TETRA
(TErrestrial Trunked RAdio)

Further information on TETRA:
www.tetramou.org ("official" site)
www.aeroflex.com/tetra/productinfo/TETRABackgrounder.ppt
Examples of digital wireless systems
(all originally specified by ETSI)

GSM (Global System for Mobile communication) is a cellular mobile system
• cellular concept
• high mobility (international roaming)

TETRA (TErrestrial Trunked RAdio) is an example of a Professional/Privat Mobile Radio (PMR) system
• limited access (mainly for professional usage)
• limited mobility (but other advanced features)

DECT (Digital Enhanced Cordless Telecommunications) is a cordless system
• low mobility (only within “isolated islands”)

TETRA architecture

TBS = TETRA Base Station
DXT = Digital eXchange for TETRA
DWS = Dispatcher Work Station
PDGW = Packet Data GateWay
DMO = Direct Mode Operation

Labtop computer
GPS device, etc.

TE  MT

MS

DXT  PDGW

Internet
PSTN

TBS

DWS

TBS

DXT

PDGW

Internet
PSTN

TBS = TETRA Base Station
DXT = Digital eXchange for TETRA
DWS = Dispatcher Work Station
PDGW = Packet Data GateWay
DMO = Direct Mode Operation
Standardisation

Public cellular mobile systems (like GSM) by necessity are open = multivendor systems (at least as far as the radio interface is concerned)

=> detailed standardisation necessary

PMR systems were traditionally single-vendor systems (one system for each authority...)

However, this is not considered a good solution any longer, and TETRA is the first open PMR system

=> standardised by ETSI
Open interfaces - multivendor systems

Important open interfaces: AI, PEI, ISI
Dispatcher, group calls

**Dispatcher** = a person who manages field operations via the network. The dispatcher distributes tasks to police forces, fire brigades, etc. The dispatcher

- can follow the field operations from a console (graphical workstation)
- can control the traffic in the network
- can supervise group calls

**Group call** = user pushes press-to-talk button and starts talking after which the others in this group can listen to this user at the same time (one-to-many voice communication)

Semi-duplex operation
The possibility of direct MS-to-MS communication extends the range of operation of TETRA (emergency situations, areas without cell coverage)
Three kinds of PMR networks

Public safety and security networks are typically nationwide networks providing PMR communications for police, fire, ambulance and other public rescue services. These networks are typically financed from public funds.

Commercial networks are provided by an operator who sells the PMR service to professional companies like transportation, taxi and bus companies, security services, courier companies and similar organisations.

Private networks are often small networks owned and operated by the organisations themselves.

In Europe: 380...400 MHz band

In Europe: 410...430 MHz band
TETRA vs. GSM (1)

Both systems have their strong sides:

**Benefits of TETRA**
- Security features
- Group calls
- Call setup delay
- Dispatcher station

**Benefits of GSM**
- more advanced than in GSM
- not possible in GSM
- smaller than in GSM
- not possible in GSM
TETRA vs. GSM (2)

Both systems have their strong sides:

Benefits of TETRA

- DMO (MS-to-MS)
- Supplementary services

Benefits of GSM

- not possible in GSM
- more advanced than in GSM
- Mass market => cheap equipment
- Global mobility/roaming

not possible in TETRA
TETRA vs. GSM (3)

Some other issues:

<table>
<thead>
<tr>
<th>TETRA</th>
<th>GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio frequency bands</td>
<td></td>
</tr>
<tr>
<td>380...430 MHz (Europe)</td>
<td>900 MHz, 1800 MHz</td>
</tr>
<tr>
<td>800... (outside Europe)</td>
<td>1900 MHz (USA)</td>
</tr>
</tbody>
</table>

the smaller the radio frequency, the larger the maximum cell size

<table>
<thead>
<tr>
<th>Radio interface, technical details</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDD, TDMA 4 slots/frame</td>
</tr>
</tbody>
</table>
TETRA radio interface

Separation of uplink/downlink traffic: **FDD** (like GSM)

Carrier spacing: **25 kHz** (compare: GSM => 200kHz)

4 TDMA timeslots per frame on each carrier (GSM => 8 timeslots/frame)

Flexible bandwidth allocation:

1 ... 4 timeslots per user

Several channel coding options

=> tradeoff: reliability vs. data rate

7.2 ... 2.4 kbit/s

FDD, TDMA 4 slots/frame

↑

no channel coding, unreliable

↑

most reliable transmission option
Security

GSM

- User authentication (PIN code)
- User authentication (SIM / AuC)
- Ciphering (air interface)

TETRA

- More advanced intra-terminal security ...
- User authentication
- Network authentication
- Ciphering (air interface)
- End-to-end encryption
- Key management

Special option in GSM
- not possible (without new SIM card)
DECT

(Digital Enhanced Cordless Telecommunications)

Further information on DECT:
www.dect.ch ("official" site of DECT Forum)
www.handytel.com/technology/dect01.htm
(nice introduction to DECT)
Examples of digital wireless systems
(all originally specified by ETSI)

GSM (Global System for Mobile communication) is a cellular mobile system
  • cellular concept
  • high mobility (international roaming)

TETRA (TErrestrial Trunked RA dio) is an example of a Professional/Privat Mobile Radio (PMR) system
  • limited access (mainly for professional usage)
  • limited mobility (but other advanced features)

DECT (Digital Enhanced Cordless Telecommunications) is a cordless system
  • low mobility (only within “isolated islands”)
Four application examples of DECT

WLL (Wireless Local Loop) connection, instead of wired access lines for connecting users to the PSTN/ISDN

Cordless system (residential use), only one base station => only intracell handover

PABX wireless extension (business use, e.g. HUT), several base stations => intracell and intercell handover

CTM (Cordless Terminal Mobility), wide area mobility
WLL (Wireless Local Loop)

Up to 5 km possible (utilizing directional antennas, etc.)
Cordless system

FP = Fixed Part
PP = Portable Part

Only one base station (FP), inter-PP traffic possible
PABX wireless extension

Intercell handover between base stations is possible
Cordless Terminal Mobility (CTM)

=> Portability over a wider area
=> Public service

Examples:

Same DECT terminal can be used at home and in the office

DECT terminal can be used at several locations in a city

However: no advanced mobility management like in GSM
DECT is a TDD FDMA/TDMA system

Like GSM, DECT is a FDMA/TDMA system. Unlike GSM, however, DECT is based on TDD. The multiple access structure uses $10 \times 12 = 120$ bi-directional channels. Each channel can carry 32 kbits/s.
TDD <=> reciprocal radio channel

FDD system (e.g. GSM): Signal fading due to multipath propagation is different in uplink and downlink.

TDD system (e.g. DECT): Multipath fading is the same in uplink and downlink.
Dynamic channel selection and allocation

1. All idle channels are scanned at regular intervals (30 s).

2. An RSSI (Received Signal Strength Indication) list is generated.

3. When a new channel is needed, the DECT terminal (PP) or base station (FP) selects an idle channel with minimum interference for this purpose, utilizing the RSSI list.

4. In this way, the interference level in the DECT network is kept as low as possible.
**Mobile-controlled handover**

MCHO ⇔ Handover is always initiated by the terminal

<table>
<thead>
<tr>
<th>Downlink interference:</th>
<th>Intracell handover to a better channel at another frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink interference:</td>
<td>Base station (FP) tells terminal to perform Intracell handover</td>
</tr>
</tbody>
</table>

Better quality connection to another base station => **Intercell handover**
Intracell handover

Interference on channel 1 causes an intracell (inter-frequency) handover to channel 2.
Intercell handover
GAP (Generic Access Profile)

Minimum mandatory requirements (October 1997) allow a 3.1 kHz teleservice connection to be established, maintained and released between FP and PP with the appropriate access rights, irrespective of whether the FP provides residential, business or public access services.

GIP – DECT/GSM Interworking Profile
IIP – DECT/ISDN Interworking Profile
RAP – Radio Local Loop Access Profile
CAP – CTM Access Profile
DSP => DPRS = DECT Packet Radio Service (new!)

other profiles

see: www.handytel.com/technology/dect01.htm