December 2016

TETRA Data Solutions

The Current Status

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Issued by the TCCA - December 2016

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Executive Summary

This paper is designed to give a high level overview of TETRA data services, which are increasingly being used as part of critical communications solutions to give operational and efficiency gains. With its rich feature set, TETRA is an attractive bearer for a growing number of data applications.

Features and functionality common in TETRA terminals, such as GPS, RFID, 'man down' alarms, Wi-Fi, and SDS cards, are being harnessed as part of the data solutions. Some applications are being designed as bearer-independent, to enable and allow interaction with other technologies such as GSM and LTE.

These advances in data applications can enhance the value of an existing TETRA system, and/or provide a new level of service where security, resilience and robustness are operational necessities.

Introduction

The use of TETRA for data has significantly increased due to the active development of relevant applications and solutions. This is being driven by users wanting to make efficiency and performance improvements, and to maximise their investment in TETRA networks.

Given that TETRA is a narrowband technology, developing data applications for TETRA might not seem the most obvious route. However many of the operational benefits that can be achieved require relatively small amounts of data to be exchanged. The TETRA system over which the data is transmitted is secure, available and accessible. Most of the data exchanges in a radio network are between terminals and a central server, not between two terminals. TETRA is optimised for such communication by offering short data addresses for the servers which reduce address fields and extends data capabilities.

Operators have a trusted tool in their TETRA network, and want to make the most of it. Recognising this, industry has developed solutions that use the core TETRA functionality as well as adding extra capabilities into terminals such as Global Positioning System (GPS), accelerometers, Radio-frequency Identification (RFID), Wi-Fi and Bluetooth, and integrating these into the TETRA system. Some of these solutions make innovative use of the bandwidth available to deliver results that exceed expectations. At the same time, the deployment of TETRA Enhanced Data Service (TEDS) delivers increased bandwidth that has allowed applications to be supported that previously were assumed to need broadband.

Working with external sensors TETRA has seen increasing deployment as a telemetry, telecontrol and Supervisory Control and Data Acquisition (SCADA) solution where availability and security are key requirements.

Core TETRA Functionality

Short Data Service (SDS) on TETRA has been used for simple messaging for a long time, and with some applications this messaging is now extended to interfacing with e-mail over GSM networks. In order to make some uses of SDS more efficient for the user, a simple Short Data Application (SDA) is often used.

During Finland's presidency of the European Union, a significant element of the Finnish Police's duties centred on monitoring convoys. Instant messaging was used on both TETRA and GSM networks. With a Short Data Application, the police were able to message between the two technologies, allowing them to closely monitor the real time status of convoys whilst leaving voice channels free for emergency calls.

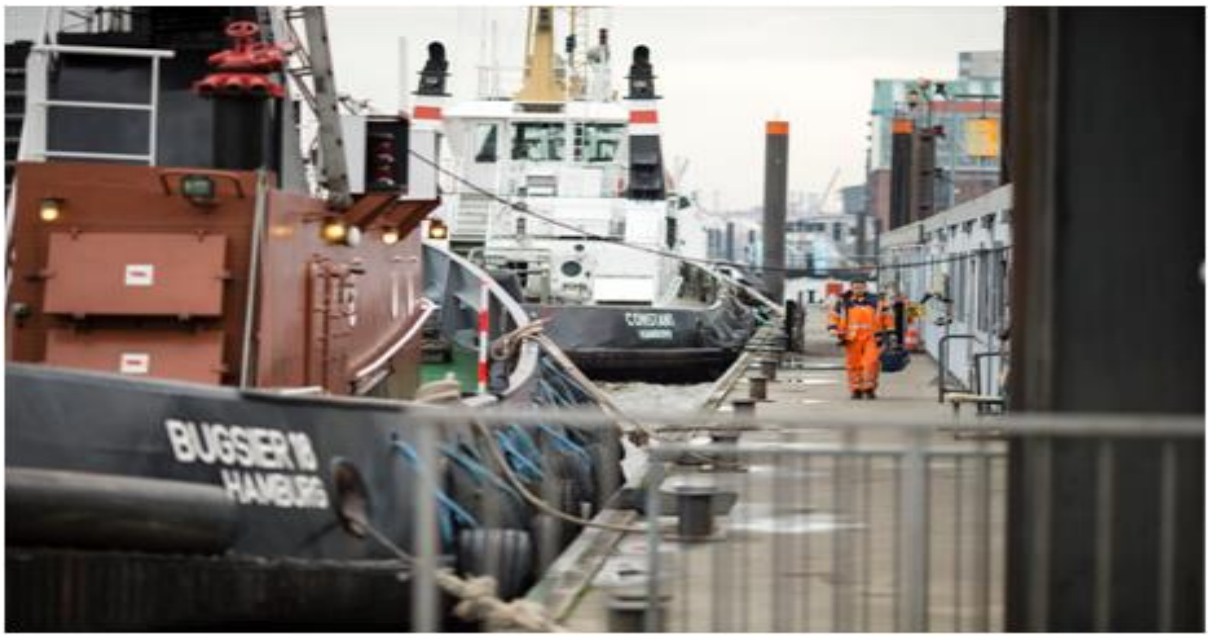
SDS is used for automatic fault notification. One example is BMW's manufacturing plant in Dingolfing, Germany. Whenever a fault occurs on the production line, the maintenance team receives an automatic SDS message on their TETRA terminals directly from a server. This SDS is generated with predefined text. The text is sent to the TETRA radios of the relevant maintenance team, where one team member has to accept the job, confirming back via SDS. If no team representative is able to accept, the system resends the SDS up to three times, after which the request is escalated to a supervisor who then makes the final decision with regards to job allocation. If more than one operative accepts the repair job, only one of them will be automatically selected to receive instructions to attend the fault. An SDA is used to make the process achievable with fewer key presses.

SDS can be used to help with work flow management. A good example is at airports where a number of suppliers have applications that link work groups to flight numbers and location to help manage the ground crews fuelling, cleaning and provisioning of aircraft in a co-ordinated way with each new work assignment (flight number) being automatically presented. With external beacons the system can be extended to the management of people and assets throughout the airport area.

TETRA is used in airports worldwide, including in the US, where TETRA has only been available relatively recently. The technology has already been selected for three major airports – San Francisco International (SFO), Los Angeles International (LAX), and John F. Kennedy (JFK) in New York. The TETRA networks are intended for mission critical airline and aviation ground-based communications, and enhance operations and services for airline ramp area personnel, airline passenger services, ground handlers, terminal security teams, and other ground staff working at the airports.

Coupling with location information is critical for another type of SDS use, an example of which is a solution to warn mine operators when they are approaching a blasting area. Safe working at sea ports is also supported by using SDS to cause safety messages to be broadcast at key points and times in the port.

The Port Authority of Valencia



To safeguard the handling of potentially hazardous cargo along one of the Mediterranean's primary shipping routes, the Port Authority of Valencia (PAV) has installed a resilient, automated early warning system.

"If an incident occurs, we must be able to react rapidly and efficiently. The integration of technologies such as TETRA with our SCADA platform is essential to provide accurate information in real time, enabling us to make the right decisions quickly. This is a robust and reliable solution for managing one of the most important Mediterranean ports." Alfredo Canet Pechuan, Head of Maintenance and Facilities, PAV.

SDS is also used extensively for train operations. In Australia, the Gold Coast Light Rail uses a TETRA radio network solution to monitor the location of the trains and to communicate with the train drivers. Built around a redundant TETRA switch, the radio access network is built with seven dual carrier base station systems installed on strategic points along the track. To support various data interactions with the trains, the network supports secondary control channels used to increase the control channel capacity for SDS message-based communications. The network interfaces with the tram supplier's signalling and control system, and is integrated in the control room environment with a voice and data logging system used to record all communications carried on the TETRA network.

SDS Remote Control: Another benefit of SDS is the access it enables to the TETRA terminal device for the purpose of management or control.

This capability allows terminals to receive AT ("attention") commands. Obviously in these scenarios security is important so that only authorised controllers can access and control the

devices. The feature provides the ability for remote radio management and allows users to obtain information from radios. The full set of commonly used AT commands can be used. These can include read/change the following: Audio volume setting, Trunked Mode Operation (TMO) or Direct Mode Operation (DMO), Talkgroup, Scanning and scan list. SDS Remote Control can also be used to read GPS location and base station quality.



Example scenario: An event is taking place where a number of volunteer fire-fighters are required and they have little experience of using radios. Some radio users may not know how to perform certain functions on the radio as there was limited time for training. The more experienced users could explain how the functions work by communicating over the radio, however this is time consuming and will create unnecessary congestion on the network. SDS Remote Control means the more experienced users can be installed as "Controllers". They are then able to send AT commands over the air via SDS to execute the change for the less experienced users.

Status messages are used for reporting and can be part of a workflow system that ensures certain locations are visited and inspected as part of a security patrol; they can be part of a performance system such as that used by the National Health Service in the UK to record attendance at incidents, or as an integral part of a remote working application.

Circuit mode data - This is connection oriented data suitable for constant bit rate applications. It is good for situations where reliable file transfer is required.

Packet data – this allows IP data over TETRA. It is the way of connecting with the customer's Internet and it is resource efficient in that it will dynamically change the number of slots being used as the load varies. It is the reliable way to transfer data when mobile as it can handover seamlessly even when the number of timeslots used is different

Callout is a special feature that is used to page volunteer or home-based users to call in to respond to a request or incident. It is possible to have different alerting tones and alert volumes depending on the seriousness of the situation. This is a two way communication that enables controllers to know who is responding to the alert so that resourcing can be managed. An example of this is the use of callout with voluntary fire-fighters.

In a TEDS operational network, along with supporting the core TETRA functionality, TEDS is used to share video in order to improve situational awareness.

DNK, Norway



"Although voice communications are still the most important service for our public safety users, we are seeing more demand for data applications – for instance to send videos and images, status messages and reports to and from accident scenes. We are deploying TEDS and it is supporting all of the services our users require, including video streaming, picture messaging, database look-ups, fingerprint scanning and Automatic Vehicle Location (AVL). By using TEDS over TETRA we can offer these services with the exceptional reliability that teams under pressure require so they can make more informed decisions and better co-ordinate emergencies to better protect themselves and the public." Dagfinn Sjøvik, Nødnett Project Director, DNK

Common Functionality in TETRA terminals

Location – most TETRA terminals include GPS sensors for navigation and some also include the Russian equivalent, Glonass and/or Europe's Galileo. These are integrated into TETRA using Location Information Protocol (LIP) and this allows for the frequency of reports to be remotely managed, for geo- fencing to be applied or for alerts to be triggered if a tracked radio travels beyond a certain speed. The most common use is the linking of location reporting with the pressing of the emergency button so that the location of the emergency is immediately known. The effective deployment and management of assets using location information is well developed and there are sophisticated implementations.

The fitting of accelerometers into terminals has been used to enhance location finding in buildings through dead reckoning (the process of calculating one's position by estimating the direction and distance travelled rather than by using landmarks or astronomical observations).

Bluetooth – is used in TETRA terminals to enable wireless connection to peripherals so for example a printer can be used to provide hard copy of SDS information, or a wireless headset can be used to give improved freedom for the user.

Lone Worker – this periodically checks the user's status, automatically calling for help if the user becomes inactive and incapacitated. Ideal for health workers, maintenance staff or other employees working in isolation, it can be configured to send an emergency call or GPS co-ordinates if an emergency situation is detected.

Man-down capability – is often available as an option with hardware fitted in the radio to sense the fall, coupled with software to screen out false alarms, send the appropriate messages, give a high level audio alarm and provide location detail.

CERN, Switzerland

At the European Organisation for Nuclear Research (CERN) in Switzerland, individuals often work alone in vast areas underground, and ensuring their personal safety is a top priority. As well as an emergency button, users can press to call the fire service directly in an emergency; all the TETRA hand-portable radios in use at CERN include sophisticated 'man-down' functionality. Based on motion sensing technology, the radio automatically alerts the fire service if a user is motionless or suffers a serious impact.

These radio-based features are combined with an in-building tracking and location solution, consisting of beacons and software that enable a radio user's position to be precisely displayed on a map of the CERN site if a man-down alarm sounds, and accelerating the rescue operation.

With safety being a top priority in gas metering and receiving terminals, commercial Oil and Gas companies have chosen to deploy TETRA networks to provide robust and reliable communications between operators and maintenance staff at their plants. ATEX-approved terminals (for use in explosive atmospheres) with a 'man down' feature and real-time GPS tracking solutions enable workers to keep in contact throughout the plants, enhancing security and efficiency.

Gassco, Germany





"The TETRA system and GPS location solution meet our high safety standards and provide peace of mind for staff working in potentially hazardous areas of the plant. The quality of our voice communications is greatly improved, while the increased channel capacity allows our maintenance staff to get on with the job without having to disturb operators." Frank Tabbert, Process and ICT Professional at Gassco Germany

User Specific/Custom Applications

Wireless Access Protocol (WAP) to allow websites organised for access from TETRA to be viewed to assist with productivity

JAVA to allow applications prepared for use with JAVA to be run, to aid productivity.

Düsseldorf Airport, Germany

Creating a role-oriented communication system was one of the key criteria for choosing the new TETRA system. The various user organisations needed to be able to communicate seamlessly within teams that change 'on the fly'. Fixed talk groups with fixed subscriber numbers were out of the question. The TETRA radios feature a Java platform. Together with the innovative application, this presented a completely new way of building a virtual, role-oriented communication system. The solution is based on dynamically changeable user roles and rights, as well as on tactical numbers. "Ensuring quick flight turnarounds is our main task. With the previous analogue radio network it was a challenge to coordinate several flight operations with teams mixed up on the same radio channel. The main benefit of the new solution is that it provides a dedicated communication group for each team." Manuel Wenders, operations manager for Düsseldorf Ground Handling.

Short Data Applications (SDA), used to create a forms that can be completed and sent by the user, or to deliver a required functionality. SDA is used by Greater Manchester Police in the UK to make the recording of stop and search activities more efficient.

Using a series of menu-based prompts, officers can record the details of any encounter at the scene using their TETRA radio or smart device. The device then interacts with the police force's back-end system, accurately recording and instantly storing the data.

The member of the public is given a card with all the details of the encounter; the officer need only add a reference number, which is generated by the application. The entire process can take as little as five minutes from start to finish, with no need to re-enter the information later.

FIFA World Cup, South Africa

The SDA developed for the 2010 Johannesburg World Cup Organising Committee covers specific medical, security, fire and logistic events and also monitors the capacity status of the venues (e.g. 25% full, 50% full etc.). The messages are then divided in categories according to the severity or type of incidents (single or multiple). The messages are common for all the venues in the region and, for this reason, can be more easily monitored by the dispatcher.

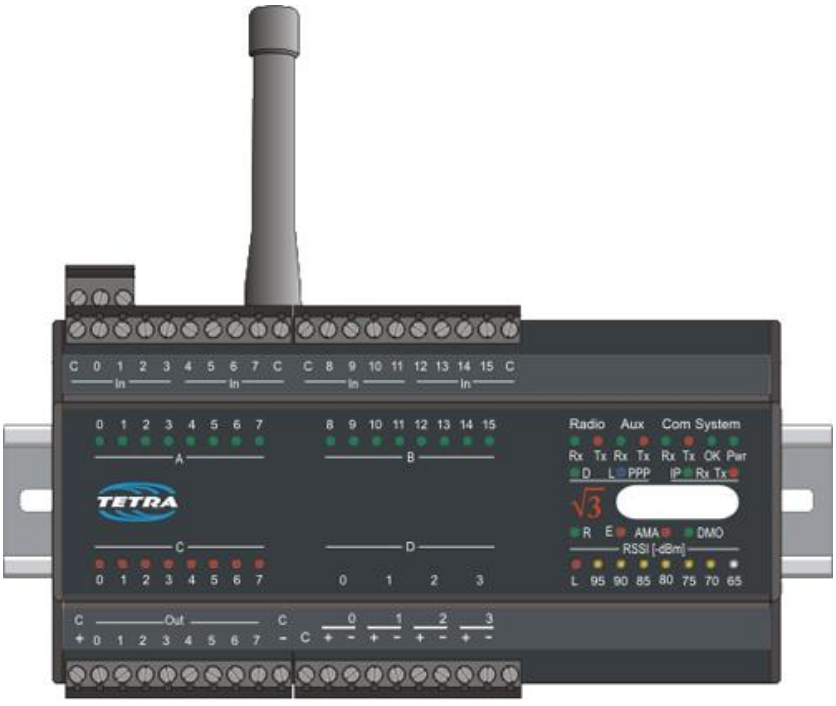
Status triggered functions – allow remote control of a radio through unique status codes, which can activate one of 60 functions. Triggering is permitted from authenticated sources only and can be used to remotely control vehicle-based radios or to set operating parameters on temporary staff radios, limiting training time without compromising safety.

RFID – can be built into terminals to allow asset registration and tracking but also as a means of accessing secure areas, triggering an input on context information. With beacons, RFID can be a way of providing accurate, in-building location.

Secure Digital (SD) Cards – are routinely built into TETRA terminals to store data and applications. They can be used for example to store pictures for reference or to run a local WAP site providing organisational procedures to which the user can refer.

TETRA Modems

TETRA was designed as a “Voice plus Data” technology and it is an easy task for any TETRA user to operate - beside his voice communication - also his Data and SCADA Applications via the TETRA infrastructure.
Several years ago, the only way for Data over TETRA was to use a TETRA Hand-Terminal and to interface it via the AT-Command Set to the Application, but meanwhile there are a lot of “real” TETRA Data Modems available on the market. These devices are designed to fulfil the SCADA and Data Application users’ needs providing a wide power supply range, serial and IP interfaces, serial and IP protocol support, embedded web-server, embedded IP-routers as well as embedded digital and analogue I/O and PLC functionality.



Most serial and IP based SCADA and telemetry protocols can directly be used on TETRA networks. With a polling throughput of up to 1000 Modbus RTU polling within 5 minutes on a single 25 kHz TETRA carrier, this technology can compete even against 3G. This can increase the utilisation of an existing TETRA communications system, making the investment in the technology all the more beneficial.

TETRA has a key role to play in smart grid and smart metering markets, and in creating and advancing smart cities.

TETRA & SCADA - Integrated TETRA and SCADA systems provide robust and reliable transmission of data from SCADA systems and sensors to control and operation centres enabling operations to run more safely and smoothly. In a deployment where site access is restricted, a Remote Terminal Unit (RTU) can send commands over the TETRA network to a siren controller to execute specific actions or collect status reports. This information can be sent from the RTU to a Front End Processor (FEP) using the TETRA network SDS or TEDS. The FEP is connected directly to a TETRA Switch which transmits the data across the TETRA network. Additional applications can then be added that allow users to monitor sirens using their TETRA radios and select locally stored, pre-recorded messages to be broadcast in the event of an emergency.

Integrated TETRA and SCADA is used in utilities, meter reading, fresh and waste water management, and in the gas and oil industries.

CREOS, Luxembourg

CREOS Luxembourg S.A. is the main electricity transmission and distribution operator in Luxembourg; it owns and runs circa 9,300km of power lines and 1,911km of natural gas pipelines, as well as serving nearly 245,000 electricity customers and approximately 45,000 customers connected to natural gas.

CREOS is implementing a complete communication solution comprising a TETRA infrastructure covering an area of 2,586 km², TETRA radio terminals for voice communications, and 2,850 RTUs for SCADA control for implementation in the medium voltage substations.

The RTUs will be used to manage the electricity and gas networks controlled by SCADA, and these will ensure uptimes via the resilient TETRA infrastructure even during power failures. A first step will be the acquisition of basic data from the medium voltage substations in order to gain better visibility of the medium voltage grid, identify potential problems and, subsequently, decide which medium voltage substations should also feature a remote control capability.

In South Africa, Sasol employs TETRA and SCADA for oil and gas flow meter management, emergency announcement systems – voice, monitoring and control – and TETRA high site monitoring and control.

Vattenfall Distribution, Berlin

Vattenfall employs 1,000 RTUs over TETRA using packet data and SDS to telecontrol a Medium Voltage network. Vattenfall integrated diagnostic equipment and telecontrol systems into the network stations, which provide power distribution to individual households. This allows all the systems and equipment to be monitored and controlled from the control centre."It is our aim to set new standards for safety and customer focus as an energy supplier in the German market. We therefore put our trust in communication solutions, which allow us to respond quickly to developments and also introduce future oriented services for our customers." Matthias Wittig, Head of Project Management & Strategy TETRA Networks Vattenfall Distribution

Johannesburg City Power, South Africa – Utility Applications

In Johannesburg, South Africa, the Utility Company JCP (Johannesburg City Power) operates more than 1,500 TETRA Data Modems on 28 TETRA multi carrier sites for different utility applications. Street Lighting Control using Packet Data and TCP/IP communication with the IEC60870-5-104 protocol, control of Medium Voltage Stations using the serial IEC60870-4-101 Protocol with SDS on a Secondary Control Channel and different other applications using the Modbus, DNP3 and DBP3/IP protocols.The main reasons for JCP to choose TETRA for their applications are the safety and security features the TETRA technology provides, as well as the capability of TETRA to provide simultaneous Voice and Data capabilities.

SONATRACH - Hassi R'Mel, Algeria – Oil and Gas Field Control

Hassi R'Mel is a main hub for natural gas and oil pipelines running to the Algeria coast line for delivery of Gas and Oil to the European region and to other countries. Sonatrach, a state owned company, is the global player in this market. To control and monitor Oil and Gas wells, Sonatrach decided to choose TETRA technology as a secure and safe infrastructure, also working under the harsh and extreme conditions in the desert. Parallel access to Field-PLCs of the DNP3 SCADA protocol and the Highly Addressable Remote Sensor (Hart) Protocol via the TETRA infrastructure was the main focus.

Applications working with TETRA terminals to enhance data solutions

Access to databases for queries – to improve security following the 2008 Mumbai terrorist attacks, the Parliament of India installed a high-capacity digital TETRA network for voice and data communications. The users have an application on their TETRA terminals as part of their public safety and security operations to gain fast, straightforward access to critical information on databases.

Airwave, UK



The Airwave network in the UK delivers fully-integrated voice and mobile data communications, with SDS and packet data supporting status and text messages, plus database enquiries of the Police National Computer (PNC), Electoral Roll and local intelligence databases. Users of these services will in the future have an added benefit with the introduction of multi-slot packet data capability, increasing the data throughput by up to a factor of 4. Such practical applications have proved of particular importance to police users, given that the majority of officers currently have to return to the station to access such databases, file reports and assign tasks. Statistics from research conducted by the Home Office and PA Consulting (Diary of a Police Officer) estimates that such tasks keep officers off the street for 30% or more of their time on duty. Not surprisingly, many now believe that mobile data via TETRA is the best solution for delivering increased visibility, effectiveness and efficiency, while also enabling more accurate resource management.

Transfer of images (photos, plans etc.) Images with associated text information can be transferred to a variety of devices including, uniquely, TETRA radios. Fully scalable, from small to national networks, simultaneous access can be given from multiple client applications and

to multiple users in different geographic locations. Used from the client application or integrated into existing command and control systems via an application programming interface (API), the service supports multiple languages, with the facility to upload more.



Routing of messages application – allows the customised routing of messages between email, SMS (GSM/3G/LTE) and SDS (TETRA), permitting seamless communication among the various technologies. It ensures that communications are delivered to the desired device in the appropriate format, based on a set of user-defined rules, as well as offering a store-and-forward service that holds messages until they can be delivered.

The Future

The resilience, availability and security of TETRA coupled with its efficient use of spectrum will continue to make it an attractive bearer for dedicated data solutions where the controlling function has any criticality. The standard includes data relevant functionality such as economy energy mode and flash messages that have not been fully implemented but when they are they offer opportunities to extend data capability. The sustained development of additional functionality within TETRA terminals with creative applications that can use this functionality alongside TETRA to produce operational efficiency improvements will be important not only for existing TETRA users but new users too. In this latter category the opportunities presented by smart metering and smart cities may be significant.

Applications using TETRA along with other bearers are already in use and it is likely that hybrid solutions will be increasingly common.