fjord-e-design

mobile communication engineering

TETRA

AirAnalyzer

Protocol analysis, tracing and measuring technology for TETRA radio networks

Contents

Outline

The TETRA AirAnalyzer (protocol analyzer) can be used to record and analyze the communication between TETRA components. In addition, the TETRA AirAnalyzer can be used to carry out measurements.

The entire radio communication between two frequencies (usually uplink and downlink) is monitored simultaneously. The frequencies can be chosen independently (the frequency range depends on the chosen option). Since TETRA uses a fourfold TDMA process the entire data of a total of 8 physical channels (time slots) is recorded.

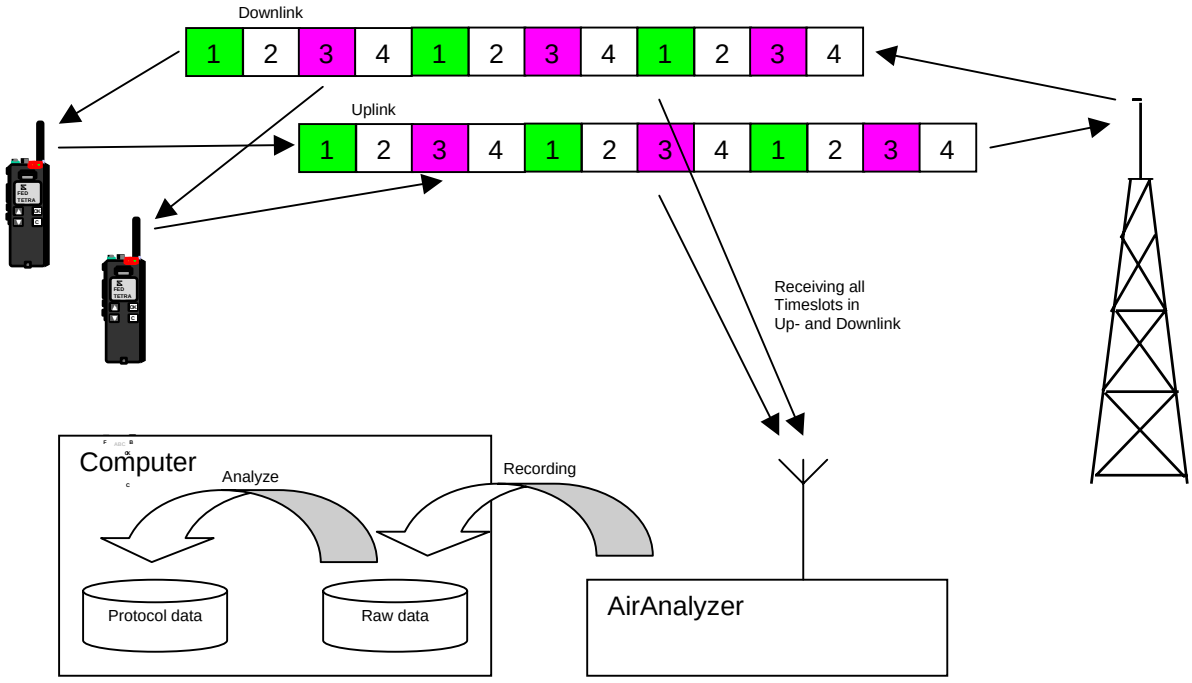

Figure 1: Overview of the TETRA AirAnalyzer functioning

The raw data saved on the hard disk of the computer always contains the demodulated bits of all time slots within the period of the analysis. The period for the analysis can be chosen.

The evaluation of the protocol (analysis) is carried out on the basis of this set of raw data. It is therefore possible to analyze the recorded data multiple times for different aspects.

Features

- High sensitive broadband receiver functionality (360 – 460 MHz) for the TETRA frequency range.
- Capturing/demodulation/decoding/saving of air interface data.
- Analysis of the captured data also with remote PC.
- External data input for LAN and file interface.
- Complex filtering of analyzed data (protocol/subscriber).
- Display in a graphical MSC view.
- Online analysis of live data with the MSC view.
- Display in the expert text view.
- Measurements (RSSI/frequency error/timing error) for each burst.
- Export/saving function of the MSC view data.
- Microsoft Windows® 2000, XP, 98 support.

Evaluation of the Protocol

The evaluation of the protocol offers the possibility to analyze, filter and display the recorded raw data.

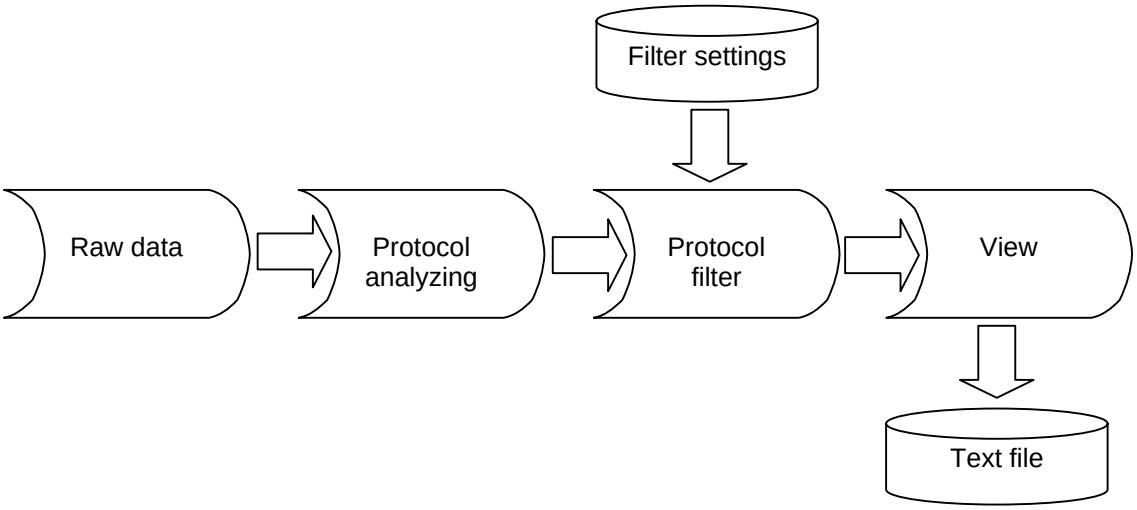

Figure 2: Protocol evaluation of the TETRA AirAnalyzer

Presentation / Storage

The presentation of the filtered signaling messages is MSC (message sequence charts, see Figure 3) and text based. But you can also use HEX format to present the raw data forming the basis (see Figure 4).
When using this presentation single PDU types may be filtered out to achieve a better overall view.
Each signaling message is marked by a time stamp. Because of the synchronizing data of the base station the time stamp contains the current valid frame data of the examined cell.

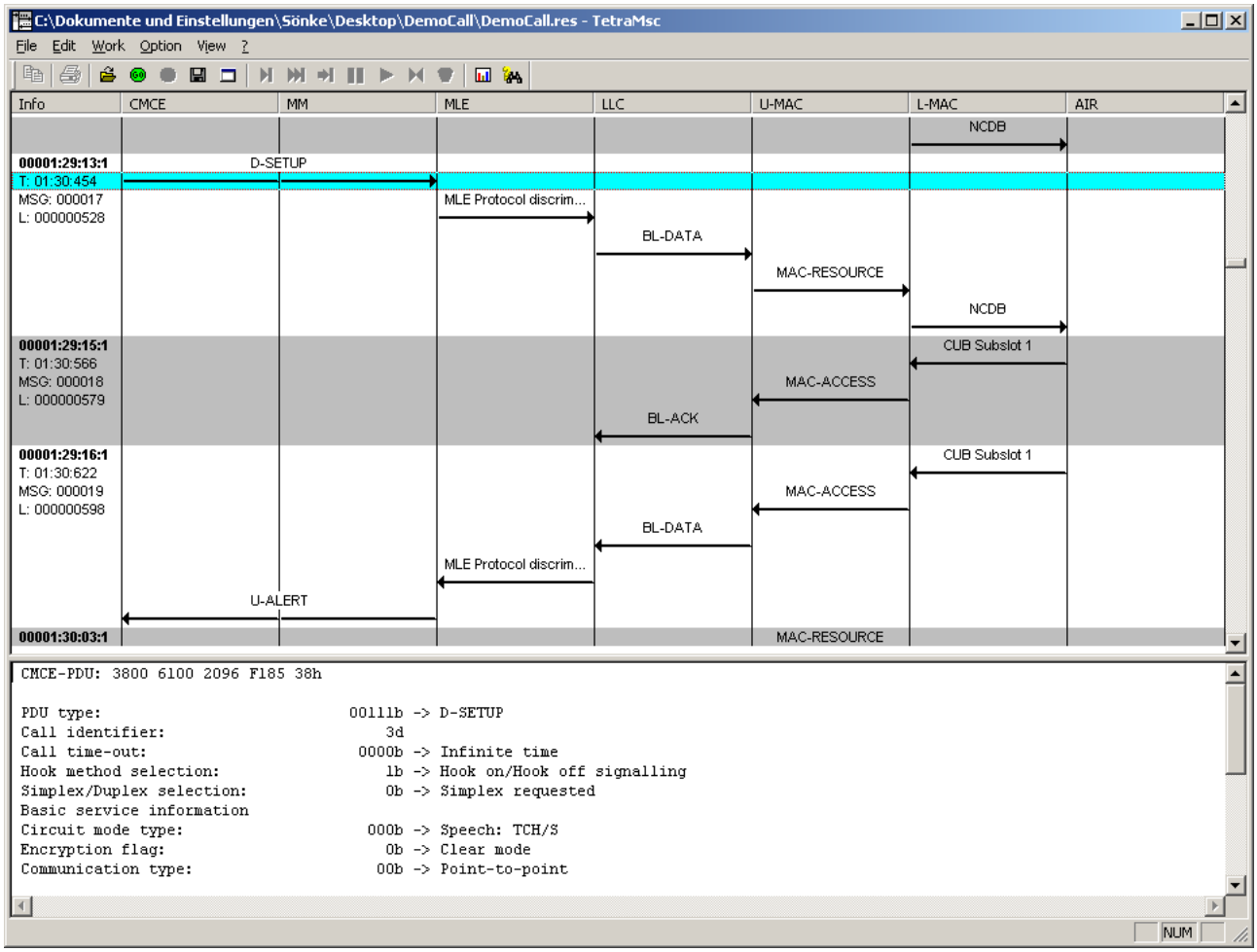

Figure 3: MSC chart of a call setup

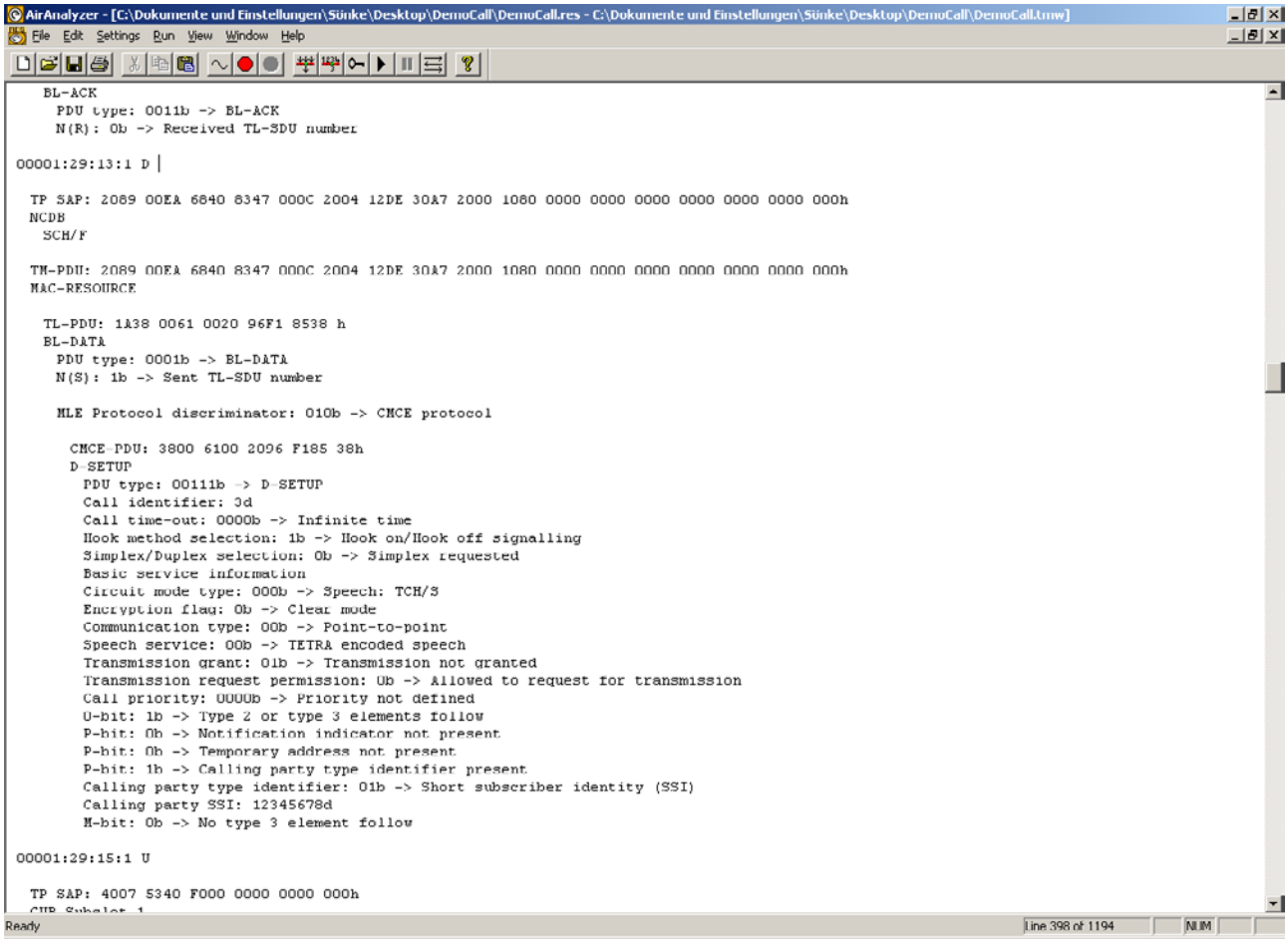

Figure 4: Expert view of a call setup PDU

The resulting filtered signaling messages can be stored in a file. This data is available in ASCII format for easy processing (see Figure 5). Apart from this data the file with the raw data is also available so that further analysis is possible.

democall.txt - Editor

Datei Bearbeiten Format ?

```
T00001:13:430 |                |                |                |----------->| MAC-RESOURCE |
M00000016     |                |                |                |            |------------->|
L00000504     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:29:13:1|        D-SETUP |                |                |            |              |
T00001:30:454 |--------------->|MLE Protocol discrim|            |            |              |
M00000017     |                |--------------->|        BL-DATA |            |              |
L00000528     |                |                |--------------->| MAC-RESOURCE |              |
              |                |                |                |------------->|              |
..............|................|................|................|............|..............|
F00001:29:15:1|                |                |                |            | MAC-ACCESS   |
T00001:30:566 |                |                |         BL-ACK |            |<-------------|
M00000018     |                |                |<---------------|            |              |
L00000579     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:29:16:1|                |                |                |            | MAC-ACCESS   |
T00001:30:622 |                |                |        BL-DATA |            |<-------------|
M00000019     |                |MLE Protocol discrim|<---------------|            |              |
L00000598     |        U-ALERT |<---------------|                |            |              |
              |<---------------|                |                |            |              |
..............|................|................|................|............|..............|
F00001:30:03:1|                |                |                |            | MAC-RESOURCE |
T00001:30:902 |                |                |                |            |------------->|
M00000020     |                |                |                |            |              |
L00000627     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:30:05:1|                |                |                |   DL-ACK   |              |
T00001:31:014 |                |                |                |----------->| MAC-RESOURCE |
M00000021     |                |                |                |            |------------->|
L00000646     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:34:01:1|                |                |                |            | MAC-ACCESS   |
T00001:34:822 |                |                |        DL-DATA |            |<-------------|
M00000022     |                |MLE Protocol discrim|<---------------|            |              |
L00000670     |      U-CONNECT |<---------------|                |            |              |
              |<---------------|                |                |            |              |
..............|................|................|................|............|..............|
F00001:34:06:1|                |                |                |   BL-ACK   |              |
T00001:35:102 |                |                |                |----------->| MAC-RESOURCE |
M00000023     |                |                |                |            |------------->|
L00000699     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:34:08:1|D-CONNECT ACKNOWLEDGE            |                |            |              |
T00001:35:214 |--------------->|MLE Protocol discrim|            |            |              |
M00000024     |                |--------------->|        BL-UDATA|            |              |
L00000723     |                |                |--------------->| MAC-RESOURCE |              |
              |                |                |                |------------->|              |
..............|................|................|................|............|..............|
F00001:34:17:2|                |                |                |   BL-ACK   |              |
T00001:35:732 |                |                |                |----------->| MAC-RESOURCE |
M00000025     |                |                |                |            |------------->|
L00000765     |                |                |                |            |              |
..............|................|................|................|............|..............|
F00001:35:02:2|        D-TX CEASED             |                |            |              |
T00001:35:900 |--------------->|MLE Protocol discrim|            |            |              |
M00000026     |                |--------------->|        BL-UDATA|            |              |
L00000790     |                |                |--------------->| MAC-RESOURCE |              |
              |                |                |                |------------->|              |
..............|................|................|................|............|..............|
```

Figure 5: exported ASCII file of the MSC application

External Data Input

There are several ways to run the TETRA AirAnalyzer Software without the hardware device connected, e.g. to run the software with a data stream via UDP or to analyze previously recorded/generated file:

- UDP LAN interface
  Two interface formats for the LAN interface are provided to analyze live LAN data via UDP packets presented like common air interface data or logically higher than U_MAC.

- File interface
  Disregarding the internal raw file format of the TETRA AirAnalyzer there are three simple but overall file formats specified that you may use to create external data.

Online Protocol Analysis

The following layers of the protocol TETRA Voice+Data are evaluated during the protocol analysis:

CMCE (CC, SDS), SS (relevant parts)
MM completely
MLE/BLE completely
LLC completely
Upper MAC completely
Lower MAC completely
Physical Layer completely

The analysis of the TETRA protocol trace is switchable online/offline (see Figure 6) so you may decide if the analyzed messages get displayed instantly on the screen or if you will analyze the trace offline after the recording process.

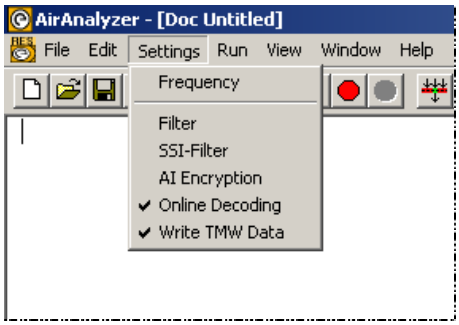

Figure 6: switching the Online Decoding on/off

The evaluation is carried out according to the TETRA Air Interface, Edition 2 (EN 300 392-2) and 300 392-7 for all security PDU types.

Additional TETRA standards (e.g. DMO) are available soon as an Option.

Filter

Fault tracing in communication protocols is usually quite difficult because of the quantity of the occurring messages. Only by adding powerful filters it is possible to get the right perspective while tracing for faults. The TETRA AirAnalyzer software offers two kind of filters to get master of the information flood:

adaptive SSI filter
extensive TETRA protocol filter

SSI filter

The adaptive SSI filter feeds in adaptive all existing SSI´s of the trace. Like shown in Figure 7 you will be able to choose specific SSI´s or to add manual SSI´s to filter the information in the trace.

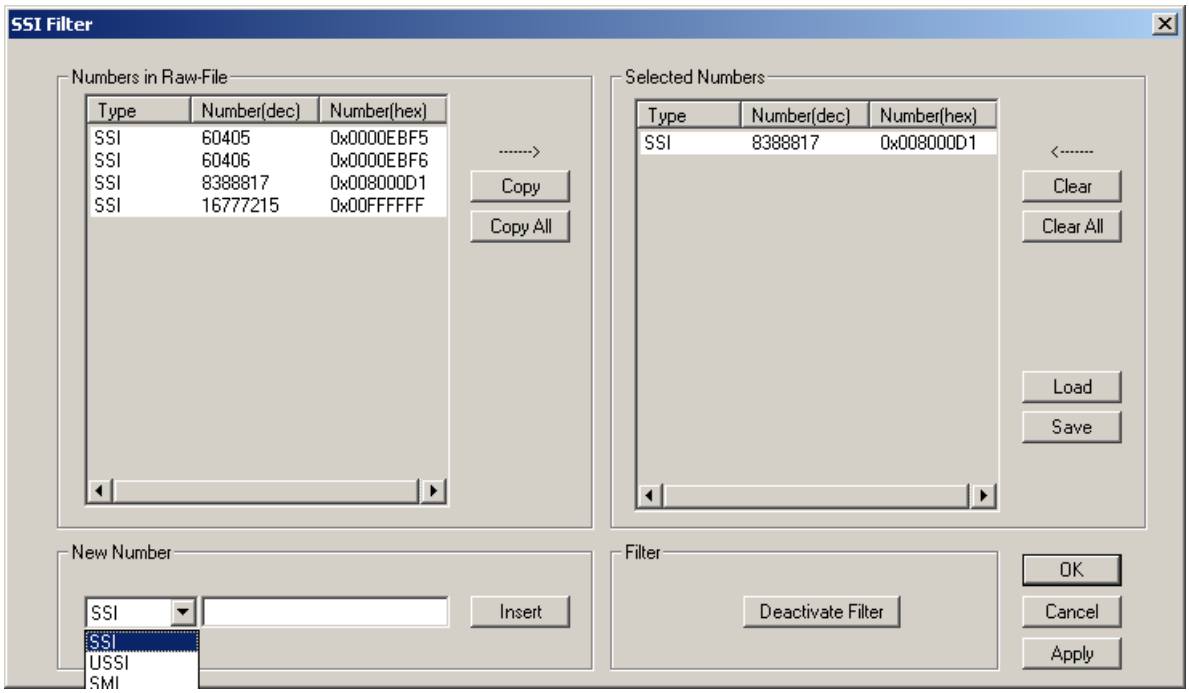

Figure 7: Filter specific messages by SSI

TETRA protocol filter

The TETRA AirAnalyzer offers the following TETRA protocol filters:

Physical Layer (PL)
- Slot 1
- Slot 2
- Slot 3
- Slot 4
- Frame 1-17
- Frame 18

Lower Medium Access Control (LMAC)
- L-MAC recursive
- Layer 1 Measurement
- Raw Data
- Logical Channels

Upper Medium Access Control (UMAC)
- Broadcast
  - Raw Data
  - PDU Types
  - PDU Elements
- Signaling
  - Raw Data
  - PDU Types
  - PDU Elements
- AACH
  - Raw Data
  - PDU Types
  - PDU Elements
- Null PDU

Logical Linc Control (LLC)
- Raw Data
- PDU Types
- PDU Elements

Mobility Management (MM)
- Raw Data
- PDU Types
- PDU Elements

Mobile Linc Entity (MLE)
- Broadcast
  - Raw Data
  - PDU Types
  - PDU Elements
- Signaling
  - Raw Data
  - PDU Types
  - PDU Elements

Circuit Mode Control Entity (CMCE)
- Raw Data
- PDU Types
- PDU Elements

TETRA Test (TT)
- Raw Data
- PDU Types
- PDU Elements

Layer 1 measurements

With the TETRA AirAnalyzer receiver or by external data input you will be able to display for each burst:

- power measurements
- Frequency error
- Timing error

like shown in Figure 8.

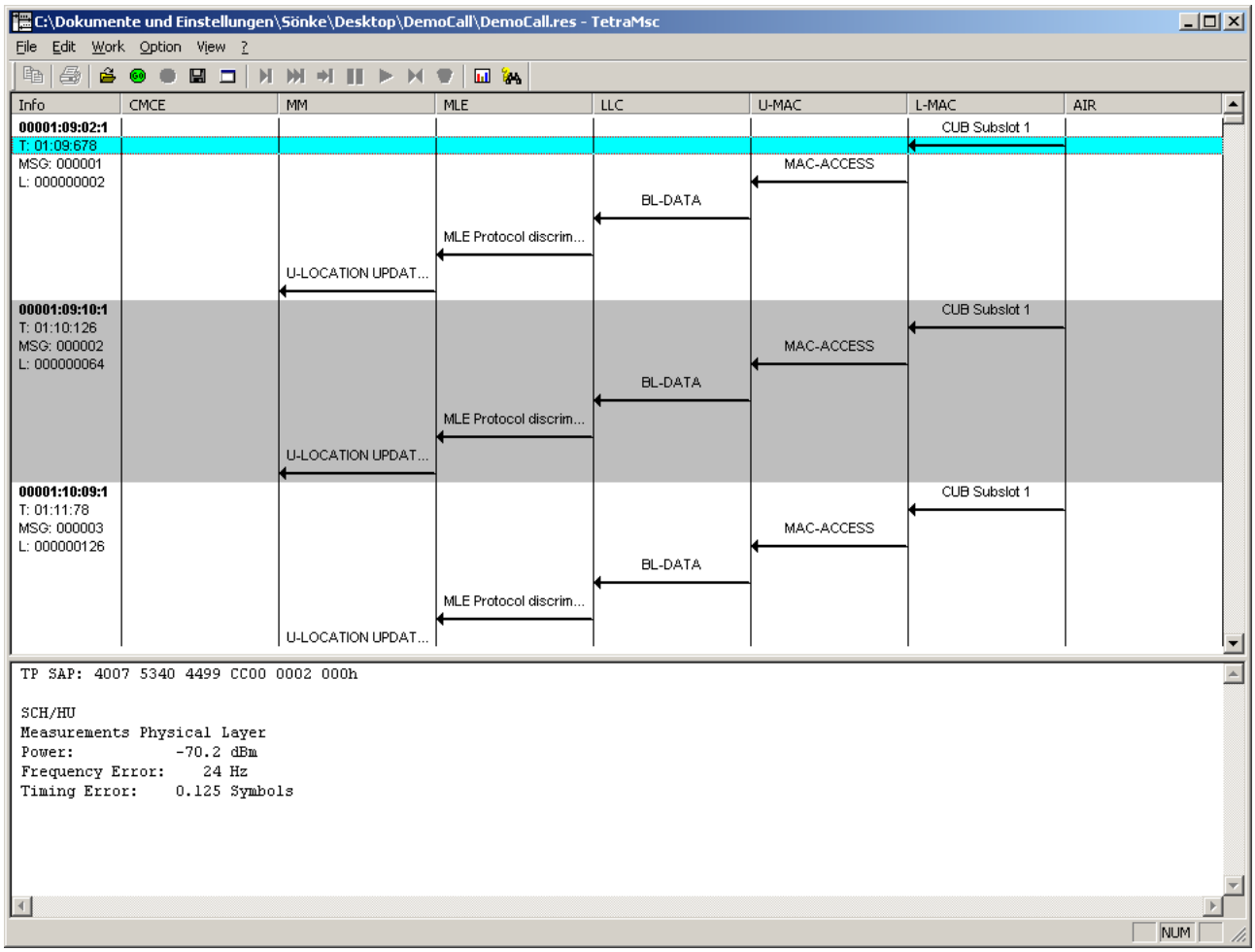

Figure 8: Display of the layer 1 measurements

Basic Equipment

The basic device contains a cable compliant receiver with a static sensitivity of 0 to -115 dBm. An AC wide range input with PFC for 95 VAC - 250 VAC is the power supply. On a separate PC the software to record data and analyze protocols gets installed. This PC is connected to the TETRA AirAnalyzer via the parallel port.

Using the available options the basic equipment can be modified to meet your individual needs.
It is also possible to use a DC input for the usual voltages for the power supply.

Options

The hardware and software is available with different types of equipment. These options can be added to the basic device. When ordering the device the installation is carried out without addition costs. The installation at a later time is usually possible.

DC Input

The DC input offers three different voltage ranges: 9 to 18 V, 18 to 36 V and 36 to 72 V. This supports all common DC values (12 V, 24 V, 48 V) which may be used in cars or for other purposes.
Additional voltage ranges are available as a special design.

Air Interface Encryption (static)

The option “Air Interface Encryption” allows the analysis of air interface data encrypted with static cipher keys. Encrypted messages for up- and downlink will get decrypted automatically during analysis.

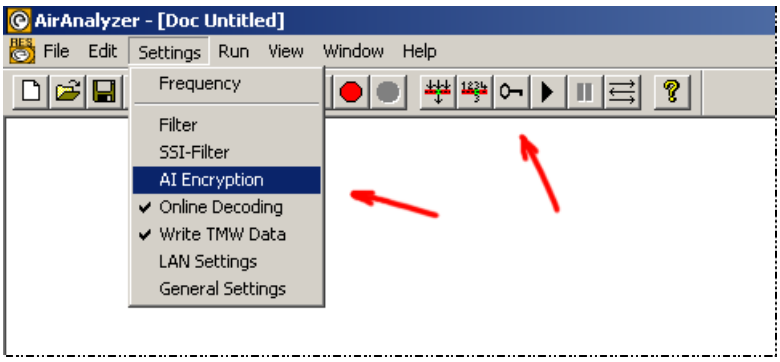

Figure 9: Starting the encryption dialog

The user feeds the application with the relevant information (SSI´s, secret keys) and provides the secret TETRA algorithms. The software itself will detect if a message is encrypted and will decrypt it with the appropriate algorithm and encryption key.

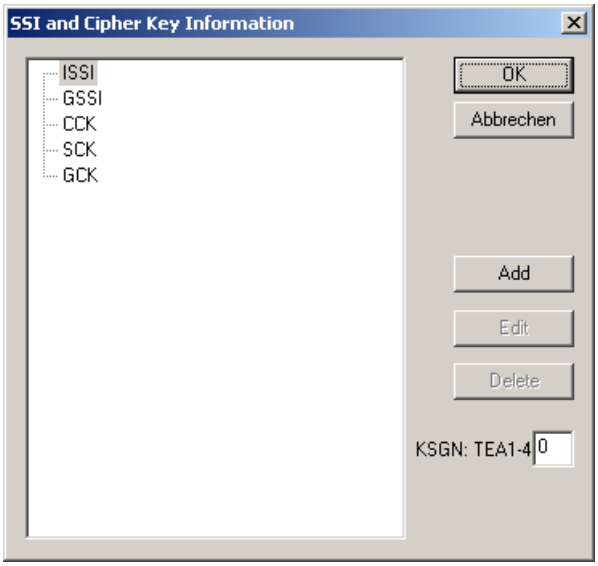

Figure 10: Feeding the application with encryption data

There are two ways to feed the application with the encryption information: via dialog (see Figure 10) and via a DLL that is provided by fjord-e-design GmbH within a framework.

The decryption process is not visible by itself and results in a “normal” protocol presentation like shown in Figure 3, Figure 4 and Figure 5. If encrypted traces get analyzed without the application having the according encryption information the decoding and presentation will finish after the unencrypted part of the message (i.e. L-MAC and lower parts of U-MAC).

Customized Development

TETRA networks are very complex systems. In addition TETRA is used in very different special areas. The qualified fault tracing in such systems requires a powerful protocol analysis. Sometimes it might be necessary to use special features for fault localization or recognition. With our TETRA AirAnalyzer we can offer customized solutions meeting your every need. This covers the recording of voice signals or SDS messages, special trigger conditions or special requirements regarding the hardware (e.g. unusual power supply).
We offer the solution that you need.

Technical Specification

Basic equipment

Casing	19'' rack-mount model 3 HE
Temperature range	0°C ... +50°C
Voltage supply	AC Wide Range Input with PFC 95 VAC - 250 VAC
Power consumption	< 60 W
Connection	Power Plug (CEE22)
Receiver	
Frequency range	360 – 460 MHz
Connection	two N sockets
Max. input power	0 dBm
Typical sensitivity	< -106 dBm dynamic < -115 dBm static
Data connection	parallel port (25-pin sub-D plug)
Weight	< 15 kg

Basic software

Online analysis of live captured data
MSC and text display (message sequence charts)
Adaptive subscriber filter (SSI filter)
Support for external data input (e.g. BS/MS data stream)
Extensive protocol filter for each TETRA layer
Export functions for MSC and text view
Microsoft Windows® 2000, XP, 98 support

Equipment options

DC Input

Input voltage	9 VDC – 18 VDC or 18 VDC – 36 VDC or 36 VDC – 72 VDC
Connection	Neutrik POWERCON Type A (NAC 3 MPA)

Software options

Static AI encryption (security class 2)	(according to EN 300 392-7)

Requirements

A precondition for the measurements with the TETRA AirAnalyzer is a proper Windows system on a standard PC with the following minimum requirements:

P2 with at least 300 MHz
Windows 98 SE, 2000, XP
Enhanced Parallel Port Interface (EPP)
USB port for dongle (if software shall run without AirAnalyzer hardware)
at least 10 MB free hard disk space for the application (not regarding traces)
64 MB of RAM

The newer and faster the PC the faster the analysis will be to shorten your waiting time.

Contact

Do you have further questions or special requirements for which you need a customized solution? Please feel free to contact us:

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