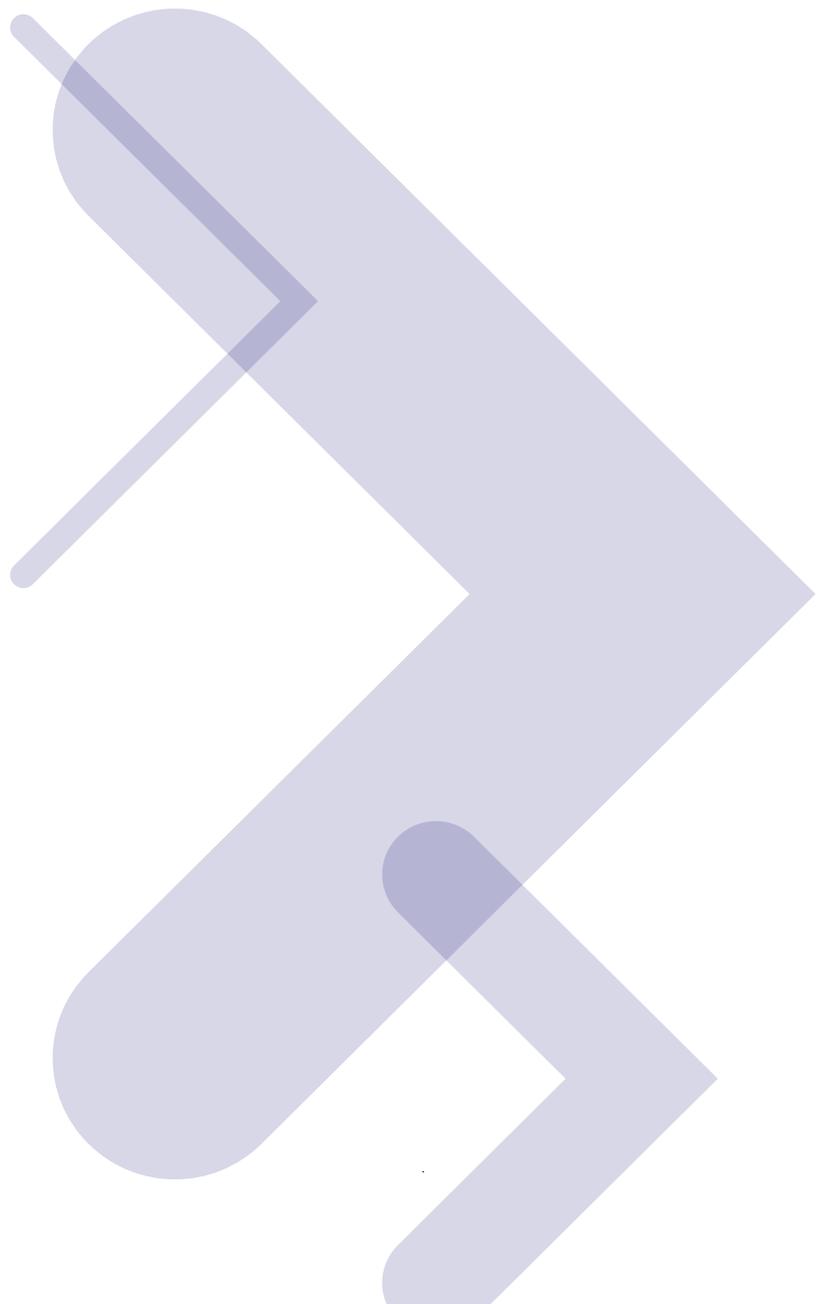
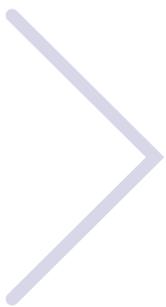




TETRA: Enabling Critical Communications in the Oil and Gas Sector



The Oil and Gas sector plays a vital role in supporting the world economy. This white paper introduces TETRA technology and examines its role in helping the industry to meet a range of business challenges – including safety, security and environmental requirements.

INDUSTRY CHALLENGES

As with any commercial undertaking, organisations operating in the oil and gas sector face the key business challenges of delivering earnings and profits, increasing their share value, and maintaining strict budgetary controls that ensure healthy returns on capital investment. Innovative communications technologies are being adopted to achieve new targets in efficiency and productivity. Yet the myriad of options available makes selection particularly difficult. However, wireless communications can play a major role in realising new levels of business efficiency and productivity.

The oil and gas industry does not have a single set of needs, rather, each operational area has different expectations from a communications solution:

Safety is always a first priority, followed closely by concern for the environment. Effective communication during an emergency evacuation, shut-down or man-down alarm is a clear instance where the right wireless communications technology is required.

A wireless communications system is also a tool that will be used to help protect investments and personnel against criminal or even terrorist threat. However, today's criminals are tech-savvy, thus any system must be secure against potential mis-use if it was to fall into the wrong hands. With a typical oil pipeline pumping more than \$3-million worth of oil an hour, effective communications are essential in keeping revenues flowing.

Requirements fall into six key areas: Flexibility & Scalability; Efficient Communications, Reliability & System Availability; Data Communications; User Environment & Interface; and Operations & Maintenance. So what is TETRA and how does it meet expectations in each of these vital areas?

Upstream	Midstream	Downstream
Exploration & Production	Transport & Process	Refining, Marketing, Distribution
		
<ul style="list-style-type: none"> Enhance Employee Safety Cost Reduction & Operational Efficiency Remote Platform Management Regulatory Compliance 	<ul style="list-style-type: none"> Security of Supply Environment Protection Remote Pipeline Monitoring & Control Disaster Recovery Tracking of People & Vehicles 	<ul style="list-style-type: none"> Safety & Disaster Recovery Asset Protection Operational Maintenance Improve Workforce Productivity Managing Data, Assets & People



TETRA – PROVEN FOR CRITICAL COMMUNICATIONS

TETRA (Terrestrial Trunked Radio) is an established and proven standard that has achieved worldwide adoption with both public safety and commercial user organisations.

Developed by ETSI (European Telecommunications Standards Institute), TETRA is an open digital standard that offers a feature set aimed at Mission Critical and Business Critical users. Motorola has been involved from the inception of TETRA and is a leading contributor to the standard. TETRA provides interoperable, spectrum-efficient, secure, resilient and fail safe networks complemented by an extensive

range of voice and data services. It uses allocated, protected radio spectrum for both public safety and civil networks.

TETRA's unique set of capabilities means it is now being adopted extensively by commercial users in the transportation, manufacturing, oil & gas, mining and utilities sectors. The technology has proven a real success. According to the TETRA Association, which represents over 130 organizations from every continent, more than 200 companies are involved in the development of applications and in excess of 40% of nations have adopted TETRA. What's more, the standard continues to evolve with new releases that support additional functionality, such as higher-speed data services.



FLEXIBILITY & SCALABILITY

Any oil and gas communication system needs to be flexible enough to cope with the varying locations and requirements of each operational area – from offshore facilities, to pipeline infrastructure. Some users will need to cover just one location, such as a refinery, while others will benefit from a system that covers every area of the production life cycle.

Motorola experience is that the benefits of TETRA will drive expansion. One customer in the Caspian Sea region installed a TETRA solution in 2005 and has since extended it to cover over 300km of pipeline.

TETRA network solutions can grow as the user base expands or operational requirements change. Users may start small with a voice-only solution, expand this capability with data services, opt for a comprehensive system with geographical redundancy, or anything in between. A modular approach assists in expanding coverage and abilities as demand grows.

Examples of how TETRA meets typical expansion requirements include:

Typical Expansion Requirement	TETRA Implementation
Adding more users	Today's radios are small, robust, and user-friendly, with feature sets including alpha-numeric key pads, text capabilities and colour displays. They can be added to the network easily and incorporate innovations such as cellular-style handsets and PDAs. Additional capacity can also be added, thanks to the modular infrastructure that TETRA employs.
Increasing in-building coverage	In-building coverage solutions include distributed Indoor Antennas or Leaky Coax, dedicated BTS with Leaky Cable, RF Amplifier Distribution, Cell Enhancers, and RF over Fibre System.
Control room solutions	Control Consoles extend IP communications into the control room, giving the dispatcher instant access for management and communications with the radio fleet.
Multiple dispatchers	Wireless Dispatch Solutions provide additional flexibility and deliver operational efficiencies. Multiple dispatchers can be deployed as required to support different user groups.
Managing additional subscribers and user groups	The ability to add New User Groups is important. Network Manager Terminals can support additional subscribers and improve network performance. For example, if new user groups are required at a particular distribution site.
Adding security & encryption	TETRA solutions incorporate the high levels of protection inherent in digital communications. However, even greater security is assured with TETRA as the technology supports two types of encryption. Group Cipher key encryption is used to provide privacy between user groups on the same network, while End-to-End Encryption provides complete security against eavesdropping.
Adding resilience	TETRA network architecture is proven through years of operational use in the most demanding environments. Further system redundancy and resilience can be built-in using additional links and network elements, as well as Geographical Redundancy. This ensures continued performance, even in the event of major site disasters such as fires or explosions.
Maintaining and reporting on records of incidents	Voice Recording solutions enable users to record and playback communications at any time.
Telephony	Telephony Services can extend access to private and public telephony systems.
Data messaging	Tetra's Short Data Service (SDS) improves efficiency and productivity with the use of messaging. Locate resources using GPS, or dispatch tasks and monitor status using SDS messaging.
Integrated voice and data	Packet Data Services can provide a truly integrated voice and data network supporting single- & multi-slot packet data to deliver data bandwidth that can truly mobilise a workforce and enhance business efficiency.

EFFICIENT COMMUNICATIONS

Effective communication is critical in increasing operational efficiency and employee productivity. Each user will have different needs, communicating on a one-to-one or one-to-many basis. However, for most organisations there are clear priorities. The prime example is for emergency communications, as this is crucial to ensure safety of personnel and assets. Group communication is the next most important requirement, while support for individual and telephony calls is typically a lower priority.

TETRA is unique in supporting critical emergency communications and offers the group call capabilities required for maintenance, production, safety and security staff. Furthermore, TETRA's independence from public or cellular networks assures the ability to carry critical communications when other systems typically fail.

A full range of voice services designed to ensure efficient operations is also available with TETRA. These include faster call set-up than with traditional telephone systems, and group calling for seamless work-group collaboration on an all-informed basis, often coordinated by one or more dispatch operators.



TETRA Call Type	Characteristics
Emergency Call	Emergency calls can support a set of key elements for handling emergency operations, including: special handling (and prioritisation) of emergency calls; automatic alarm capability (to raise the alarm if, for example, a user cannot talk); special dispatch console features; and an easily accessible emergency button on terminals.
Group Call	Group calls are critical to business efficiency. At a refinery for example, talk groups can be assigned to different functions: production workers, maintenance, fire etc. These talk groups are typically controlled by a dispatcher.
Individual Call	Individual calls are private calls between two users, or one user and the dispatch console.
Telephony	Telephone (interconnect) calls are typically used by management functions and may employ a gateway to permit connections between a user and a PABX or public telephone network (PSTN).
Priority Call	Priority call assignment by user or group can be set by the network manager. Emergency calls always take the highest priority, regardless of who initiates them. Pre-emptive priority calls can take priority too, and can be made by supervisors and key personnel, so that important operational information is relayed without delay.
Announcement Call	Announcement call is a valuable extension to the group call service, allowing announcements to be broadcast to multiple talk groups.
Advanced Calls	TETRA supports several other advanced call types, including: Recent User Priority; Dynamic Regrouping Services; and Site Wide Calls.

A good example of the importance of emergency communication is the use of TETRA by the Karachaganak oil and gas field in Kazakhstan. The safety of personnel is critical in this upstream facility, which covers more than 280 square kilometers. Features like emergency and priority calling are vital in overriding all other calls and ensuring an instant reaction to critical situations. Emergency scenarios are pre-configured on the system and are activated automatically in response to incidents.

RELIABILITY AND SYSTEM AVAILABILITY

Effective and seamless communications are vital for oil and gas user organisations from both a business and safety perspective. A key aim is to reduce the possibility of an event that would require the facility (well, pipeline, plant) to be shut down. Interruptions to drilling, pipelines or refinery operations due to inefficient communications can have major financial consequences and the scale is immense. A typical oil pipeline pumps around \$3 million worth of oil per hour, while a typical refinery produces around \$6 million worth of fuel per day. Refineries and plants all have safety targets too and, of course, 24-hour operation is the norm.

Communications are also essential for ensuring the safety of both staff and the general public. Prime examples are the need for communications to alert on 'man-down' scenarios, or to control emergency evacuations. Communications in the oil and gas sector are therefore just as Mission Critical (defined as when lives/safety is at stake) as public safety operations. Safety is also an issue that extends beyond the immediate bounds of a plant or oil field. Oil companies have a duty of care to the environment, as well as their neighbours. In this case, the aim has to be first to minimise the risk of an environmental incident, and then to ensure the tools are in place to manage any incident and accelerate response or clean-up.

TETRA is the solution of choice for critical communications networks because:

- It provides a dedicated critical communications network enabling users to define levels of resilience suitable tailored to their specific requirements (as opposed to commercial networks).
- Field proven TETRA solutions (unlike commercial systems) have been shown to cope well with emergency situations. In many situations, commercial systems become overloaded, or worse, they fail entirely (for example, if the main control channel becomes overloaded).

Take an example of a public emergency at a refinery. This will typically drive a public reaction – causing an increase in the use of the cellular network as users communicate by voice, send pictures and messages and so-on. The cellular network will quickly become overloaded and may compromise emergency calls.

The dedicated TETRA network at the refinery however, remains robust and reliable and there is no impact on voice and data services. Emergency calls and priority calls for incident handling are connected almost instantaneously by the TETRA network. Finally, voice logging on the TETRA system provides a ready-documented record of how the incident was handled.

TETRA solutions have inherent reliability and system availability

TETRA is designed to be ultra-reliable. This is achieved using several different, yet complementary approaches:

- High reliability design – designing all the components for low failure rates (high MTBF)
- Fallback solutions – enabling alternative means of providing service in the event of a failure
- Resilient solutions – ensuring continued operation even in the presence of faults
- Disaster recovery – minimising loss in the event of a disaster (see example below)
- Services and support – from designing the optimal solution to third-party support
- Expansions and upgrades – maintaining availability during network expansions/upgrades with minimal downtime

Geographic Redundancy

TETRA can provide a resilient, disaster recovery solution through the use of geographic redundancy at a refinery site.

By using two switches in different locations and a ring interconnection, if one switch fails due to a minor disaster, the other switch automatically provides near-instantaneous connectivity.





TETRA PDA

DATA COMMUNICATIONS

Wireless data is growing strongly. In cellular networks for example, it now accounts for almost one-third of overall user revenue in developed countries, an increase of some 20% in the last year. Motorola is also seeing significant growth in the uptake of TETRA data services and expects this to continue.

For oil and gas user organisations, wireless data has shown it can improve efficiency in several areas:

- Remote monitoring solutions – e.g. for corrosion monitoring (SCADA)
- Faster decision making based on instant update of process data enables a faster response and can help the identification and prevention of potential problems
- Maintenance inspections and operator rounds – collecting status data and records
- Business-process-driven schedule & dispatch of personnel, vehicles and other assets
- Alerts of emergency situations
- Location solutions – help users find missing or broken-down vehicles and manage the workforce.

Integrated Voice and Data

An integrated voice and data network such as TETRA means users only need carry one device for all their communications needs.

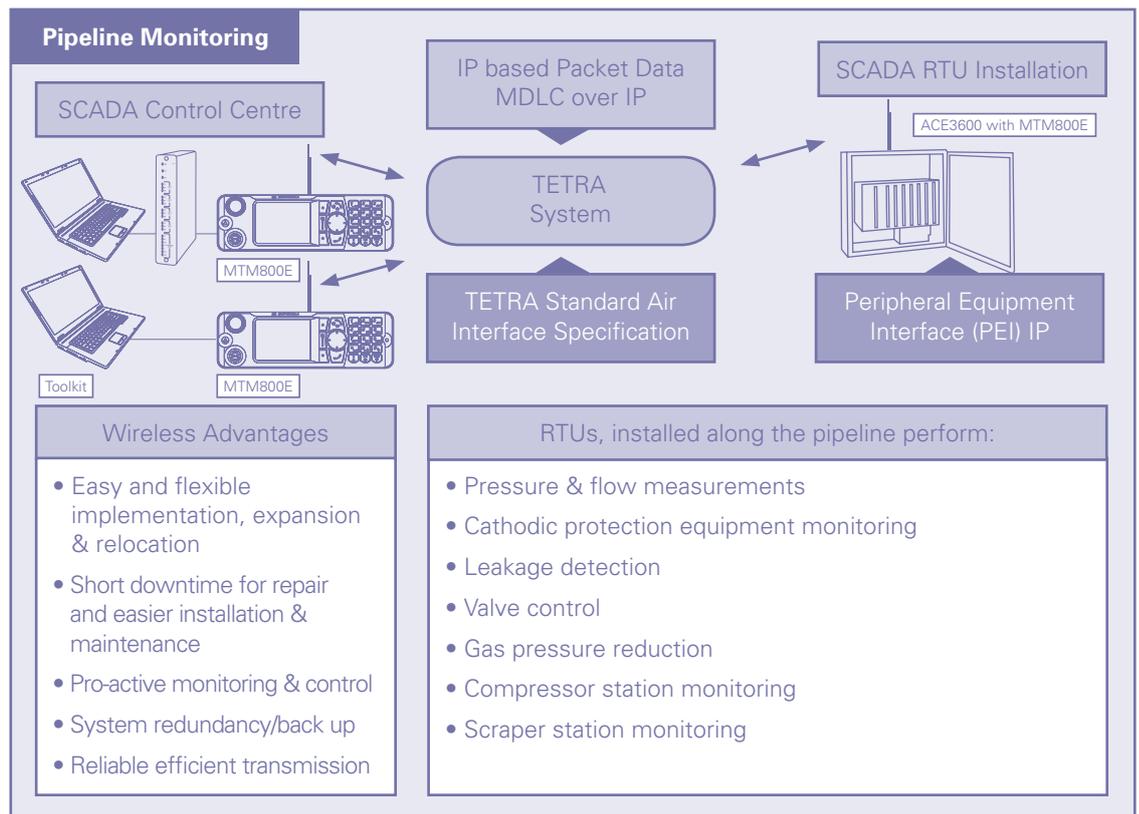
Standard TETRA portables and mobiles have a small display and simple keypad for text entry. This makes them ideal for basic transactions such as database enquiries and text messaging. More specialised

devices are available for use in vehicles, that handle complex enquiries and email. There are also handheld PDAs and other mobile units available.

Location Solutions are the most commonly used TETRA data application today. They can be used to locate vehicles that are lost or have broken-down, while helping to effectively manage the workforce by determining the nearest available person for a specific task. Location Solutions can also enhance reporting, improve response times and increase safety. Automated reporting for example, can record and advise the dispatcher of the TETRA terminal's location, whether its radio battery is low or the device is powered on/off, and when the emergency key has been pressed.

Improved operational efficiency and worker safety are expected to be key drivers for investment in new data applications. Immediate safety opportunities lie within connection of peripheral devices, such as environmental/gas sensors, GPS Location and alarm applications. Connection of environmental sensors to TETRA devices will drive development of new security applications. As an open standard, and a wide range of applications can be developed for TETRA using Application Programming Interfaces (APIs) published by TETRA manufacturers. This allows the creation of new services tailored for teams working in some uniquely demanding environments.

TETRA can be used to support solutions requiring telemetry, such as SCADA. Motorola has deployed SCADA solutions in several locations, including Russia and the Middle East. The diagram below shows an example of SCADA pipeline monitoring and highlights the advantages of this wireless approach:



USER ENVIRONMENT & INTERFACE

With such a wide range of operating environments and user types, business/mission-critical communications solutions must provide user organisations with a variety of terminal options and configurations. In the Oil and Gas sector, there is the specific need for intrinsically-safe TETRA terminals.

Current TETRA terminals include portable, mobile, and data-focused solutions. Compatible accessories and terminal management software add to the mix.

In order to deliver flexibility and reduce training overheads, some key elements must be considered when selecting terminals:

- A common user interface across mobiles and portables reduces training requirements and enables easier transfer of users between the various devices
- One-touch functions and ease-of-configuration
- Security capabilities (against criminal or other sources) – such as end-to-end encryption
- Full colour display for accurate display of pictures and maps
- High quality audio for use in noisy environments
- Support for data (WAP, MSPD)
- Support for GPS positioning
- Compatible accessories
- Terminal management software for easy re-programming of radio fleets



Modern TETRA Terminal

Intrinsically Safe Terminals

A vital part of any communications solution for Oil and Gas user organisations is the ability to extend communications safely into potentially hazardous areas. For example, in refineries, plants and well-heads, where the risk of explosion requires the use of intrinsically safe equipment. This applies not just to day-to-day operations staff, but also to users such as fire-fighters at refineries, or incident response staff, who may have to enter hazardous environments.

Motorola develops radio terminals with user needs as a priority, and is increasing its range of TETRA solutions to meet the needs of particular sectors. Motorola undertook extensive new research into the needs of the oil and gas industry when developing one of its latest TETRA radios – the MTP850Ex. Motorola already has experience in delivering intrinsically-safe solutions, and this has guided the development of the TETRA ATEX radio. In addition, extensive market research was conducted by Motorola into the specific needs of oil and gas user. This has directly influenced the inclusion of several key features:

- ATEX/IEC-EX certification for the most demanding of explosive gas environments (group 2C)
- High quality audio that lets you hear and be-heard even in high-noise areas
- ‘Gloveability’ – easy-to-use even with heavily-gloved hands
- “Man-Down” alert with GPS to ensure injured personnel get help faster
- Fully-certified accessories to allow users to move between zones

Every Motorola terminal is subjected to 13 extremely rigorous (ALT) Accelerated Life Tests, designed to simulate over 5 years harsh usage in the field. These tests include:

- **Dropping the terminal onto a concrete floor**
- **Dropping a steel ball onto the display**
- **Subjecting the terminal to vibration and rain-spray**
- **Dust ingress test**
- **Subjecting the terminal to temperature extremes and thermal shocks**

Given that the MTP850Ex is intended for use in extreme operating environments, its robust design has been subjected to equally extreme testing. An excellent example of this is the ability of the terminal to withstand a massive 1kg steel ball being dropped onto the display.

A range of ATEX-certified accessories are also available for the MTP850Ex – including noise cancelling microphones, headsets for use under helmets or protective suits, as well as PTT switches for use under protective clothing.



MTP850Ex ATEX



OPERATIONS AND MAINTENANCE

Efficient and cost-effective operations and maintenance helps reduce risks and control costs. Potential upgrades of the system also need to be implemented with a minimum of interruption.

Modern TETRA solutions offer several key applications that enhance and enable efficient network operations:

- **Integrated terminal management** software can be used to update the terminal automatically with new parameters. Users simply update as required by placing the terminal in a charger. This removes the time-consuming process of handing in radios for manual re-programming. Advanced solutions are included to manage the upgrade process, with the ability to identify whether new software features have been downloaded fully, and can therefore be activated.
- **Remote software site upgrades** allow the loading of new software releases, upgrades and patches to base stations. Optimising parameters such as power settings, alarms and timeslots not only saves on site visits, but drives a more highly optimised network, as these parameters can be changed more frequently.
- **Network sharing** by two or more organisations can reduce costs. TETRA has key features that facilitate network sharing, including functions that help maintain security and availability (i.e. secure agency partitioning and group cipher keys).

Performance & Fault Management solutions can monitor and manage the health of TETRA networks, helping to maximise the resources and minimize downtime, while reducing maintenance costs.

Services can ease the running and setup of a TETRA solution. TETRA solution providers can offer a range of practical services to plan, install and run a TETRA network. Motorola for example, offers a comprehensive and flexible portfolio of services delivered by Motorola Global Services. This organization uses local, trained and qualified service personnel backed by extensive R&D resources and centres of excellence worldwide, to deliver services including integration, planning and design, support and network management, and value-added services and training.

CASE STUDY – TETRA IN THE NIGER DELTA

An oil and gas user organisation in Nigeria operates a comprehensive TETRA solution provided by Motorola. The customer's key requirement was for a radio solution to provide coverage in the production area to meet operational needs such as staff coordination, logistics, and transportation coordination. Particular requirements for this solution were TETRA & marine channel integration, and a solution that countered criminal activities. The system delivered covers approximately 3200km² with eight sites, including three offshore. The system has over 2,000 users and offers full telephony services, as well as TETRA secure data capabilities including authentication and encryption.

The communication network supports the daily supervision, dispatching and monitoring of oil workers and security personal, independent of their location in the production area. Doing business in the Nigeria Delta region demands a communication system that can provide a high level protection for sensitive data and voice communications.

Motorola was chosen for the project for the following reasons:

- Proven technology and technical expertise
- Reputation and experience
- Advantages of the TETRA standard (e.g. multi-vendor sourcing)
- Understanding user needs and security issues

Motorola is providing a fully TETRA-compliant Dimetra system, which consists of several sites installed onshore and offshore, one master site, and over 2,000 subscriber units. To boost coverage, BDA's (Bi-Directional Amplifiers) are used as a cost-effective solution for coverage in difficult propagation areas, such as large buildings, other constructions and tunnel systems, or to extend coverage in rural areas. The Dimetra network offers high quality voice communication, while users are able to transmit both voice and data simultaneously. Deployment of wireless GPS/AVL Systems for the location and management of boats and patrol cars, is also planned.

Protection from illegal monitoring via stolen radios, as well as other security needs, were key drivers for TETRA in the Niger Delta. System authentication of legitimate radios guards against unauthorized access by Mobile Stations that may have been cloned, or to whom the network manager has denied access. Communications between the onshore and offshore oil platforms, the marine fleet and helicopters is facilitated via the single TETRA system. Sites have also been expanded to include TETRA marine channel capabilities to allow the marine fleet (oil tankers and rescue boats) direct access to the network.

This TETRA network has been instrumental in helping the customer hit an early production target.

TETRA – A FUTURE IN OIL AND GAS

TETRA offers an ideal communications solution for today's Oil and Gas industry. It increases safety and efficiency for upstream, midstream and downstream operations and provides a secure and resilient foundation for the future.

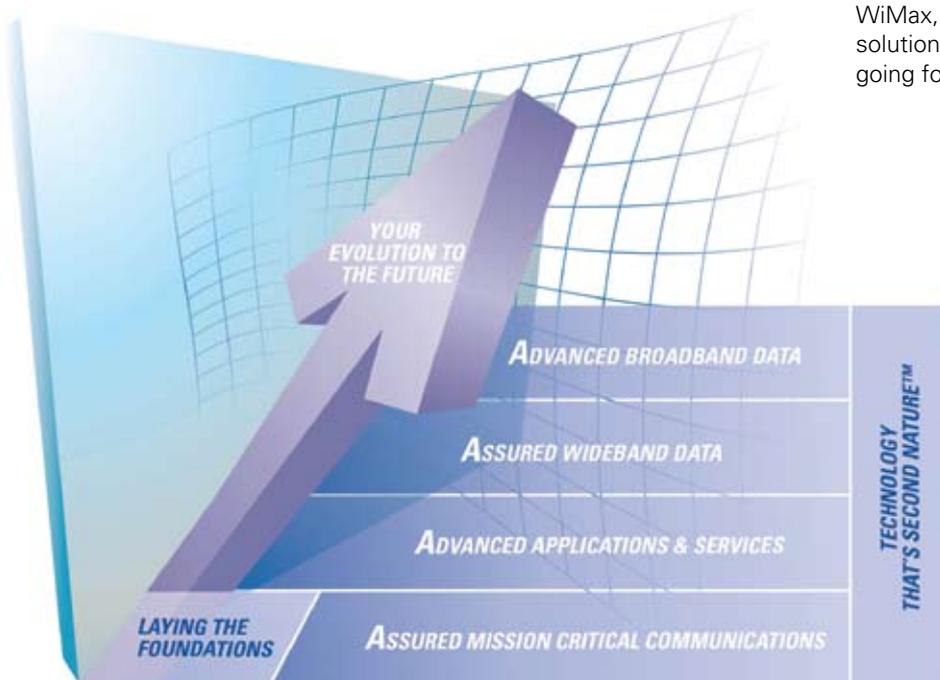
What's more, today's TETRA solution is easily evolved to support advanced applications & services, and assures wideband and advanced broadband data.

Once the secure and resilient TETRA foundation has been laid, TETRA's integrated voice and data capabilities can enable further returns on investment. Examples are the use of SDS and status messaging to report on activity This will facilitate maintenance, dispatch & work ticket

management. WAP may be used to enable pull information for task lists and automatic (push) filing of reports for remote workers. This means workers can spend more time where they are needed – in the field.

The availability of TETRA Enhanced Data Service (TEDS) technology will drive new efficiency-enabling applications, such as real time video, asset and workforce management and Mobile Office. It will also provide additional capacity for concurrent data usage by multiple users sharing the same data channels, and intelligent mechanisms for managing the distribution of data resources between users.

Finally, advanced wireless Broadband solutions can complement the secure and resilient foundation provided by TETRA As a leading supplier of Wireless Broadband solutions such as Mesh and WiMax, Motorola is able to provide complementary solutions to meet the needs of oil and gas users going forwards.



MOTOROLA – CRITICAL COMMUNICATIONS HERITAGE

Motorola's Enterprise Mobility Solutions division offers a range of solutions based on professional 2-way radio, TETRA, Project 25, Network services & applications, Fixed and mobile data and Wireless broadband. This gives Motorola a tremendous portfolio of solutions that we can leverage for critical communications customers around the world.

Motorola is the market leader in critical communications, supporting both TETRA and APCO standards. Motorola has supplied more than one million TETRA terminals and over 450 TETRA systems in more than 80 countries. Motorola is fully committed to the future of TETRA infrastructure and devices, and also committed as a long term partner to our TETRA customers, with contract commitments extending to 20 years.

MOTOROLA EXPERIENCE IN OIL AND GAS

Some of Motorola's Oil & Gas customers that benefit from Motorola's Business Critical solutions:

- Caltex
- Exxon Mobil
- Petronas
- Shell
- TOTAL
- Unocal
- Karachaganak
- Kaspygazprom
- Reliance Jamnager
- SK Corp
- OMV (Vienna)

Plus confidential awards....



MINI-GLOSSARY

Term / Acronym	Description / Complete Name
ALT	Accelerated Life Testing
APCO	Digital Radio standard
ATEX	ATmosphères EXplosibles
AVL	Automatic vehicle Location
BTS	Base Transceiver Station
ETSI	European Telecommunications Standards Institute
GPS	Global Positioning System
IP	Internet Protocol
MSPD	Multi Slot Packet data
MTBF	Mean Time Before Failure
PABX	Private Automatic Branch eXchange
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
PTT	Push To Talk
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
SDS	Short Data Service
TETRA	TErrestrial Trunked RAdio
TEDS	TETRA Enhanced Data Service
WAP	Wireless Application Portfolio

