Photo: R&S BICK Mobilfunk

FIG 1 "On break": Underground trains at their depot in Bangkok.

Bangkok Metro Corporation Limited contracted Siemens TS (Transportation Systems) to equip the first underground train system in the Thai capital. The order covered the delivery of the complete infrastructure including signal technology, set of coaches, power supply, depot equipment and radio communications system. Siemens TS selected the *ACCESSNET*®-T TETRA radio system from R&S BICK Mobilfunk as the radio communications system.

TETRA Mobile Radio System *ACCESSNET*®-T

Reliable communications system for Bangkok's underground train system

Reliable operation throughout the world

TETRA radio systems such as *ACCESSNET*®-T implement an open ETSI standard and are known for their reliability throughout the world. *ACCESSNET*®-T systems are already being used successfully at government authorities and organizations with security missions, oil and gas companies, railway companies, public transport and private network operators. Secure communications facilities are also a basic prerequisite for trouble-free operation in underground trains. Siemens TS thus had good reason to select *ACCESSNET*®-T for its project in Bangkok. The main criteria were reliability, ruggedness and flexibility.

Complex infrastructure

Nineteen TETRA base stations cover the above- and underground lines, the railway premises (FIG 1) and the stops. The project implements a wide variety of antenna types. Special antennas were installed to cover the inner and outer areas, and flat vehicle antennas were installed on the trains. Leaky feeders ensure secure communication within tunnels.

The central exchange controls all communications facilities (FIG 2). The base stations are coupled to the central exchange via E1 lines and an optical network. The exchange has interfaces to the private telephone network

(PABX), the voice recording system and the SCADA system. The network management system and the control center for trains are also directly coupled to the exchange. The trains have two trainborne radio subsystems each.

SRP-2000 TETRA terminals from Sepura were selected as radios for mobile use; SRM-1000 terminals, also from Sepura, were selected for use in the vehicle. *ACCESSNET*®-T of course also operates with terminals from other manufacturers. This allows each operator to choose the units that fit their specific requirements.

Control center

The control center is the heart of the complete system. It manages and monitors all communications including rail traffic. If necessary, the control center coordinates and controls unscheduled events. The multiposition R&S®TRD-500 dispatcher system with eight workstations was installed for this task. It is connected to the central exchange via a LAN. Voice communications are handled via a voice-over-IP connection. The full functionality of the PABX interface can be used via the control center. TETRA subscribers can thus make phone or mobile phone calls to other communications networks.

Addressing is user-specific and based on train numbers, i.e. staff members wanting to make a call use the corresponding train number as an address. This number will then be displayed on the units and in the control center. Received and sent status calls, text messages as well as individual or group calls will be processed in the control center. A control center monitoring mode is available as well as a data mailbox and a call memory. You can also assign priorities for individual subscribers, if required.

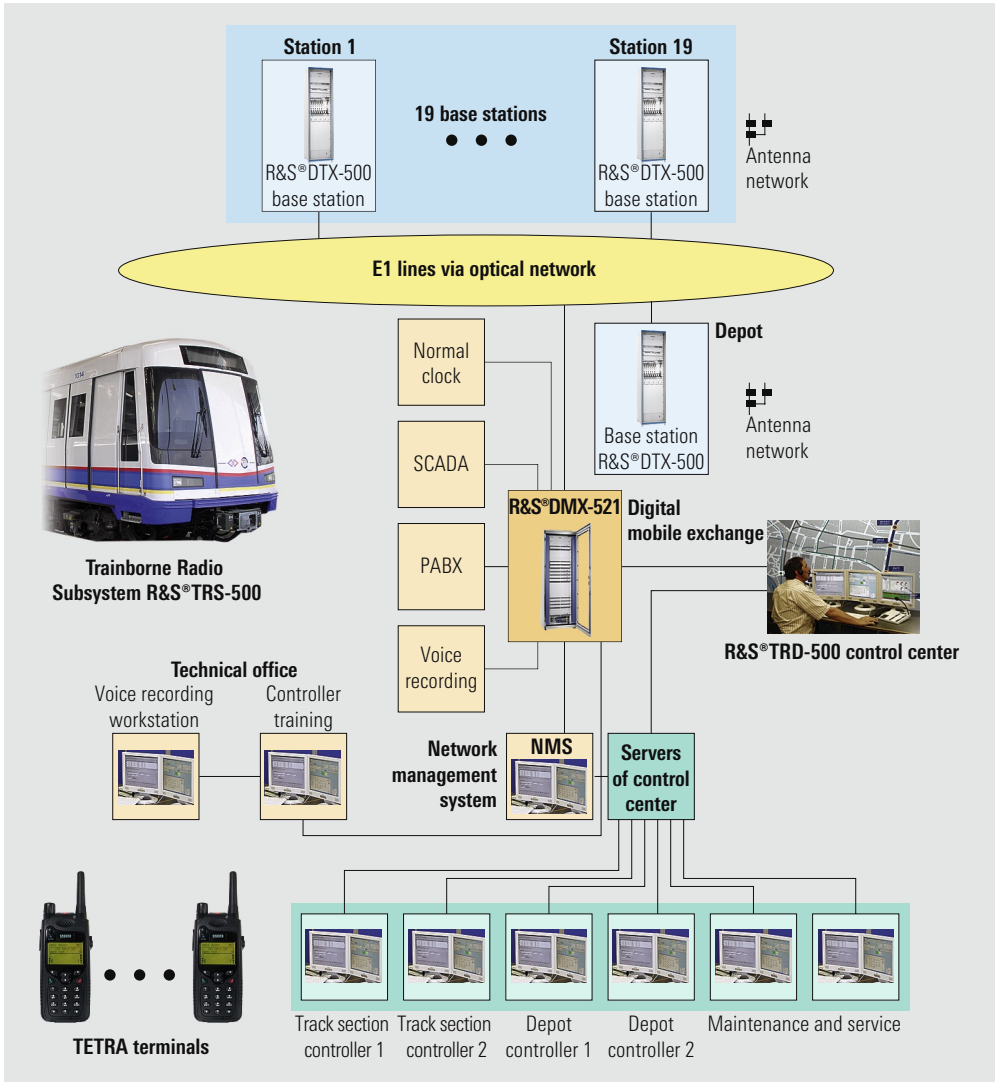
Voice recording

Public transport applications are subject to particularly stringent security requirements. The TETRA Voice Recorder R&S®TVR-500 was installed to ensure continuous traceability of communications in the event of downtime or emergencies. The system records the 8-kbit data stream as a TETRA-coded signal. This ensures much higher capacity than other voice recording systems on the market.

Network management system

You can perform service and maintenance work on the radio system with the Network Management System R&S®NMS-500. Every network element (exchange, base station) has its own network management server including database. Operating data is exchanged via the lines of the network elements. You can use different clients for different tasks – one for subscriber management, another for network configuration and network optimization, and a third for error analysis. The clients are connected to the server via a LAN and can be operated either locally or remotely, e.g. in a central control office. The clients are installed on commercial PCs as a central network management system in a technical office.

FIG 2 Basic setup of the *ACCESSNET*®-T system in Bangkok's underground train system.



Inhouse and tunnel coverage

In addition to the four-story underground stations and technical offices, underground train paths and tunnels are also covered. Antennas tailored to the specific requirements of the coverage area as well as leaky feeders for tunnel coverage were coupled to the base stations. To meet high security requirements also in this area, R&S BICK Mobilfunk developed a leaky feeder monitoring facility which automatically signals cable breaks or ruptures to the control center.

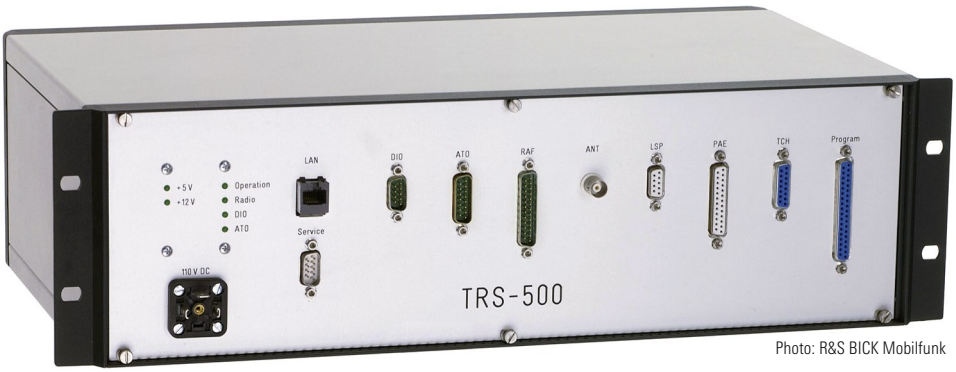


Photo: R&S BICK Mobilfunk

FIG 3 The Trainborne Radio Subsystem R&S®TRS-500.

Trainborne radio subsystems

The Trainborne Radio Subsystems R&S®TRS-500 (FIG 3) were developed to ensure communication with and inside the trains. The SRM-1000 terminals are connected to these trainborne radio subsystems. The trainborne radio subsystems transmit train maintenance and positioning data. A maintenance system in the underground trains uses sensors to monitor the electronics, air pressure and temperature. The maintenance system signals any data deviating from specified values to the maintenance control center via the TETRA system. The maintenance control center immediately takes appropriate actions and provides the maintenance staff with the required information. This saves valuable time and helps to avoid costly repairs. The trainborne radio subsystem transmits general information for passengers to the loudspeaker system of the train. In the event of emergency, emergency calls are transmitted to the control center via the R&S®TRS-500 systems.

Since GPS reception is not possible in a tunnel, a different procedure was selected: The train receives its positioning data when traveling over induction loops installed in the stations. A positioning signal is transmitted to the control center via *ACCESSNET*®-T and displayed there.

SCADA interface

Each network element has alarm sensors. An alarm is immediately triggered at high priority via *ACCESSNET*®-T. The SCADA interface is the preset address. This ensures that the alarm is sent to the SCADA system and can be processed in compliance with the required operating regulations.

Training and operation

To ensure trouble-free operation and maintenance of the system, staff and engineer training was also included in the package. This training was provided in spring 2004 at the R&S BICK Mobilfunk headquarters in Bad Münder.

In operation ahead of schedule

The installation of the communications system was started in 2003 and completed in summer 2004. The underground train has been in operation since July 2004 ahead of schedule. The opening ceremonies were attended by His Majesty, King Bhumibol Adulyadej of Thailand, and his wife, Sirikit.

Harald Haage

Important abbreviations

E1	Physical interface in line with ITU standard
GPS	Global positioning system
LAN	Local area network
PABX	Private automatic branch exchange
SCADA	Supervisory control and data acquisition; traffic management and process visualization system
TETRA	Terrestrial trunked radio (only European ETSI standard for digital trunked radio)

More information and data sheets at www.rohde-schwarz.com (search term: ACCESSNET)