TETRAPOL Digital Professional Mobile Radio

Advanced Protocols

WAVECOM NACHRICHTENTECHNIK

TETRAPOL Overview

TETRAPOL is a digital trunked mobile radio standard, using an open, digital, purpose-built PMR (professional mobile radio) technology for mission-critical public safety users. TETRAPOL offers voice and data services for the most demanding users and professional organizations for mission-critical communications.

TETRAPOL was developed by Matra Communication (today AIRBUS), France. The first users of TETRAPOL were the Gendarmerie (mid 1992) and then the police (early 1995) in France. Today the TETRAPOL technology is supported and further developed by two organizations: by TETRAPOL-Forum (mainly manufacturer) and User's club. The main users of the trunked communication system are closed user groups, such as transport services (taxi, state railway and local transport companies), airports, energy companies and public security agencies (as police, fire brigade, rescue forces, army, civil protection and boarder control etc.). [5] Different to the mobile cell phone, the number of participants of a digital trunked communication system (as TETRAPOL) is limited. However, TETRAPOL provides a secure and robust voice and data communication in critical situations.

Currently, TETRAPOL is proven around the world with 85 networks in around 30 countries. TETRAPOL Forum (www.tetrapol.com) provides a collection of manufacturers of TETRAPOL products. The Publicly Available Standard (PAS), which defines the various interfaces in a TETRAPOL infrastructure, can be downloaded by registered users.

TETRAPOL Operating Mode

The TETRAPOL system works in mainly three different modes:

- Network mode. In this mode, the terminals connect to a base station (a fixed infrastructure) and are controlled by this. The communication between two mobile stations (MS) always run through the base station (BS).
- Direct mode. In this mode two or more mobile stations communicate to each other directly, without the co-ordination by a base station. This so-called walkie-talkie mode can work also in area where the base station can not cover, e.g., in a tunnel or basement of a building.
- Repeat mode. The communication run through a repeater, which just relays the signal. It does not have any co-ordination functions. The mobile stations can communicate in a longer distance than in direct mode.

The Fig. 1 shows the TETRAPOL operating mode.

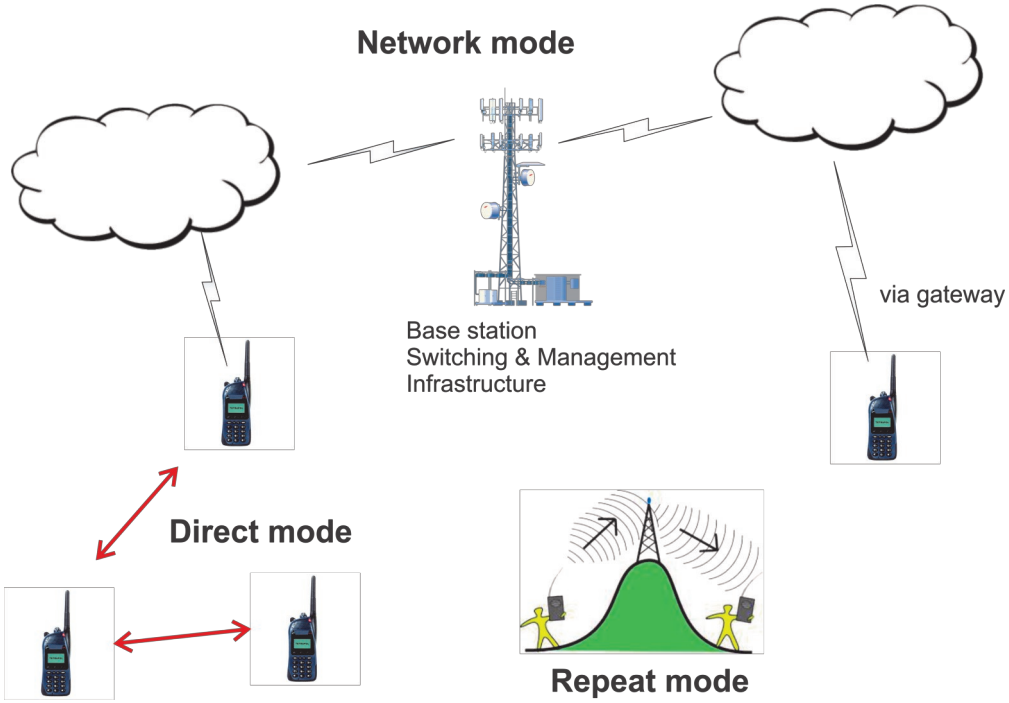

Fig. 1 TETRAPOL operating mode.

TETRAPOL Protocol Stack

The TETRAPOL radio protocol layers are shown in Fig. 2. They include:

- Call Control (CC), Mobility Management (MM) and Data Application layers (Layer 4);
- Transport layer (Layer 3);
- Link Level Control (LLC) + Medium Access Control (MAC) (Layer 2) and
- Physical layer (Layer 1).

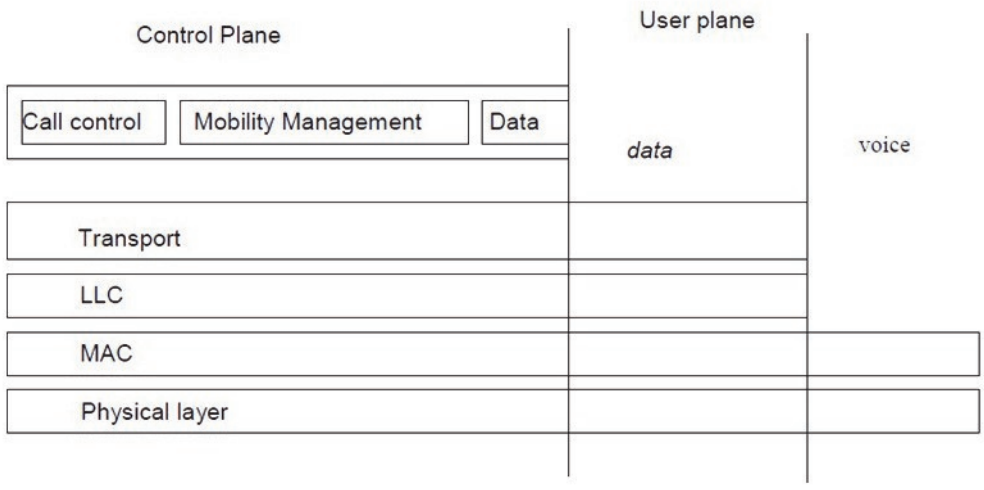

Fig. 2 TETRAPOL protocol stack [1].

In the TETRAPOL Physical Layer, systems may operate at radio frequencies of 70 MHz to 520 MHz both in VHF (Very High Frequency) and UHF (Ultra High Frequency) versions. TETRAPOL chooses the FDMA (Frequency Division Multiple Access) as channel access method. The channel bandwidth is 5 MHz with channel spacing of 10 kHz or 12.5 kHz.

TETRAPOL uses the GMSK (Gaussian Minimum Shift Keying) modulation scheme at the symbol rate 8 kBd. The bit rate is 8 kpbs (bit per second) as well. Each radio link of a channel is a succession of 160-bit frames transmitted during 20 ms time intervals.

In the Network Mode a base station (BS) transmits one Control Channel (CCH) and several Traffic Channels (TCH), which can be in total up to 24 radio channels. Frames are organized in superframes, with a 4 seconds period (or 200 frames), which is synchronized by special frames in CCH, e.g., Paging Channel (PCH) and Broadcast Channel (BCH) frames.

The Control Channel contains BCH, SDCH (Signalling and Data Channel), DACH (Dynamic random Access Channel), PCH, RCH (Random access answer Channel) and RACH (Random Access Channel). Traffic Channel (TCH) contains SCH (Signalling Channel), SCH/TI (Signalling Channel / Transmitter Interruption), and Voice / Data Channel.

All these channel frames can be coded in 5 different types in the Network Mode: Voice, Data, Random Access Frames, Training Frame and SCH/TI Frames. Additionally, Direct Mode Emergency Frame can also be found in the Direct Mode.

Generally, the frame is obtained by several steps: Discriminator with CRC, Channel encoding, Interleaving, Scrambling with formatting, Differential with encoding and Modulation as in Fig. 3.

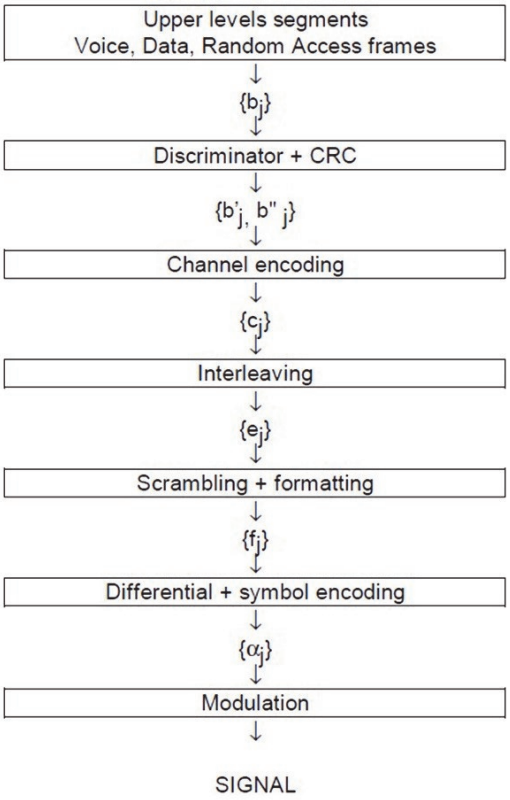

Fig. 3 General frame building scheme [2].

In the LLC (Link Level Control) layer, the transmission function is based on high-level data link control (HDLC) procedures which has basic format as Fig. 4. It has two bytes FCS check at the end of structure to check the bits error. RCH, PCH and some inter-frame time stuffing on SDCH have different structures [3]. The command field is used to distinguish between four different formats: Information (I), Supervision (S), DACH (A) and Unnumbered (U) format.

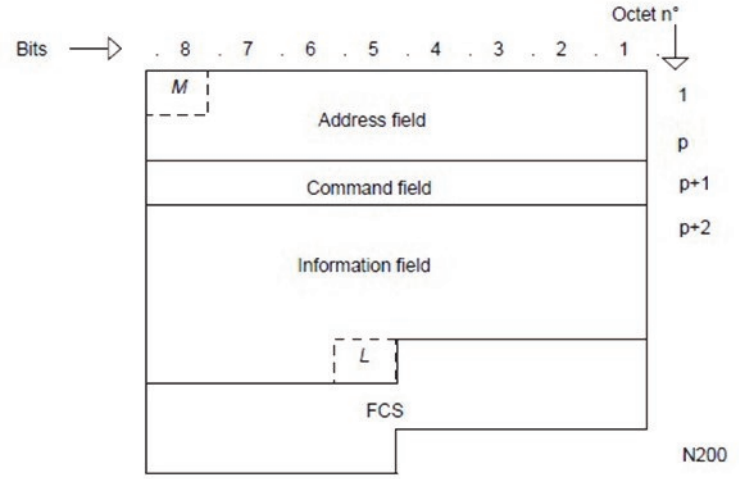

Fig. 4 HDLC data structure [3].

The information field of the I format contains basic TPDU (Transport service Protocol Data Unit) structure as shown in the left of Fig. 5. The TPDU header contains the SEG field delimits a user data TSDU (Transport Service Data Unit), which can be sent by several consecutive TPDU. The information field of the A format and U format may have slightly different structure as shown in the right of Fig. 5.
The TPDU also contains the code in the header to identify 8 different types: Connection Request (CR), Connection Confirm (CC), Fast Connection Request (FCR), Disconnection Request (DR), Fast Disconnection Request (FDR), Disconnection Confirm (DC), Data (DT) and Data Expedited (DTE).
The Application Layer can further process the message sent by TSDU with uniquely defined byte in the Code of Operation (CODOP) as in [4].

Most of the TSDU have the structure as shown in the right of Fig. 6. Some of the CR and CC has the TSDU format as shown in the left of Fig. 6.

TETRAPOL should not be mixed up with TETRA (another transmission mode with almost the same name). TETRA was standardized and developed by the ETSI (European Telecommunications Standards Institute) in co-operation with the industry. The standards for TETRA are in the ETSI library available. TETRAPOL is proprietary, not all detail standards are publically available. [5]
TETRAPOL and TETRA are the two most popular digital trunk communication systems in Europe. Wavecom supplies both decoders.

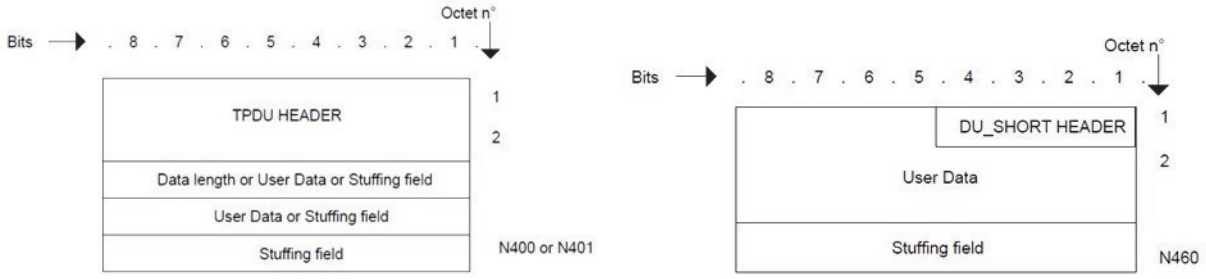

Fig. 5 Generic TPDU structure [3].

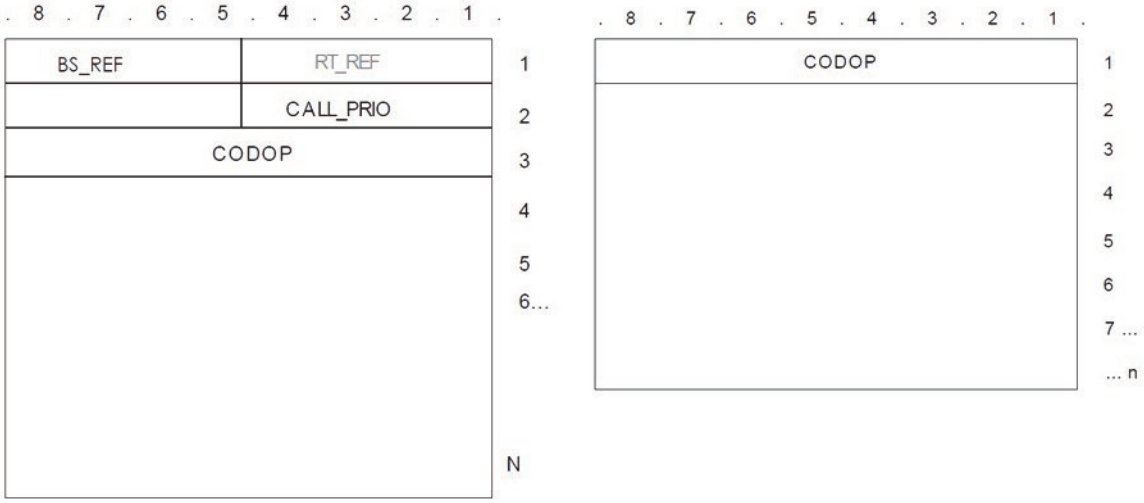

Fig. 6 Generic TSDU format [4].

TETRAPOL Implementation by Wavecom

The Wavecom implementation of TETRAPOL is shown in the screenshot Fig. 7. A powerful equalizer delivers the optimal demodulation / decoding in the physical level. The original data / voice frames are then displayed in the binary format. Each data and voice frame is output together with a timestamp in a resolution of 1 millisecond. This receiving resp. decoding timestamp is very helpful checking wether the real-time decoding works in a correct way and no frame is missed. After the bit level decoding, the data frames in the HDLC format are displayed in the hexadecimal format. The detail interpretations of the TSDU based on the protocol are displayed as well. The voice frame is encoded by the RP-CELP (Regular Pulse Code Excited Linear Prediction) technology. Wavecom TETRAPOL can decode the voice to the final stage and output it to the speaker for live monitoring purpose. At the same time each voice sessions is saved in a wav file and voice frames in bits are saved in a txt file.

Examples can be found in the TETRAPOL section of the Decoder User Manual.

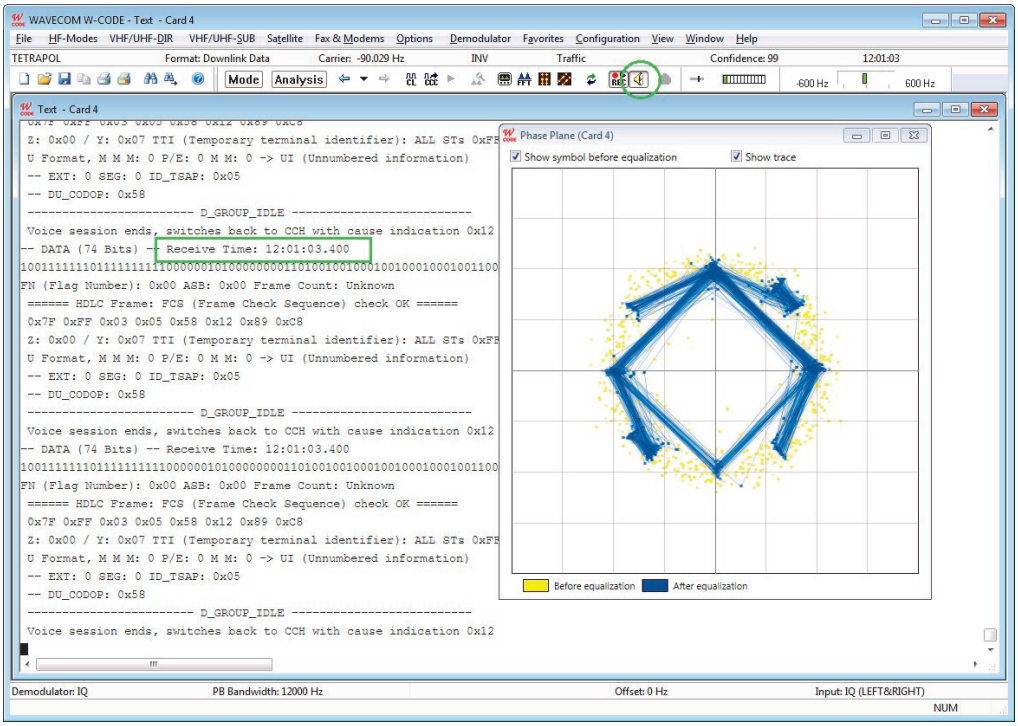

Fig. 7 TETRAPOL decoding screen in W-CODE. Live voice output to the speaker enabled.

Reference

[1] TETRAPOL Specifications Part 3-1: Air Interface Application Protocol, TETRAPOL Forum, 1999
[2] TETRAPOL Specifications Part 2: Radio Air Interface, TETRAPOL Forum, 1999
[3] TETRAPOL Specifications Part 3-3: Air Interface Transport Protocol, TETRAPOL Forum, 1999
[4] TETRAPOL Specifications Part 3-2: Air Interface Application Messages, TETRAPOL Forum, 1999
[5] TETRAPOL Faktenblatt: Bündelfunksystem für Sicherheitsorgane: Bundesamt für Kommunikation BAKOM, Swiss Confederation

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 http://www.wavecom.ch/content/ext/MonitoringSystemOnlineHelp/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	P4 Dual-Core 2.4 GHz	Core i5 or Core i7 2.8 GHz
Memory	2 GB RAM	4 - 8 GB RAM
OS	Windows XP	Windows 7 32-bit or Windows 7 64-bit

Distributors and Regional Contacts

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

WAVECOM ELEKTRONIK AG
8090 Zurich, Switzerland
E-Mail: sales@wavecom.ch
Internet: www.wavecom.ch