TETRA, APCO Project 25 and GSM Communications Standards

TETRA (Europe)
Terrestrial Trunked Radio (TETRA) is a professional mobile radio and two-way transceiver standard designed for use by government agencies, emergency services, police force, fire department, ambulance, rail transportation staff, transport services and the military. TETRA is an ETSI standard, first version published 1995. TETRA is endorsed by the European Radio Communications Committee (ERC) and mandated for use in Europe. TETRA uses Time Division Multiple Access (TDMA) with four user channels on one radio carrier and 25 kHz spacing between carriers. Both point-to-point and point-to-multipoint transfer can be used. Digital data transmission is also included in the standard though at a low data rate.

TETRA Mobile Stations (MS) can communicate Direct Mode or using Trunked infrastructure (Switching and Management Infrastructure or SwMI) made of TETRA Base Stations (TBS). As well as allowing direct communications in situations where network coverage is not available, Direct Mode or DMO also includes the possibility of using one or a chain of TETRA terminals as relays for a signal. This functionality is called DMO gateway (from DMO to TMO) or DMO Repeater (DMO to DMO). In Emergency situations this feature allows direct communications underground or in areas of bad coverage.

In addition to voice and dispatch services, the TETRA system supports several types of data communication. Status messages and short data services (SDS) are provided over the system's main control channel, while Packet Data or Circuit switched data communication uses specifically assigned traffic channels. TETRA provides Authentication Mechanisms of Terminals towards Infrastructure and vice versa. For protection against eavesdropping, over the air encryption and end-to-end encryption is available.

TETRA Benefits
Some advantages of TETRA over other technologies (GSM):
* The lower frequency used gives longer range, which permits very high levels of geographic coverage with a smaller number of transmitters, thus cutting infrastructure costs.
* High spectral efficiency - 4 channels in 25 kHz and no guard bands, compared to GSM with 8 channels in 200 kHz and guard bands.
* very fast call set-up - a one to many group call is generally set-up within 0.5 seconds (typical less than 250 msec for a single node call) compared with the many seconds (typically 7 to 10s) that are required for a GSM network.
* Works at high speeds >400 km/h. TETRA was used during the French TGV train speed record on 3 April 2007 at 574.8 km/h.
* the system contains several mechanisms, designed into the protocols and radio parameters, to ensure communication success even during overload situations (e.g. during
major public events or disaster situations), thus calls will always get through unlike in cellular systems. The system also supports a range of emergency calling modes.

* TETRA infrastructure is usually separate from (but connected to) that of the public (mobile) phone networks, resulting in (normally) no call charges for the system owners, substantially more diverse and resilient communications and it is easy to customise and integrate with data applications (vehicle location, GIS databases, dispatch systems etc).

* unlike most cellular technologies, TETRA networks typically provide a number of fall-back modes such as the ability for a base station to process local calls. So called Mission Critical networks can be built with TETRA where all aspects are fail-safe/multiple-redundant.

* in the absence of a network mobiles/portables can use 'direct mode' whereby they share channels directly (walkie-talkie mode).

* gateway mode - where a single mobile with connection to the network can act as a relay for other nearby mobiles that are out of range of the infrastructure.

* TETRA also provides a point-to-point function that traditional analogue emergency services radio systems did not provide. This enables users to have a one-to-one trunked 'radio' link between sets without the need for the direct involvement of a control room operator/dispatcher.

* unlike the cellular technologies, which connect one subscriber to one other subscriber (one-to-one) then TETRA is built to do one-to-one, one-to-many and many-to-many. These operational modes are directly relevant to the public safety and professional users.

* TETRA supports both air-interface encryption and End-to-end encryption

* Rapid deployment (transportable) network solutions are available for disaster relief and temporary capacity provision.

* Equipment is available from many suppliers around the world, thus providing the benefits of competition

* Network solutions are available in both the older circuit-switched (telephone like) architectures and flat, IP architectures with soft (software) switches.

**APCO Project 25 (North America)**

Project 25 (P25) or APCO-25 refer to a suite of standards for digital radio communications for use by federal, state/province and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in emergencies. In this regard, P25 fills the same role as the European Tetra protocol, although not interoperable with it.

P25 was established to address the need for common digital public safety radio communications standards for First Responders and Homeland Security/Emergency Response professionals. TIA TR-8 facilitates such work through its role as an ANSI-accredited Standards Development Organization (SDO). Project 25 (P25) is a set of standards produced through the joint efforts of the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected Federal Agencies and the National Communications System (NCS), and standardized under the Telecommunications Industry Association (TIA)... The P25 suite of standards involves digital Land Mobile Radio (LMR) services for local, state/provincial and national (federal) public safety organizations and agencies. P25 is applicable to LMR equipment authorized or licensed, in the U.S., under the National Telecommunications and Information Administration (NTIA) or Federal Communications Commission (FCC) rules and regulations.
Although developed primarily for North American public safety services, P25 technology and products are not limited to public safety alone and have also been selected and deployed in other private system applications worldwide. P25 equipment has also been selected for a railroad system, including rolling stock, personnel, and transportation vehicles. P25-compliant systems are being increasingly adopted and deployed. Radios can communicate in analog mode with legacy radios, and in either digital or analog mode with other P25 radios. Additionally, the deployment of P25-compliant systems will allow for a high degree of equipment interoperability and compatibility. P25 standards use the Improved Multiband Excitation (IMBE) vocoders which were designed by DVSI to encode/decode the analog audio signals. P25 may be used in "talk around" mode without any intervening equipment between two radios, in conventional mode where two radios communicate through a repeater or base station without trunking or in a trunked mode where traffic is automatically assigned to one or more voice channels by a Repeater or Base Station.

The protocol supports the use of DES encryption (56 bit), 2-key Triple-DES encryption (112 bits), 3-key Triple-DES encryption (168-bits), AES encryption at up to 256 bits keylength, RC4 (40 bits, sold by Motorola as Advanced Digital Privacy), or no encryption.

As public safety agencies evaluate their two-way radio needs for the future, many are reaching some similar conclusions:
Radio spectrum is becoming more congested
The demand for data transmission is more pronounced
Systems need increased functionality
Secure communication is a growing necessity
Improved voice quality is essential over more of the coverage area.

Of course, upgrading a communications network is a major undertaking in terms of time, energy and expense. A number of possible solutions are available, including the digital technologies that will become, and are now becoming, available. They offer the potential to address many or all major concerns, and they can provide a true platform for the future. However, the decision to go digital is only the first step. There are several different digital technologies on the market, making the selection difficult. Each one has its own set of features that may or may not suit public safety organizations.

The Association of Public-Safety Communications Officials - International, Inc. (APCO International) is committed to making the selection process easier through APCO 25, an industry-wide effort to set the recommended voluntary standards of uniform digital two-way radio technology for public safety organizations. By working together with APCO International, public safety agencies can take this opportunity to move technology along a common path that benefits the greatest number of users.

There are two phases of P25 development:
Phase 1 is completed - It specifies a 12.5 kHz bandwidth.
Phase 2 is in development - It will use a 6.25 kHz equivalent bandwidth to allow better spectrum efficiency and benefit a greater number of users.
GSM (Global)

GSM (Global System for Mobile communications) is the most popular standard for mobile phones in the world. Its promoter, the GSM Association, estimates that 80% of the global mobile market uses the standard. GSM is used by over 3 billion people across more than 212 countries and territories.[2][3] Its ubiquity makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world. GSM differs from its predecessors in that both signaling and speech channels are digital, and thus is considered a second generation (2G) mobile phone system. This has also meant that data communication was easy to build into the system.