

TERRESTRIAL TRUNKED RADIO

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Abstract-An efficient Communication helpful to a nation in emergency conditions is discussed. TETRA standard which has been defined by the European Telecommunication Standards Institute (ETSI) is a digital mobile radio system for voice and data communication in ultrahigh frequency (UHF) band. The main function of the system is to provide alternative service to private/professional mobile radio (PMR) types of users because it has disadvantages. TETRA system has a robust and professional mobile communication through cell type system which enables digital data transmission. It overcomes the traditional PMR telephony. It helps users that require their communication system to provide instant transmission, high reliability. It is a reliable system suitable for use by different people and availability with a set of services designed to accommodate the daily use of the system as well as provide support in extraordinary conditions.

Keywords- PMR, Tetra, Centralized tetra, Distributed tetra, tetra over IP, voice, data.

I. INTRODUCTION

Communication is essential for Military, Police and paramilitary forces, Fire Force, Aid in emergency due to natural calamities. So the new and very useful technology is TETRA. [1] Tetra is a modern standard for digital private mobile radio (PMR) and public access mobile radio (PAMR). [2, 4] Terrestrial Trunked Radio [1] (TETRA) (formerly known as Trans-European Trunked Radio) is a professional mobile radio [2] and two-way transceiver (colloquially known as a walkie talkie) specification. TETRA was specifically designed for use by government agencies, emergency services, (police forces, fire departments, ambulance) for public safety networks, rail transportation staff for train radios, transport services and the military. TETRA is a European Telecommunications Standards Institute (ETSI) standard, first version published 1995; it is mentioned by the European Radiocommunications Committee (ERC). [3]

A. Existing system and limitations

Basically the existing system is Professional mobile radio (also known as private mobile radio (PMR) in the UK and

land mobile radio (LMR) in North America)[4] are field radio communications systems which use portable, mobile, base station, and dispatch console radios. Operation of PMR radio equipment is based on such standards as MPT-1327, APCO 25 which is designed for dedicated use by specific organizations or standards such as NXDN intended for general commercial use. Typical examples are the radio systems used by police forces and fire brigades. Key features of professional mobile radio systems can include:

Point to multi-point communications (as opposed to cell phones which are point to point communications), Push-to-talk, release to listen (a single button press opens communication on a radio frequency channel), large coverage areas, closed user groups, Use of VHF or UHF frequency bands. [4] But this system has the disadvantages are Analog Voice encryption (most current FM or PM-modulated systems can be tapped), Less data transmission rates (MPT1327 allows only 1.2kbits/s), Late entry to groups calls, not operate without a base station, lesser spectrum efficiency.[13]

B. New technology

Tetra technology has implemented to overcome the limitations in the existing technology. It has following advantages over existing technology are Digital speech transmission, Fast call set up, Additional encryption supported, 7.2kbits/s per channels (protected) and 28.8kbit/s with multi lot operation (protected), supported by tetra standards, Direct mode operation (DMO), Four channels per 25 kHz (4:1TDMA), Short data service, More than 20 supplementary services defined, such as ambience listening, call bearing, call hold, call diversion.[13] It has highly secured voice & Data Communication. It provides multilevel authentication. It has wide coverage area and data calls can use up to 4 channels (multi-slot data). So tetra is very applicable as compared to the existing PMR system.

II. HISTORY

TETRA was developed by the European Telecommunications Standards Institute (ETSI) and has been adapted from America to the Asia and was developed to address the unique integrated requirements of PMR and PAMR. At the beginning, Research has started in 1989 as Mobile Digital Trunked Radio System (MDTRS). In the early 90's the project name changed to Trans European Trunked Radio (TETRA). In the mid 90's the meaning of the TETRA acronym changed to Terrestrial Trunked Radio, as global popularity increased. Development of the TETRA standards began in 1990 and has relied on the support of the European Commission and the ETSI members. Experience from highly successful GSM cellular radio standard and trunked radio systems was used to design TETRA standard. In addition to this the process has gained from the co-operation of manufacturers, users, operators and industry experts. With this combined expertise TETRA were ready in 1995. The first contracts of TETRA networks were back in 1996 and the first generation of networks were deployed in July 1997. In November 2004, it was reported that 622 contracts had been placed for TETRA spanning 70 countries world. At the end of 2010, TETRA was in use in 121 countries around the world. [5]

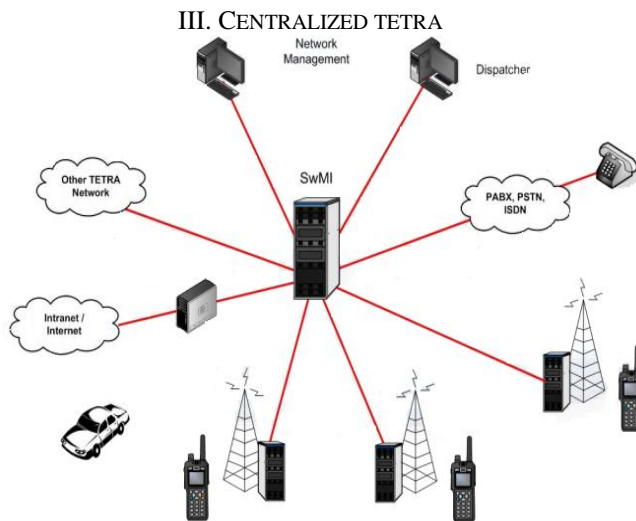


Figure1. Centralized tetra network [6, 9]

A. The TETRA network switch

The above picture shows a TETRA network switch that is the central heart of the TETRA network. Depending on the needed network availability most manufacturers can offer a redundant TETRA network switch to be able to take over the network services of a failure in the active switch. When a redundant TETRA network switch is available this is usually at a geographical separated location.

Depending on the manufacturer of the TETRA network and required capacity additional TETRA switches are needed to provide the required capacity. The TETRA network switch basically holds the database with information of the allowed mobile radios and the services assigned to them. Mobile radios are also called subscribers of Mobile Stations (MS). It has knowledge of the configured talk groups and switches the speech coming to and from the mobile radios. It holds track of the affiliation of the mobile radios to the base Stations and assigns the traffic channels of the basestations. [7]

B. The TETRA basestation

The TETRA basestation sends out the TETRA radio signal delivering coverage and receives the TETRA signals send out by the mobile radios. The TETRA basestation is connected to the TETRA network switch. The depending of the manufacturer design the connection is single or redundant, via landline or via microwave link. Depending on the manufacturer design the basestation are connected with the TETRA switch in a star configuration. When the TETRA mobile radio moves it roams from one basestation to the other providing that there is sufficient overlapping coverage. As the name implies (TETRA Terrestrial Trunked Radio) the air interface is trunked. A TETRA carrier is divided into four time slots as specified by the ETSI. The maximum number of carriers for one basestation is eight. This gives a total of $(4 \times 8 = 32)$ timeslots. Where the first time slot is always used for the control channel. The control channel is used for signaling (for example neighbor cell information). Information is broadcasted using the control channel. Mobile stations listen to the control channel and get informed to go to a traffic channel (which is one the time slots of the basestation) where the mobile station can receive the audio. Vice versa, when the mobile station wants to transmit, the mobile station does a request using the control channels that ask the TETRA infrastructure (SwMi Switched Mobile Infrastructure). [7]

C. Control room or dispatchers

To communicate with the users in the field that are equipped with a TETRA portable radio (mobile station, mobile radio or subscriber) from one or more fixed positions dispatchers can be added to the TETRA network. A location with dispatcher(s) is also known as a control room. Generally the control room is the central point in the voice communications. Control rooms are connected to the TETRA network switch using a (redundant) landline. The control rooms generally have priority in voice communication but are depending on the manufacturer implementation or operator configuration. [7]

D. Standardized interfaces

The TETRA air interface is standardized but not the networkmanagement interface, the basestation interface or

the control room interface. These interfaces are manufacturer proprietary interfaces and depending on the manufacturer these interface are most times available for third party developers. [7]

IV. DISADVANTAGES OF CENTRALIZED TETRA

A dedicated TETRA switch needs specific interfaces for external subsystems such as radio dispatching positions, recording devices, command & control (C2) systems. The need for such subsystem specific interfaces limits interoperability with non-TETRA subsystems. The hardware switch is specific to each manufacturer’s switch and requires costly dedicated engineering resources for the ongoing development and maintenance of the switch. The others are found a weak–Single point of failure, High operational cost, high power consumption, limited data and voice services, not upgradable. [10]

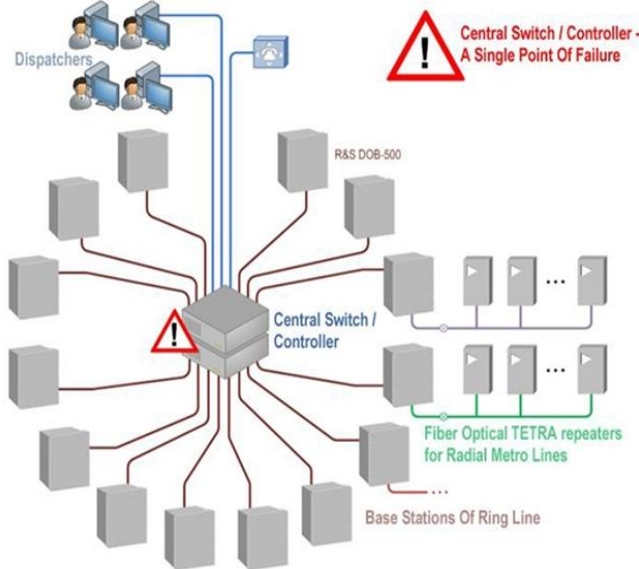


Figure2. Disadvantages of centralized tetra[10]

V. OVERCOME IN NEW TETRA SYSTEM

Figure shows Distributed tetra which overcomes the drawback of the centralized tetra technology. Centralized is star configured but Distributed is star, mesh, ring configured. Centralized has central switching device as hub but Distributed has no central switching device as hub. Centralized has centralized intelligent but Distributed has base station and other application connected anywhere in IP backbone. Centralized has proprietary protocols but Distributed has standardized protocols. Centralized has connection of peripherals through the central switch but Distributed has high percentage of hardware based on cots. Distributed has extremely fast upgrade of new software versions of all base stations < 5 minutes. [8]

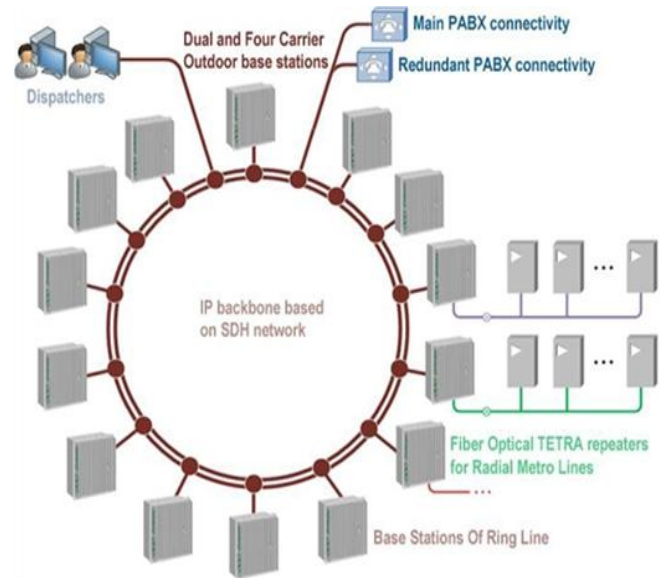


Figure3. Distributed tetra [10]

VI. DISTRIBUTED TETRA

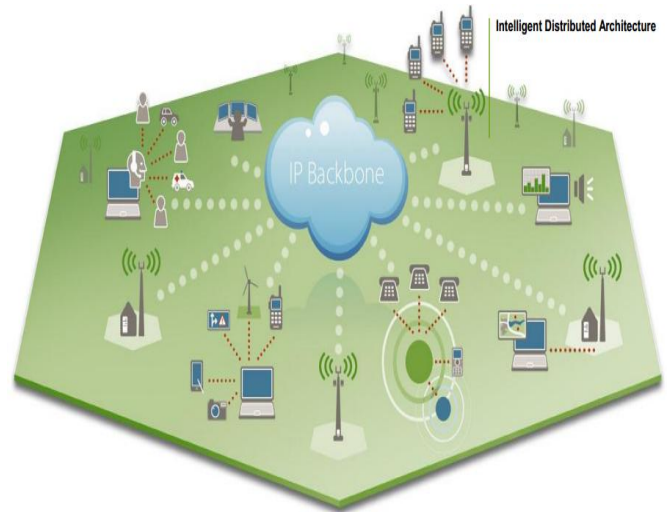


Figure4. Distributed tetra network[7]

It has distributed soft switching, no hardware required for call routing, distributed Database –Fast Call set-up, and distributed intelligence, high Degree of resilience. It can be configured as STAR, RING or MESH COTS (Commonly available off the shelf). It can works in Stand-alone mode / shared mode. An IP Network is used in this distributed tetra. IP is modular & Scalable so network components can be used. Internet driven performance improves in system working. Gateways, CBSC, Dispatchers etc. can be located at any point in the Network. It provides 64kbps data rate / carrier –Bandwidth

which very good, sufficient and more applicable than centralized tetra system. No requirement for central processing elements. TETRA traffic carried as IP packets. TETRA provides IP packet data in a similar way to GPRS in GSM. Most transactional services work well using TETRA IP packet data with a one-slot gross bit rate of 7.2 kbit/s. This gives a net bit rate of 2.5-3.5 kbit/s for applications. That is sufficient for WAP and email, while images, fingerprints and slow-speed video can all be supported using compression. TOIP Network uses standard IP techniques such as IP Unicast (point-to-point) and IP Multicast (point-to-multipoint). TETRA IP packet data is supported by the same capacity and coverage plan as a basic TETRA voice network because the TETRA standard makes the most of any available capacity. TETRA IP packet data is already available in TETRA networks and is a standard feature of many TETRA terminals and applications. So network flexibility gives best balance between transmission costs and required resilience.

VII. APPLICATIONS

Applications for this technology are very diverse. Military, Police and paramilitary forces, Fire Force, Railways, Communication in Rural areas, Aid in emergency due to natural calamities, Lifesaving communication in coasts, Public safety like more applications are available.

VIII. IMPLIMENTATIONS IN WORLD

A. Oil/Gas and Utilities

Australia (Chevron, Bechtel), Norway (Maersk Oil), the Netherlands (Shell), Oman (BP)

B. Mining

Australia (BHP Billiton, Xtrada, Rio Tinto), Sweden (Boliden)

C. Public Safety

Italy (Regional Network, Province of Lombardy), Russia (Sct. Petersburg City Network), Mexico (Mazatlán Municipality)[8]

D. Transportation

Rail

Russia (Moscow Metro), Express rail (Thailand).

Airports

Air France – Charles de Gaulle (France), Bangkok Airport (Thailand), Billund Airport (Denmark), Dubai Airport (UAE), Fiumicino Airport & Rome International Airport (Italy), Frankfurt Munich, Cologne Bonn, Lubeck and Leipzig-Halle Airports (Germany), Kiev Airport (Ukraine), Royal Jordanian Airlines Queen Alia Airport (Jordan), Sofia Airport (Bulgaria), 9 Regional Airports (Spain), 18 Regional Airports (Brazil), Hong Kong Airport (Hong Kong), Malaysian Airport and Airport Express rail (Malaysia), Beijing, Shanghai, Chengdu,

Guangzhou, Shenzhen Airports (China), Incheon Airport (Korea), Schipol- Airport (Amsterdam Netherlands), Perth Airport (Australia), Finish Main Airports, Athens Airport (Greece), Oslo Airport (Norway), Sallzberg (Austria), Changi (Singapore), Brussels Airport (Belgium), Ruzyne International Airport- Czech Republic (Sri Lanka). [8]

IX. USED IN INDIA

Tetra system is also used in India in large extent. In transportation, Cochin & Hyderabad, New Delhi & Bangalore Airports are using the tetra technology in India. In Rail DMRC L1-6, Delhi Airport Express, Central Railways Mumbai, Mumbai Metro One, Mumbai Monorail, Bangalore Metro are using the tetra technology in India. For the Public Safety also tetra system is being used. In Delhi GRN (CWG2010), Parliament House, Jharkhand Police, Haryana Police, Kolkata Police, AP Police, Cyberabad tetra is used. In Industries like Reliance Jamnagar Refinery, Essar Refinery tetra is used. [11]

X. FUTURE WORK

Future work will focus on LTE and WiMAX. LTE and WiMAX are both based on 4G technologies; however LTE is still work in progress whereas work on WiMAX is complete.

A. tetra over LTE

Once work on LTE is complete, it will surpass WiMAX. LTE is the perfect technology for building the next-generation of broadband public safety networks. It can deliver video-based data that more difficult with conventional TETRA. LTE offers high throughput (up to 170 Mbps) and low latency (10 ms), making it compatible with any mission-critical application. However, replacing TETRA with LTE is not a short term option, for many reasons. [12]

B. tetra over WiMAX

WiMAX is wireless IP, microwave communication system whose range is up to 50km. It has base transceiver station, a central antenna which communicates with subscribers' antennas. The term point-multipoint link is used for WiMAX's method of communication. It provides private voice calls and supports very high bandwidth applications. It is observed that loss is more sensitive than delay; hence, we compromise the delay performance within acceptable limits in order to achieve a lower packet loss rate. Massive power saving can be achieved by using WiMAX with sleep mode and idle mode. Speed of data transfer is more as Maximum bandwidth of 70Mbps and has a maximum range of 30 miles with a direct line of sight. WiMAX uses a strong cryptographic property which provides security. [12]



Figure5. Tetra network with Wi-Fi and LTE [8]

XI. CONCLUSIONS

Tetra is an essential communication network developed exclusively increase security and efficiency in various industries. A network which has never let its subscribers down in the need of the hours. Moreover, Tetra over IP is the latest buzz is the western countries as they have realized the importance of software and internet and unsurpassable growth in it. Many countries have already removed the old centralized system and replaced it with the newer IP version seeing no scope of up gradation in the former. Many communication networks were revolutionized when GPRS, Internet were integrated into it. Hence, to keep TETRA in the race with other networks, Tetra over IP was developed and has since then has brought TETRA to new heights and it continues to do so.

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