Frequently Asked Questions (FAQ) about TETRA, SCADA, Telemetry and Telecontrol

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What are SCADA, Telemetry and Telecontrol?

SCADA stands for "Supervisory, Control and Data Acquisition" and is fairly broad term that covers the remote measurement (see also Telemetry) and control (see also Telecontrol) of plant and equipment.

'Telemetry' refers to the remote measurement and reporting of information, from remote sensors, meters etc.

'Telecontrol' refers to the remote control of equipment such as power switches and breakers, including load control/load shedding, valves and actuators.

SCADA systems have been in existence for many years, and do not have to use radio communications. However since outstations are often in remote areas, radio bearers are an important part of many modern SCADA systems.

What are the traditional SCADA markets?

Traditional SCADA systems are used in many utilities, including electricity and gas distribution. They are also used for clean water distribution and waste water removal. There is extensive use in oil and gas production.

What are the up and coming SCADA markets?

- **Smart grid**: as part of an electricity power system can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to deliver sustainable, economic and secure supplies
- **Smart city***: smart buildings and integrated city services, utilities, waste management, lighting, heating, transport etc.
- **Smart meter***: typically includes two-way communication to the energy supplier, real-time consumption/billing information to consumer and load management capability (electricity).

Who is actually using SCADA over TETRA?

There are many SCADA schemes using TETRA. Some examples are:

- Electricity : Stromnetz Berlin, Creos (Luxembourg), CLP Power (Hong Kong), Kepco (Korea). Energa (Poland), Tauron (Poland)
- Oil and Gas: Sasol (South Africa), Sibur (Siberia), Saudi Aramco (Saudi Arabia)
- Police: South African Police
- Water: Bilbao Water (Bilbao)
- Maritime: Port of Valencia and Ebro River
- Mining: Mobilight (USA), Pilbara Mine, Mount Whaleback mine (Pilbara)

What TETRA bearers can be used for SCADA?

Status Message

- A Status message is the shortest and fastest way to send or receive command or state information over TETRA
- Status Message size is a 16 Bit word giving 65,35 codes of which typically more than 28,000 are available for users
- Destination may be TETRA system dependent: can usually be sent from outstations to SCADA host and some systems may also allow status to be sent from SCADA host to outstations

SDS (Short Data Service) Messaging

- An SDS message is similar to an SMS text message in GSM networks but a SDS will be instantly delivered
- SDS message size typically 130 characters
- Multi SDS can be used for larger data

Packet Switched Data

- With Packet Data, IP communication is possible on TETRA networks
- Packed Data uses Traffic Channels for communication, in the same way as voice communication
- TETRA provides Packet Data channel sharing between devices (not all networks)
- Single or multi-slots can be allocated. Capacity is typically up to 3kbit/s for a single slot or multiple slots can be used to increase capacity (up to three slots can be used on the main carrier or upto four timeslots on additional carriers)
- UDP is preferred. TCP can be used but needs care over a wireless channel.

Circuit Switched Data

- Circuit mode service can offer up to 4.8kbit/s with low error protection, but there is limited support by suppliers

What is TEDS?

TEDS stands for TETRA Enhanced Data Service and uses QAM modulation and wider RF channels to achieve higher data rates. Typically up to 80kb/s is achievable using a 50KHz carrier and the highest modulation rate.

What is a TETRA Control Channel?

A TETRA control channel is used to control mobile stations (radios) in each cell. It includes signalling for call setup as well as broadcast information such as neighbour cell details. Each TETRA base station has at least one control channel (the main control channel) which is broadcast on the 'main' carrier.

How much capacity does a TETRA main Control Channel have?

The main control channel capacity is just over 17 timeslots per second but only some of this is available for user signalling. The base station advertises forthcoming random access slots that can be used by radios. It is not possible to give a definitive figure of capacity as the base station allocates capacity dynamically depending upon the current loading of the cell and the allocation mechanism can vary between manufacturers.

What are Secondary Control Channels?

The main control channel (MCCH) always occupies the first time slot on the main carrier. Additional secondary control channels can be allocated to each of the remaining three timeslots so that a single carrier can support a maximum of four control channels.

What sorts of TETRA Architectures are typically used?

SCADA using only Radio to Radio Communication

- Easy to set up
- No need to be physically linked to the TETRA switch (infrastructure)
- Point to Point and Point to Multi Point
- Low cost solution
- Two RF links to the TETRA infrastructure (SwMi) needed
- Reduced end-to-end communication speed

SCADA using an SDS Gateway to SCADA Host

- No RF traffic on the control room side
- About 50% faster than Radio-to-Radio communication
- Needs an SDS Gateway and an IP connection to the SCADA host
- SCADA host needs to support the SwMi API

SCADA using a Packet Data Gateway to SCADA Host

- No TETRA RF uplink on the control room side
- About 50% faster than Radio-to-Radio communication
- Reduces Main Control CHannel (MCCH) loading
- Needs a Packet Data Gateway and an IP connection to the SCADA host
- SCADA host needs to support the SwMi API

What serial Protocols can be used with TETRA?

- Most of the common serial protocols such as Modbus, DNP3, IEC60870 etc. can be used with TETRA.
- Depending on chosen TETRA architecture (radio/radio radio/gateway etc.) communication the SCADA Server response timeout will need to be tuned (typically between 2 and 5 seconds).
- Intelligent protocol compression algorithms in TETRA modems can allow line based protocols to be used with little modification whilst minimising TETRA air interface loading

What IP Protocols can be used with TETRA?

On Radio-to-Radio communication care should be taken when using TCP protocol (which is optimised for transport over a fixed rather than wireless link), but it is no problem to use UDP.

What is "Serial over IP" and when should it be used?

This refers to the packaging of serial data into IP packet data frames of up to 1500 bytes and sent over a packet data channel (single or multislot). This might for example be used where the TETRA Main Control Channel (MCCH) has limited capacity and Secondary Control Channels (SSCH) are not an option.

What is "Packet Data Channel Sharing"?

Packet data sharing refers to the ability of a TETRA network to allow multiple radios to share a packet data channel. This is not really necessary to be supported by all TETRA networks since there are other methods that can meet the requirements in this kind of applications.

Use of packet data sharing can increase the throughput for some low volume data polled SCADA applications. That means that the SCADA host server sends a request to an outstation asking for application data (e.g. water level, current). Once the outstation device has responded, the next field device will be polled and so on.
In case of Packet Data communication, as each outstation responds it will switch to the packet data traffic channel to send the reply.

The TETRA infrastructure (SwMI) can ensure a fair use of the available channel resources using normal MAC random access procedures and resource allocations via downlink slot. Allocation of resources can be based upon the amount of throughput requested in a mobile station's resource request or via a SwMI specific mechanism

How can TETRA be used efficiently for SCADA applications?

- For SCADA applications group communication should be avoided because it generates unwanted traffic
- Data compression should be used if possible
- A direct connection between the SCADA host and the TETRA switch gives a much better performance than using a radio (TETRA air interface) connection.
- For Data Applications using a dedicated SCCH avoids overload of the Main Control Channel

Can you give some real-life examples of TETRA short data throughput?

Performance of course is very dependent upon the type of application, the distribution of the radio terminals and other traffic on the network.

For a "bursty" polling type application on a live TETRA network measurements were made over a period of several weeks the typical time to send an SDS from a host application to a radio terminal and to get a reply was 600-700mS with 95% of messages being delivered in 2.4 seconds.

One manufacturer or TETRA modems has reported the following measurements for a DNP3 class poll (24 bytes sent to RTU and 18 bytes back) for a number of control channels (main + secondary). The figures show the maximum number of RTUs that can be polled within 40 seconds.

40s DNP3 Poll	One Polling Node	Two Polling Nodes	Three Polling Nodes	Eight Polling Nodes
One timeslot	36	70	105	140
Two timeslots	69	134	207	270
Three timeslots	106	204	296	360
Four timeslots	146	280	270	420

Can you give some real-life examples of TETRA packet data throughput?

The following tests were carried out by a modem supplier in their test lab.
A TETRA base station with one RF Carrier was used. An IEC60870-5-104 Test Frame was sent without data compression to 10 RTUs per timeslot. Test figures are for a 15 minute polling cycle. (The test figures in brackets have been normalised to a 40 second polling cycle to give a allow a rough comparison with the SDS figures)

IEC60870-5-104 Test Frame	One Polling Node	Two Polling Nodes	Three Polling Nodes	Four Polling Nodes
One timeslot	1260 (56)	2070 (92)	2410 (107)	< 2500 (<111)
Two timeslots	2500 (111)	4100 (182)	2750 (122)	
Three timeslots	3750(166)	6110 (271)	6850 (304)	

As a comparison, the same supplier has also stated that for uploading and updating their modem firmware when using IP (Packet Data) communication and the TFTP protocol approximately one Megabyte of Data can be uploaded (or downloaded) per one hour on one single TETRSA channel (Time Slot). This is based upon actual measurements.