**PROJECT REPORT**

**ON**

**“TETRA”**

*US$21M Delhi Government contract to set up India’s first exclusive Government Radio Network (GRN) based on TETRA (TErrestrial Trunked RAdio) to provide a secure communication network*

In Partial Fulfillment

For the Award of the Degree of

**“BACHELOR OF TECHNOLOGY (B.Tech)”**

(2007-2011)

**SUBMITTED BY:-**

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Sonepat

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I am very thankful to **Mr. Mukesh Budhwar** who was always there to solve my problems which I have encountered in the course of my project. I would also like to thank Mr. **Abhishek Ahuja** (**M.I.S**. Department, **HCL InfoSystems**) who helped me a lot from the analysis to the implementation of the project work. And last but not the least my team members who provided me with full support, knowledge and ideas to complete this project.

**Kapil Chuttani**

ECE/07/117

**CERTIFICATE**

It is to certify that the project has been carried out by the students of **6th semester** **Kapil Chuttani(ECE/07/117)** under my supervision. The report covers all the aspects of the work done (including H/W & S/W , Coding etc.)

The project report is complete in all respects and I have gone through and understood the entire software of the relevant project.

**Mr.** **Mukesh Budhwar Mr. Abhishek Ahuja**

**( M.I.S Department) (M.I.S Department)**

**HCL InfoSystems** **HCL Infosystem**

**COMPANY PROFILE**

#### HCL Infosystems Ltd. with revenue (LTM) of US $ 2.6 billion (Rs. 12,307 crores) in financial year 2009 is one of India’s premier hardware, services and ICT system Integration companies offering a wide spectrum of ICT products that includes Computing, Storage, Networking, Security, Telecom, Imaging and Retail. HCL Infosystems Ltd. aims to be a one-stop-shop for all the ICT requirements of an organization. One of India's leading System Integration and Infrastructure management services organizations, HCL Infosystems Ltd. has specialized expertise across verticals including Telecom, BFSI, E-Governance and Power. HCL Infosystems Ltd. has one of India's largest distribution and retail networks for ICT products, taking to market a range of Digital Lifestyle products in partnership with leading global ICT brands, including Apple, Cisco, Ericsson, Kingston, Kodak, Konica Minolta, Microsoft, Nokia and Toshiba. HCL Infosystems Ltd. today has one of India's largest vertically integrated computer manufacturing facilities; with over three decades of electronic manufacturing experience, and HCL desktops are among the largest selling brands in the business enterprise space. With one of India's largest ICT services networks that reaches most regions in India, HCL's award winning support services make it a preferred choice of enterprise and consumers alike. For more information on HCL Infosystems Ltd. and its subsidiaries, For more information please visit us at [www.hclinfosystems.in](http://www.hclinfosystems.in/index.htm)

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**1.INTRODUCTION**http://kona.kontera.com/javascript/lib/imgs/grey_loader.gif

HCL Infosystems, India’s premier hardware, services and ICT systems integration company, in partnership with Motorola, a global leader in mission-critical government radio networks, today announced the win of a prestigious project worth approximately US$21M (Rs.100cr) from the Delhi Government to establish the country’s first exclusive Government Radio Network (GRN). This TETRA (TErrestrial Trunked RAdio) communication network will facilitate swift and secure communication among various Government agencies such as the Delhi Police, Fire Services, Hospitals, Public Works Department and the Delhi Transport Corporation during the Commonwealth Games and beyond. The project is a part of Delhi Government’s vision, fueled by the will and commitment of the capital’s premium agencies like the Delhi Police, leaving no stone unturned in providing Delhi a solid security net.

“The deployment of the Government Radio Network based on TETRA will not only enhance our communication infrastructure but will also firmly place New Delhi amongst the leading cities of the world. If the Asiad brought a shift from black & white television to colour television, the 2010 games will see the advent of TETRA, which will open a new chapter of secured and efficient communication between various government agencies.” said Mr. Savitur Prasad, Secretary, Information Technology, Delhi Government.

HCL Infosystems and Motorola will jointly collaborate with all Delhi Government departments to deploy a secure communication network for seamless inter-department communication. This network would cover the entire metropolitan area of the capital, including transportation networks such as Delhi Metro Railway Tunnels and New Delhi Airport Terminal-II. The GRN has been designed to minimise the reaction time in the toughest of situations, ensuring minimal call drops and encrypted communication to maintain the highest levels of security.

Commenting on the project, Mr. Ajai Chowdhry, Chairman & CEO, HCL Infosystems Ltd said, “We are proud to be a part of the Delhi Government’s movement to build a secure information network and congratulate backbone institutions like the Delhi Police for their relentless efforts in providing the capital city with a state-of-the–art security cover. HCL has always been committed towards nation building and in today’s scenario; security has to be top priority. The deployment of a TETRA-based communication system will enable authorities to timely prevent or minimise the chances of potential adverse impact in an emergency situation. I am confident that, in times to come, systems such as the Government Radio Network will strengthen communication infrastructure across the country.”

The GRN is an advanced digital inter-operable communication platform that will operate on a secured spectrum and will have 46 base stations. Communication on the GRN is encrypted to ensure security, and unlike other public communication infrastructure, this network is specially designed and built robustly to ensure failsafe performance even during emergencies. The GRN will help multiple agencies collaborate over a single platform to ensure well coordinated optimum response. In the long run, the GRN will continue to offer options of scalability with easy expansion through additional radio terminals.

Phey Teck Moh, corporate vice president, Motorola Enterprise Mobility Solutions, Asia Pacific, said, “Interoperability is a key feature for Government Radio Network and Motorola has been working with various governments across the world to support their stringent requirements for a multi-agency interoperable environment. We understand that security and reliability are of utmost importance to our customers and these aspects are built into our GRN solution. Motorola has the experience from more than 600 digital mission-critical network roll-outs across the world. Some of the most significant GRN projects in the world, including Airwave, world’s largest TETRA GRN network, and the largest Asian GRN in Korea are examples of Motorola’s leadership. We are proud to be selected by the Delhi Government to transform the capital city’s public safety infrastructure that will ensure the availability of a world-class GRN for the 2010 Commonwealth Games."

As the world's largest TETRA supplier, Motorola has been supporting the critical communication needs for various organizations including metros and airports around the world. Whereas, HCL Infosystems has been a pioneer in innovation and using technology to deliver citizen benefit programs.

# In the past HCL has deployed many citizen oriented projects such as Emergency Response Center for Police (Dial 100), Ambulance (Dial 102) etc in cities like Delhi, Hyderabad, Chennai, Bangalore, Bhopal, Nagpur, Pune, Bhopal, Dehradun etc in partnership with various state governments.

**2. ABOUT TETRA**



Terrestrial Trunked Radio (TETRA) is a digital trunked mobile radio standard developed by the European Telecommunications Standards Institute [(ETSI)](http://www.etsi.org/). The purpose of the TETRA standard was to meet the needs of traditional Professional Mobile Radio (PMR) user organisations such as those listed below.

The air interfaces, network interfaces as well as the services and facilities are specified in sufficient detail to enable independent manufacturers develop infrastructure and radio terminal products that would fully interoperate with each other. For example, radio terminals from different manufacturers can operate on infrastructures from other manufacturers.

The ability for full interoperability between different manufacturer's products is a distinct advantage of open standards developed by ETSI. As the TETRA standard is supported by several independent manufacturers this increases competition, provides second source security and allows a greater choice of terminal products for specific user applications.

* *Public Safety*
* *Transportation*
* *Utilities*
* *Government*
* *Military*
* *PAMR*
* *Commercial & Industry*
* *Oil & Gas*

Because the TETRA standard has been specifically developed to meet the needs of a wide variety of traditional PMR user organisations it has a scaleable architecture allowing economic network deployments ranging from single site local area coverage to multiple site wide area national coverage. Besides meeting the needs of traditional PMR user organisations, the TETRA standard has also been developed to meet the needs of Public Access Mobile Radio (PAMR) operators.

The information folders listed below, which can be accessed from the menu, are intended to provide a basic understanding of the TETRA Technology.

* [*First Time Visitor*](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=1192)
* [*TETRA Release 1*](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=1181)
* [*TETRA Release 2*](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=1186)
* [*Security*](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=1184)

**2.1. First Time Visitor**

The TETRA standard is in practice, a suite of standards covering different technology aspects, for example, air interfaces, network interfaces and its services and facilities. Because TETRA is an evolving standard it has been developed in Releases (phases) known as TETRA Release 1 and TETRA Release 2. Even though both TETRA Releases have been completed, work continues within ETSI Technical Committee (TC) TETRA to further enhance the standard thus satisfying new user requirements as well as gleaning the benefits of new technology innovations. Outside of Europe the ETSI TETRA Standard has been formerly adopted in China and South Korea.

**Market Uptake**Since the first generation of networks were deployed in 1997, hundreds of TETRA networks have been deployed across the world. Even though a considerable number of these networks are deployed in Europe, a rapid uptake is occurring in the regions of Asia, Middle East and South America. Although all PMR market segments are already being served by TETRA, the largest market is that of public safety, where the trend is for the deployment of nationwide networks shared by all public safety organisations for reasons of economics (sharing), autonomy of operation for routine communications and the ability to fully interoperate with other services during emergency situations and disasters.

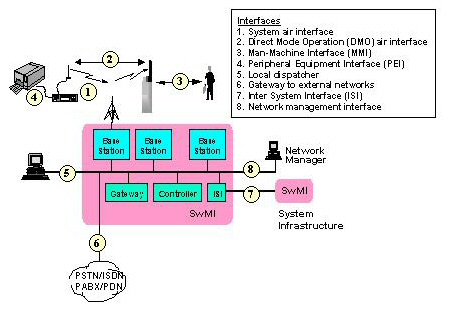
The transportation market is the next fastest growing market, especially for Mass Rapid Transport systems and major Airports. Interestingly, TETRA is also used by the military for non-tactical operations, a market application not originally anticipated for TETRA.

The success and market uptake of TETRA has attracted many independent manufacturers and suppliers of TETRA products and services, thereby providing users with healthy competition, second source security and wide choice of radio terminal equipment for specific applications. The success of TETRA has also created a strong base of application developers who are able to provide a wide variety of applications for use with TETRA.

**The TETRA Association**Recognising that important market requirements outside the responsibility of ETSI needed to be addressed to ensure the success of TETRA, a number of organisations formed the TETRA MoU (Memorandum of Understanding) Association in December 1994. Since it has been established, the TETRA Association has grown significantly and now provides a forum which acts on behalf of its members, being user organisations, manufacturers, application providers, integrators, operators, test houses, regulators, consultants, etc. The main objectives of the TETRA Association are to promote the TETRA standard and to ensure multi-vendor equipment interoperability.

**2.2. TETRA Release 1**

The original TETRA standard first envisaged in ETSI was known as the TETRA Voice plus Data (V+D) standard. Because of the need to further evolve and enhance TETRA, the original V+D standard is now known as TETRA Release 1. An overview of the network elements covered in the TETRA standard are shown in figure 1.



**figure 1: TETRA Standard Interfaces**

Switching and Management Infrastructure (SwMI)  
The abbreviation SwMI is used to classify all of the equipment and sub-systems that comprise a TETRA network, including base stations. Even though some ETSI Technical Committee (TC) TETRA members felt that a standard base station interface would be useful (as provided in GSM) it was decided that owing to the way in which different manufacturers configure their networks for optimum performance and design flexibility, it would be impractical to implement.

It was also agreed, for the same reasons as the base station interface, that everything contained inside the SwMI would not be standardised, thereby allowing TETRA infrastructure manufacturers flexibility in design, and the ability to differentiate their portfolio offerings, when in competition with other TETRA manufacturers. This practical approach also meant that new technologies in the areas of transmission and networking could be used without having to go through a long standardization process.

**Air Interfaces (1 & 2)**The most important (and complex) interfaces are considered to be the ‘air interfaces’ between the base station and radio terminals (1) and the Direct Mode Operation (DMO) interface (2). DMO is a facility that allows terminals to operate in local radio nets independent of the main TETRA network infrastructure.

**Peripheral Equipment Interface (4)**This interface standardises the connection of the radio terminal to an external device, and supports data transmission between applications resident in the device and the connected TETRA radio terminal. The PEI also supports certain elements of control within the radio terminal from the external device and/or application.

**Remote Dispatcher Interface (5)**This interface was originally intended to allow connection to remote wire line dispatcher consoles like those located in major control rooms. Unfortunately, work on this interface was dropped in ETSI TC TETRA as the complexity to provide a universal interface without degrading performance was impractical. This was because the PMR industry had specialist manufacturers of control room equipment, the majority of which differed in the way they interfaced to PMR networks. Similarly, the TETRA network architecture of manufacturers also differed adding to the complexity of providing a universal interface. For these reasons only TETRA manufacturer specific interface specifications are available to support the many voice and data applications requiring access to TETRA infrastructures.

**PSTN/ISDN/PABX (6)**This standardised interface enables TETRA to interface with the PSTN, the ISDN and/or a PABX.

**Inter-System Interface (7)**This standardised Inter-System Interface (ISI) allows infrastructures supplied by different TETRA manufacturers to inter-operate with each other allowing interoperability between two or more networks. There are two methods of interconnection in the standard, one covering information transfer using circuit mode and the other using packet mode.

**Network Management Interface (8)**Like the local dispatcher interface, it was recognised during standardisation activities that a common network management interface was impractical. Fortunately, this early standardisation was not wasted as it was later turned into a comprehensive guide to assist users in defining network management requirements.

Besides these network element standards, the many services and facilities available on TETRA are also standardised. The most significant of these being:

* *Advanced and fast group call services - clear and encrypted*
* *Individual calls - clear and encrypted*
* *Short Data Services - clear and encrypted*
* *Packet Data Services - clear and encrypted*

**2.2.1. Voice + Data (V+D)**

To meet the needs of traditional PMR user organisations, a wide range of V+D services and facilities have been provided in the standard, of which the most important are considered to be:

* *Voice Services*
* *Group Call (commonly called ‘all informed net’ and ‘talk group call’)*
* *Pre-Emptive Priority Call (Emergency Call)*
* *Call Retention*
* *Priority Call*
* *Dynamic Group Number Assignment (DGNA)*
* *Ambience Listening*
* *Call Authorised by Dispatcher*
* *Area Selection*
* *Late Entry*
* *Data Services*
* *Short Data Service*
* *Packet Data*

**Voice Services**

**Group Call**This is probably the most basic voice service in TETRA but yet the most complex to support effectively and efficiently. This is because group calls need to:

* *Use simple “Push To Talk” operation to provide fast call set-up group communications*
* *Be operated and managed in particular ways to optimise network loading*
* *Operate on a "preferred" site for optimum network loading*
* *Have a defined of operation (Area selection)*
* *Have a very reliable call-set up signalling protocol to ensure all users in a group are connected together when a call is first initiated (call acknowledgment signalling is impractical for group calls)*
* *Have priority mechanisms to ensure that specified users in a wide area group call (spanning multiple base station sites) are connected together when a network is busy*

It is this complexity needed to support group calls that makes public cellular networks unsuitable, simply because they were originally designed to support “One to One” calls, unlike TETRA which was primarily designed to support group calls.

**Pre-emptive Priority Call**This call service, of which the highest priority is the emergency call, provides the highest uplink priority and highest priority access to network resources. If a network is busy, the lowest priority communication is dropped to handle the emergency call. Unlike 911, 112 or 999 initiated public network emergency calls (which can also be supported on TETRA) the TETRA emergency call can be initiated by using a dedicated switch located on the terminal. Activating the emergency call automatically alerts the affiliated control room dispatcher and other terminal users in that persons talk group.

**Call Retention**This service protects selected radio terminal users from being forced off the network as a result of pre-emptive calls (emergency calls) during busy periods. When emergency calls are supported in a network, it is essential that only a small number of radio terminal users are provided with this facility as the objective of retaining important calls during busy periods could be lost.

**Priority Call**During network busy periods, that service allows access to network resources in order of user terminals call priority status. As there are 16 levels of priority in TETRA, this service is very useful in providing different Grade of Service (GoS) levels (and tariff structures) during busy periods. For example, front line officers would be provided with the highest priority levels in a Public Safety network to maintain the highest level of service access whilst routine users would be provided with lower priority levels.

**Dynamic Group Number Assignment (DGNA)**This service allows the creation of unique Groups of users to handle different communication needs and may also be used to group participants in an ongoing call. This service is considered by many public safety organisations to be extremely useful in setting up a common talk group for incident communications. For example, selected users from the Police, Fire and Ambulance could be brought together to manage a major emergency where close co-ordination between the three emergency service are required. Similarly, DGNA is also considered useful for managing incidents by other user organisations such as Utilities and Transportation.

**Ambience Listening**A Dispatcher may place a radio terminal into Ambience Listening mode without any indication being provided to the radio terminal user. This remote controlled action allows the dispatcher to listen to background noises and conversations within range of the radio terminal’s microphone. This is an important service to utilise for those persons transporting important, valuable and/or sensitive material that could be ‘hijack’ targets. Similarly, this is a useful service to have implemented in public service vehicles where a driver’s health and safety could be at risk. The number of user applications for the Ambience Listening service are numerous and in many cases application specific. However, it is important to note that many users feel that this service invades a person’s privacy and for this reason only those users who need Ambience Listening as part of their work duties should be provided with this service.

**Call Authorised by Dispatcher**This service allows dispatcher to verify call requests before calls are allowed to proceed. This is a useful service to utilise when radio user discipline needs to be maintained. This service also reduces the amount of radio traffic on a network as only essential work related calls are permitted. However, the frequent need for all informed net group communications between terminal users and the time delay experienced in authorising calls can make this service unacceptable for some user organisations.

**Area Selection**This service defines the areas of operation for users. Areas can be chosen on a ‘call by call’ basis. This service basically simulates the ability for a dispatcher to select different base stations to make a call as was possible in conventional networks. This service also helps to improve network loading and overall spectrum efficiency by restricting the area of operation for selected all informed net group calls.

**Late Entry**This service provides continuous call in progress updates to allow latecomers to join a communication channel. This is not a service but an air interface feature that allows a trunked radio terminal to behave in a similar way to conventional PMR terminals. For example, if a user turns on their TETRA terminal the control channel will automatically divert the user’s terminal to a talk group call, if a call is already in progress. Similarly, if the user’s terminal has been outside radio coverage, for example in a tunnel, the control channel will also divert the user’s terminal to a talk group call assuming a call is already in progress.

**Data Services**

**Short Data Service**The Short Data Service can provide up to 256 bytes of data, which can be used for basic status messaging, location information such as that provided by the TETRA Location Information Protocol (LIP) and free form text message applications in either ‘point to point’ or ‘point to multipoint’ call set-up configurations. Because of the relative short duration of each data message, this service is supported on TETRA control channel TDMA time slots.

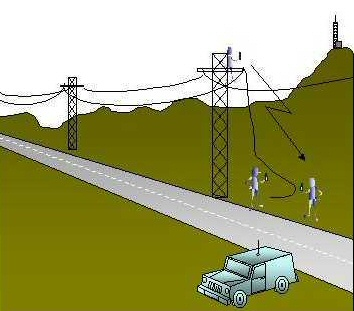
**Packet Data Service**The packet data service can be supported on one TDMA time slot with a gross protected bit rate of 4800 bits/s or multiple TDMA time slots up to a maximum of four. The use of multiple TDMA time slots is often referred to as bandwidth on demand and can be used to increase gross protected data throughput up to 19.2 kbits/s, thus increasing the number of non-voice applications that can be supported on TETRA.

**2.2.2. Direct Mode Operation (DMO)**

DMO is the term used by the TETRA industry to describe the ability of TETRA radio terminals to communicate directly with each other (like ‘Walkie-Talkies’) independent of the Trunked Mode Operation (TMO) network. DMO is not new and has been a fundamental mode of operation by many traditional PMR user organisations for several decades. The primary requirement for DMO in TETRA has been brought about by the need to balance the RF coverage, Grade of Service (GoS) and reliability of a network with that of the network’s overall cost.

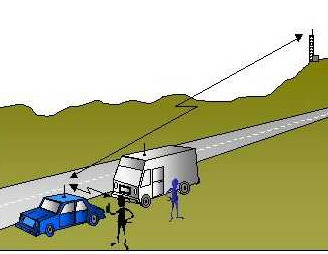
Typical DMO Applications  
The typical applications for DMO are local area communications outside the TMO network and range extension of the TMO network. To improve communication capabilities when using these applications, facilities are provided to enable DMO users to be contacted by TMO network users when operating outside the network as well as facilities to enhance local area DMO RF coverage performance.

**Local Area DMO Communications**Local area DMO communication is mainly used to provide additional capacity outside the TMO network for localised work activities, major incidents and/or periodic events. To a lesser extent, local area DMO communication is also used in poor TMO RF coverage areas and/or when service from a local base station site is lost. To provide this local area communication capability, practically all TETRA terminals, whether mobile or handportable terminals, are equipped with both TMO and DMO facilities.



**Figure 1 shows a team of Electricity Utility workers repairing a damaged overhead** power cable, which is a typical application for local area DMO communications. Because of the localised nature of the work, there is no need to load the main TMO network with localised voice traffic. For this reason, the team has made the decision to operate in DMO. Another contributing factor to this decision is that the team does not want to suffer GoS access problems when the TMO network is busy. It could also be possible that RF coverage from the local base station site may not support handportable operation and therefore DMO would be the only form of communication. For this type of local communications application a RF coverage range performance of approximately 250 metres is considered more than acceptable.

**TMO network range extension**The most frequently used DMO application is to provide TMO network range extension allowing handportable communications in areas of a TETRA network where only mobile radio coverage is supported. To provide this TMO network range extension facility a vehicle mounted TETRA mobile radio terminal equipped with ‘Gateway’ operation is required to link a handportable or or mobile radio terminals operating in DMO with the TMO network. Figure 2 shows a typical police application for TMO network range extension.



**Figure 2: Typical TMO Network Range Extension Application**

From Figure 2 it can be seen that a police officer has stopped a goods vehicle on a main highway running through the countryside where only mobile communications are supported. In this example, the police officer needs to verify the vehicle registration, driving licence, and nature of goods carried. For this purpose it is more efficient for the officer to use a handportable radio terminal for communications with the police control centre than it is walking backwards and forwards between the goods vehicle and his patrol car. Also, having direct access to communications when away from the patrol car is important for the officer’s health and safety. Again, for this type of local communications application, a RF coverage range performance of approximately 250 metres is considered more than acceptable.

**Communications between DMO and TMO users**As mentioned previously, communications between DMO and TMO users can be provided using DMO Gateways. Although Gateways are normally used to extend TMO network coverage, they can also be used to link local area DMO communication nets into the TMO network when required. This form of Gateway linking can be used independent of the type of RF coverage provided by the TMO network. Another form of providing communications between users operating in DMO and users operating in TMO is the use of a facility called ‘Dual Watch’ which, when enabled, periodically ‘listens out’ for calls on either DMO or TMO dependent on mode selected. For example, if the mode of operation was DMO the radio terminal would listen out for calls on TMO and vice versa if the mode of operation was TMO. This Dual Watch facility can be provided on both handportable and mobile radio terminals. Obviously, for Dual Watch to operate on handportable radio terminals, RF coverage would be required from the TMO network.

**Enhanced local area DMO RF coverage performance**Even though DMO RF coverage performance is more than adequate for most applications, there are instances when RF coverage needs to be enhanced, for example in localised areas where there is a significant amount of building clutter over a relatively large area causing unacceptable signal losses. In these instances, enhanced RF coverage can be provided by a ‘Repeater’ facility incorporated in a vehicle mounted TETRA mobile radio terminal, or a transportable radio unit, suitably located to provide the required area coverage. For practical reasons, this ‘Repeater’ facility is only made available on mobile radio terminals. Also, Repeaters can be provisioned with a Gateway facility to link DMO and TMO communications when necessary.

**User Application Summary**From the application examples provided it can be seen that many traditional PMR user organisations will achieve economic benefits by using DMO without seriously compromising RF coverage, GoS and network reliability requirements. From practical experience, the maximum RF coverage performance required for DMO is approximately 250 metres for most localised communication applications and 1 km for major incidents.

**2.2.3. Packet Data Optimised (PDO)**

This is a completed part of the TETRA suite of standards produced for "Data Only" wireless communication applications. To date, no manufacturer has developed PDO systems and products because all traditional Professional Mobile Radio (PMR) users require voice communications as well as data communications, hence the reason why the TETRA Voice plus Data (V+D) standard is very successful. Interestingly, the work from this standardisation activity has been carried forward in the Project [**MESA**](http://www.projectmesa.org/) space - a Partnership Programme between [**ETSI**](http://www.etsi.org/) and **TIA.**

**2.3. TETRA Release 2**

TETRA Release 1 (Voice + Data) already provides a very comprehensive portfolio of services and facilities but as time progresses there is a need to evolve and enhance all technologies to better satisfy user requirements, future proof investments and ensure longevity. Like GSM moving to GPRS, EDGE and UMTS/3G, TETRA also needs to evolve to satisfy increasing user demand for new services and facilities as well as gleaning the benefits of new technology.

As early as 1999, interest groups comprising both users and manufacturers within Technical Committee (TC) TETRA and the TETRA Association identified the need to enhance TETRA in several areas. Although the initial number of areas identified were very comprehensive, significant events in the telecommunications industry, combined with changing market needs, resulted in the following services and facilities being standardised at the end of 2005 as part of TETRA Release 2.

* Trunked Mode Operation (TMO) Range Extension
* Adaptive Multiple Rate (AMR) Voice Codec
* Mixed Excitation Liner Predictive, enhanced (MELPe) Voice Codec
* TETRA Enhanced Data Service (TEDS)

Trunked Mode Operation (TMO) Range Extension  
The ability for TETRA to operate beyond the 58 km range limit (a function of TETRA’s TDMA structure) was required by certain user organisations to allow efficient Air-Ground-Air (AGA) communications whilst operating on the main TMO network. By modifying uplink and downlink bursts, as well as guard times, the TMO range of TETRA is extended up to 83 km for AGA applications. (Note: DMO has no TDMA structure range limitation as synchronisation takes place in DMO at the start of each transmission).

Adaptive Multiple Rate (AMR) Voice Codec  
The AMR codec, operating in the 4.75 kbits/s only mode, has been chosen for possible future applications in TETRA. However, completion of the Air Interface Standard to accommodate the AMR codec is suspended in TC TETRA until sufficient market need is identified

Mixed Excitation Liner Predictive, enhanced (MELPe) Voice Codec  
The STANAG 4591 (MELPe codec), to use its correct NATO reference, has been standardised by NATO for its own military communication applications because of its low bit rate (2400 bit/s), immunity to high background noise and acceptable voice quality performance. Because of TETRA’s suitability for certain military communication applications TC TETRA carried out a technical feasibility study to see if could be supported on TETRA. The results of this study indicated potential benefits such as

* Interworking with government systems (no tandem operation)
* Suppression of background noise
* Improved RF Coverage using spare bits available for extra FEC
* Simultaneous V+D using spare bits available for data

However, the way the MELPe codec needs to be implemented in TETRA increases “end to end” voice delay, which needs to be balanced against its possible benefits. Completion of the TETRA standard to accommodate the MELPe codec will be dependent on the outcome of cost/benefit comparisons with the existing TETRA codec, which will be carried out in TC TETRA.

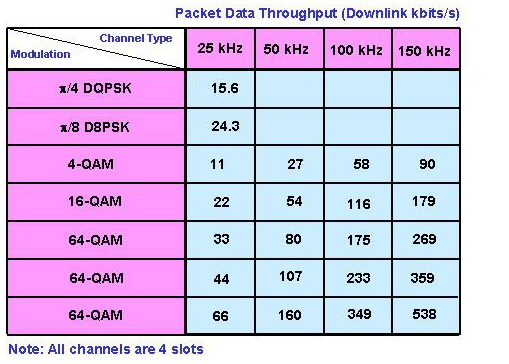
TETRA Enhanced Data Service (TEDS)  
TEDS is a new TETRA High Speed Data (HSD) service using different RF channel bandwidths and data rates for flexible use of PMR frequency bands. TEDS is fully compatibility with TETRA Release 1 and allows for ease of migration. It has been optimised for efficient use of PMR frequency bands and designed for all TETRA market segment applications. The RF channel bandwidths supported in TEDS are:

* 25 kHz
* 50 kHz
* 100 kHz
* 150 kHz

The modulation schemes supported in TEDS are:

* pi/4 DQPSK (for common TETRA V+D and TEDS control channel)
* pi/8 D8PSK (for early migration requiring modest increase in speed)
* 4 QAM (for efficient links at edge of coverage)
* 16 QAM (for moderate speeds)
* 64 QAM (for high speeds)

Figure 1 is a matrix showing the different RF channel bandwidths and data rates supported in TEDS.

**Figure 1: TEDS RF channel bandwidths and data rates**

With adaptive selection of modulation schemes, RF channel bandwidths and coding according to propagation conditions, user bit rates in the region of 10 to 500 kbits/s can be expected. For ease of evolution and migration from TETRA Release 1 reuse of the TETRA protocol stack and TDMA structure have been maximised. TEDS also allows up to 8 multimedia applications and QoS negotiation for real-time class data applications, such as voice and video and telemetry, with the QoS attributes negotiated being; throughput, delay, priority and reliability. Support for sectored cells is also provided enabling the use of existing TETRA Release 1 Base Sites for TEDS without the need for additional sites. Even though TEDS is capable of providing High Speed Data in 150 kHz RF channels, the current limitation caused by insufficient RF spectrum to support the growth of TETRA will probably limit early deployments to 50 kHz RF channel assignments only.

Now that the TETRA Release 2 standards are sufficiently complete for product development purposes, actual product availability will be dependent on the different manufacturers development plans.

**2.4. Glossary and Definition of Terms in TETRA**

|  |  |
| --- | --- |
| **Issue 3 February 2006** |  |
| ACELP | Algebraic Codebook Excited Linear Prediction method for low bit rate voice coding and decoding |
| ADPCM | Adaptive Differential Pulse Code Modulation |
| AES | Advanced Encryption Standard |
| AI | Air Interface |
| Air Interface encryption | Encryption on the air interface - the vulnerable link between base station and terminal |
| Air Interface protocol | The protocol, which defines the way in which signals are transmitted between radio terminals and the system infrastructure |
| AKD | Authentication Key Distribution |
| AL | Ambience Listening, Supplementary Service in TETRA to allow an authorised user, e.g. a dispatcher, to remotely switch the MS into transmit mode and monitor its environment without the intervention of the MS user |
| AMR | Adaptive Multi-Rate, Codec, one which in the low-error environments operates at a higher bit rate to give higher quality speech, whilst in higher-error environments, when higher speech quality cannot be sustained, the codec reduces its operational bit rate. |
| Analysis-by-synthesis | Speech coding technique which aims to minimise the mean-squared error between the input analogue speech and its synthesised version |
| ANSI | American National Standards Institute, |
| APCO | Association of Police Communications Officers |
| API | Application Programming Interface, published software interface specification for designing applications on top of some lower layer software |
| ARIB | Association of Radio Industries and Businesses, Japanese radio standardisation body, |
| ATSI | Alias TETRA Subscriber Identity |
| Authentication | A security mechanism in TETRA, based on the challenge -response between the MS and the infrastructure, in order to ensure the legitimacy of each party |
| AVL | Automatic Vehicle Location, service or application showing location of a vehicle, either in terms of its geographical coordinates or by its location on a map |
| BER | Bit Error Rate |
| BS | Base Station |
| C/N | Carrier/Noise power ratio |
| Carrier | A radio channel which could carry one or more communication channels |
| CCK | Common Cipher Key, used to protect group downlink calls in class 3 systems |
| CDMA | Code Division Multiple Access |
| CEPT | European Conference of Postal and Telecommunications Administrations (Conference Européenne des Administration des postes et des telecommunications), |
| Channel surveillance | Monitoring of signal strength against a pre-determined threshold level in order to decide if DMO may be allowed |
| CMCE | Circuit Mode Control Entity |
| CMD | Circuit Mode Data, a method for data transmission where a continuous connection is required for the lifetime of the session to transmit all the data in a complete burst as opposed to Packet Data where the data can be split into sections or 'packets' |
| CMIS/P | Common Management Information System/Protocol |
| CNM | Central Network Management |
| CNMI | Central Network Management Interface |
| CODEC | also Codec - Combined Coder and Decoder |
| COMSEC | Communications Security |
| Conventional | Non-trunked radio communication where communication resources (RF channels and base station sites) are manually selected. |
| CORBA | Common Object Request Broker |
| Covert Secret, hidden | Usually refers to type of equipment, e.g. covert terminals, for use with agencies involved in surveillance and under-cover operations |
| CRC | Cyclic Redundancy Code (Block coding) |
| CVO | Clear Voice Override, switching from encrypted to clear voice |
| DCK | Derived Cipher Key, key produced as a result of authentication, used for uplink and one to one messages |
| DDI | Direct Dial In |
| DES | Digital Encryption Standard |
| DGNA | Dynamic Group Number Assignment, Supplementary Service defined in the TETRA standards which is used for dynamic management (creation and dissolution) of user talkgroups |
| Dialling | Exchange mechanism between User and Terminal; the act of selecting the called party |
| Discreet Listening | TETRA Supplementary Service enabling an authorised user like a dispatcher to covertly (secretly) monitor the calls in progress |
| DM Repeater | A radio device designed to retransmit each call and thus increase the operational area of Direct Mode terminals |
| DM Direct Mode | (DM or DMO), the facility for TETRA terminals to communicate directly with each other without using TETRA infrastructure |
| DMO | Direct Mode Operation, the facility for TETRA terminals to communicate directly with each other without using TETRA infrastructure |
| DMR | Digital Mobile Radio, an ETSI standard being developed for low tier conventional PMR applications. |
| Downlink | Transmissions from the base station to a radio terminal. |
| DQPSK | Differential Quaternary Phase Shift Keying |
| DSS 1 | Digital Subscriber Signalling 1 |
| E2E | End to End Encryption - Encryption of the total communication link (from one end to the other) without intermediate decryption, required for maximum security |
| ECC | Electronic Communications Committee, the telecommunications committee of CEPT, producing Decisions, Recommendations and Reports to harmonise European regulation, |
| EN | European Norm, a standard like TETRA approved through national voting procedure |
| Encryption key | A pseudorandom number used "to seed" a key-stream generator |
| Encryption | Method for coding/ scrambling the information (voice or data) so that it cannot be understood or deciphered without special equipment or software |
| EPT | ETSI Project TETRA (now changed to Technical Committee (TC) TETRA) |
| ERC | Earlier name for ECC, |
| ERO | European Radiocommunications Office |
| Es/No | Energy per symbol / Noise power spectral density |
| ETS | European Telecommunication Standard (ETSI document prefix) |
| ETS | European Telecommunication Standard, name of standards (earlier) produced by the European Telecommunications Standards Institute (ETSI) |
| ETSI | European Telecommunications Standards Institute |
| EU | European Union, |
| Excitation generator | Generates pulses of variable amplitudes (and maybe positions) to represent the actions of the lungs and vocal chords |
| FCC | Federal Communications Commission, |
| FDMA | Frequency Division Multiple Access |
| FEC | Forward Error Correction (Convolutional coding) |
| Free-running | A device not requiring any human intervention or control in order to function (e.g. free running DM repeater). |
| Frequency Efficiency DMO | A variant of DMO protocol that uses all four timeslots, thus enabling two conversations on a single carrier |
| FSSN | Fleet Specific Short Number, one of numbering mechanisms in TETRA |
| Gateway | A device which interfaces TETRA network with other private or public telecommunications networks, e.g. PSTN, ISDN |
| GCK | Group Cipher Key, a key used (in conjunction with CCK) to give crypto group separation between groups |
| GGSN | Gateway GPRS Support Node |
| GoS | Grade of Service, used to specify the level of access on a radio network. |
| GPS | Global Positioning System |
| GPRS | General Packet Radio Service |
| GTSI | Group TETRA Subscriber Identity |
| GW | Gateway |
| HTML | HyperText Mark-up Language |
| IDEA | International Data Encryption Algorithm |
| I/F | Interface |
| IEC | International Electro-technical Commission |
| IMSI | Individual Mobile Subscriber Identity |
| Infrastructure | Base stations, switches, links, and various management equipments - all forming the network of equipments that enable mobile radio terminals to operate over a particular geographical area |
| IOP | Interoperability (of TETRA equipment) |
| IP | Internet Protocol |
| IPR | Intellectual Property Rights |
| ISCTI | Istituto Superiore delle Comunicazioni e tecnologie dell'Informazione, the current certification body for TETRA IOP |
| ISDN | Integrated Services Digital Network |
| ISI | Inter-System Interface, open interface standard used to connect two TETRA networks together |
| ISO | International Standards Organisation |
| ITSI | Individual TETRA Subscriber Identity |
| ITU | International Telecommunications Union |
| ITU-T | International Telecommunications Union-Telecomms |
| KMC | Key Management Centres, an entity for remotely loading keys to user terminals |
| Keystream | Pseudorandom data derived from KSG, used to mix with plain text data to produce encrypted data stream |
| KSG | Key stream generator: produces key stream from inputs of encryption key and synchronisation vectors fed into the encryption algorithm |
| LAN | Local Area Network |
| Late Entry | TETRA Supplementary Service which allows a user who has, for example, just switched his/her MS or has finished another call, to join a call in progress between the members of the group he/she is also a member |
| Lawful Interception | Facility for telecommunications networks like TETRA to be monitored and calls intercepted by government agencies |
| LNM | Local Network Management |
| LPC | Linear Predictive Coding |
| LS | Line Station, a fixed, wireline user terminal, as distinct from a mobile radio terminal, connected to a TETRA network, providing services and facilities available to a mobile user but without the need to be in the operational range of the system |
| LSI | Line Station Interface |
| MAC | Medium Access Control |
| Master DMO terminal/radio | The radio that initiates a DMO conversation and, in the absence of the synchronisation signal from the infrastructure, is acting as a control of the synchronisation timing |
| MCC | Mobile Country Code, (part of TETRA Number Identity) |
| ME | Members Enquiry, consultation process in TETRA interoperability specification work |
| MELPe | Mixed Excitation Linear Predictive, enhanced, the voice codec type adopted by NATO. |
| MGCK | Modified Group Cipher key, the key used for downlink group calls when GCKs are used. Formed from GCK modified by CCK |
| MII | Ministry of Information Industry (of the Peoples Republic of China) |
| MM | Mobility Management |
| MMI | Man-Machine-Interface |
| MNC | Mobile Network Code, (part of TETRA Number Identity) |
| MOPS | Million Operations Per second |
| MOS | Mean Opinion Score |
| MPT1327 | Analogue trunking standard defined by UK DTI |
| MS | Mobile Stations are TETRA radio terminals, including hand-held, mobile and fixed ones |
| MS-PD | Multislot Packet Data, IP data service using multiple timeslots |
| MTBF | Mean Time Between Failure |
| MTTR | Mean Time To Repair |
| NATO | North Atlantic Treaty Organisation, |
| NMS | Network Management Subsystem |
| Number | Decimal digits dialled by the user, decimal representation of air-interface addresses as seen by the user i.e. user visible number |
| OTAR | Over The Air Re-keying. TETRA facility which allows for change of the encryption keys in the terminals to be done remotely over the air |
| PAMR | Public Access Mobile Radio |
| PCM | Pulse Code Modulation |
| PCN | Personal Communication Network |
| PD | Packet (Mode) Data, a mode of data transmission where data message is split into small 'chunks' or packets, transmitted packet-by-packet to the end destination (without a need for dedicated connection in between, as for circuit data), and assembled again in the correct order |
| PDN | Public Data Network |
| PDO | Packet Data Optimised, another variant of the TETRA standards set originally developed, which was not taken up by the market, largely because of its marginal advantage in terms of efficiency of packet-data communications when compared to V+D TETRA combined with a significant disadvantage of not offering the voice service |
| PEI | Peripheral Equipment Interface, standard interface defined in TETRA for connecting a data terminal to a TETRA radio terminal |
| PMR | Private Mobile Radio |
| Portable Radio | An older term for a hand-held radio |
| PPP | Point to Point Protocol |
| Priority | A service that in case of system congestion offers one or more levels of "call queue jumping", to those users who are allocated it, on the basis that their communication needs or requests are deemed to be more important. The highest priority call is an Emergency call. |
| PSS 1 | Private integrated Signalling System No. 1 |
| PSTN | Public Switched Telephone Network |
| QAM | Quadrature Amplitude Modulation, scheme used in TETRA Release 2 for the TETRA Enhanced Data Service (TEDS) |
| QoS | Quality of Service |
| Roaming | Facility for offering an MS a service inside a visiting network, i.e. not its own home network |
| SAR | Specific Absorption Rate |
| SAP | Service Access Point |
| SCK | Static Cipher Key, used for protecting Direct mode transmissions where no authentication is possible, for class 2 systems and as a fallback key for use on base stations disconnected from the SwMI |
| SCN | Switching Control Node |
| SDS | Short Data Service |
| SDS | Short Data Service, a service in TETRA standards to deliver short data messages between user terminals. A message is composed of a number of characters and/or numerals, up to a pre-determined maximum |
| SFPG | Security and Fraud Prevention Group |
| Secret key (k) | The unique key embedded securely in the terminal, which is used for authentication |
| SIM | Subscriber Identity Module: A module used for storing personalization information of the user that can be moved from one terminal to another |
| Slave DMO terminal/radio | The receiving participant radio in a DMO conversation. |
| SNDCP | Sub Network Dependent Convergence Protocol |
| SNMP | Simple Network Management Protocol |
| SSI | Short Subscriber Identity, part of TETRA Subscriber Identity |
| STANAG | Standardisation Agreement [NATO] |
| Standard DMO | Direct Mode Operation using two out of the four timeslots available in a frame (one for uplink and other for downlink), thus enabling a single conversation on the carrier |
| Status Messages | Words or concise phrases selected from a pre-determined list that is resident in the terminal, which are transmitted as a simple code reference, and then de-coded by the receiving device and displayed as the word message, e.g. "At the scene" |
| Status Service | mechanism to deliver short messages between user terminals in compact form by transferring only an integer number with textual interpretation provided by the terminals, e.g. 09 could be interpreted as 'off-watch', and 08 as "at the scene". |
| SwMI | Switching and Management Infrastructure |
| TC | Technical Committee, an ETSI body formed to develop standards such as TETRA |
| TCP | Transmission Control Protocol |
| TCP/IP | Terminal Control Protocol/ Internet Protocol |
| TDMA | Time Division Multiple Access |
| TDMA | Time Division Multiple Access, a technology for delivering digital wireless service that works by dividing a radio frequency into time slots and then allocating slots to multiple calls. In this way, a single frequency can support multiple, simultaneous, communication channels. |
| TEA1/2/3/4 | TETRA Encryption Algorithm(s) 1,2,3 and 4 |
| TEK | Traffic Encryption Key End to end keys used to protect the user traffic payload |
| Temporary/permanent disabling | The process by which the network disables terminals which have been reported as lost or stolen or have fallen into unauthorised hands. |
| Terminal | also radio terminal or a mobile radio terminal or a TETRA mobile station (MS) - a hand-held, mobile of fixed radio unit connected to the TETRA system via air interface |
| TETRA MoU Association | The TETRA MoU Association founded in 1994 to support promotion of ETSI TETRA standard worldwide, now known as the TETRA Association |
| TETRA V+D | TETRA Voice + Data, the suite of TETRA standards normally referred to as "TETRA" |
| TETRA | Terrestrial Trunked Radio, the ETSI standard for digital trunked radio communications (earlier known as Trans-European Trunked Radio and before that MDTRS Mobile Digital Trunked Radio System) |
| TIA | Telecommunications Industry Association, a U.S. standardisation body, |
| TIP | TETRA Interoperability Profile, a test specification produced under the TETRA Association for testing TETRA equipment from different suppliers |
| TM | Trunked Mode |
| TMN | Telecommunications Management Network |
| TMO | abbreviation standing in for Trunked Mode Operation, as distinct from DMO, direct mode operation |
| TNP 1 | TETRA Network Protocol 1 |
| Trunked Radio Communications | A computer controlled communications system, which allocates communication channel for a call (either voice or data) from a "common pool" of available channels, and at the end of that call, returns them to the same "pool" to be reallocated for another call. |
| TS | Time Slot |
| TSI | TETRA Subscriber Identity |
| TTR | TETRA Association Technical Report, publication series for TETRA interoperability specifications |
| UDP | User Datagram Protocol |
| UMTS | Universal Mobile Radio System |
| Uplink | Connection from radio terminal to the base station |
| V. 24 | ITU-T Recommendation V. 24 |
| V. 28 | ITU-T Recommendation V. 28 |
| V+D | Voice plus Data |
| VATSI | Alias TETRA Subscriber Identity allocated in the visiting Network |
| VGTSs | Group TETRA Subscriber Identity(ies) allocated in the visiting Network |
| Vocoder | Voice coder |
| WAP | Wireless Application Protocol, open protocol for delivery of Internet content over radio path in a condensed format |
| WG | Working Group, usually a small team formed as part of an ETSI TC to produce a specific ETSI deliverable |
| WML | Wireless Mark-up Language |
| X.121 | ITU Recommendation - Numbering Plan for Data Networks |
| X.25 | ITU-T Recommendation X. 25 |
| X.75 | ITU-T Recommendation X. 75 |

**2.5. TETRA Security**

The area of TETRA security is extensive, as it needs to provide different levels of security ranging from what is acceptable on commercial networks to what is acceptable on a national public safety network. The security mechanisms in the standard are covered through Authentication, Air Interface Encryption (AIE) and End to End encryption. The threats to Confidentiality, Authenticity, Integrity, Availability as well as Accountability are covered with those three mechanisms.

The standard based services are constantly being expanded by a sub-group of the Association - Security and Fraud Prevention Group (SFPG).

Mutual Authentication is a service required to ensure that a TETRA system can control access to it and for a radio terminal to check if a network can be trusted. In TETRA, as in most other secure systems, authentication is the basis for much of overall network security and can also be used to ensure validated billing in public access systems, and can provide the foundation for a secure distribution channel for sensitive information such as other encryption keys. The mutual authentication security mechanisms protect both Voice and Data services.

The TETRA standard supports four AIE TETRA Encryption Algorithms (TEAs), these being TEA1, TEA2, TEA3 and TEA 4. There are differences in the intended use and the exportability of equipment containing these algorithms. For example, TEA2 is intended for use by public safety users in Schengen and related European countries only; the others have wider applications ranging from general commercial use to public safety use in regions where TEA2 is not used. The main benefit of over the air encryption is that it protects all signalling and identities as well as user speech and data. This provides an excellent level of protection from traffic analysis as well as from eavesdropping. The encryption system is closely bound to the TETRA signalling protocols and the algorithms can (if desired) be implemented as software within radio terminals and base station equipment, instead of using encryption modules, which could consume space and increase cost.

The TETRA standard also supports End to End encryption using a variety of encryption algorithms as deemed necessary by national security organisations. The TETRA Association Security and Fraud Prevention Group has extended the work carried out in the TETRA standard to define a general framework for the incorporation of End to End encryption. Recommended sample solutions have also been provided for the International Data Encryption Algorithm (IDEA) algorithm (IPR owned by Ascom) and the newer Advanced Encryption Standard (AES) algorithm (IPR free), which benefits from a larger cryptographic algorithm block size. Custom and indigenous algorithms are also possible with End to End encryption, although these are not recommended for air interface encryption due to their need for integration in signalling protocols and availability of standard compliant terminals.

Besides these core security capabilities TETRA can also support a wide range of security management capabilities such as those used to control, manage and operate the individual security mechanisms in a network. The most important of these is Encryption Key management, which is fully integrated in TETRA standard functions. Even though security functions are integrated in a network this does not automatically imply that a network is fully secure. However, what is normally achieved is that the security risks are “condensed”, that is they are concentrated to specific elements in the network, which can be adequately controlled.

**3.WHY TETRA**



This section is designed to help you to carry out your own assessment before investing in TETRA, whether this investment is as a potential user organisation, operator, manufacturer, supplier, applications developer or other type of investor.

To assist with this assessment a range of TETRA specific and TETRA related aspects are described in detail. Included as part of these descriptions are the advantages and benefits relating to each subject area.

For ease of description and understanding each subject area is provided with its own sub-section under the following headings. Links to these subject areas can be achieved by either clicking the subject area highlighted below or by clicking the relevant subject area on the left hand menu.

* [Markets & Applications](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=2237)
* [Markets & Applications](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=2237)
* [TETRA Standard](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=2228)
* [Technology Benefits](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=2552)
* [Key Services](/workarea/linkit.aspx?LinkIdentifier=id&ItemID=2229)

**Markets & Applications**In this section the positioning of TETRA is described with regard to markets served and other technologies. Also, the interface specifications used by Application Developers to enhance the capabilities of TETRA are described. In addition, some of the applications available on TETRA that use these interfaces are listed. Besides these applications, TETRA specific applications such as Public Protection & Disaster Relief (PPDR) and operation in hazardous environments are covered.

**TETRA Standard**The areas covered in this section relate to several specific and related aspects of the TETRA standard, which inherently provide numerous advantages and benefits. For example, benefits relating to the ETSI TETRA Standard itself and its use of Digital, Trunking and Time Division Multiple Access (TDMA) technologies. In addition, this section provides details on the planned evolution of the TETRA standard within the ETSI Technical Committee (TC) TETRA and factors indicating the expected longevity of TETRA.

**Technology Benefits**  
The core technologies used in the TETRA standard, such as Digital, Trunking and Time Division Multiple Access (TDMA) provide a number of inherent advantages and benefits. This section describes these benefits and also provides a downloadable pdf document containing more detailed information.

**Key Services**The services and facilities supported on TETRA are numerous (see "About TETRA" page). However, this section describes the key services and facilities that are specifically designed to meet traditional PMR user requirements. Some of the key TETRA services and facilities described are those that cannot be adequately provided on other wireless communication technologies such as GSM and UMTS/3G.

**4. USING TETRA**



Procurement and operation of a modern communications system requires consideration of several complex issues. This section is aimed at providing basic facts and guidance to help successful rollout and use of a TETRA system. The TETRA MoU Association manages the Interoperability Certification process to enable and maintain a fully interoperable multi-vendor market for the benefit of all stakeholders.  
- Read more about TETRA **interoperability**- See **summary table** of issued IOP certificates   
- Download the official TETRA **interoperability certificates**

Constructing and operating a radio communications system requires the understanding of several **regulatory** issues related to radio frequencies, licensing, etc. regarding formal procedures. This chapter aims to give guidance on how to access the essential regulatory information required.

Users of radio systems and citizens in surrounding communities may have concerns regarding occupational safety, health and environmental issues. The chapter [**Health, safety and environment**](/tetramou.aspx?id=43) provides tools to access the latest research findings and supporting material related to these issues. Also included is download area for TETRA [**Health Leaflets**](/tetramou.aspx?id=2175) .

Planning a mobile communications system is not a trivial task and requires expertise and professional resources. The chapter [**System Planning**](/tetramou.aspx?id=40) gives a brief introduction to the design tasks to be taken into consideration when starting a network project. Furthermore, several topics related to the operational aspects of the system from the tactical/operational model to details of numbering and information security control need to be understood and planned to produce an operational environment that efficiently serves all users of the service. These issues are briefly addressed in the [**Numbering**](/tetramou.aspx?id=41).

**4.1. Interoperability**

Interoperability developed for good reasons  
The TETRA MoU Association developed the Interoperability Certification process and continues managing it to enable a truly open multi-vendor market for TETRA equipment and systems. The multi-vendor market gives concrete benefits both to the users in terms of wide portfolio of compatible equipment, fast development of new product models and competition; and to the industry in terms of wider accessible market, faster market take-up and better possibility to invest to new development.  
  
Interoperability certification process  
The certification process is managed by the Technical Forum (TF) of the Association with targets and their priorities set jointly with the Operators/Users Association (OUA) annually. For each feature to be certified a TETRA Interoperability Profile (TIP) specification is created in the working groups established under the TF. The draft TIP specification subjected to open Members' Enquiry (ME) to give all the members of the Association an equal opportunity to comment it before the TIP is approved by the TF. Subsequently to the TIP a detailed Interoperability Test Plan document is produced in an identical procedure. The Association has contracted ISCOM (Istituto Superiore delle Comunicazioni e tecnologie dell'Informazione), laboratory of the Italian Ministry of Communications to act as an outside certification authority, to supervise the testing sessions and to issue the certificates.  
  
After the official certification documents are approved, test sessions can be conducted between the manufacturers. The sessions are supervised by the experts of ISCOM, who then analyse the results and issue a detailed official Interoperability Certificate. The certification process is funded by the participating manufacturers.  
  
How protocol testing is done: Background on IOP certification  
The results presented in the TETRA Interoperability Certificates are derived from evaluating the information exchange between live TETRA terminals and live TETRA infrastructures, this constitutes IOP certification testing. The IOP certification testing is done in a multi vendor environment testing the interaction between different brands of equipment

Interoperability certification documents  
The TIP specifications and Test Plans have been created by voluntary effort of the members and are available to all the members of the Association free of cost. The detailed feature content of the TIP's is visible in public domain in the issued certificates.  
The Interoperability Certificates are public documents and are published at this website. To find our which manufacturer's product has been granted a certificate for which functionality/TIP, a set of summary tables is available by clicking this link.

**4.2. Regulatory: Radio Regulation and Spectrum**

**Licensing obligation**Operating a radio communications network in most countries is subject to licensing by national telecommunications regulators, both for its type of use and the radio frequency spectrum it utilises, especially as radio frequency spectrum is a scarce resource and needs to be used efficiently.

**Operating license**Operating a commercial mobile radio network practically always requires a specific operating license. In case of private radio networks, i.e. Professional Mobile Radio (PMR), the interpretation of the licensing requirements is country specific and the opinion of the national regulator should thus always be consulted before setting up a TETRA network. In most cases a private radio system requires only a frequency license.

**Radio Frequency license**Usage of radio frequencies is practically always controlled either by the national radiocommunications regulator or alternatively some frequency band specific frequency management body to whom the regulator has delegated the management responsibility. Upon successful application, the regulator will grant right to use specific radio frequencies for a specified purpose within a specified region. Radio frequency licenses are not normally issued free of charge and the cost of the license can vary greatly depending on country and type of usage. For details of the procedures and fees regarding a radio frequency license the national regulator should be consulted.

**TETRA standards and radio spectrum**The TETRA standard was developed to provide optimal performance in the frequency range 300 to 1000 MHz and outside this range the performance has not been verified. In practice, TETRA system deployments and product developments concentrate on only a few frequency bands as a result of European harmonisation and also de facto global spectrum harmonisation. This reduced number, but widely available number, of radio frequency bands has greatly contributed to developing the current multi-vendor market for TETRA with multiple suppliers delivering interoperable products for the same radio frequency bands. Interestingly, if the radio frequency spectrum for TETRA was fragmented, there would be a risk that some frequency spectrum allocations would only have products available from one supplier, thus defeating the benefits of an open standard supported by multiple vendors. This is not a situation that users would usually appreciate.

The TETRA standards have recently been updated to Release 2 which includes the wideband TETRA Enhanced Data Service (TEDS) air interface that can support 50 kHz, 100 kHz and 150 kHz channel widths. In Europe the TEDS capable channels are already taken into account in PMR spectrum decisions even though those channels are not yet readily available for use in all countries.

**4.3. Intellectual Property and Patents**

The TETRA Association was founded to promote and support TETRA technology throughout the world and to encourage an open and competitive market for the supply of TETRA products and services. The technology was developed through the standardisation processes of the European Telecommunications Standards Institute (ETSI). This process is based upon the principle that contributors to ETSI’s drafting process may propose technologies that are protected by Intellectual Property Rights (IPR), such as patents.  
  
ETSI’s processes include an IPR policy (Annex 6 of its Rules of Procedures) that seeks to reduce the risk to ETSI, its members and others, that standards become unusable due to the non availability of licences for essential IPR. It also seeks to set a balance in compensating owners of IPR for the use of their technology in the standard. The policy therefore requires that ETSI members, that are owners of such essential IPR, agree to licence their IPR for use in ETSI standards-based compliant products on fair, reasonable and non-discriminatory (FRAND) terms.  
  
Whilst the inclusion of patents in a public standard, and the imposition of related licence fees, may at first sight seem anti-competitive, the reality is that in many cases such fees accelerate standards development and encourage innovative solutions. Companies that invest in the research and development activities that produce these innovative solutions are entitled to be fairly recompensed for their work, which ultimately is for the benefit of the marketplace as a whole.  
  
As Intellectual Property Rights are granted by the government and are enforceable by the owner, any company that is considering manufacturing or supplying TETRA equipment should ensure that they have fully reviewed the patents that may be applicable for their products and have the appropriate licences in place prior to offering for sale or manufacturing TETRA compliant products.  
  
It is also important to understand the following:  
1) ETSI maintains a database of all patents that have been declared as essential candidates to the TETRA standard. This database is searchable by the public and is updated periodically. ETSI does not attempt to validate claims of the essentiality of the patents declared. Therefore, manufacturers that wish to enter the TETRA market are encouraged to contact the IPR holders and obtain a listing of TETRA essential patents.  
2) Not all declared patents are necessarily essential to the TETRA standard.  
3) Patents from companies outside the ETSI process may also be applicable and will not be registered on the ETSI database.  
  
As a result of the above, the TETRA Association strongly recommends that Manufacturers/ Developers conduct their own searches and satisfy themselves of the relevance of any patents and ensure that they are suitably licensed before employing a TETRA essential technology in their products.

**4.4. Numbering and other aspects of operational planning**

**Why operational planning**The user organisations of a new TETRA network normally face a ‘high class’ problem, this problem being that the network offers more features and facilities than the system it replaces. In order to get the best out of the new TETRA system, careful planning of how to use the network is needed. This planning process is called Operational Planning. (could also be called operative planning or tactical planning). Careful operational planning obviously is most important (and complex) in a shared system supporting multiple user organisations.

Operational planning is a process that binds technical possibilities and user needs together. During the operational planning process the user representatives gain a deep understanding on the new system and it's capabilities from an end user perspective. After thorough training on the system they are able - in co-operation with the system provider - to plan the use of the new TETRA system in efficient and secure way. Involving end users in the planning process will also make the new system and new practices more easily adopted in the user community.

The system provider (together with the service provider) is usually needed in the operational planning process to make sure that the outcome follows the design philosophy and capabilities of the system, even though there could be differences in the system design approaches. The provider is also able to assist in the overall understanding of dependencies between different decisions and help with interpreting detailed technical information.

The Operational Planning process is a top-down process, ranging from high level joint planning between user organisation representatives and the provider, to regional/organisation level planning carried out by user organisation’s own "change agents" and assisted as required by the provider.

**The many things to be planned**  
The items to be planned during the Operational Planning process of a shared system include at least the following topics (including a detail level understanding of system capabilities):

- **Management hierarchy definition:**  
Who are the key super users and/or super users from end user organisation/user point of view.  
- **Numbering plan for:**  
radio terminal users,  
applications,  
fixed voice clients,  
IP connections,  
integration to PABX numbering ...  
- **Talk group plan covering:**  
Talk group numbers,  
co-operation talk groups,  
talk group members,  
usage of dynamic groups,  
group areas, shifting/fixed area groups,  
how to use group scanning and possible use of priority scanning  
- **System sharing related planning:**  
How to separate organisations,  
hierarchies between organisations,  
communication rules between organisations  
**- Usage of services:**  
How to use individual and group calls, messaging and data securely and efficiently  
- **Rights to use services:**  
group calls,  
individual calls,  
individual calls to/from outside the network,  
status messages, text messages,  
data usage, access to applications...  
- **Emergency call:**  
emergency call targets, routing of emergency call  
- **Priorities:**  
for individual radio users, groups and fixed voice clients,  
of pre-emptive type or not,  
usage of subscriber classes,  
scanning priorities  
**- Connecting to external systems and communication to them:**  
analogue networks, PABXs, PSTN interfaces and call routing  
**- Usage of end-to-end encryption:**  
who, how, controlled by who, end-to-end encryption key delivery  
- Radio terminal related logistics:  
storage, delivery and distribution of terminal hardware,  
software, parameters, authentication keys  
- **Usage of applications**:  
what, how to integrate, roll-out time-schedules, access rights/usage rights  
- **Training implementation per needs of each target group:**  
where, when, content, to whom, methods  
- and there may be many more

**4.5. Roaming**

**Need for cooperation**The world is changing towards one where both people and organisations need to communicate across wider regions than before and that is setting new requirements to the interoperability of communications systems. European Public Safety community has recognised the need for efficient cooperation across the national borders to be able to respond to the challenges of an evolving operating environment. Cross-border cooperation of European police forces and customs has been officially agreed and defined in the documents of the Schengen Agreement between 13 European countries.

**TETRA Inter-System Interface gives the tools**The technical means for providing cross-border cooperation and roaming between networks are provided by the TETRA Inter-System Interface (ISI). The TETRA ISI standards define common protocols to support all the important services between interconnected networks:  
- roaming and mobility management of radios between networks  
(roaming is called 'migration' in the TETRA standards)  
- security, i.e. authentication and encryption  
- individual calls in visited network and between networks  
- group calls in visited network and between networks  
- supplementary services to support e.g. emergency calls  
- status and short data messaging

It should also be noted that interconnection of IP packet data services is defined in other TETRA standards and IP gateway solutions are available today.

Interoperable implementations of the TETRA ISI functionality are specified in the TETRA Interoperability Profile (TIP) specifications produced by the TETRA Association and those are already available for manufacturers. The relevant Test Plan documents for ISI certification test sessions are currently being prepared, the plans for ISI Individual Call and ISI Mobility management were completed late 2005. The first Interoperability Certificates have been issued in accordance with the Air Interface Migration TIP that specifies the air interface signalling for roaming.

**4.6. TETRA Health & Environment**

The societies and their individual members are becoming increasingly conscious of their environment and the importance of maintaining safe and secure conditions for sustainable development. This awareness is reflected in the legislation where new regulation is created for product safety, recycling of end-of-life products, etc., matters that the manufacturers and distributors of products need to accommodate in their processes

**Safety Concerns and TETRA**During recent years some public concern has been raised about the TETRA technology and exposure to radio frequency energy. The TETRA Association recognises and understands the basis of these concerns and takes, very seriously, any questions relating to the Health and Safety of the general public and also the users of TETRA technology.

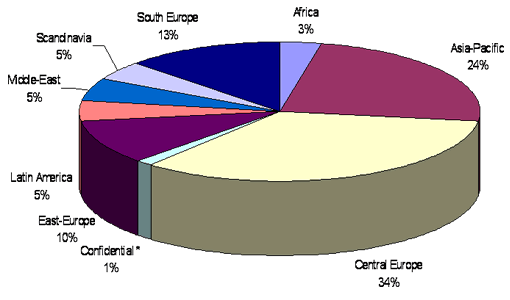
The TETRA Association welcomes expert research into all safety aspects of radio communications and indeed a number of its members have, and continue to make contributions to this type of funded research. The TETRA Association also recognises the international standards bodies and experts that create standards, which recommend safety levels for RF exposure and other health and safety issues relating to the safe operation of radio telecommunications equipment. The TETRA Association further recognises the need for continuing relevant and high quality physiological and epidemiological research and will continue to monitor and keep abreast of the very latest research results.

**5. Tetra News & Events**

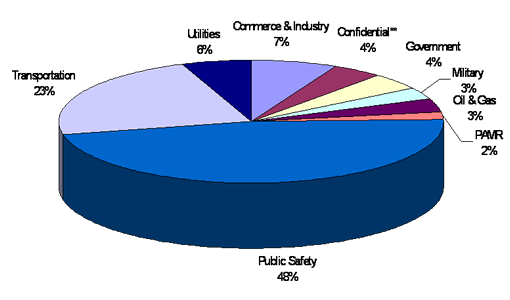


This section contains news supplied by TETRA users, the TETRA industry and the TETRA Association. Topics cover TETRA in use; new products, applications, and services; latest contracts as well as planned events and seminars. Free subscription or a pdf download of the Association’s TETRA News is available from here. Press Releases from the Association’s members are posted in this section plus the latest reports from the world of TETRA such as reviews of events or significant market announcements. Dates and venues for global TETRA Events, including the TETRA Association’s own world-wide series of seminars and accompanying exhibitions, are also located here.

The reason why this section on TETRA News and Events needs to be regularly updated with new information is because of the success TETRA is achieving around the world. A good indicator of this success is the market information published each year by the TETRA Association. For example, the pie chart below shows how the 1964 significant contracts are spread (as a percentage) across the regions of the world as of May 2008.



As can be seen from the pie chart, TETRA is deployed in all regions of the world with the exception of North America.



The pie chart above shows how the 1964 contracts are spread (as a percentage) across the different PMR market segments as of May 2008. As can be seen the Public Safety Sector (PSS) represents the largest market for TETRA followed by the transportation market.

**6. Tetra Association**



The TETRA MoU (Memorandum of Understanding), now known as the TETRA Association, was established in December 1994 to create a forum which could act on behalf of all interested parties, representing users, manufacturers, application providers, integrators, operators, test houses and telecom agencies. Today the TETRA Association represents more than 150 organisations from all continents of the world.

The goal for the TETRA Association is to provide a forum for all those interested in TETRA to encourage adoption of the standard and support initiatives to obtain appropriate levels of spectrum such that growth in operational TETRA systems is not restricted by regulation.

In 1994 a Memorandum of Understanding was created by the founding members that describes the objectives of the Association and includes a commitment to support the ETSI processes and to promote the standard as widely as possible. All members are required to sign this MoU before joining the Association. A revised and updated version of the original document was approved by members at the 2006 Annual General Meeting and is available for download by using the following link:

* TETRA Association Memorandum of Understanding

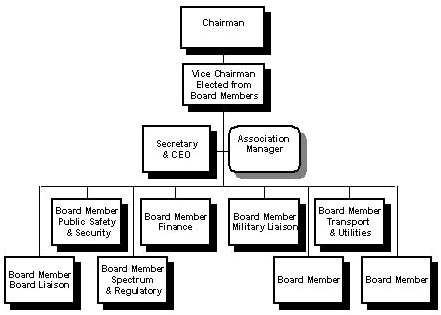
The TETRA Association is a Limited Company and is registered in the United Kingdom. It is governed by UK Law and, as such, is required to have two legal documents in place. The first is the Memorandum of Association which describes the purpose and principles of the Association. This document should not be confused with the Memorandum of Understanding although it incorporates many of the same principles.  
  
The second legal document constitutes the Articles of Association. This is a set of legally binding rules and procedures that have been agreed by the Members and which the Board and Chief Executive follow when conducting the business of the Company.  
  
Both of these documents are available on this web site and can be downloaded using the following links:-

* Memorandum of Association
* Articles of Association

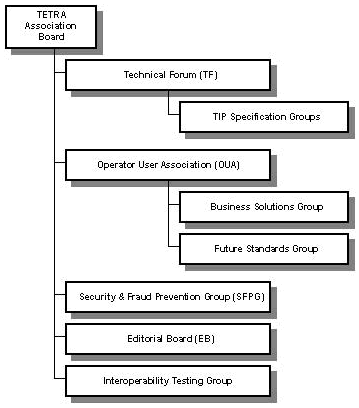
Organisations or individuals that wish to join the Association can do so by downloading and completing an application form and sending this, along with a signed copy of the MoU, to the Association’s membership department. Full details and the forms can be found on the following page

The TETRA Association's objectives are to support and promote the TETRA standard world-wide and to provide a forum to share and exchange information and ideas amongst a wide variety of individuals who share a common interest in the success of the TETRA standard.

To meet these objectives the TETRA Association comprises an Executive Board, which meets on a regular basis to manage and direct the organisation’s many activities.



Within the structure of the TETRA Association there are also a number of groups that have been formed to specifically address important activities in support of the TETRA Association’s objectives



**7. Benefits of Membership of the TETRA Association**

**Access to knowledge and Information**  
Members of the TETRA Association are invited to participate in the numerous working groups within the Association for example:

**Technical Forum (TF)**

* Manages the preparation of TETRA Interoperability Profiles (TIPs)
* Interfaces with the Operator User Association to define the market priorities for TIP standardisation
* Interfaces to ETSI for Standards maintenance
* Oversees the TETRA Interoperability Testing and Certification Process
* Provides a forum for technical knowledge exchange

**Operator User Association (OUA)**

* Provides a forum for knowledge exchange between Operators and Users of TETRA systems
* Prepares input to Technical Forum for establishing priorities of TIP work

**Security and Fraud Prevention Group (SFPG)**

* Prepares and manages recommendations on use of encryption in TETRA networks

**Access to restricted technical information**

* By participating in any of the above groups or having access to the Members only area of the TETRA Association Web Site Members gain early access to new technical documents and participate in their Member Enquiry stages to express their views prior to publication

**TETRA Association Web Site**

* Access restricted technical and marketing information and reports with a unique username and password in the Members only area
* Access presentations in the Members only area for use in your own marketing activities
* Post your Press Releases on the TETRA Association Web Site for the world to access
* Be listed as a Member on the Web site with a reference to your major areas of work

**Access to Unique TETRA Branding**

* Only Members of the TETRA Association have access to and use of the instantly recognised and unique TETRA Logo and Brand image

**Involvement in TETRA Market development**

* The TETRA Association has produced a number of Seminars in new market areas promoting the benefits and adoption of TETRA. As a Member you are invited to participate in such events and become recognised in these new areas as part of the global TETRA community
* Receive bulk copies of the TETRA News for use in your own internal or external marketing activities

**Involvement in the ongoing business of the TETRA Association**

* The TETRA Association is a membership organisation and as a Member you participate in the management and future strategies of the Association and thus influence the future of TETRA
* As a Member you join more than 100 other like minded organisations globally whose success is dependent upon TETRA

**8. CONCLUSION**

* Project is in progressive mode with every aspect of coding and connectivity with the database
* We have tried to present simple and comprehensive user interface.*.*
* But there are certain features that could have been included but are not due to shortage of time and is work of future.

The result is a better application which will help in better development of an

organization. The main approach behind our project is that it can easily track record of orders and payement whenever required and at the same time assist its user .The project is running successfully without any discrepancies and

the software can be updated if required.

**9. REFERENCES**

1. Object Oriented Programming Using C++ , E. Balagurusamy.
2. Complete Reference in C++, Herbert Schildt, TMH Publications.

**WEBSITES**

1. [www.w3schools.com](http://www.w3schools.com)
2. [www.sourcecodeworld.com](http://www.sourcecodeworld.com)
3. [www.google.com](http://www.google.com)
4. [www.wikipedia.org](http://www.wikipedia.org)