MOBILE TRAIN RADIO COMMUNICATION

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ABSTRACT

The purpose of this paper is to highlight the role of Mobile Communication in the train operations. This paper elaborates the various technologies that are available in the field of Mobile Communication today, and their evolution. The paper also compares the various important technological options, and explains the reasons for the use of the type Mobile Communication technology in Railways, and also suggests their judicial selection in meeting the Modern Railways operational needs. This paper also throws some light into the Western Railways Mobile Communication System, which is commissioned in the Suburban Section of Mumbai Division as a part of the Train Management System Project.

1.0 INTRODUCTION

1.1 Mobile Communications Principles

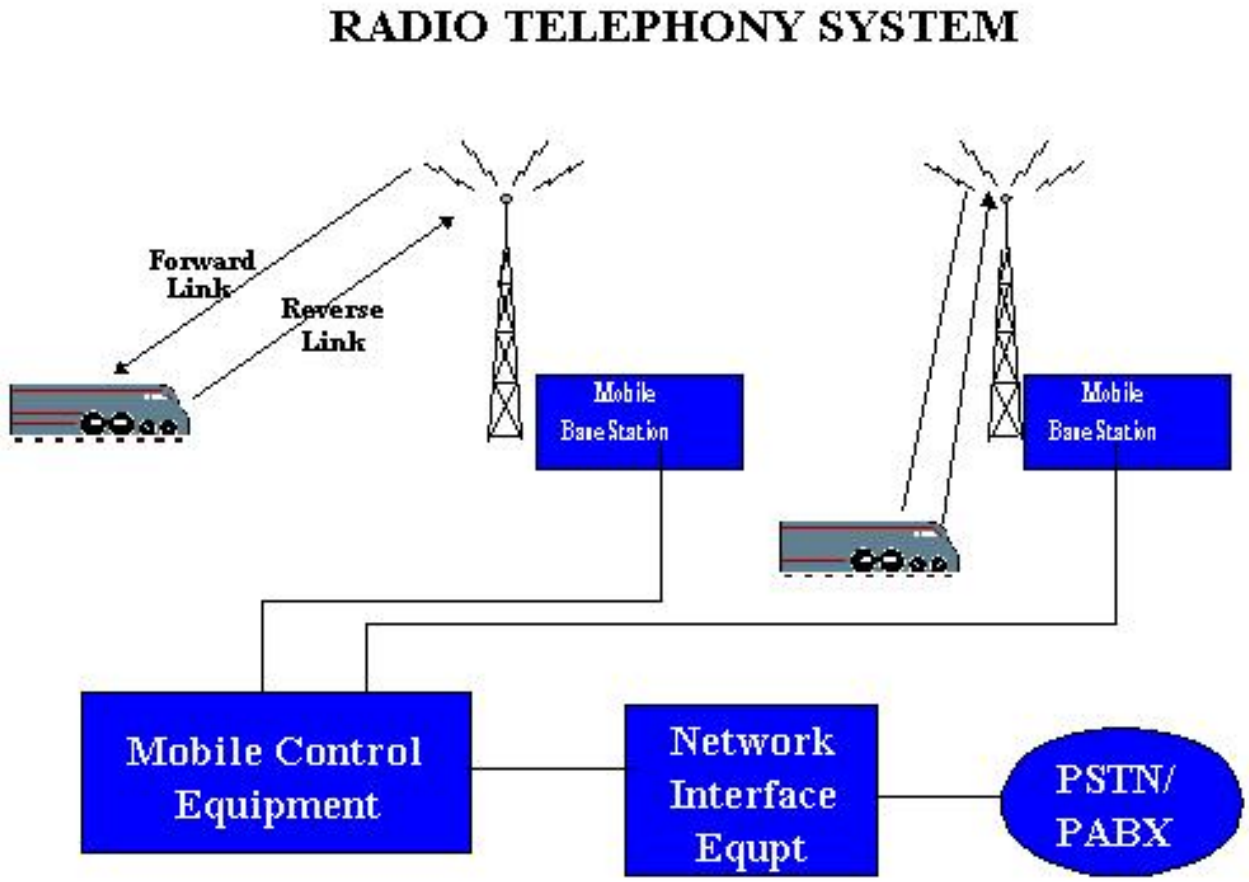
Each mobile uses a separate, **temporary radio channel** to talk to the cell site. The cell site talks to many mobiles at once, using one channel per mobile. **Channels use a pair of frequencies** for communication. One for transmitting from the cell site, **the forward link**, and one frequency for the cell site to receive calls from the users, **the reverse link.**

Communication between mobile units can be either **half-duplex** or **full-duplex.** In case of **half-duplex**, transmit and receive communications between the mobile units are not at the same time, i.e. talking and listening can not be done at the same time. In case of full-duplex communication, transmit and receive communication is at the same time, i.e. one can talk and listen at the same time.

When communications between mobile units are **within a cell**, and if the same is **half-duplex**, then it shall require only **one pair of frequency.** If the same is **full-duplex**, then requirement of **frequency pair shall be two**.

When a mobile unit is communicating with a mobile unit **outside the cell,** then the requirement of frequency pair shall be **one per cell** for both **half-duplex** and **full-duplex** communication. Hence the system resources are utilized more if the mobile units communicate with each other in full-duplex mode.

Figure 1: Basic Mobile Telephone Service Network



1.2 **Early Mobile Telephone System Architecture**

Traditional mobile service was structured **similar to television broadcasting.** One very powerful transmitter located at the highest spot in an area would broadcast in a radius of up to fifty kilometers. The "cellular concepts" structure the mobile telephone network in a different way. Instead of using one powerful transmitter, many low-power transmitters were placed throughout a coverage area. For example, by dividing a metropolitan region into one hundred different areas (cells) with low-power transmitters using twelve conversations (channels) each, the system capacity theoretically could be increased from twelve conversations - or voice channels using one powerful transmitter- to twelve hundred conversations (channels) using one hundred low-power transmitters.

1.3 **Different Type Of Communication Systems**

The different types of communication systems available today can be broadly classified into the following categories.

- Landline System
- Cellular System
- Satellite System

The evolution of the above Systems had been broadly **as a point to point system**.

- Two-Way Radio System

  The evolution of the Two-way Systems has been both **as a point to point and a point to multi point system.**

1.4 **Mobile Communication Evolution**

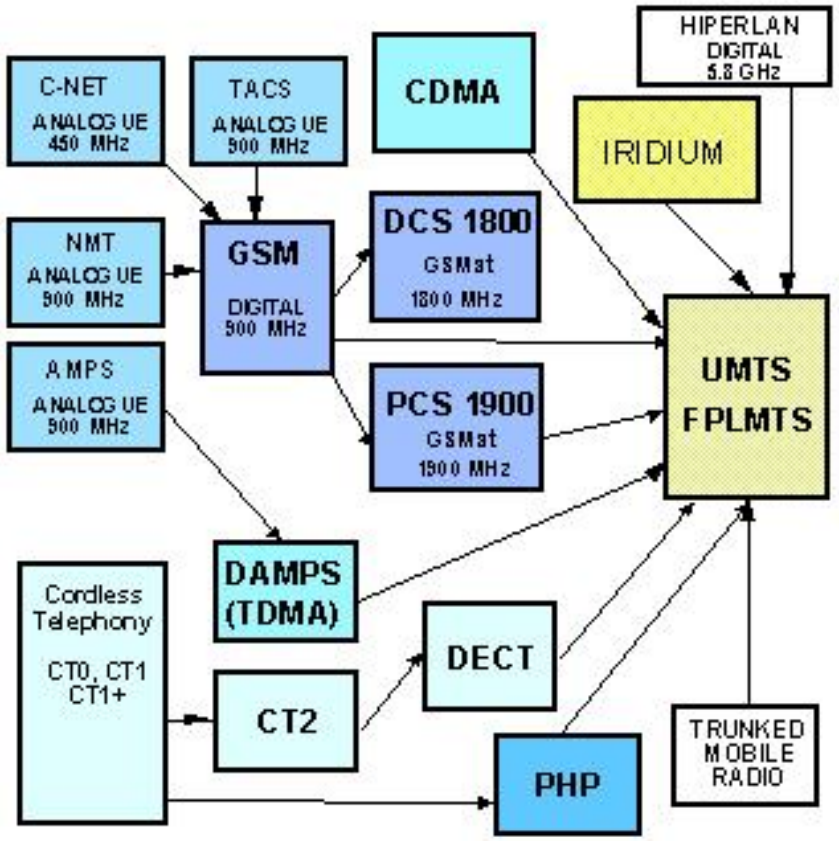


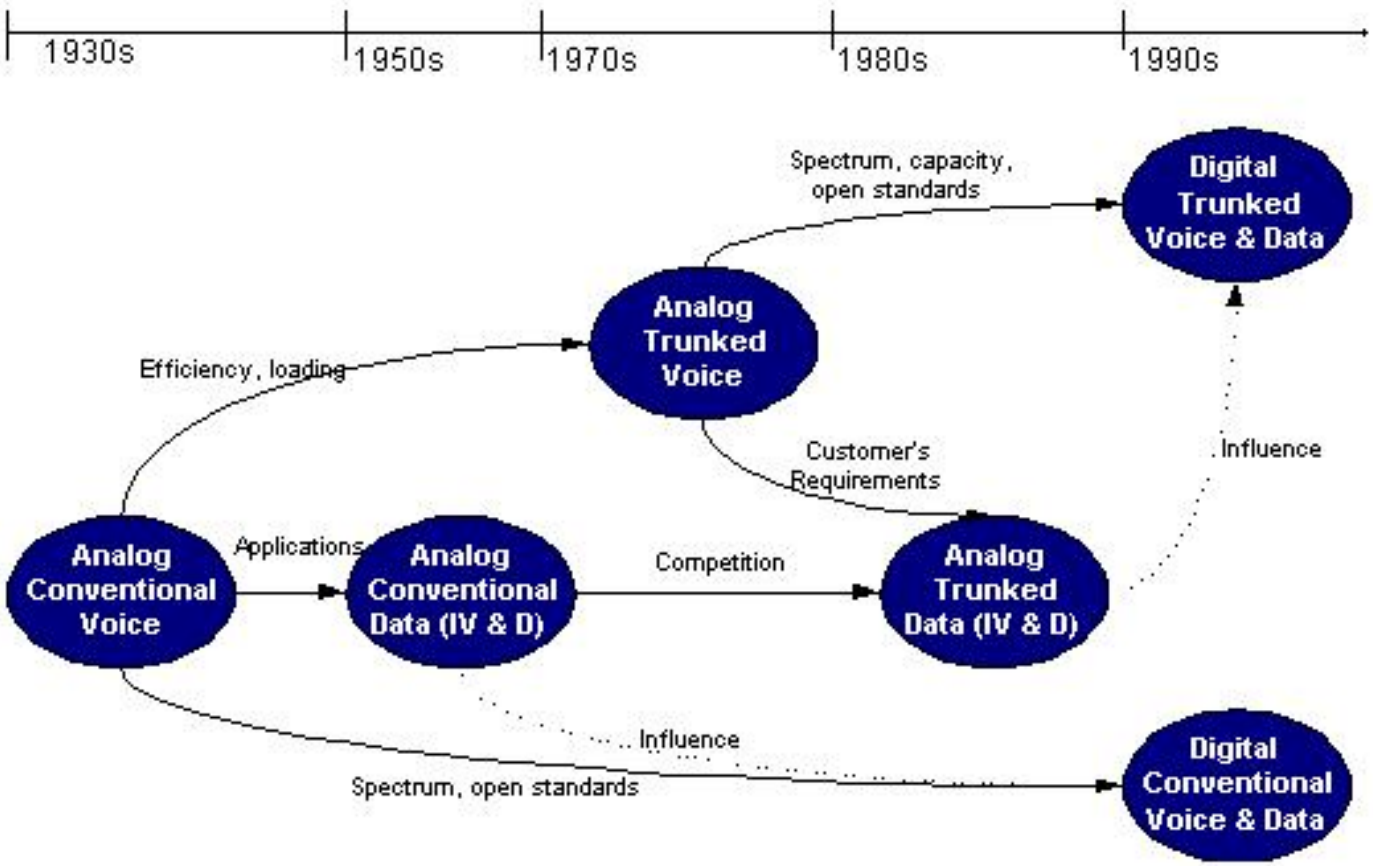
Figure 2: Mobile Technological Evolution

1.4.2 Evolution of 2-Way Radio Platform

The following diagram explains how the evolution of 2-Way radio platform has taken place.

Figure 3

Evolution of 2-Way Radio Platforms



2.0 MOBILE TRAIN RADIO SYSTEMS

2.1 **Present Day Scenario**

A choice of mobile system for a set up is governed mainly by the following facts.

- Coverage area
- Number of subscriber to be catered
- Frequency spectrum available
- Nature of the terrain
- Type of application i.e. voice of data or both
- Integration with other systems
- Future technological migration capability
- Cost of the system

2.2 **Railways' Present Day Requirements.**

The Train Mobile System's present day requirements are not just voice transmission, but also along with voice the system shall be capable of handling data also. Typical applications for the Modern Train Mobile System are as under.

- Text and status message transmission.
- Automatic Train operation's critical alarms.
- Train status and alarm information
- Passenger information system control
- Train passenger emergency system
- Closed circuit TV system

2.3 **Comparison of Various Open Standard Technologies Available Today**

2.3.1 **MPT1327 System**

MPT1327 is an **Open Standard for Analog trunked radio networks**. The British Department of Trade and Industry (DTI) developed it in year 1988. In the course of the next twelve months of development continued and resulted in MPT1343 standards. A system based on MPT1327 generally comprises of several radio channels. At least one of these channels will have been defined as the CC (Control Channel) and all the other channels are TCs (Traffic Channel). Data messages between the mobiles and the networks are exchanged on the Control Channel at 1200 bits/sec using FSK (Frequency Shift Keying). Each subscriber in a trunked radio network has a unique call number. It consists of a prefix (3

digits), a fleet number (4 digits), and a subscriber number within the fleet (2 or 3 digits). After it has been entered the call number will be converted in the mobile to a 20-bit address. For the duration of the call a subscriber is exclusively allocated a traffic channel from the available trunk.

Western Railway has already opted for a MPT1327 system for the Motorman and Controller communication in its Suburban Section in Mumbai Division. This system is as a part of the TMS project between Churchgate and Virar Sections. M/s Tait New Zealand has supplied the Mobile System.

2.3.2 **Tetra Systems**

TETRA stands for Terrestrial Trunked Radio, covering PMR (Professional Mobile Radio) as well as PAMR (Private Access Mobile Radio) applications. As a trunked system, it is designed to be the true follower of MPT1327. TETRA applies digital speech transmission with TDMA (burst transmission), very fast call setup times, and may use powerful encryption. TETRA is an Open Standard defined by ETSI (European Telecommunication Standards Institute). TETRA applies a

modulation format called pi/4 DQPSK, TDMA with 4 channels per carrier, and a carrier spacing of 25 KHz. TETRA does not have a fixed frequency allocation as GSM. But the systems currently planned or installed in Europe assumes frequencies in the range of 380..400 MHz for public a safety communication, and 410..430 MHz for commercial systems.

2.3.3 **GSM System**

- The GSM (Global System for Mobile Communication) MoU Association, a Swiss registered Corporation, is the principle body responsible for promoting and evolving the GSM wireless platform worldwide. Today GSM is the most successful implementation of a global wireless standard using digital technology for point to point operations. There are over 293 members representing 120 countries/areas. The overall objective of the GSM MoU Association is " The promotion and evolution of the GSM900, GSM1800, GSM1900 systems, and the GSM platform for international roaming, for the provision of standardized services.

3.0 WESTERN RAILWAY SUBURBAN SYSTEM (CHURCHGATE TO VIRAR)

3.1 Western Railway has gone for a mobile communication system in its suburban section in Mumbai. This project is a part of the Train Management System, which is commissioned in the suburban section of Mumbai Division. Basic purpose of this communication system is to provide a continuous communication between the Motorman and the controller. The system consists of two base stations. One is installed at Mahalakshmi, and the other at Borivili each transmitting 50 watts of power. The Regional Node is installed at Mumbai Central. Mobile units are 25 watts full-duplex sets installed in the Motorman and Guard compartment of the 75 EMU rakes of the Suburban section of the Mumbai division. Together they cover the whole suburban section between Churcgate and Virar, a distance of 60 Kms. The system works on the principle of trunking, and is based on the MPT1327, MPT1343 protocols. M/s Tait New Zealand has supplied the System.

Figure 4: Western Railway Churchgate to Virar Mobile

SYSTEM LAYOUT

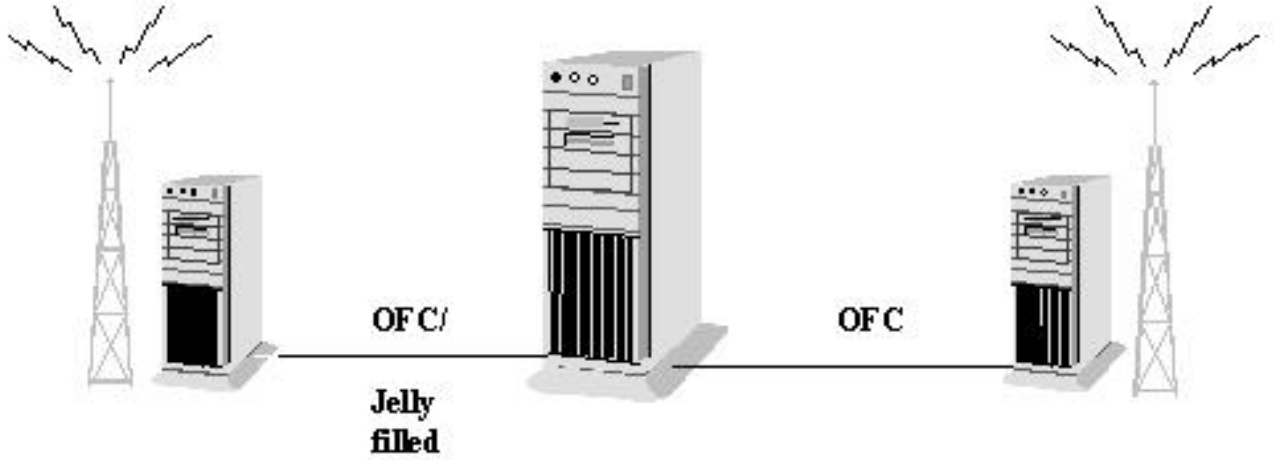
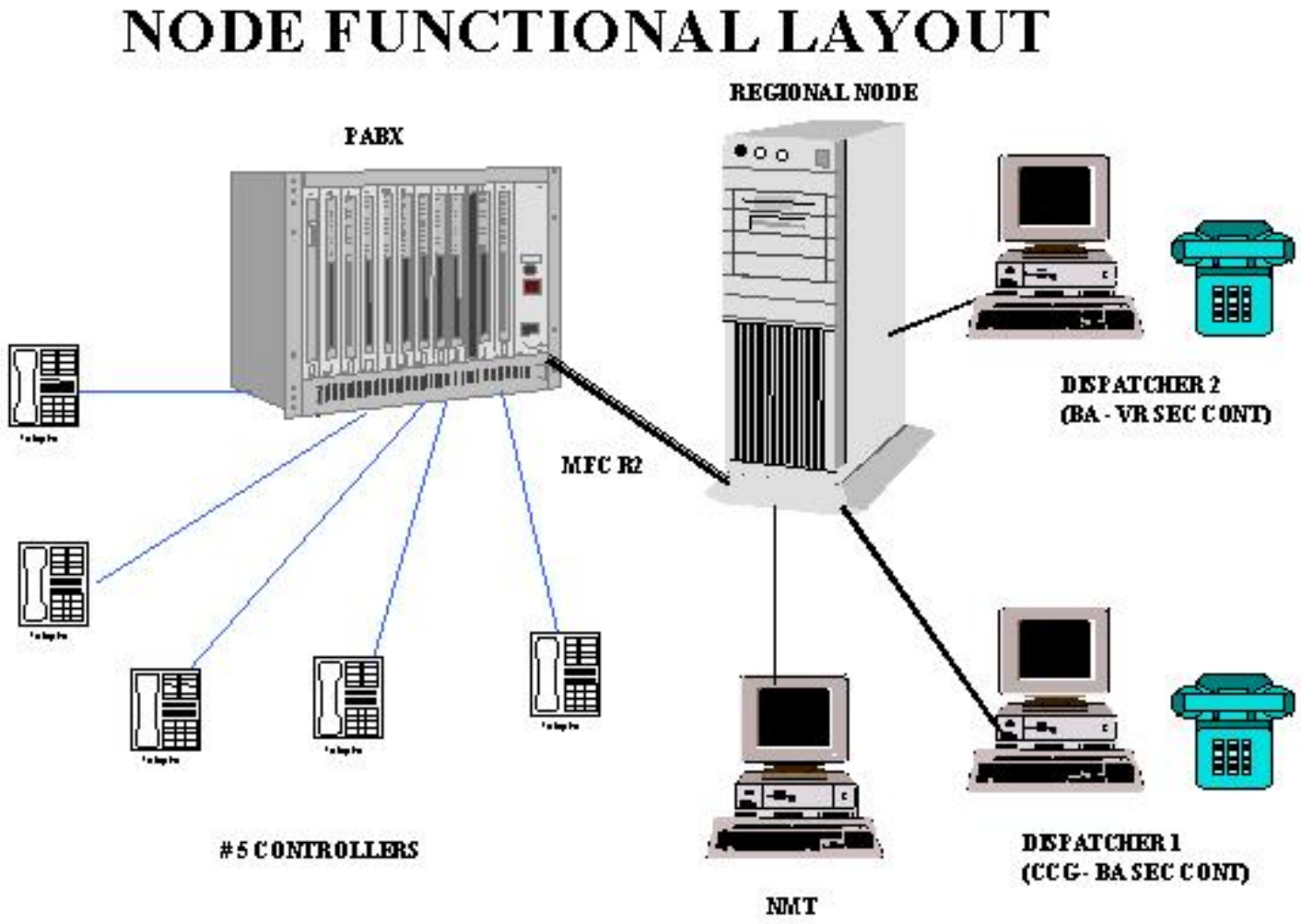


Figure 5: Western Railway Churchgate to Virar Mobile



3.2

3.3 The System (T1540) Overview

The system consists of a number of radio sites, which are linked in groups to "Regional Nodes" (in the Western Railway System there are two radio sites, one at MX, and the other at BVI). Regional Nodes may be linked together to form a wide area network. Radio sites (base stations) are connected by fixed audio and data links (V.24 interface at 1200 bauds) in "Star Configuration around the Regional Node".

In case of wide area network the interconnection between the Regional Nodes shall be with X.25/TCP IP (9600-baud link) for data, and by an audio network consisting of fixed link bearers for audio signals.

PSTN & PABX interconnection is provided at the Regional Node now.

The expansion capability of the T1540 system is as under.

- Each Regional Node can support upto 16 base stations connected in a star configuration.
- Each base station can support upto 24 channels including the control channel (both the base stations of W.R are configured for only 5 channels each).
- Overall System can be configured for a maximum of 32 Regional Nodes.

The overall access for management of the system is provided by the Network Provider Interface (NPI). The NPI provides an interface for external systems running applications (a Network Provider Package (NPP)) using the following facility.

- Statistic
- System Configuration
- Validation
- Monitoring
- Fault Management and Alarms
- Call Records
- NPI management

Frequency of operation of the Western Railway System is between 338 to 350 MHz.

4.0 Conclusion

Mobile Communication today is a fast growing field. No one can deny its role in Modern Railway Operations. However there is a need of proper choice of technology looking into Railways' Operational needs. It is beyond doubt that incorporation of Mobile Communication into Railways will open new operational

avenues, there by reducing operational costs and increasing customer satisfaction by providing better services. This shall not only help in increasing productivity, but also help in increasing safety of operations. This is an age of communication. Indian Railways, which is a lifeline of the nation, is also geared up to take the requirements of the new millennium, which is knocking the door of this century.