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### **TETRA Overview**

TETRA (Terrestrial Trunked Radio) is a digital, trunked mobile radio standard developed by ETSI, the European Telecommunications Standards Institute. TETRA was designed using the experience gained from GSM and from several trunked radio systems. It provides some security measures including authentication mechanisms, air interface encryption and end-to-end encryption. TETRA has found widespread use all over Europe and also outside the EU in public safety, transportation, military and general land mobile applications.

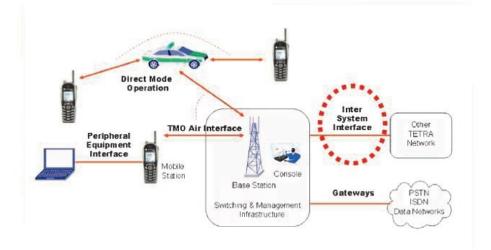


Fig. 1 TETRA network architecture

#### **TETRA Architecture**

The common mode of operation is the group calling mode where the user pressing the talk-button is heard by all other users in the same call group. On the other hand private calling enables users to talk in a one-to-one walkie-talkie-like mode. As a more advanced option it is also possible that the devices act as mobile phones where two users can talk in a full-duplex, direct connection like in GSM. Moreover it is possible to transmit Short Data Services (SDS) messages such as SMS, status messages or GPS coordinates and IP data over packet data service.

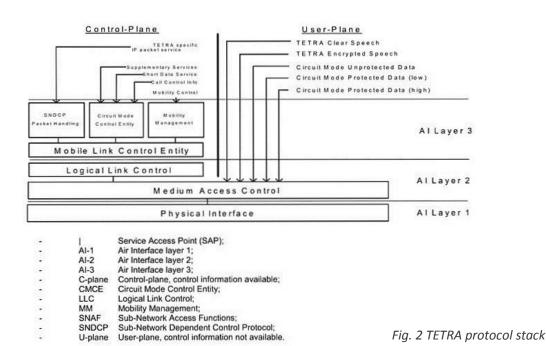
Mobile stations (MS) can communicate either in

Direct Mode (DMO) using a shared frequency or they can communicate using the trunked infrastructure (TMO) after subscribing to a base station. In the Direct Mode, the MSs should be located in the same geographical area. Any MS can access the channel any time if the channel is free and not reserved. DMO allows relay connectivity using a mobile station in a car as a repeater or as a gateway to the TETRA network.

In TMO, the MSs can be located in different geographical areas and the channel access and slot and frequency allocations are handled by the base stations (see fig. 1).



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# TETRA Protocol Stack

The complete protocol stack for TETRA is depicted in fig. 2. On the physical layer TETRA uses TDMA with 4 time slots and a  $\pi$ /4-DQPSK, pulse shaping modulation scheme in a 25 kHz wide radio channel and a channel rate of 36 kBit/s. The voice codec used is ACELP. Data is organized into a frame structure shown in fig. 3. The higher level protocol layers are divided into a user plane, which handles user voice and data and a control plane (see fig. 2), which handles signaling and control data. Synchronization and other functions as encryption are based on a frame structure (see in fig. 3).

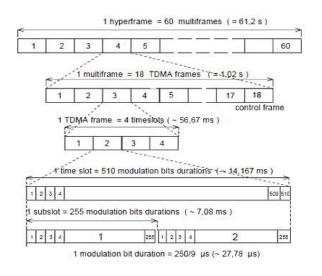


Fig. 3 TETRA frame structure

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The data link layer interleaves, scrambles and adds various error-protection functions to the payload data as is evident in the bit processing path of a TETRA terminal illustrated in fig. 4.

As is the case for GSM, TETRA also maintains a complex hierarchy of logical channels mapped to the physical channels, which are the Control Physical channel in time slot 1 and the Traffic

Physical channels in slots 2-4. The logical Main Control Channel (MCCH) resides in slot 1. All terminals listen to this channel when in idle state. TETRA supports end-to-end encryption under use control as well as air interface encryption. A great number of security related TETRA networks employ encryption.

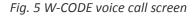
1) BLOCK ENCODER (2) CONVOLUTIONAL (3) RE-ORDERER AND (4) SCRAMBLE	ER (5) LOGICAL CHANNEL MULTIPLEXER (6)
(1) type-1 information bits (transmit)	BURST BUILDER
(2) type-2 block encoded bits	
(3) type-3 convolutionally encoded bits	DIFFERENTIAL
(4) type-4 re-ordered and interleaved bits	(8)
(5) type-5 scrambled bits	MODULATOR
(6) multiplexed bits	
(7) modulation bits	TRANSMITTER
(8) modulation symbols	L

Fig. 4 Bit processing in a TET-RA terminal (transmit functions)

#### **TETRA Implementation**

WAVECOM's implementation of TETRA is based on TETRA release 1 (TETRA V+D, Voice and Data) and will decode all voice and data traffic albeit with certain constraints. All layer 3 PDUs can be partially decoded (see the TETRA section of the Wavecom Decoder User Manual). TMO and DMO voice calls and SDS messages in all time slots are decoded and can be monitored in real-time as well as being saved to disk for later playback and analysis (see Fig. 5 and Fig. 6).

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ot Mode	e	ID			Dest 1	ination											
ot Mode	e ID	ID	Desti	nation	Dest 1 Source		Date		ATED		File						
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ot Mode	ID 2	ID	2	nation	1 Source 2		07.03.2013	Tim 11:: 11:4	ATED e 39:29	1	1425 1425 1425		130307	1140	07_T 15_T	ETRA_	TMO



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Encrypted data and voice poses specific problems for decoding as decryption of the payload is not attempted. In the current decoder version encrypted traffic similar to other traffic will trigger the indication "TRAFFIC" in the status box, and an option is available for saving traffic to a text file. Saved data and meta-information may be fed to an external decryption process.

A sample of the text file containing encrypted voice and meta-data is shown below:

TMO: Main Freq: 393.912 MHz 383.912 MHz MCC: 123 MNC: 4567 LA: 15972 Security class 3 and class 1 CN: 3756 CC: 2

Encrypted Channel Allocation Dest: 568463 Slot: 1 Frame: 11 Enc. Mode: 2

2 8 40 5337 (slot - frame - multi-frame - hyper-frame)

The Short Data Service (SDS) includes a number of protocols of which the Wavecom decoder fully supports Text Messaging. Other data protocols are

displayed as bits due to the lack of detailed protocol descriptions.

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	-4000 Hz	4000 Hz						
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Faighbour(s): 4	27.121							
lender: 10075	2 Sestimation:	100701						
Protocol: Tes	it Messaging Ma	g. ID: 167						
Navecon the s	reference in da	ta Secoding, Trunked	Mode test mess	age				
Sender: 10070	1 Destanations	100702						
Protocol: Tes	t Messaging St	G data transfer 2000	222 Mag. 10: 14	67				
4								>
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Node TMO TMO	168 168	100701 100702	100702 100701	30.08.2010 30.08.2010	08:54:37 08:54:37	VTETRA_TMO_SDS_168 VTETRA_TMO_SDS_168	3_100702_2010.08.30_0	8
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Noie TMO TMO TMO TMO TMO TMO	168 168 169 169	100701 100702 100701 100701	100702 100701 100702 100702	30.08.2010 30.08.2010 30.08.2010 30.08.2010 30.08.2010	08:54:37 08:54:37 08:54:42 08:54:42	VIETRA_TMO_SDE_166 VIETRA_TMO_SDE_166 VIETRA_TMO_SDE_169 VIETRA_TMO_SDE_169 VIETRA_TMO_SDE_167	3 100702 2010.08.30 0 9 100701 2010.08.30 0 100702 2010.08.30 0	8 9.5 9.5
Node TMO	168 168 169 169 167	100701 100702 100701 100702 100701	100702 100701 100702 100702 100702	30.08.2010 30.08.2010 30.08.2010 30.08.2010 30.08.2010 30.08.2010	08:54:37 08:54:37 08:54:42 08:54:42 08:54:42 08:54:51 08:54:51	VIETRA_TMO_SDE_166 VIETRA_TMO_SDE_166 VIETRA_TMO_SDE_169 VIETRA_TMO_SDE_169 VIETRA_TMO_SDE_167	3 100702 2010.08.30 0 0 100701 2010.08.30 0 100702 2010.08.30 0 2 100702 2010.08.30 0	8 9.5 9.5

Fig. 6 W-CODE SDS decoding

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Since more than thirty years Wavecom Elektronik AG has developed, manufactured and distributed high quality devices and software for the decoding and retrieval of information from wireless data communication in all frequency bands. The nature of the data communication may be arbitrary, but commonly contains text, images and voice. The company is internationally established within this industry and maintains a longstanding, world-wide network of distributors and business partners.

#### **Product Information**

Products	http://www.wavecom.ch/product-summary.php
Datasheets	http://www.wavecom.ch/brochures.php
Specifications	http://www.wavecom.ch/product-specifications.php
Documentation	http://www.wavecom.ch/manuals.php
Online help	http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm
Software warranty	One year free releases and bug fixes, update by DVD
Hardware warranty	Two years hardware warranty
Prices	http://www.wavecom.ch/contact-us.php

#### **System Requirements**

	Minimum	Recommended
CPU	Core i5 or Core i7 2.8 GHz	Core i7-6700 3.4 GHz
Memory	4 - 8 GB RAM	16 - 32 GB RAM
OS	Windows 7	Windows 10 32-bit or 64-bit

#### **Distributors and Regional Contacts**

You will find a list of distributors and regional contacts at <u>http://www.wavecom.ch/distributors.php</u>



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