

# **Meeting the Challenges of Rural Connectivity**

-Some Observations

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# Telecom and Development

- Role of Telecom in economic development is well known
- Teledensity as an index of development
- Only basic telephone facilities
- Serious problems in operation and maintenance
- Recognize that accessibility is more important

# Technology in the 70s

- Mostly electromechanical switches with very limited 'intelligence'
- Very limited, basic facilities
- Low traffic handling capability of Switches
- Expensive to install, operate, maintain and manufacture
- Poor reliability

# Situation in Developing countries like India

- Traditional conservative administration
- Total government control
- Imported technology, not matching the requirements
- Very few lines/telephones (only a few million) in the whole country
- Failure of crossbar technology
- Govt looking for 'electronic' switches in early 80s  
(i.e. computer controlled analog switches)

## In early 80s a favourable situation develops for India

- Advances in Technology
- Digital transmission
- Beginning of digital switching
- Movement toward all digital PCM-TDM network
- Emergence of microprocessors
- Low power CMOS
- The IBM PC
- High Level Languages, Hardware and Software development tools
- Stimulus for entrepreneurs

# The Initiative by Centre for Development of Telematics - CDOT in 1984

- Matching technology with the needs
- Benefitting from advancements in technology
- Availability of competent teams with relevant experience
- Focus on rural communications
- Opportunities for the private sector for the first time

# The Rural environment

- Very irregular power supply with large variations
- Long noisy transmission lines (open wires)
- Heat, dust and humidity
- Less skilled staff
- Need for simplified operation and maintenance essential

# A Switch in Rural Environment

- Required to meet several contradictory requirements
- More reliable, more rugged
- No airconditioning, no fans, only convection cooling
- Less power consumption
- Longer lines, lower subscriber density
- Must be simple to operate and maintain
- Need a more advanced system at lower cost

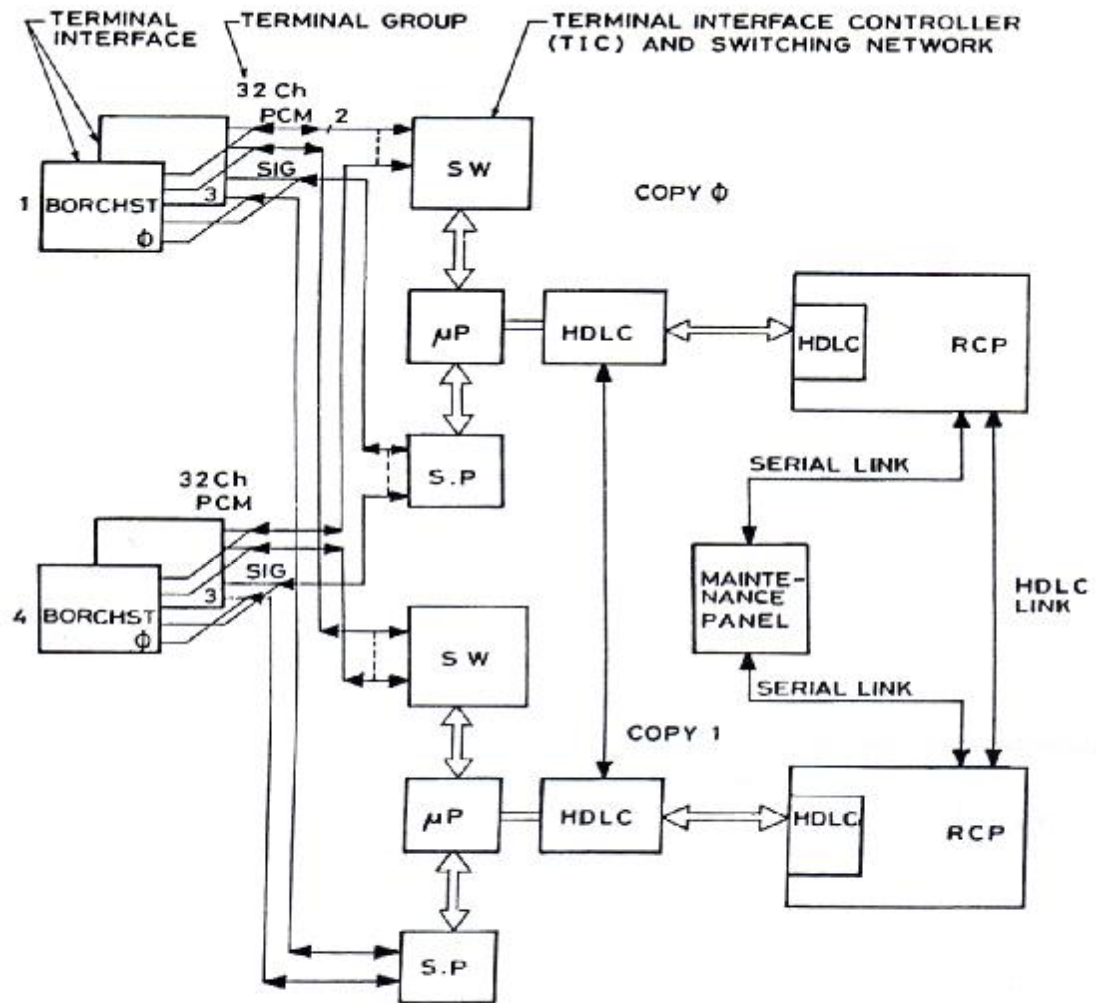


# The Solution

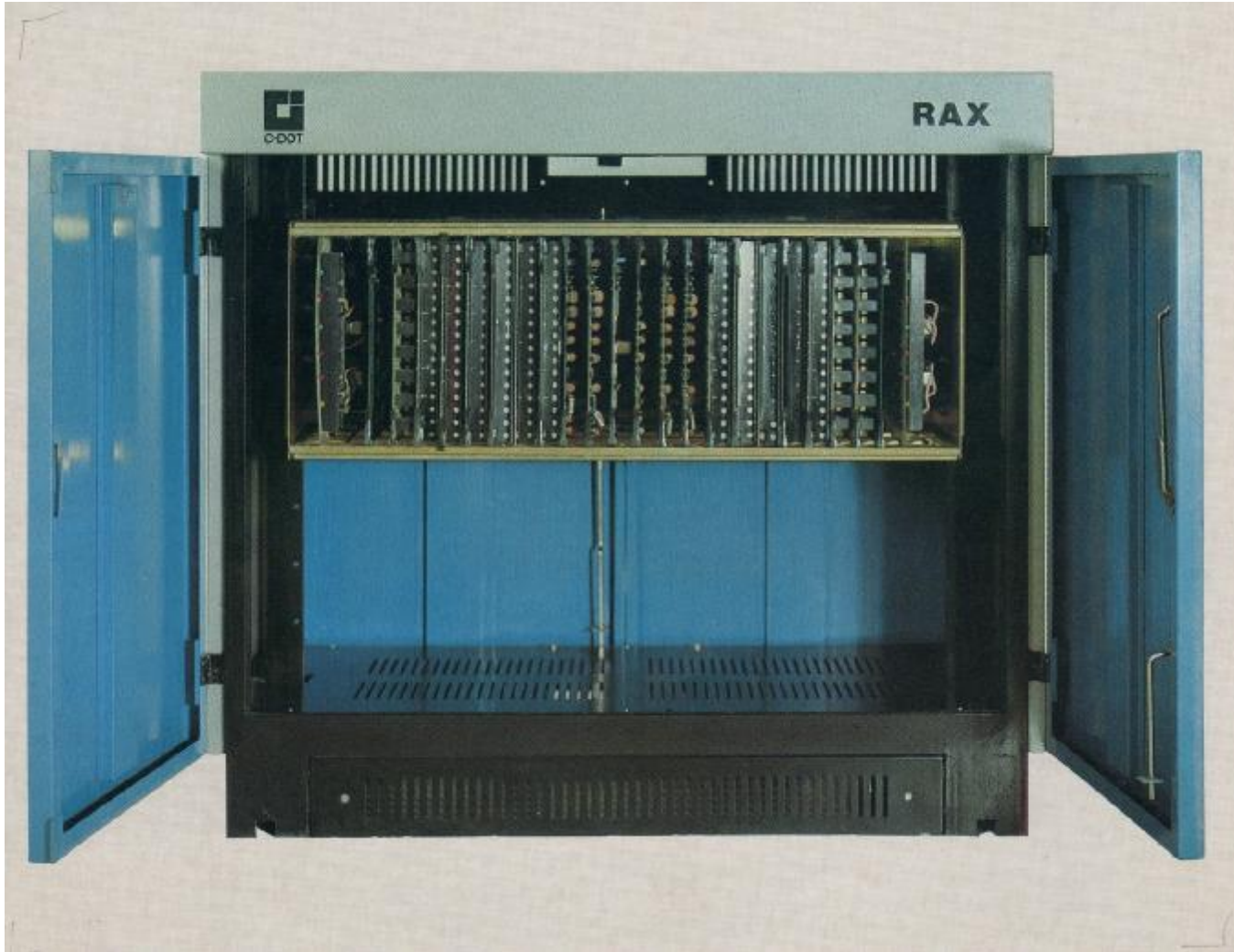
- Benefit from the experience in developing a mobile switch for defence applications
- Situation very similar to rural environment
- Focus on CMOS components, 6502 microprocessor used for school computers
- Presence of a good component industry in India
- Simple sparse packaging, with only two layer boards
- Innovative duplicated control
- Novel scheme for automated remote monitoring and maintenance

# The Architecture

- Evolved after close working with telecom people working in rural areas
- 128 port module of the large switch adapted as rural switch RAX
- Fully digital PCM-TDM Switch with basic central office facilities
- Remote maintenance, administration, charging, etc
- All basic facilities, national and international dialling
- User friendly
- Simple. less expensive manufacturing process, a series of 'assemble and test' steps
- IBM PC managed
- Low cost, less than Rs 1000 per line



128 LINE RAX - ARCHITECTURE



# Field Trial

- First installation and trial at Kittur a small town near Belgaum in Karnataka
- Highly successful operation
- Availability of automatic national and international subscriber dialing facility made it extremely popular.
- This facility was not available in most large towns!
- National Institute of Bank Management carried out a study of economic impact of RAX and came up with some very interesting results. Increase in bank deposits, etc.

Impact of Improved Telecommunication Facilities  
on Rural Development

Within two years of its inception, CDoT installed the first RAX at Kittur, a village in Karnataka, 50 km. from Bangalore. On July 21, 1986 the strowger electromechanical exchange was replaced by a 128 port CDoT RAX, the first such installation in the country. The old exchange served 44 subscribers with a wait list of 8. Trunk booking had to be done through the operator at Belgaum. After initial teething troubles, it stabilized in about six months providing high quality automatic subscriber dialled national and international service. This resulted in doubling the traffic as well as the revenue and fully subscribing the 88 lines of the exchange. As this was a unique opportunity to study the impact of improved telecommunication on rural development, a study was conducted by Prof. P.D. Malgavkar of the National Institute of Bank Management. This study summarizes the benefits to the people as:

- . Saving of time and money
- . Better price for agricultural products
- . Increased sales, returns to the traders
- . Quicker medical attention and health services
- . Increased social interaction
- . Better law and order control
- . Faster flow of information/news

# Nationwide Demand for RAX

- An important problem: implementing a nationwide dialing plan
- Every RAX needed to have dialling code
- Country dotted with RAXs
- Improved accessibility along with the payphone booths (NSD and ISD)

## Mid 90s

- Large Demand for Broadband Internet Access
- A Transformation of the Communication Network
- Dominance of Data communication, packets, internet, etc.
- Data traffic exceeds telephone traffic
- Slow growth of 3G, lack of customer interest
- 'Computer networks' dominate over 'telephone networks'
- Domination of IEEE stds WiFi, WiMax, etc.



## Several interesting solutions around the world for Rural Broadband

- Good opportunities of innovation
- Focus on WiFi, WiMax and other standards
- Innovative low cost solutions for extending WiFi range to several Kms
- Antennas, power management and signal processing
- International Centre for Theoretical Physics (ICTP) in Italy develops wireless solutions for Africa

# Some Examples

- Using Tin Can as antenna
- Special Antennas giving a record of 380Km range. (in Venezuela)
- IIT Kanpur experiment
- ICTP in Nigeria
- UCLA
- Ref: Books “Rural WiFi Cookbook” and “Wireless networks in Developing Countries”



Figure 4.32: The finished cantenna.

#### Parts list

- one screw-on N-type female connector
- 4 cm of copper or brass wire of 2 mm of diameter
- an oil can of 8.3 cm of diameter and 21 cm of height

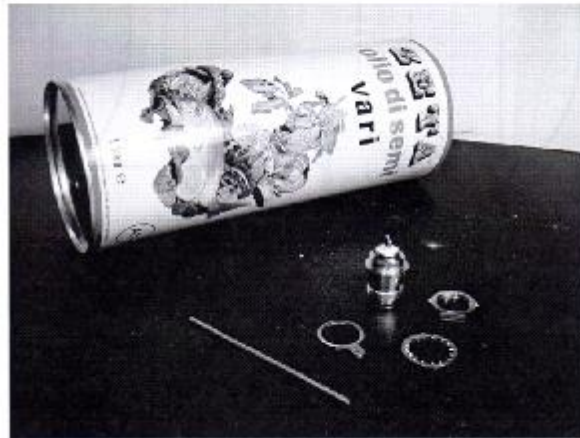
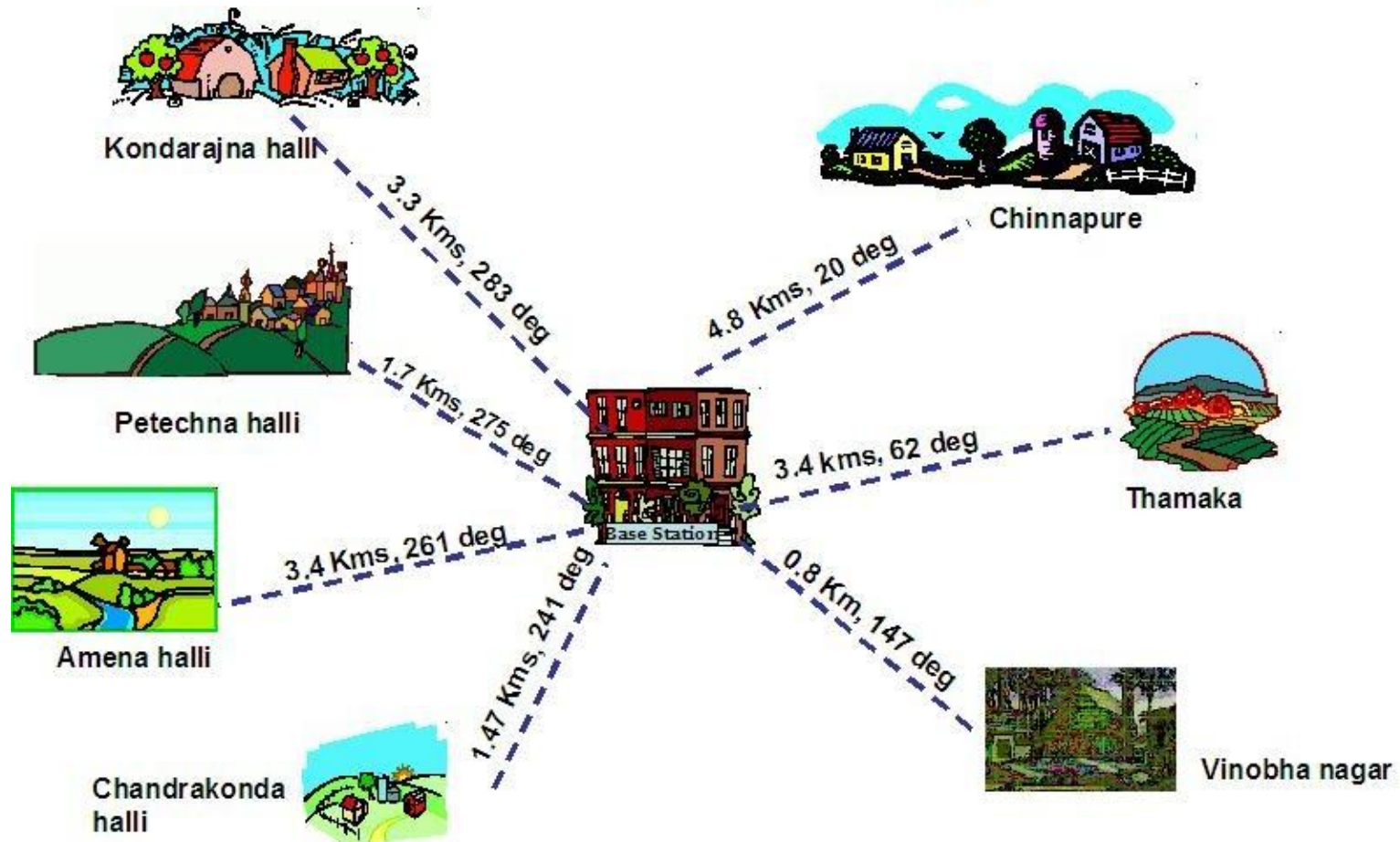


Figure 4.33: Parts needed for the can antenna.

# Pilot Trial at Kolar near Bangalore

- A 'digital pipe' to the home
- Antennas (grids, sectors, parabolic) for range extension
- 250+ Kbps internet service to a customer
- Low cost
- Integrating with PSTN with media gateways
- Integrating with other services..Mobile, Satellite, etc.

# One Cell Coverage





# Important Considerations

- Significant cost reductions possible with innovations
- The right Business model
- Application Development
- Ease of use, user friendliness
- Reliability, ruggedness, maintenance, etc.
- Rural Connectivity needs more advanced technologies, not obsolete solutions

# Applications

- Lot of attention, but somewhat slow progress
- Several ambitious initiatives
- Education
- Health and Medicine
- Food and Agriculture
- Microfinance
- Ecommerce
- Government Land records, etc.



# More Development Needed

- Special Needs of Rural Population
- Simple to use
- Local languages
- Non textual Symbolic IO
- Simple Speech Processing

# The Next Generation

- Higher and higher bandwidths 100Mbps to the home?
- All IP environment, fixed and mobile
- Transformation of network architecture..moving to (2 dimensions) mesh or grid in the future?
- Handling data on a vast scale?
- Impact of moving into Terahertz region?
- Nanoscale electronics?

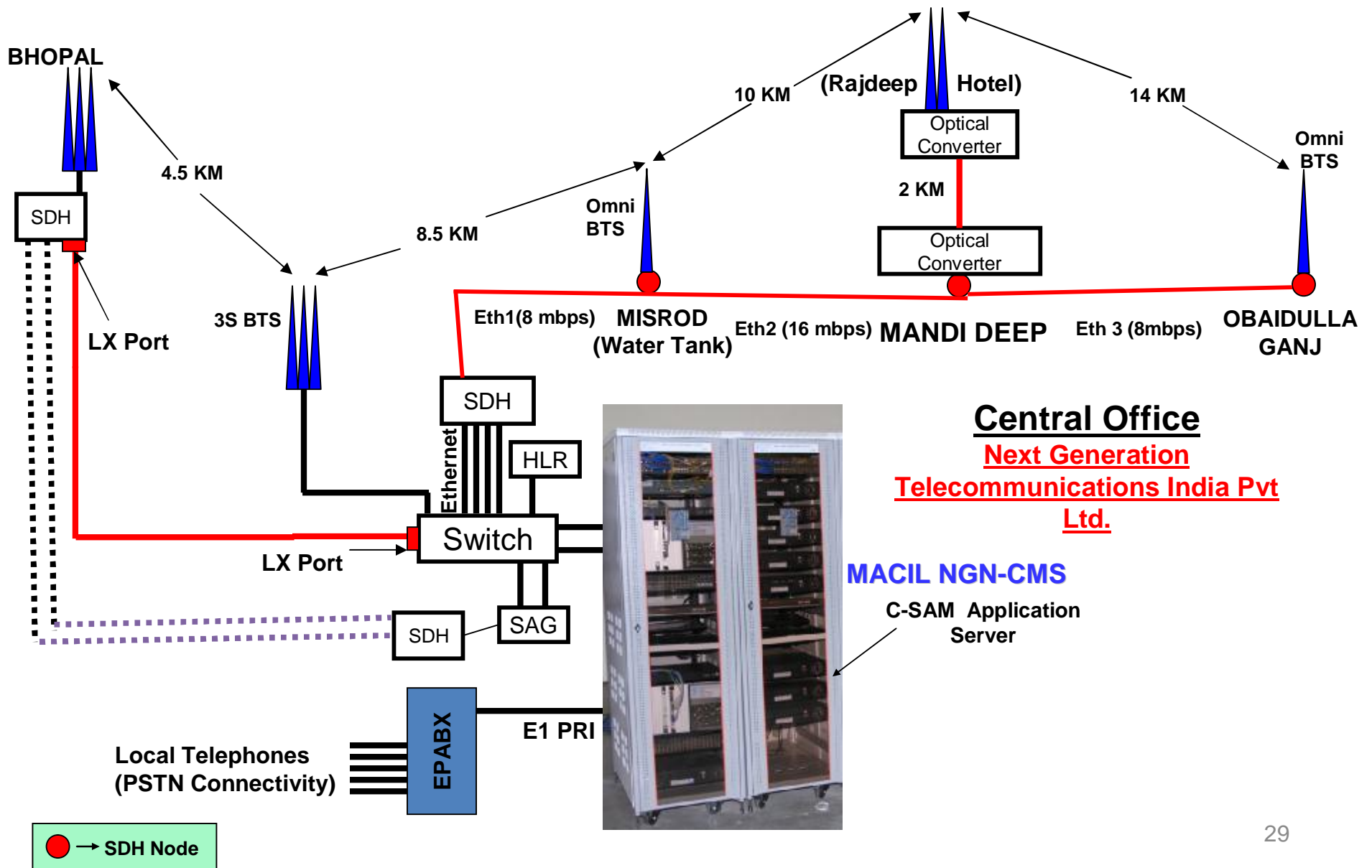
# Experimenting with next generation technology

- All IP mobile network
- CS-OFDM technology
- Higher bandwidth
- Higher spectral efficiency
- Spectrum Sharing
- Improved antenna techniques

# Area of Bhopal Trial



# Network for India Trials



# Benefitting from New Technologies

- Timing is now just right for a new generation of technology
  - Recognition of importance of all IP networks
  - Data traffic far exceeds voice traffic
  - Present mobile services are stretched to the limit?
  - Problems in integration of various services?
  - Need for wide ranging new services?
  - Need for still higher bandwidths

# Merits of an All IP network

- Being all packet networks, fullest utilization of the 'potential' of digital technology
- Potentially the lowest cost technology
- Ease of interoperability, compatibility
- Easy of integration of all services (unified)
- More efficient utilization of bandwidth ?
- A single high bandwidth digital pipe to the home would meet  
all communication requirements?

# Key Technologies/Techniques to Master

- DSP, Digital Signal Processing
- Antenna Design
- Software Defined Radios
- Cognitive Radio Networks
- Power Electronics?
- Display Technology?



# Target Specifications

- Up to 2 Mbps mobile and up to 100Mbps fixed (to the home)
- ADSL quality in mobile service
- Compatibility and interoperability
- Wider coverage, wider variety of services
- Less expensive by an order of magnitude (?)
- Plan for over 100 Million Broadband connections  
Within the next 5 years.

# Technologies to watch

- 4G developments, Take these further
- New upcoming mobile systems
- New miniature intelligent antennas, air interface
- Innovative coding and bandwidth compression
- Recent work at Universities and R&D centers

## In conclusion...

This is just the beginning of an entirely new generation of Communications Technology .

There are far more challenging and interesting opportunities ahead of us

Best Wishes to our young engineers and entrepreneurs.

Thank you