TETRA

A Pocket Guide

TETRA – critical communications for all professional users

- **Robust**

- **Reliable**

- **Resilient**

- **Secure**

- **High spectral efficiency**

- **Cost-effective geographical coverage**

- **Advanced air encryption**

- **Full end-to-end encryption**

- **Immediate remote disablement of lost or stolen devices**

- **Interoperable secure Virtual Private Networks**

- **Rapid call set-up and group call activation (inside 500 milliseconds)**

- **Exceptional call quality**

- **Direct mode operation**

- **Gateway mode operation**

- **Simultaneous voice and data communication**

- **ATEX radios for use in hazardous environments**

- **Wide range of data applications**

- **Public voice and data network interoperability**

- **Portable stand-alone systems for rapid deployment**

- **Open standard supported by multiple manufacturers**

- **Ongoing investment and development**

- **World-leading Interoperability Certification Process**

TETRA – at your service

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Introduction

TETRA (Terrestrial Trunked Radio) technology is in use throughout the world, delivering secure, reliable and robust critical communications.

TETRA was born in ETSI in the 1990s, when the professional mobile radio community collaborated to write a standard to meet the requirements of public safety and government users, commercial professional users, operators, spectrum regulators, manufacturers and others involved in the implementation of critical communications.

Today, TETRA is the public safety communications technology used by governments around the globe looking to protect their citizens. The rapid adoption of TETRA technology by the public safety sector has catalysed its growing use in an increasingly wide range of markets. These include air, rail, road and water transport, utilities, mining, the oil and gas exploration, extraction and delivery industries, commercial, retail and leisure organisations from car manufacturing plants to casinos – benefiting from networks of all sizes, whether a single site or 3500.

TETRA is regularly deployed to ensure resilient and secure communications at major sporting events such as the Olympic Games, the FIFA World Cup, and Formula One racing.

Although the first region to adopt TETRA was Europe, today the technology is used around the world. Asia Pacific is the fastest-growing region in terms of TETRA implementations, rapidly approaching Europe in terms of number of contracts.

The success of the TETRA standard speaks for itself.

TETRA for major events

Setting the standard

Within the TETRA standard, the air and network interfaces, services and facilities are specified in sufficient detail to enable any manufacturer to develop infrastructure and radio terminal products that will fully interoperate with each other. This is a distinct advantage of open standards developed by ETSI. As the TETRA standard is supported by an increasing number of independent manufacturers, this interoperability increases competition, provides second source security and allows a greater choice of mobile and hand-portable terminal products for user applications.

As with all standards there was flexibility in how TETRA technology could be developed. To ensure that users benefited from the best possible quality and economies of scale, the TETRA Association (now the TCCA: TETRA + Critical Communications Association) created the Interoperability Test and Certification (IOP) process. Association member manufacturers agreed how this should be implemented, and incorporated priorities and new requirements from the growing user community. The output of this process was fed back to ETSI and the standard updated.

A number of enhancements to the TETRA standard were made in what is known as TETRA Release 2. The most significant of these was TETRA Enhanced Data Services (TEDS) which provides a substantial increase in data speeds. Supporting documentation is available at www.etsi.org

Over €10 billion has been invested by users to date on installed TETRA networks and terminals. The technology is a 'living' standard, continuing its development and evolution through the work of ETSI and the TCCA.

TETRA for communications clarity

The benefits of TETRA

Communications security

Communications security is a prerequisite for public safety agencies, and a critical requirement for the increasing number of commercial organisations that rely on TETRA.

TETRA builds on the inherent security strengths of digital technology. A key feature of TETRA is the protection of the radio connection between devices and radio sites through the application of advanced Air Interface Encryption techniques. TETRA's security measures deliver the strongest levels of protection; ensuring the privacy of conversations and the secure transmission of sensitive data.

A potential security loophole in networks – devices – is also addressed. Authentication at the connection between device and network controls traffic to ensure that transmissions are from approved users. If a terminal is misplaced or stolen it can be immediately disabled, preventing unauthorised personnel listening to private conversations or viewing sensitive information.

TETRA allows networks to be partitioned. This ensures that different user groups and organisations have access to private communications over their own Virtual Private Network (VPN) securely tunnelled across the system. If interoperability between agencies is required, this can be immediately and securely provisioned.

TETRA offers an extended range of voice capabilities. A critical feature is call quality. Call clarity is exceptional due to digital technology and special coding algorithms that help to screen out background noise. TETRA's capacity management features support rapid call set-up – across many users and over large areas – even while the network is being used heavily.

Group calls can be activated at the touch of a button – inside 500 milliseconds – enabling almost instantaneous group communication, collaboration and coordination. Many TETRA solutions also enable calls to be recorded for analysis to refine crisis management and operational procedures.

Delivering the data

User access to a wide range of applications is key to the ongoing success of TETRA. Applications can vary from location information to the delivery of images, and video over TEDS-capable networks. TETRA offers a range of data features to support these applications, and delivers them with the same quality and security as voice services, on the same network. There is also a standardised Peripheral Equipment Interface (PEI) when additional equipment such as a laptop or camera is required

Status messaging can be used to quickly report a change of status such as going off duty. It can also be used to trigger functionality such as enabling or disabling gateway mode.

Short Data Services (SDS) looks similar to text messages (SMS) over GSM (and can be delivered to and from GSM devices through a gateway) but have more functionality and can be concatenated to give around 1000 characters. This capability supports many critical applications where the guarantee of delivery is more important than the quantity of data, such as allocating work items or interrogating databases,

It is Internet Protocol (IP) technology at the heart of TETRA networks that delivers this range of operational and commercial benefits. IP is a flexible and highly scalable technology so capacity can be efficiently added as required. An open standard, IP also reduces the cost of developing and provisioning new applications, resulting in an increasing number of services. As IP will be the backbone of communications systems for the foreseeable future, new developments can be easily integrated to upgrade networks providing long term protection for legacy investments.

Multifunction TETRA radios and terminals provide connectivity to public data networks even in hazardous areas; enable users to take, send and receive images,

and deliver the capability to interact with more advanced remote applications.

Dispatch teams can send information to emergency response officers about a call they're about to attend. The intelligence may include statistics on likely injuries and the number of casualties for paramedics. For fire teams it can include information on the possibility of hazardous substances being present in a building. In other situations police dispatch teams can access the records of a suspect and review the types of officers available to assess the best way to approach the individual.

Train mechanics can be sent an image of a damaged metro train to advise them on the problem in advance, and utility engineers can send site images back to base to ask for advice on how to repair a damaged component.

TETRA systems are now widely used in the utilities, oil and gas industries, and by firefighters. In all these situations, users face hazardous environments and the possible presence of explosive substances, dust and gases. TETRA terminals with ATEX[1] certification can be safely used in all these areas as the terminals will comply with rigorous safety requirements.

Firefighters can also transmit images to control centres for assistance in identifying symbols on chemical storage drums; police officers looking for a suspect for a street robbery can be sent real-time pictures of the individual from security cameras, while paramedics can provide pictures of a casualty's injury to a remote specialist to seek treatment advice.

In public safety markets, real-time field-based biometric systems enable officers to use their TETRA devices to capture the fingerprints of a suspect and immediately verify identity against a remote database in a matter of seconds.

By applying TETRA's two way data communication channel, field-based employees and public safety officers can also manage administration. Applications to improve device-based reporting while mobile include voice to text recognition, tablet and stylus data entry, drop-down forms and on-screen keyboards.

Field engineers can use their TETRA devices to log service requests and complete reports on work conducted. Couriers can record customer signatures and remotely update central control systems to verify when packages have been collected: an application that improves service by providing customers with real time delivery status.

In public safety environments, officers can log incidents and update records on the move, so they spend more time patrolling rather than managing paperwork back at base.

Effective Dispatch

With GPS-enabled TETRA radios and terminals, individuals and vehicles can be viewed by location. This data is complemented by integrated applications presenting a real-time overview of operational intelligence (such as officers' specialist skills) to recommend the most appropriate resource to send to incidents.

Alongside managing personnel efficiently, officers can attend situations secure in the knowledge that their exact position is tracked by the control room. If they encounter trouble they can request immediate back-up using voice channels or by triggering their radio's distress signals.

This capability is equally valuable in private TETRA networks and supports a wide range of applications across industry sectors – for example, utility firms have to deploy engineers to work in remote regions on infrastructure such as pylons and substations. In the event of problems, they can instantly contact base for assistance. In the transport industry, TETRA can be integrated with vehicle-tracking GPS systems to provide real-time timetable feeds to customers at bus stops. With fleet management systems, controllers can also amend services – perhaps by adding more vehicles – to meet unexpected spikes in demand.

[1] The ATEX directive consists of two EU directives describing what equipment is allowed in an environment with an explosive atmosphere. ATEX derives its name from the French title of the 94/9/EC directive: Appareils destinés à être utilisés en ATmosphères EXplosibles

TETRA for public safety

TETRA for road transport

The IOP Certification Process

TETRA offers true interoperability achieved through the IOP Certification Process, a strict, independent and tightly controlled process developed by the TCCA (the TETRA + Critical Communications Association) to ensure a truly open multi-vendor market.

A healthy, competitive market brings proven benefits to users such as choice of equipment and supplier, continuous development of new products, increased product functionality and improved price performance.

For manufacturers, it eliminates different and incompatible implementations of the TETRA standard, and provides a formal compatibility test forum. Users can be confident that products awarded an IOP certificate have been rigorously tested, and that the functions listed in the certificate fully meet the TETRA standard. This allows users selecting equipment from a number of suppliers to reduce the amount of system integration and testing.

The TETRA IOP process is managed by the Technical Forum (TF), a TCCA Working Group. Targets and priorities are set each year in agreement with the Operators & Users Association (OUA) Working Group.

For each feature that is to be certified, a TETRA Interoperability Profile (TIP) specification is created, together with an Interoperability Test Plan. The Test Plan is a detailed document that ensures that the tests are repeatable and identical in all test sessions. After the TIP and Test Plan have been approved, test sessions can be conducted.

The TCCA contracts an independent testing house to act as the certification authority for TETRA. Sessions are carried out in a multi-vendor environment, and test the interaction between products from different suppliers.

After each session, the testing house analyses the test results and issues a detailed official IOP Certificate that lists each feature and function that has successfully passed its test. Test schedules and certificates are posted on **www.tandcca.com.**

TETRA for trains

Competitive or complementary?

TETRA's dominance of the PMR marketplace is accepted, yet the competitive landscape is changing, and it is a difficult time to be a user looking for a PMR network. Other technologies are emerging with claims of critical communications credentials, and users can be understandably confused. Society too is changing, and the need for genuine mission critical communications capability across a range of situations and scenarios has never been more important.

Users need to consider their options based on the delivery of the features and functions necessary today, yet with full consideration given to the requirements of the future.

There will be different approaches to the evaluation of PMR requirements depending on whether the customer is a new user, or an existing user looking to upgrade. Is the migration process required to be gradual, or is the demand for the rapid roll-out of an enhanced voice and data network? Are significant increases in capacity, functionality, and coverage required? Is multi-vendor choice important in the procurement process – or not?

Users with a sizeable network need resilience, redundancy, full network control and accurate reporting. For public safety, the network must be capable of remaining operational even under attack from man-made or natural disasters If radio communications are critical to the safety of personnel and business survival, then the network must be truly business-critical.

Radio networks need to be specified with the future in mind. Users expecting to grow radio use need to consider channel usage – will trunking be required in the future?

It is unrealistic to expect that PMR networks can stand alone, isolated from other communications. Users may need their radio network to be an integral part of an overall telephone network, with full duplex communication, and/or as an integral part of an IT network with full voice and data capabilities.

There are other PMR standards, and there are communications standards that can work in tandem with TETRA, such as WiMAX, LTE and the GSM family. But they are not mission-critical, they provide complementary capabilities that enable users to tailor network services to suit their individual needs, while retaining the critical core network. Consumer-focused networks are developed for maximum profit, not maximum resilience, so cannot offer the levels of availability required by mission and business-critical organisations.

Selecting the right standard is crucial; if the wrong one is chosen, that investment will be lost when the shortcomings become clear.

MULTIBRID M5000

TETRA for power

The future evolution of TETRA

TETRA is now a mature technology with a wide and competitive supplier base, and this can give the false impression that the technology reached a certain state, and no longer changes. The reality is different. Ever since the first TETRA release in 1996, the standard has continuously evolved to add new services to meet the needs of its user base. This has been particularly apparent in the area of data communications.

The original TETRA standard contained a Short Data Service (SDS), and rudimentary end-to-end data bearer services based around the older X.25 line communications standards. These were quickly superseded by a packet data service based on IP, and extensions to SDS to allow it to carry various different types of information (text, location data and so on) in a standardised format.

To fulfil the requirements for greater data capacity, the Multi Slot Packet Data service (MSPD) was developed on the TETRA 1 system. In turn TEDS was standardised to provide much greater flexibility in data provision, and much higher data rates with a choice of channel widths. TEDS is a truly wideband data service, allowing channels up to 150kHz wide to be utilised, and data rates in excess of 500kbps.

There is now an identified need from the TETRA customer base, in particular those involved in Public Protection and Disaster Relief (PPDR) activities, for higher data bandwidths up to broadband data speeds. They need to share more multimedia content including video for situational awareness of operational incidents. Accordingly, ETSI has approved a work item to develop a broadband data standard that is complementary to TETRA.

Although there are other broadband data technologies already in the marketplace that can provide part of a solution, it is important that the solution that we produce for the TETRA market offers the same unique attributes as TETRA itself. These include high levels of security and availability, sharing information between many users simultaneously using group calls and the

ability to provide coverage over large geographical areas without excessive numbers of base station sites. These requirements are somewhat different from those driving other technologies, which is why we will develop a solution that is tailored to the needs of the TETRA community.

We are currently working with ETSI on the next evolution of TETRA – this could be broadband TETRA, or TETRA interfacing to a broadband technology such as LTE.

Whatever technical aspects are agreed, the result will need to integrate with existing TETRA solutions to allow integration of current voice and data services with broadband services. It will also need to address the possibility of a single terminal that can provide voice, wideband and broadband data services together.

It has been suggested that cognitive radio solutions that can share spectrum with other applications may be part of a solution. This would allow emergency access for PPDR users while permitting the same spectrum to be utilised when not required by the emergency services. Work has been initiated in conjunction with the ETSI Technical Committee looking at Reconfigurable Radio Systems to investigate this possibility.

On the way to this broadband future, we are also looking at other evolutions to the current TETRA and TEDS solutions. These include enhancements to improve throughput and reliability of data to enable coverage and capacity improvements. Another potential development is the merging of voice and data services together on the TEDS wideband data channels. This would allow greater flexibility in planning TETRA systems, as voice channels could then be adaptive in the same way that data channels can be so, to allow coverage and capacity to be tailored in each area according to its needs. Mixing voice and data together on the same carrier is also more efficient, as the voice and data capacity can be traded from one instant to the next according to demand.

TETRA on the metro

TETRA for rapid response

The TETRA + Critical Communications Association

The TETRA MoU (Memorandum of Understanding), now the TCCA (the TETRA + Critical Communications Association), was originally established in 1994 to act on behalf of all interested parties in the development of the TETRA communications standard.

Our goal remains to develop, promote and protect the TETRA standard worldwide. In addition we will be looking at new, future and complementary technologies. Mobile broadband will be the immediate focus.

Our members include manufacturers, application providers, integrators, operators, test houses and telecommunications agencies. The TCCA represents more than 160 organisations from all continents of the world, providing a forum for all those interested in TETRA and the future of critical communications.

We encourage the ongoing development of technology, and drive and support initiatives to ensure appropriate levels of spectrum to enable the market expansion of TETRA and the evolution of critical communications.

Members of the TCCA have the opportunity to be fully involved in influencing and advancing critical communications technology. Users can share knowledge, experience and requirements.

Manufacturers and suppliers can seize the opportunity to help open new markets and develop products and services that meet the needs of the professional communications user.

The TCCA provides the central role in the enhancement of the TETRA standard. We advise and inform existing and potential customers, manufacturers, suppliers and partners around the world and promote the TETRA standard to countries and their governments.

TETRA for airports

Working Groups

Within the TCCA (the TETRA + Critical Communications Association), there are a number of Working Groups, mainly comprising volunteers, who play a critical role in protecting, promoting and advancing the TETRA standard. All TCCA members are welcome to participate.

The Applications Working Group (Apps WG) brings together users, application developers and equipment manufacturers interested in data applications on TETRA networks. The Apps WG collects and organises requirements and provides a place to discuss data applications, the sharing of experiences and best practices.

The Critical Communications Broadband Group (CCBG) recognises the increasing demand for mission critical mobile broadband. The CCBG is driving the development of harmonised broadband solutions for the existing users of TETRA, Tetrapol, GSM-R and other mission critical technologies.

The Marketing Group (MG) drives the integrated marketing communications activity, positioning and raising the profile of the Association and the technology through the Events programme, media activity and other market-facing activities.

The Operator User Association (OUA) is a forum for knowledge exchange between operators and users of TETRA systems. In close operation with ETSI Working Groups, new user requirements are identified, and converted into Service Overviews. The OUA carries the responsibility of collecting and submitting user priorities to the Technical Forum.

The Radio Spectrum Group (RSG) works with pan-European regulatory bodies and across continents with governments and regulators to safeguard and promote the needs of critical communications users, providing a collective voice on spectrum requirements.

The Security and Fraud Prevention Group (SFPG) produces advice, Technical Reports and makes recommendations which, if complied with, ensure the TETRA security features used in equipment supplied by different manufacturers are optimally and securely implemented whilst supporting interoperability.

The Small and Medium Enterprise Forum (SME Forum) provides a mechanism for the small and medium enterprise TETRA manufacturers to ensure their interests, views and proposals are noted by the TCCA's Board, Forums and Working Groups.

The Technical Forum (TF) provides a general forum for technical knowledge exchange. It develops and oversees the TETRA Interoperability Testing and Certification Process. This allows TETRA equipment from different suppliers to work together. The TF takes User and Operator input for the priorities for technical developments and co-operates with ETSI, which maintains the TETRA standard.

The Transport Group (TG) provides a platform for everyone interested in TETRA implementation in the transportation sector including railways, metros, trams, buses, sea ports, harbours and airports. Participants share experiences and information, focusing on the market potential for future TETRA projects as well as representing users' interests.
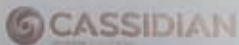
There are also a number of **TETRA Forums** with membership specific to a country or region. These provide a platform for local technology promotion and also support Association initiatives to help national members to get maximum benefit.

Please contact us at **admin@tandcca.com** to see if there is a regional Forum in your area.
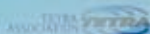
Talking TETRA – the TETRA World Congress

Events

Key to the promotion of TETRA communications across the world is the Association's programme of events. This is designed to take TETRA to its markets and to ensure all who wish to participate can access an event in their country or region.

The locations of the events are decided in consultation with the TCCA (the TETRA + Critical Communications Association) member companies. Events are held in mature and emerging markets, with the conference, seminar and/or workshop content and presentations carefully compiled to ensure relevance to each audience.

Each one-day conference, seminar and/or workshop is usually accompanied by an exhibition area which is available to TCCA member companies wishing to promote their products, services and solutions. Visitors to the events benefit from hearing about the latest developments, user case studies from a variety of sectors, and future plans for the technology standard. They can participate in interactive sessions, talk to TETRA users and suppliers from around the world, and take the opportunity to talk to a range of organisations – all brought together in a single venue.

In countries with more than one major commercial centre, the Association will plan to hold consecutive events in different cities, to enable as wide an audience as possible to attend.

This approach is designed to bring TETRA information, products and services to its existing and potential customers and users in the most cost-effective means possible. Although the Association does need to make a charge to exhibitors in order to cover costs, attendance at these events for visitors is free.

Of equal importance is the opportunity for the Association representatives to hear the views of potential, new and established TETRA users and member companies from around the world, in person.

The annual TETRA World Congress is the major event on the TETRA calendar. The event was held in Europe for many years, however in 2007 the Association took steps to ensure that the location of the annual World Congress reflected the new strengths of the TETRA market. In 2008, the event was held in Asia for the first time, and its inaugural appearance in Hong Kong proved a great success. The TETRA World Congress now alternates between Europe and the rest of the world. Please see **www.tetraworldcongress.com** for full details.

The full schedule of critical communications events can be found at **www.tandcca.com**

For further information on the events programme, please contact **events@tandcca.com**
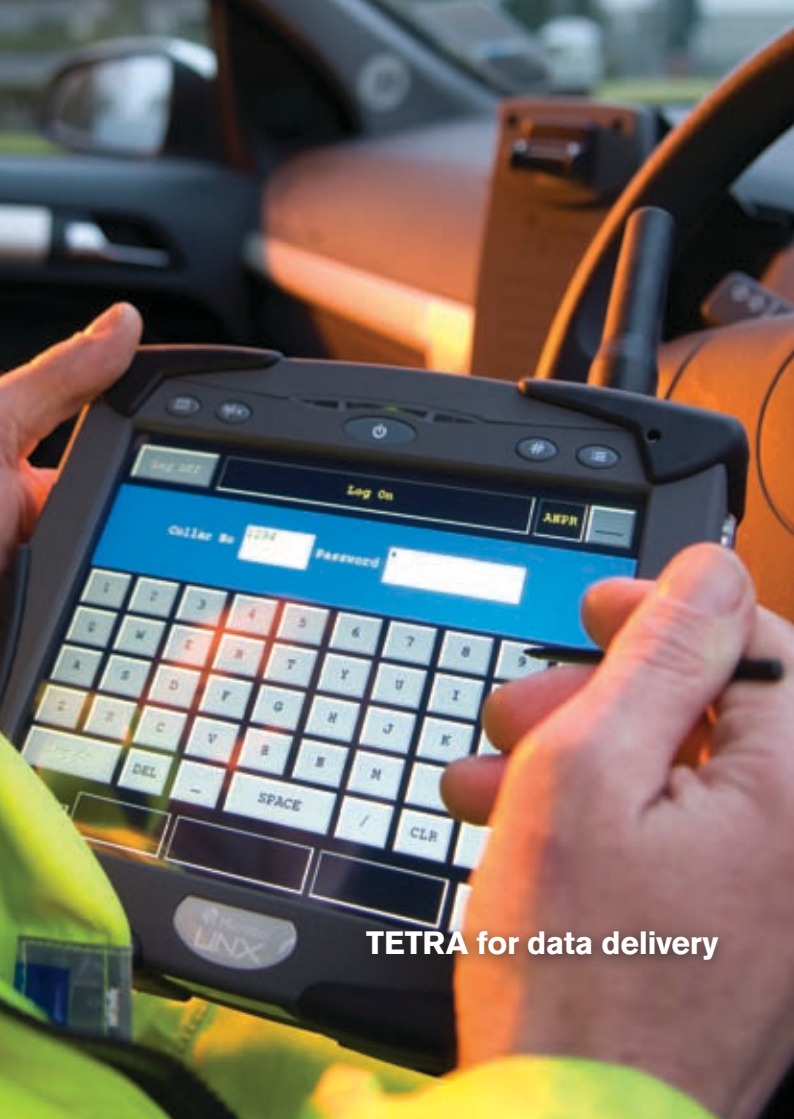
TETRA for data delivery

Join us!

The TCCA is membership-driven. Our members actively participate in the management of the Association, helping to shape future strategy and thus influence the development of TETRA and the future of critical communications.

We work together to create success, and to safeguard the end-users and the wider public who rely on TETRA.

Members of the TETRA + Critical Communications Association include:

- Application providers
- Consultants
- Forums
- Integrators
- Manufacturers
- Media
- National Government representatives
- Operators
- Test Services/Systems suppliers
- Users
- Value Added Resellers

To find out more about joining the TETRA + Critical Communications Association, please contact:
admin@tandcca.com
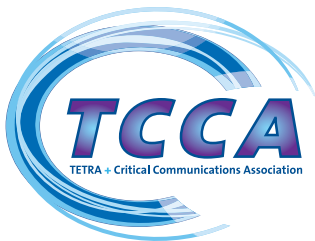
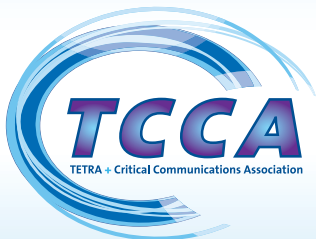# Glossary

2G	2nd Generation (of mobile cellular technology)
3G	3rd Generation (of mobile cellular technology)
3GPP	3G Partnership Project
4G	4th Generation (of mobile cellular technology)
AI	Air Interface
AIE	Air Interface Encryption
APL	Automatic Person Location
ATEX	The ATEX directive consists of two EU directives describing what equipment is allowed in an environment with an explosive atmosphere. ATEX derives its name from the French title of the 94/9/EC directive: *Appareils destinés à être utilisés en **AT**mosphères **EX**plosibles*
AVL	Automatic Vehicle Location
BS	Base Station
CCK	Common Cipher Key
DCK	Derived Cipher Key
DGNA	Dynamic Group Number Assignment
DMO	Direct Mode Operation: communication between radio terminals outside the coverage of a TETRA radio network infrastructure
DMR	Digital Mobile Radio
dPMR	Digital PMR
E2EE	End to End Encryption
ETSI	European Telecommunications Standards Institution
GCK	Group Cipher Key
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSSI	Group Short Subscriber Identity

GTSI	Group TETRA Subscriber Identity
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
IOP	Interoperability (of TETRA equipment)
ISI	Inter-System Interface
ISSI	Individual Short Subscriber Identity
LTE	Long Term Evolution (of mobile cellular technology)
MCCH	Main Control Channel
MS	Mobile Station
MSPD	Multi Slot Packet Data
OTAK	Over the Air Keying
OTAR	Over the Air Re-Keying
PEI	Peripheral Equipment Interface
PMR	Professional Mobile Radio
PPDR	Public Protection and Disaster Relief
SCCH	Secondary Control Channel
SCK	Static Cipher Key
SDS	Short Data Service
SwMI	Switching and Management Infrastructure
TCCA	TETRA + Critical Communications Association
TC TETRA	Technical Committee TETRA (ETSI)
TDMA	Time Division Multiple Access
TEA	TETRA Encryption Algorithm
TEDS	TETRA Enhanced Data Service, high speed data service in TETRA Release 2 standards
TETRA	TErrestrial Trunked RAdio, the ETSI standard for digital trunked radio communications
TIP	TETRA Interoperability Profile
TMO	Trunked Mode Operation: communication between radio terminals within the coverage of a TETRA radio network infrastructure
WiMAX	Worldwide Interoperability for Microwave Access

TETRA for law enforcement

TCCA

TETRA + Critical Communications Association

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