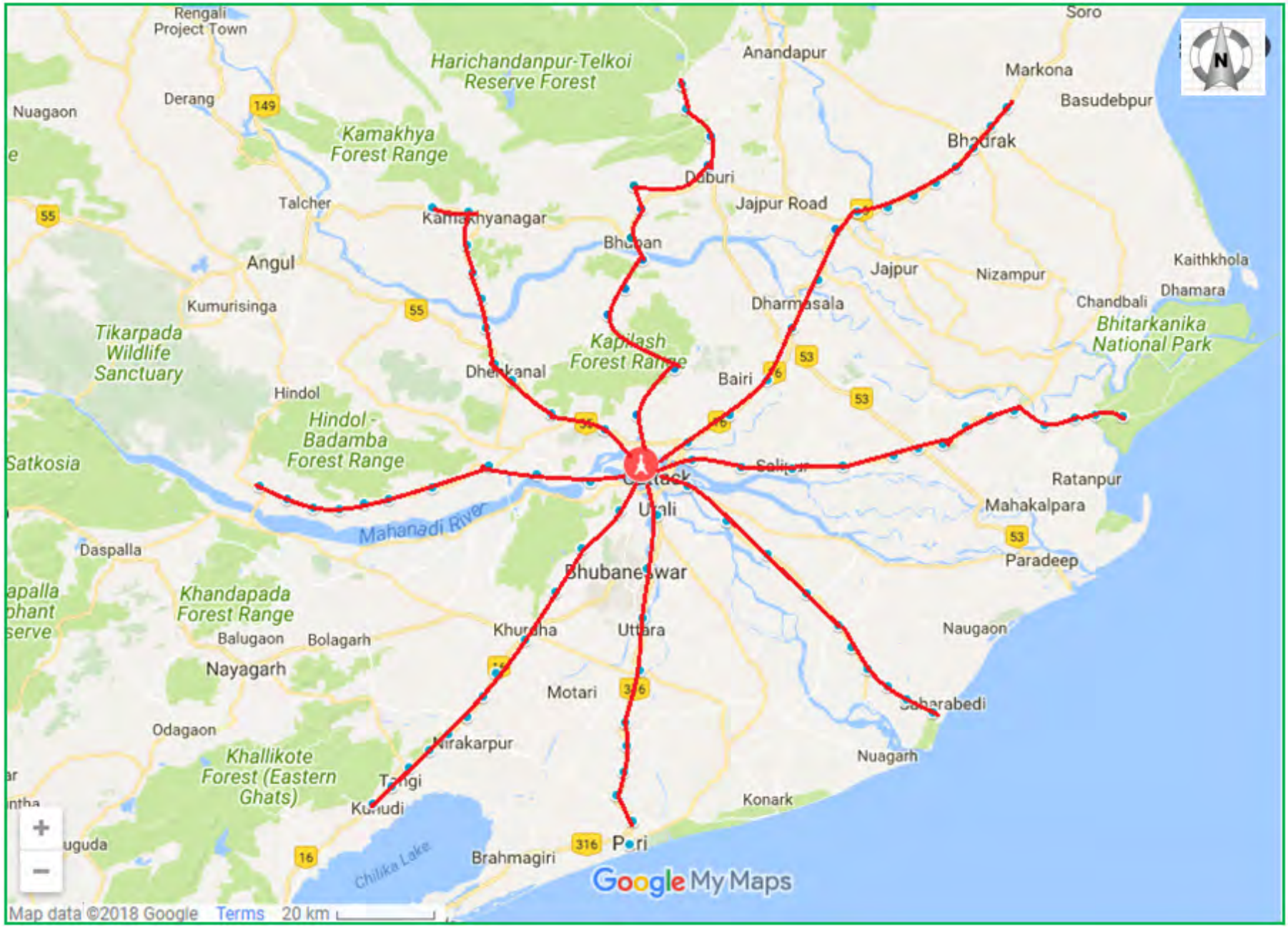
TimeHrs.	Location	Location Co-ordinates	MSL (Mtrs)	Radial Distance (kM.)	Field Strength (dBµV/m)		COFDM (IRD) Parameter				Subjective Assessment			Terrain	Remarks
					10M	3M	MER (dB)	C/N	BER(Pre)		TV Receiver		Mobile Phone 1.5M		
									LDPC	BCH	10M	3M			
0930	Kapursingh Sambalpur-Cuttack HWy	N20°32'57.1" E85°46'57.9"	*51*	*10*	94.7	69.2	87.2	46.5	1.0E-7	1.0E-6	OK	OK	OK	Rural ,Forest, Low Traffic	Near Gurudijhatia Forest Range
0955	Radha Krushnapur Sambalpur-Cuttack HWy	N20°34'33.2" E85°40'53.8"	*56*	20	56.7	48.3	31.8	29.5	1.0E-7	1.0E-6	OK	OK	OK	Rural ,Bahukhai Hill Forest, Low Traffic	Inside Bahukhai Hill Forest Range
1025	Dhenkanal Forest Sambalpur-Cuttack HWy	N20°38'07.5" E85°36'30.6"	*114*	*30*	52.8	51.3	22.4	26.7	1.0E-7	1.0E-6	OK	OK	OK	Rural ,Dhenkanal Forest, Hilly Low Traffic	Inside Dhenkanal Forest Range
1105	Nachhipura Sambalpur-Cuttack HWy	N20°39'46.1" E85°34'28.8"	*68*	*35*	50.2	45.8	16.3	24.3	1.0E-7	1.0E-2	OK	OK	OK	Rural ,Forest, Hilly Low Traffic	Between two Hill Forest
1125	Barada Kamakhyanagar-Dhenkanal Road	N20°43'39.5" E85°33'28.9"	*59*	*40*	52.2	43.1	27.5	24.3	1.0E-7	1.0E-6	OK	OK	FF	Rural ,Forest, Hilly Low Traffic	Behind the Hilly Forest
1220	Godaribili Kamakhyanagar-Dhenkanal Road	N20°46'41.6" E85°33'03.3"	*78*	*45*	46.3	40.9	19.4	11.5	1.0E-7	1.0E-6	OK	FF	NT	Rural , Vegetation Low Traffic	Behind the Hilly Forest
1300	Mahuli Kamakhyanagar-Dhenkanal Road	N20°49'33.1" E85°32'01.4"	*87*	*50*	42.5	40.0	13.8	2.0	1.0E-7	1.0E-5	OK	NT	NT	Rural , Kantajhari Hill Forest, Low Traffic	
1330	Bijadiha Kamakhyanagar-Dhenkanal Road	N20°52'25.3" E85°31'21.4"	*84*	*55*	39.9	39.6	-	-	NT	NT	NT	NT	NT	Rural ,Forest, Hilly Low Traffic	Behind Kantajhari Hill Forest
1400	Puruna Alatuma	N20°55'55.7" E85°31'30.7"	*60*	*60*	39.7	39.6	NT	NT	NT	NT	NT	NT	NT	Rural ,Forest, Hilly Low Traffic	Near Kamakhya Forest Range
1415	Siarimalia	N20°56'25.1" E85°27'25.0"	*74*	*65*	39.6	39.6	NT	NT	NT	NT	NT	NT	NT	Rural ,Forest, Hilly Low Traffic	Kamakhya Forest Range

Reception survey for satisfactory coverage of DVB-T2 Transmitter (538MHz, Ch#29), Cuttack

Table for satisfactory coverage of DVB-T2 Transmission in QPSK Mode

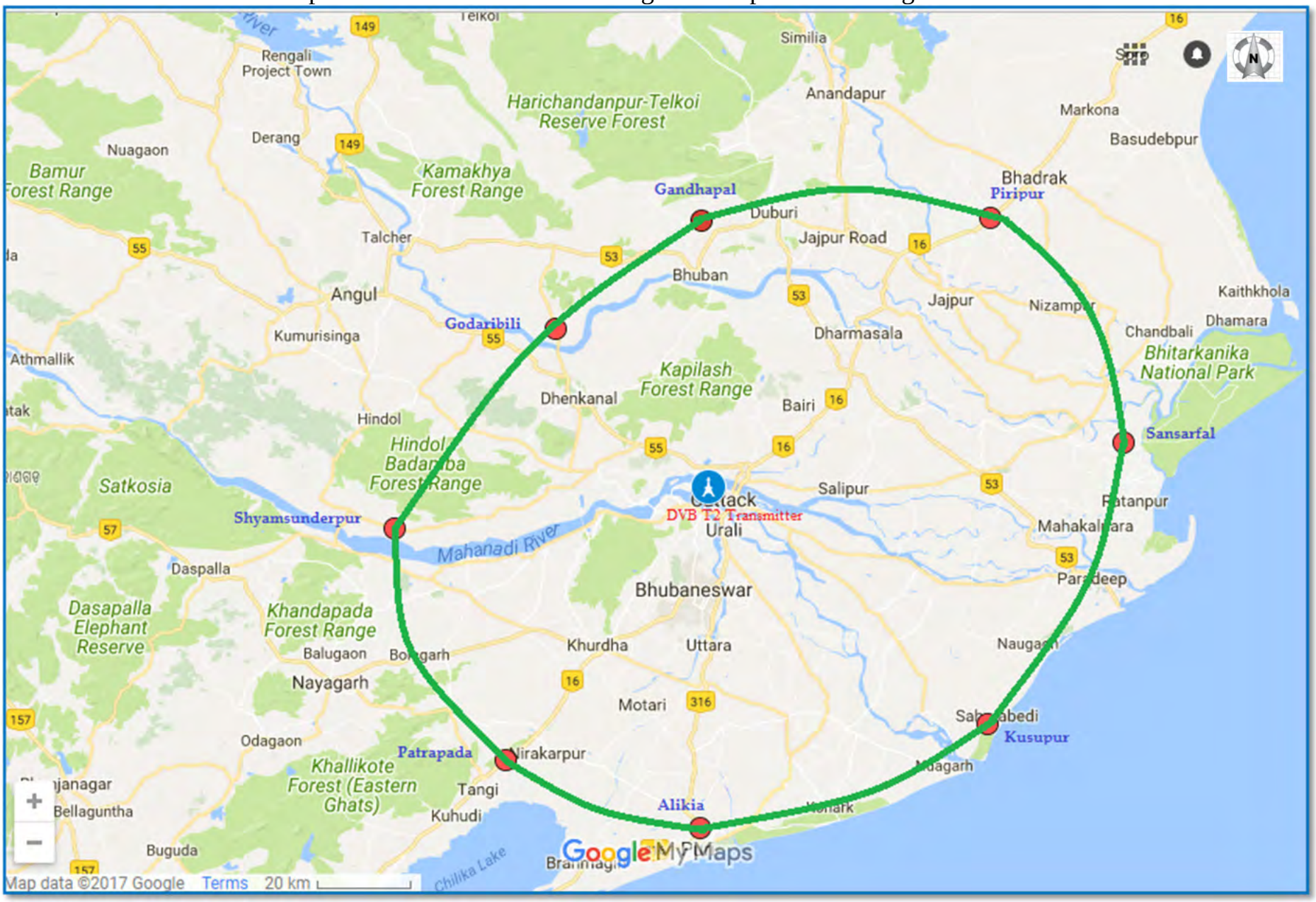
Table-9

Direction	Mode of (DVB T2) Reception	Spot/Location	Location Co-ordinates	MSL (Meters)	Radial Distance (kM)	Field Strength (dBµV/m)		COFDM (IRD) Parameter (10 Meter)				Subjective Assessment	Remarks
						10 M	3 M	MER (dB)	C/N	BER(Pre)			
										LDPC	BCH		
North	TV Receiver	Gandhapal Kuhika-Rankia Road	N20°58'42.2" E85°50'24.4"	*53*	*55*	44.3	39,7	13.9	10.8	1.0E-7	4.4E-4	OK	Behind Hilly Forest range
	Mobile Phone	Bhuban Bhuban-Mangalpur Road	N20°53'13.5" E85°49'56.6"	*43*	*45*	47.5	44.5	14.2	15.6	1.0E-7	2.3E-4	*OK*	Behind Hilly Forest range
North-East	TV Receiver	Piripur Badshahi Road	N20°59'03.6" E86°24'41.6"	*14*	*80*	44.5	40.2	8.5	6.9	1.0E-7	1.9E-2	OK	Near Forest range & Sea
	Mobile Phone	Karajanga Chhak Badshahi Road	N20°48'45.6" E86°11'14.1"	*24*	*50*	50.6	50.2	21.6	19.6	1.0E-7	1.0E-6	*OK*	
East	TV Receiver	Sansarfal Pattamundai-Rajnagar Rd	N20°34'03.8" E86°40'22.8"	*07*	*85*	44.5	37.3	12.8	13.2	1.0E-7	1.6E-5	OK	Near Forest range & Sea
	Mobile Phone	Kasoti (Kendrapada) Cuttack- Kendrapada Rd	N20°30'55.9" E86°22'39.3"	*13*	*55*	51.7	50.3	26.6	16.4	1.0 E-7	1.0 E-6	*OK*	
South-East	TV Receiver	Kusupur (Sea Beach)	N20°02'41.3" E86°24'14.3"	*12*	*75*	47.7	41.2	23.3	19.3	1.0E-7	1.0E-6	OK	Near Forest range & Sea
	Mobile Phone	Iswarpur Machhagan Road	N20°07'20.7" E86°16'55.6"	*14*	*60*	47.4	45.2	16.9	13.6	1.0E-7	9.0E-4	*OK*	
South	TV Receiver	Alikia Puri –Balanga Rd	N19°51'07.6" E85°50'10.4"	*15*	*70*	44.7	40.9	10.0	7.2	1.0E-7	5.4E-3	OK	Urban, Near Puri followed by Sea
	Mobile Phone	Thengipada(Potal) Bhubaneswar-Puri Rd	N20°01'41.0" E85°49'19.6"	*17*	*50*	50.2	46.7	23.8	22.6	1.0E-7	2.8E-5	*OK*	
South-West	TV Receiver	Patrapada Khurdha-Brahmapur Rd	N19°58'38.3" E85°27'05.4"	*57*	*70*	44.7	42.1	17.3	14.7	1.0E-7	3.0E-5	OK	Inside Forest Range
	Mobile Phone	Dadhimachhagadia Katikata-Jaipur Road	N20°06'50.4" E85°34'38.7"	*73*	*50*	50.2	46.9	26.1	18.7	1.0E-6	1.0E-6	*OK*	*Behind Forest Range*
West	TV Receiver	Shyamsunderpur Haldia-Talabasta Road	N20°24'32.3" E85°13'50.3"	*67*	*65*	44.2	41.2	13.6	10.4	1.0E-7	3.0E-4	OK	Surrounded by Forest ranges
	Mobile Phone	Gadapokhari Haldia-Talabasta Road	N20°25'27.9" E85°22'30.6"	*63*	*50*	46.6	45.7	21.2	20.4	1.0E-7	1.0E-6	*OK*	*Near Forest Range*
North-West	TV Receiver	Godaribili Kamakhyanagar-Dhenkanal Road	N20°46'41.6" E85°33'03.3"	*78*	*45*	46.3	40.9	19.4	11.5	1.0E-7	1.0E-6	OK	Behind Forest Range
	Mobile Phone	Nachhipura Sambalpur-Cuttack HWy	N20°39'46.1" E85°34'28.8"	*68*	*35*	50.2	45.8	16.3	24.3	1.0E-7	1.0E-2	*OK*	Behind Forest Range



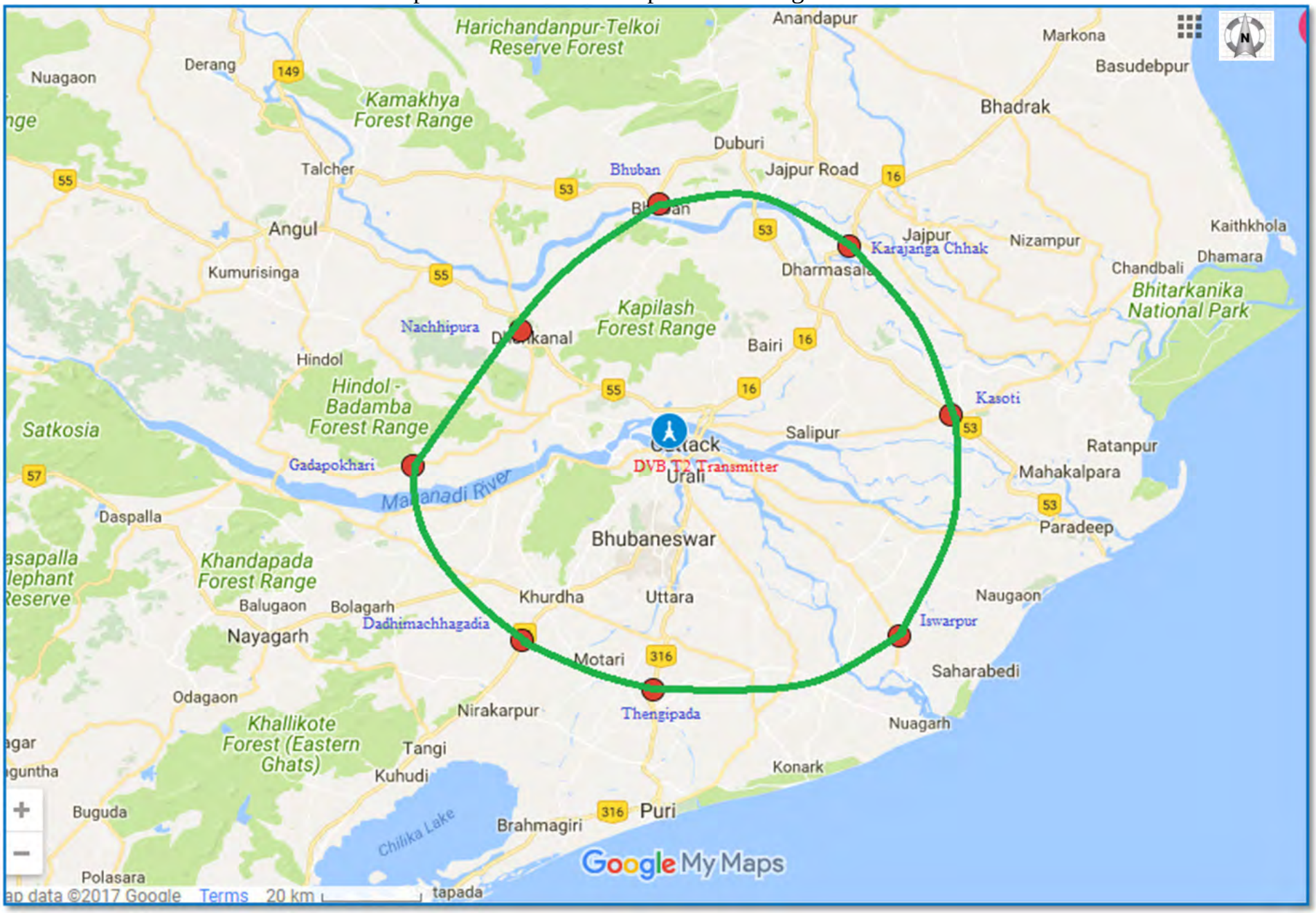
Radial Route Map originating from HPT (TV) Tower, Tulsipur, Cuttack (Odissa)

Reception on LED TV with receiving antenna placed at a height of 10 Meter



Coverage Contour Map of DVB-T2 Transmitter (QPSK Mode) Located at HPT (TV) Tower, Tulsipur, Cuttack

Reception on smart mobile phone at a height of 1.5 Meter



Coverage Contour Map of DVB-T2 Transmitter (QPSK Mode) Located at HPT (TV) Tower, Tulsipur, Cuttack