ITU Kaleidoscope 2016

ICTs for a Sustainable World

MOBILE SIGNAL EXTENSION IN DEEP SEA – TOWARDS A SAFE AND SUSTAINABLE FISHERIES

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Fisheries in India and Associated Risks

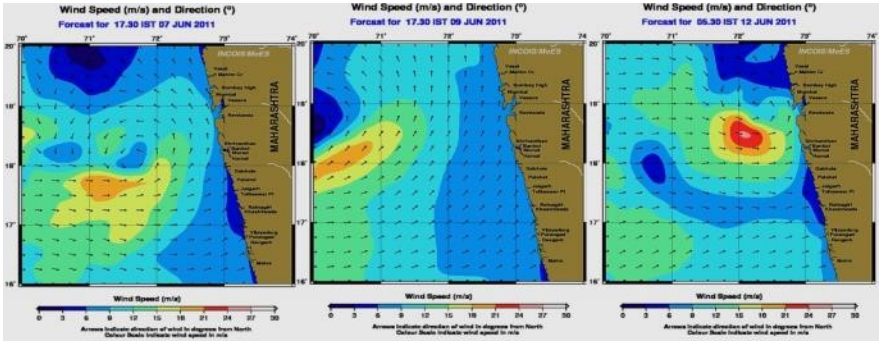
- Fisheries sector contributes 0.83% to the Indian GDP.
- It supports rural economy in 3202 coastal villages.
- Provides livelihood to 0.9 Million full time fishermen and another 3.5 million in the processing and marketing sector.
- 61% population is below poverty line, with annual earnings less than Rs 25,000 (US$400).
- Male person is usually the primary bread-winner (going on the boat). Hence his safety is of utmost importance for well-being of family.
- Wind speed, direction, wave height and swells can become dangerous, which increases the vulnerability for those at sea.

Fisheries in India and Associated Risks

- During 1891 to 2000, 308 cyclones have hit the coastal population, endangering the lives of 370 million within the 100kms off the coast.
- Indian National Centre for Ocean Information Services (INCOIS) generates Potential Fishing Zone (PFZ) and Ocean State Forecast (OSF) Advisories (fig. 1) for Indian coastal region.
- It processes the Chlorophyll and TSM images received from Oceansat-2 and Sea Surface Temperature (SST) images from NOAA-18/19 and MetOp-A/B satellites.
- These images are further processed for geometric correction, filtering and are geo-coded.

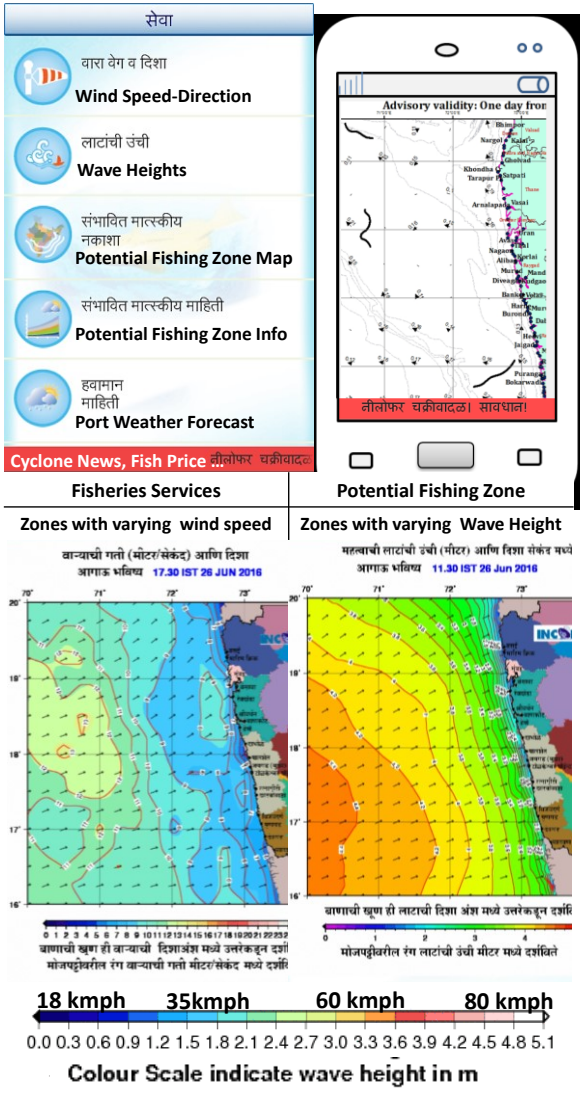
Ocean State Forecast

- OSF services display the temporal and spatial aspects of the sea using Wind Speed and Direction, Swells and Wave height parameter images.
- Images indicate the regions of sea in different colours i.e. intensity of the wind speed or wave height.
- Higher the intensity, the more dangerous the zone will be. Hence, availability of this information in advance helps fishermen to get an idea of the state of the ocean at any given point of time and forms the basis of the Early Warning System (EWS).



Challenges in Information Delivery

- Low Literacy level: Language and computer literacy.
- Infrastructure: Electricity and computer network.
- Hence, mKRISHI® Fisheries, a Java (J2ME) and Android mobile based application were developed for the fishermen.
- This mobile app translated the information in the local regional language (Marathi) in Maharashtra State of India. The services were piloted in Raigad district of Maharashtra (India) with 56 fishermen societies.



Benefits

- Advance information helped fisher to identify the PFZ location, estimate the trip duration, and accordingly budget the fuel, ice and labour requirement.
- Wind speed image helped them in finding out the areas where sea is calm and where it is turbulent.
- This brought more discipline in the trip planning and risk assurance, leading to savings in diesel, cost and life. Planning the boat cruise, in the direction of the wind, reduced the drag on the boat and hence improved the diesel efficiency.
- This further resulted in the saving of fuel. Pre-planning can help save diesel, reduction in CO2 emission and cost of catch too. This can make the fishing safer and sustainable

It is still not enough …

- Fishermen complained that the information could not be updated while they were at deep sea.
- This was especially true for the multi-day trawlers going for up to 10 to 15 days of fishing trip.
- The mobile service network was available only up to 5-8 kms in the sea and hence, it was difficult for them to get the latest information while they were away in the deep sea.
- This effectively reduced the utility of the EWS system.
- Extended mobile network in sea can help replan their route or go towards a calmer area in the deep sea.
- Research on the extension of the wireless signal (preferred mobility) in deep sea.

Communication modes

- We studied three popular modes of the ICT techniques (fig.3).
  - 1. Wireless (VHF) Transceivers (Walkie-talkie)
  - 2. Satellite based (Satellite phones and Direct To Home (DTH))
  - 3. Mobile phones (cellular technologies)
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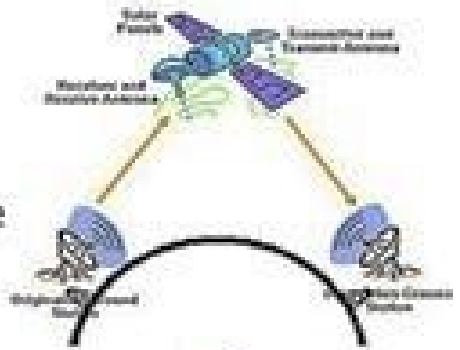
1. VHF Transceivers (Walkie-talkie)

2. Satellite based (Satellite phones and Direct To Home (DTH))



3. Mobile phones

Communication modes

- The major drawback of Wireless (VHF) Transceivers technology is:
  - generally one-way communication (at a time),
  - need for the license,
  - specific equipment, unlicensed operators,
  - can cause signal interference to licensed stations,
  - mainly voice and limited text and no graphics/image.
- Major challenges with DTH type of communication:
  - Satellite based DTH Service, could be an alternative, but transmission is only one way and in narrow band – which is costly.
  - In Ku Band Antenna position stabilization at sea is a big challenge.

Communication modes

- The major challenges of mobile phone technology is:
  - high capital expenditure involved in installing the towers and offer the signal towards the sea.
  - Telecom operators do not see a business in "seeing towards the sea" as Return On Investment (ROI) is challenging, ,
- Advantages:
  - Well established ecosystem of equipment, mobile handsets, service providers, mobile Apps, making the service affordable.
  - Young and high speed growth industry; enabling more innovation in computing, performance and features at highly reduced price.
  - Since it is already available on the land, extending the network to the sea could provide a seamless access.
  - Both Voice and data network.
  - No learning curve and would also benefit the existing investment in the people (to support the network)

Mobile Signal Extension in Deep Sea – Pilot

- Initially no telecom operator showed interest. Eventually Tata Teleservices Ltd. (TTL) agreed to do a pilot given the societal nature of the interventions.
- The entire mobile signal extension testing approach was divided into four phases:
  - Proof of Concept (PoC) and Boat Test Drive
  - Selection of cellular technology
  - Tower installation and commissioning
  - Parametric test based detailed study of major operator's signal
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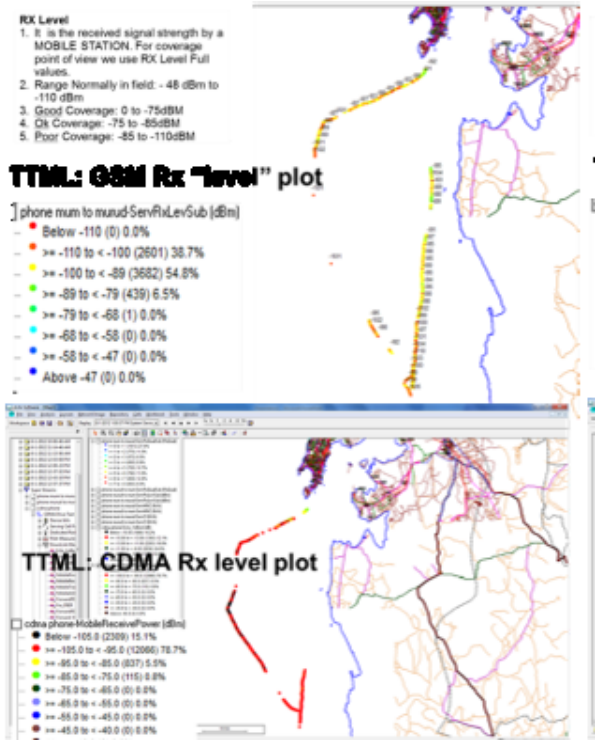
Proof of Concept (PoC) and Boat Test Drives

- TTL modified the orientation of two sectors of the antenna on one tower to direct GSM (1800 MHz) and CDMA (850 MHz) signals towards the sea.
- The RF engineers, fishermen and the fisheries research scientists carried out 11 hour signal measurement test drive in the deep sea in a fisher boat.
- Equipment used for the test drive:
  - CDMA / GSM Automatic voice and data call analyser (Call setup, Quality, data speed, completion, etc.)
  - GARMIN GPS, Mobile Phones (Voice and Data calls)



Proof of Concept (PoC) and Boat Test Drives

- Boat Test Drive 2 – GSM and CDMA comparison:
  - the line of sight is a major limitation (25-30 KM) because of the earth curvature.
  - adjusted the power level, height and the direction of the antennas at two different locations (towers). This helped to narrow down the testing parameters such as technology, frequency band, tower height, etc.
- Boat Test Drive 3 – BTS configuration:
  - installed CDMA Base Station Transceiver System (BTS) at two sites in Raigad district i.e. at Sasawane and Varsoli and a CDMA + GSM BTS at Borli-Mandla sites.
  - the cellular technology and type of the BTS to be used to achieve the maximum distance in the sea.
-

Proof of Concept (PoC) and Boat Test Drives

Latitude /Longitude	Time	Depth (Meter)	Distance (Km)	CDMA Signal	GPRS availability
18⁰ 30.279 N 72⁰54.445 E	7.20 am	-	-	Very Good	Very Good
18⁰ 30.216 N 72⁰52.272 E	7.48 am	4.26	5	Very Good	Satisfactory
18⁰30.674 N 72⁰49.981 E	8.19 am	7.6	10	Very Good	Satisfactory
18⁰31.303 N 72⁰48.447 E	8.46 am	9.1	15	Satisfactory	Unavailable
18⁰31.688 N 72⁰46.262 E	9.23 am	16	20	Satisfactory	Unavailable
18⁰31.983 N 72⁰46.262 E	10.02 am	21.6	25	Satisfactory	Unavailable
18⁰32.105 N 72⁰43.188 E	10.15 am	23.4	29	Unavailable	Unavailable

Figure Boat Test Drive 2 for GSM vs. CDMA test

CDMA TRIAL SETUP	GSM TRIAL SETUP
CDMA 850 MHz	GSM 1800 MHz
Coverage reach for CDMA (Voice + Data) – approx 25 km	Coverage reach for GSM (Voice + Data) – approx 16 km
This is with conventional solution –	This is with un-conventional solution –
Standard BTS – No Tower Top solution	Tower Top BTS. .
Normal Gain antenna used	Normal Gain antenna used
No special feature used	Special feature PBT deployed
Incidental coverage beyond 25km may be possible	Incidental coverage beyond 16km may be possible
The coverage reach can be further enhanced, with Tower Top BTS, High gain antennae (20.5 dB gain), to 30+ km	The coverage reach can be further enhanced, with High gain antenna (20.5 dB gain), to 20+ km

Table 1 Boat Test Drive 3 - Test Results

Proof of Concept (PoC) and Boat Test Drives

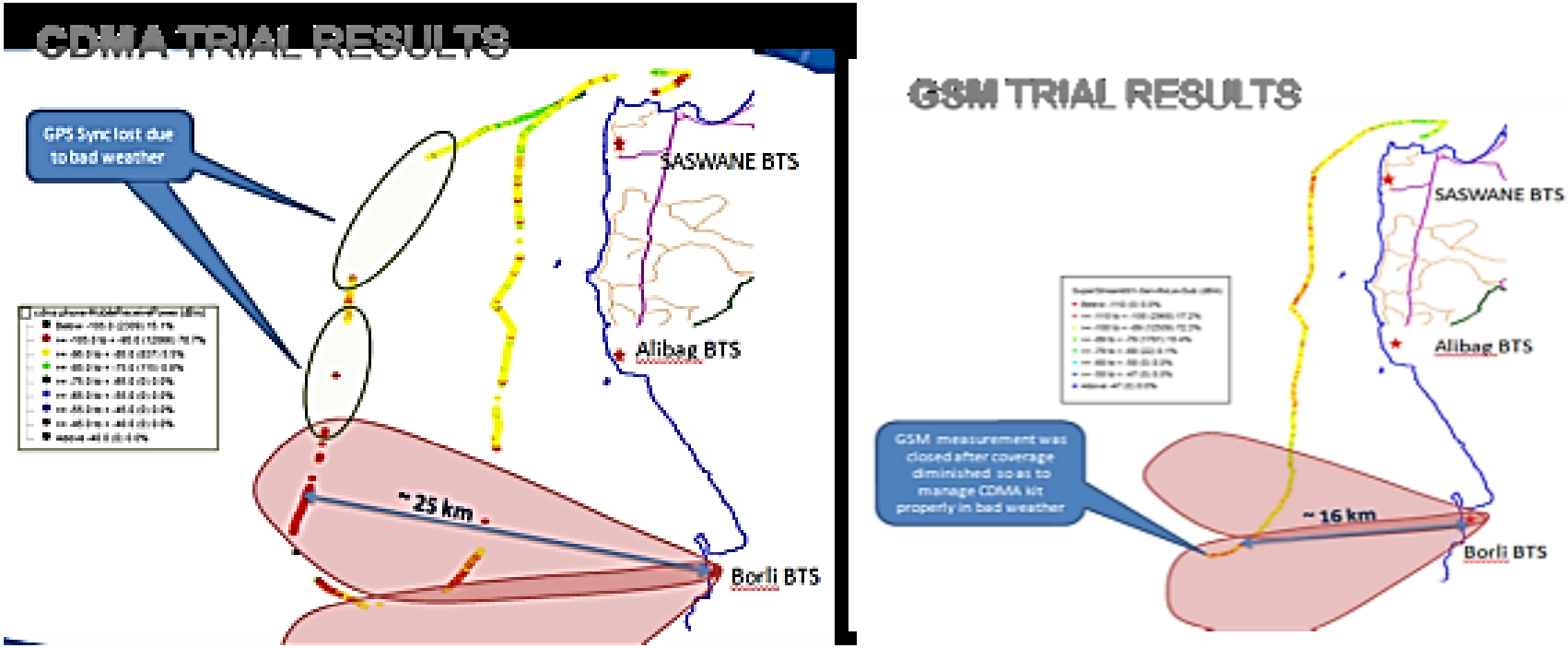


Figure Boat Test Drive 3 – CDMA and GSM tower call results

Selection of the cellular technology

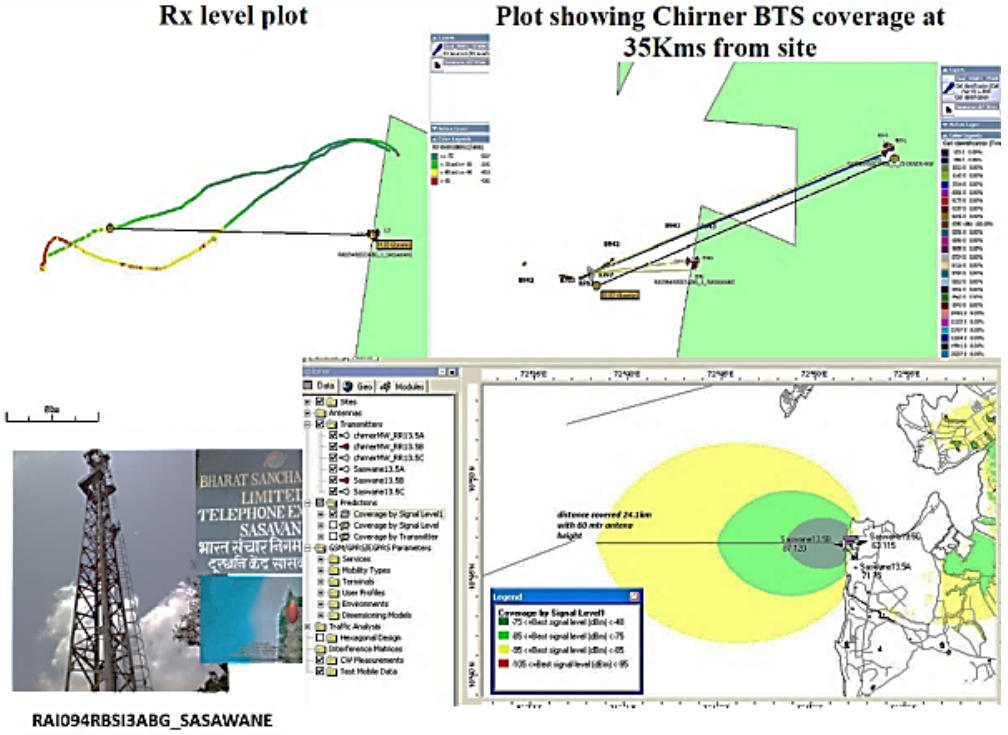
- In this case, CDMA was chosen over GSM as :
  - The link budget comparison indicates that the coverage reach of CDMA will be higher than the coverage provided by GSM technology due to lower band i.e. 850MHz.
  - CDMA technology employs processing gain concept which enhances the coverage
  - CDMA technology has superior quality by virtue of soft handoff.
  - The data speeds are higher in CDMA technology because of its robust designing, this will help enhance the access of mKRISHI® Fisheries app.
  - CDMA is less prone to interference In GSM, managing interference in open area like sea is a big challenge
  - In CDMA, more users can make simultaneous
-

Selection of the cellular technology

- Boat Test Drive 4 – Different Telecom operator with dual technology:
  - Mobile signals originating from these towers had good reception up to 17KM from the coast. The data was fed to a modeller and based on the pattern learnt by it, it projected that a tower height of 100 feet can give mobile signal range of up to 35km. (see table 2).
  - It was found that the Chirner tower (LAT 18.8675deg, LONG 73.07471389deg) was situated at a hill of Mean Sea Level (MSL) height of 240 m. The antenna height of the BTS was 30m. Hence, due to a height of the 270 m, the signal was observed at the distance of 35KM
- The data collected helped in analysis on what parameters can affect the range of the signal availability.

Selection of the cellular technology

- Some of the parameters are:
  - Mobile technologies (GSM vs. CDMA)
  - Spectrum availability (800KHz vs 1800 KHZ)
  - Height of the tower on which the BTS (Base Station Transceiver Sub system)
  - Type of the BTS
  - Feed antenna length, Type of antenna
  - Antenna angle, Antenna radiation power level
  - Type of handsets



Antenna Height	Distance covered Signal level > -95dBm	Remarks
35 ft.	17 KM	Observed
60 ft.	24 KM	Model prediction
100 ft.	35 KM	

Tower installation and commissioning

- TTL surveyed the Raigad districts mobile towers and picked up 7-8 sites where work needs to be carried out to expand the signal up to 30+ KM in the sea .
- On six existing towers, following configurations were done to increase coverage.
  - Tower Top BTS (Feeder less)
  - Std 33deg antenna – High Gain ~20.5 dBi
- One new tower erected and equipped with below :
  - Tower erection, Installation of the tower top BTS Or Remote Radio unit (RRU)s and Feeder cables
  - Antennas – MRFU V2 900MHZ CDMA (SUPPORT 4 TRX, 20W TOC,25MHZ IBW)
  - Power, Diesel Generator, Microwave Link
  - Installation and commissioning
  - IP Clearance, Site RFI, WPC certification

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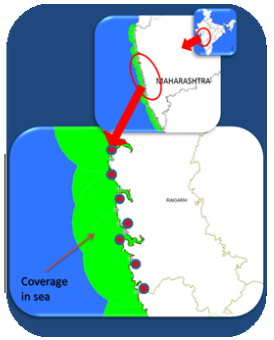
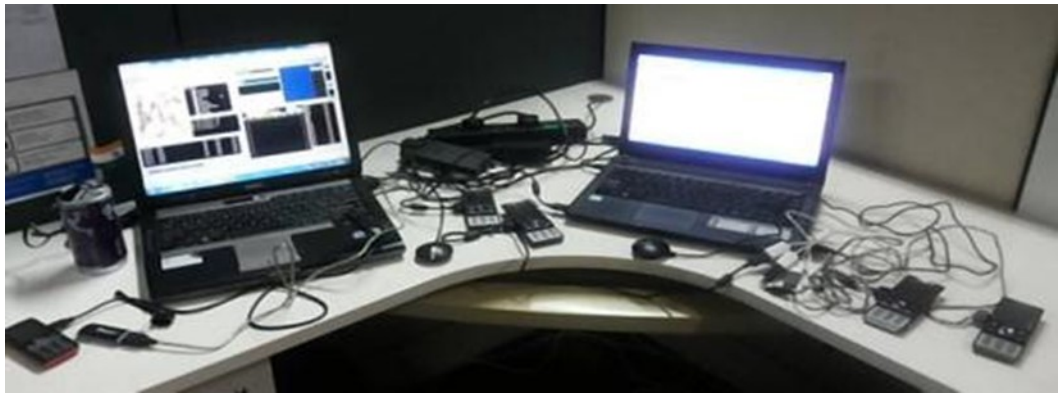


Site Name	BTS ID	Sector #	Latitude	Longi-tude	Ht. (ft)
Sasavane	380	3	18.7874	72.8654	45
Varsoli_Alibaug	381	3	18.66678	72.86875	35
Borli-Mandla	382	3	18.5105	72.9132	50
Murud_Raigad	387	2	18.3373	72.9591	60
Borli Panchtan	384	3	18.1627	73.0019	55
Shreevardhan	385	2	18.0517	73.0263	50
Aravi	386	2	18.0848	73.0062	50

Installed tower locations and details

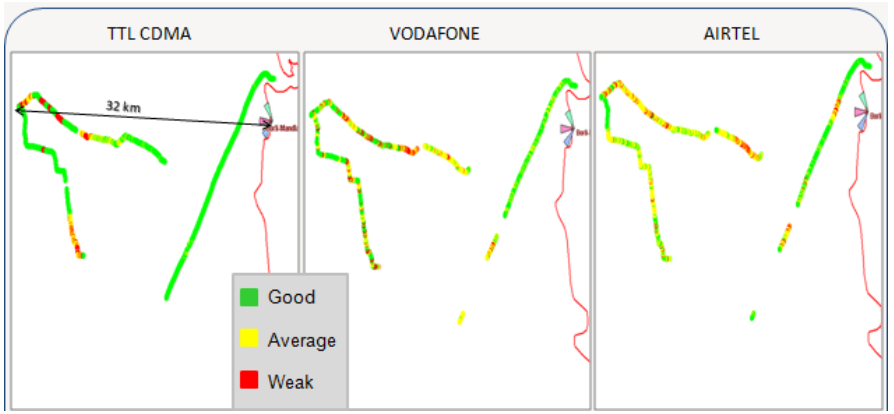
Parametric test based comparative study of major operators' signal in same region

- Test Drive approach
  - Three test drive kits were prepared to capture TTL CDMA, Vodafone and Airtel GSM network coverage parameters
  - We cruised towards deep sea in west direction for approx. 32 km. Then towards south approx. 24 km and finally back to jetty travelling approx. 30 km diagonally north-east.
  - Link budget modeler estimated: 25 km. Actual ground (sea) data indicated the signal availability upto 32+ km.
  - Following sections cover the comparative study across three major parameters: coverage, quality and data speed.
- 

Coverage Comparison

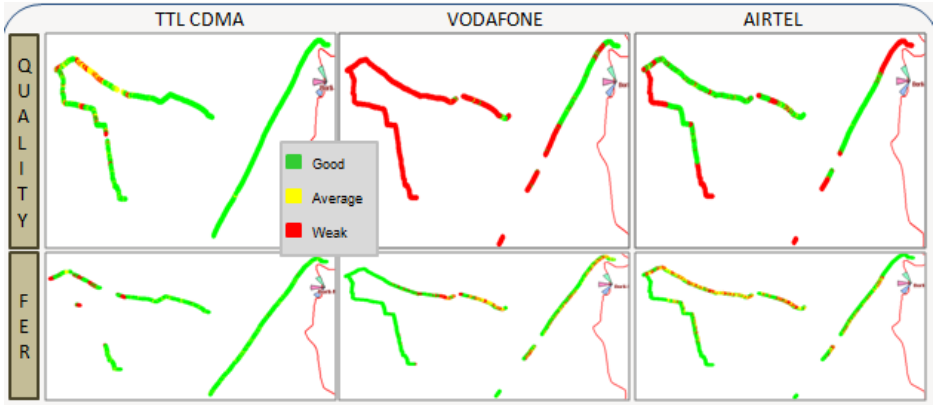
- Parameters Compared:
  - TTL CDMA – MTx Level
  - Vodafone GSM – Rx Level
  - Airtel GSM – Rx Level
- In CDMA, MTx Level produces true coverage indicator while comparing with GSM coverage.
- It was observed that TTL CDMA coverage is continuous whereas the coverage plots of Vodafone and Airtel seem to be patchy and discrete.

Coverage, Sample %	TTL CDMA	Vodafone	Airtel
Good	74%	45%	29%
Average	19%	39%	59%
Weak	7%	16%	12%



Quality Comparison

- Parameters Compared:
  - TTL CDMA – Ec/Io Level
  - Vodafone GSM – AMR C/I Level
  - Airtel GSM – AMR C/I Level
- capture the network and call quality considering the degradation due to interference
- TTL CDMA signal has superior quality compared to Vodafone and Airtel .

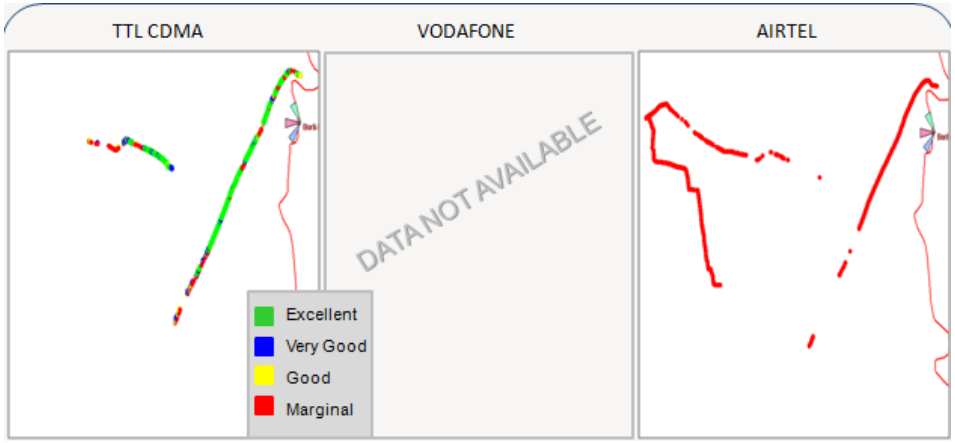


Quality, Sample %	TTL CDMA	Vodafone	Airtel
Good	83 %	26 %	64 %
Average	11 %	1 %	3 %
Weak	6 %	73 %	34 %

FER, Sample %	TTL CDMA	Vodafone	Airtel
Good	87 %	86 %	86%
Average	7 %	6 %	7 %
Weak	6 %	8 %	7 %

Data Speeds Comparison

- These parameters captures the network and call quality considering the degradation due to interference. Additionally, FER parameter of TTL CDMA compared with Rx Qual (sub) parameters of GSM operators
- TTL data speeds are higher due to selective deployment of EVDO technology, which is an evolution of CDMA technology (comparable to 3G) to cater optimum data speeds. Higher data speeds improve the customer connectivity experience.
- Airtel data speeds are lower as it works on GSM (2G)



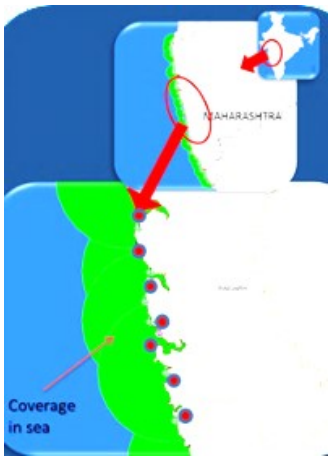
Data Speeds, Sample %	TTL CDMA	Vodafone	Airtel
Excellent (> 256 kbps)	70%	NA	0%
Very Good (128 to 256 kbps)	10%	NA	0%
Good (64 kbps to 128 kbps)	6%	NA	0%
Marginal (< 64 kbps)	14%	NA	100%

Conclusion

- Good quality mobile signal coverage upto 30-35km in deep sea.
- This provided an extended accessibility to the ICT network which helped enable a better use of the technology for a better livelihood and safety management.
- Fishermen used the extended signal to call for help when a boat was overloaded with the catch and could have toppled in the sea. This helped in transferring the excess load.
- fisher with the large catch quantity, could connect with the local traders at the landing center and negotiate the price. This helped to preserve the quality of the fish and adequate ice, labor and truck could be arranged, even before the catch landed at the sea.
- A combination of the wireless VHF sets and mobile phones provided a further extended in deep sea upto 60-70 km.
- This pilot experience presents a model for extending the early warning system using ICT in deep sea

Thank you…


GARMIN


MAHARASHTRA
Coverage
in sea


Tata Photon – Wi-Fi
Network Dongle