TETRA

A Pocket Guide

Critical communications for all professional users

TCCA

TETRA - the mission critical standard of choice

- Robust
- Reliable
- Resilient
- Secure
- High spectral efficiency
- Multi slot operation
- Cost-effective geographical coverage
- Authentication and 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

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- Exceptional call quality
- Direct mode and repeater operation
- Gateway mode operation
- SDS and IP data communications
- Simultaneous voice and data
- Wide range of data applications
- Public voice and data network interoperability
- ATEX radios for use in hazardous environments
- Portable stand-alone systems for rapid deployment
- Open standard supported by multiple manufacturers
- Ongoing investment and development
- World-leading interoperability Certificate Process

TETRA for rapid response

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TETRA - protecting the irreplaceable

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.

TETRA is the public safety communications technology used by governments around the globe looking to protect their citizens. The rapid acceptance of TETRA by the public safety sector has catalysed its adoption by 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 – all benefiting from the unique properties of TETRA networks, whether using a single site or several thousand.

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

TETRA networks are deployed across the world, with millions of terminals delivering critical communications voice and data services. The success of the TETRA standard speaks for itself.

This guide is intended as a brief introduction to TETRA. Should you require any further information please do get in touch with us at admin@tcca.info

TETRA for trams

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 mobile terminal products that will fully interoperate with each other.

As the TETRA standard is supported by an increasing number of independent manufacturers, this interoperability stimulates competition, provides second source security and allows a greater choice of vehicle and hand-portable terminals and user applications.

As with all standards, there was flexibility in how TETRA technology could be implemented. To ensure that users benefit from the best possible quality and economies of scale, the TETRA Association (now TCCA) created the Interoperability Test and Certification (IOP) process. Member manufacturers agreed how the standard 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. including TETRA Enhanced Data Services (TEDS) which provides a substantial increase in mission critical data speeds.

The technology is a 'living' standard, continuing its development and evolution through the work of ETSI and TCCA. Supporting documentation is available at www.etsi.org

TETRA for airports

Communications security and privacy

Communications security is a prerequisite for public safety agencies, and a key requirement for the increasing number of other critical communications users 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 remotely disabled immediately.

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 can be provisioned immediately and securely.

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. In particular, TETRA voice quality in noisy environments is excellent, making TETRA suitable for use on the apron at airports and other high decibel level environments.

Group calls can be activated at the touch of a button – inside 500 ms – 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 mission critical 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) if 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 a range of 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, including group data, and can be concatenated to give around 1000 characters. This capability has resulted in SDS becoming the preferred transport mode for a wide range of critical applications where the guarantee of delivery is more important than the quantity of data, such as allocating work items or interrogating databases. TETRA is used, for example, to deliver colour images of wanted or missing persons to the screen of a single terminal or simultaneously to the screens of multiple terminals

TETRA also delivers Internet Protocol (IP) data. 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.

The benefits of TETRA (continued)

There are many other examples of data applications being supported by TETRA IP and SDS data. Dispatch teams can send advance information to emergency response officers on their way to an incident. 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.

Railway 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. Firefighters working in hazardous situations can 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.

TETRA systems are now widely used in the utilities, oil and gas industries. 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 comply with rigorous safety requirements.

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 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. Police 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.

The simple use of status messaging adds significantly to user safety and it can be the basis of a comprehensive resource management process.

[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 safety

The IOP Test and Certification Process

TETRA offers true interoperability achieved through the IOP Test and Certification process, a strict, independent and tightly controlled procedure developed and managed by TCCA 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. It has contributed to a truly global market.

Users can be confident that products awarded an IOP certificate have been rigorously tested for conformance, 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. This 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.

TCCA contracts an independent testing house to act as the certification authority for TETRA. After each session, the testing house analyses the test results and issues a detailed official IOP Certificate. Test schedules and certificates are posted on www.tcca.info where they can be accessed by TCCA members.

Competitive or complementary?

TETRA's dominance of the critical communications marketplace is accepted, yet the competitive landscape is changing, and it is a difficult time to be a user looking for a PMR/LMR 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/LMR 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/LMR 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/LMR standards, and there are communications standards that can work in tandem with TETRA. Many are not suitable for mission critical communications although they can provide complementary capabilities that enable users to tailor network services to suit their individual needs, while retaining the critical core TETRA network.

TCCA has worked to help ensure that the mission critical press to talk (MCPTT) , data and video standards for broadband will deliver the user's needs. These are close to being complete but their deployment in systems will take some time as will making those systems robust, resilient and ubiquitous. Many European users see that they will need to rely on public operators to provide these services. Before 5G is deployed many public operators will not see a business case for making this investment. Early adoption may therefore need further investment from user groups.

Consumer-focused networks are developed for maximum profit, not maximum resilience, so cannot normally offer the levels of availability required by mission and business critical organisations.

If the requirement is for truly mission critical communications, then choosing the right technology is crucial.


RESPONSE
CRITICAL
DEFENCE
VOICE
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SECURITY
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RESPONSE

The future evolution of TETRA

TETRA is now a mature technology with a wide and competitive supplier base. TETRA is continuously evolving to meet user needs, and this is particularly relevant in the area of data communications. The original TETRA standard addressed a wide range of requirements. Many have been deployed as needs matured. Some parts of the standard have been re-visited as ever larger networks have been deployed and shown the need for additional functionality and predictability in capacity handling.

New features such as “Call-out” have been introduced to support the operations of large volunteer fire fighter organisations. TETRA pagers have been developed. Intrinsically safe and Factory Mutual approved terminals have been supplied and continue to be developed by manufacturers for use in hazardous areas. TETRA Inter Systems Interface (ISI) is being deployed to allow cross border working of TETRA communications and with different suppliers’ equipment.

Replacement or upgraded TETRA solutions result in improved performance and lower operational cost, even when considering the investment required. In addition, improved RF and switching performance results in a better user experience. Better efficiency and lower energy consumption saves on electricity bills, and network availability increases significantly by using IP-based link redundancy concepts.

TETRA terminals have become increasingly functional, robust and resistant to dust and water ingress. At the same time their costs have been falling to levels comparable or below other digital technologies.

To fulfil the requirements for greater data capacity, the Multi Slot Packet Data service (MSPD) was developed on the TETRA 1 system. In addition TEDS was standardised to allow higher data rates. Data solutions continue to be developed using TETRA services with functionality often available in TETRA terminals such as RFID, GPS, Wi-Fi, SD cards and man down alarms. Some of these solutions involve software applications and can work with other bearers and with wide band TETRA to deliver a seamless service to

the user. They enable users to make operational improvements and gains in efficiency. In cases where critical infrastructure is involved these solutions also make for safer, more resilient operation.

Some users are looking for the higher data rates achievable with broadband to supplement or in time replace their existing voice and data networks. TCCA is working with user organisations and the standards bodies around the worlds to bring the same benefits to the broadband world that users enjoy with TETRA.

The roll out of mission and business critical services over broadband will depend on completion of the standards, the amount of functionality adopted by manufacturers and the agreement of appropriate service contracts with operators. It will also depend on the achievement of the coverage and resilience improvements needed to adapt commercial networks for mission critical use, and the installation and roll out of services and equipment. Some large users have relatively new or newly updated TETRA systems and will want to see a return on their investment, so it is likely that TETRA and broadband will co-exist for many years.

Standards work on connectivity and joint services between TETRA and broadband domains are well advanced and targeted for completion in 3GPP Rel. 16.

Solutions are available today for interworking with broadband. Although proprietary, they provide an interim way to keep a hold of valued TETRA functionality. Integrated solutions are also available. The important message for users is that there will be a way of interworking and this means that critical voice and data services can be maintained over TETRA whilst broadband services are phased in and working practices developed to best use the technology. Users on both systems will be able to interact.

There are use cases where TETRA will remain the best choice.


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TETRA on the metro

TCCA

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

Our goals today are to continue the development, promotion and protection of TETRA standard worldwide, and to work with other technologies and user groups to look at new, future and complementary technologies that deliver critical communications. Mobile broadband data, involving the enhancement of the LTE standard, is the immediate focus.

Our Members include manufacturers, application providers, integrators, operators, and user organisations. 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 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.

TCCA takes a pivotal 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 reassurance

Working Groups

Within TCCA there are a number of Working Groups, mainly comprising volunteers, who play a critical role in protecting, promoting and advancing the TETRA standard and its evolution, together with other PMR/LMR technologies into the broadband future. 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.

Broadband Industry Group (BIG) The BIG encourages broadband vendor cooperation in the development of common global critical communications solutions. This helps to drive market adoption of standardised critical communications LTE and subsequent 5G technologies for the benefit of critical communications users and organisations, and promotes an evolutionary approach towards future solutions.

International Critical Control Rooms Alliance (ICCRA) The agenda of the ICCRA is comprehensive and covers all aspects of running an effective critical control room, including the technologies involved, the processes and operations, the environment and ergonomics of the rooms, and the people who bring them to life.

Critical Control Room Group (CCRG) is TCCA's newest group founded following a series of end user oriented workshops to provide a focus for critical service control room discussion, learning, and proactive measures designed to pursue constant evolution and best practice for control rooms.

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

The Operator and 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 SCADA, Smart Grid and Telemetry Group (SSTWG) is a forum for users, manufacturers, system integrators and developers to share experiences and requirements, and catalyse the market for TETRA. Its aim is to encourage and support the development of suitable solutions, both for traditional SCADA and telemetry applications and for new application areas such as smart grids.

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 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 and co-operates with ETSI, which maintains the TETRA standard.

TETRA Industry Group (TIG) TIG works to promote TETRA, develop the technology and advocate an evolutionary path towards future solutions for the mission critical communications market that TETRA serves, based on open standards. It develops expertise on the strengths of TETRA and LTE as competing, complementary or integrated solutions for this market.

The Transport Group (TG) provides a platform for everyone interested in the implementation of TETRA in the transportation sector. Participants share experiences and information, focusing on the market potential for future TETRA projects as well as representing users' interests.

Regional TETRA Forums: 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 TCCA initiatives to help national members to get maximum benefit.

TETRA for public safety

Events

Key to the promotion of critical communications across the world is TCCA's programme of events. This is designed to ensure that 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 Members who are all able to participate. 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. They vary from one day conferences and exhibitions to larger scale events. TCCA also participates and supports third party and Members' events.

Visitors to all 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, listen to the experiences of other 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.

The full schedule of critical communications events can be found at www.tcca.info

For further information on the events programme, please contact admin@tcca.info

Join us!

TCCA is membership-driven. Our Members actively participate in the management of TCCA, 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 upon TETRA.

Members of TCCA 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 TCCA, please contact:
admin@tcca.info


TETRA for resilience

Glossary

2G	2nd Generation (of mobile cellular technology)
3G	3rd Generation (of mobile cellular technology)
3GPP	3G Partnership Project
4G4	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 ATmosphères EXplosibles
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)
IP	Internet Protocol
ISI	Inter-System Interface
ISSI	Individual Short Subscriber Identity
LMR	Land Mobile Radio
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
SCADA	Supervisory Control and Data Acquisition
SCCH	Secondary Control Channel
SCK	Static Cipher Key
SDS	Short Data Service
SwMI	Switching and Management Infrastructure
TCCA	The 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


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TETRA for critical support

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TCCA-Critical Communications

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