Digital Mobile Radio

Radio Activity
∞ Solutions

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DMR: an open ETSI standard

ETSI STD

∞ DMR standard (ETSI TS 102 361) has been defined in ETSI environment, by a working group composed by main PMR equipment manifacturers worldwide.

∞ Digital Mobile Radio is able to give "added value" to current analog systems and at the same time it grants a gradual migration between the two technologies, safeguarding investiments and specific existing operational requirements.

DMR

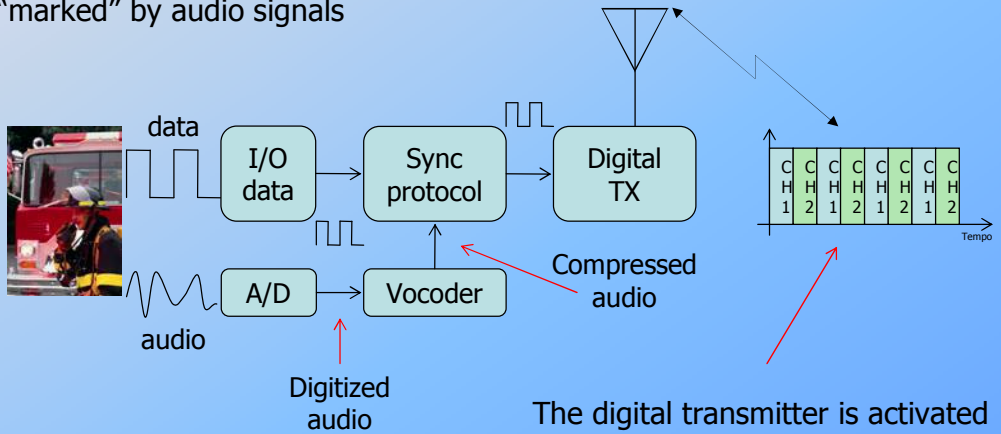
ETSI

The digital radio

ETSI STD

The radio

Data signals are directly transmitted and otherwise "marked" by audio signals



Audio signal is is converted to digital format, compressed and then "packed" in the digital transmission channel

The digital transmitter is activated during the timeslots allocated to the working channel

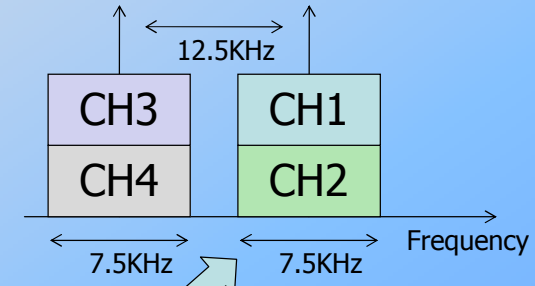
Two TDMA channels in 12,5 kHz bandwidth

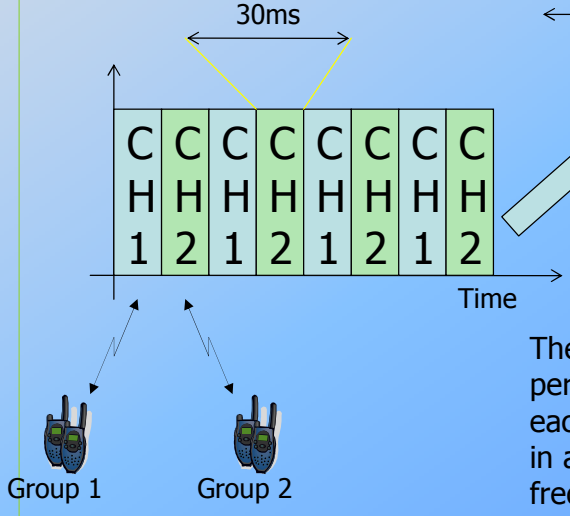
ETSI STD

The radio

2 CH TDMA

Audio/data channels are managed by two timeslots sequences, working in TDMA mode (Time Division Multiple Access), sharing the same radio channel with 12,5KHz bandwidth.





Two contemporary and indipendent communications on the same frequency carrier

The two audio/data channel are perfectly separated and indipendent each other, as if they were operating in a conventional manner on different frequency carriers.

Two TDMA channels in 12,5 kHz bandwidth

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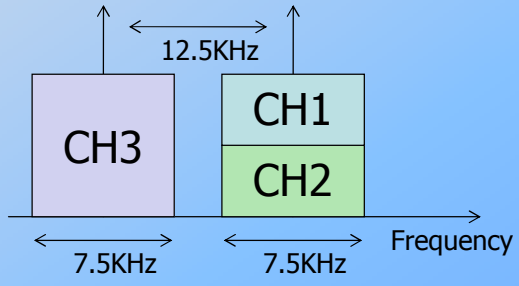
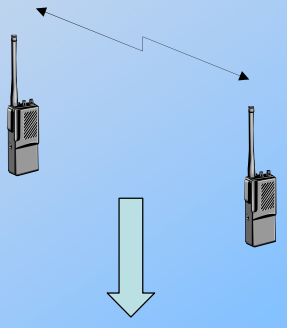
2 CH TDMA

DMR system can coexist with conventional analogical systems on adjacent channels, without any performance loss of each of systems.





Spectral efficiency of DMR system is 1CH/6.25 KHz, the same as TETRA and double compared to conventional systems.

Note: DMR system allows direct communication between mobile terminals. In this case only 1 channel in 12.5KHz is available because the repeater/network synchronization is missing.

Two TDMA channels in 12,5 kHz bandwidth

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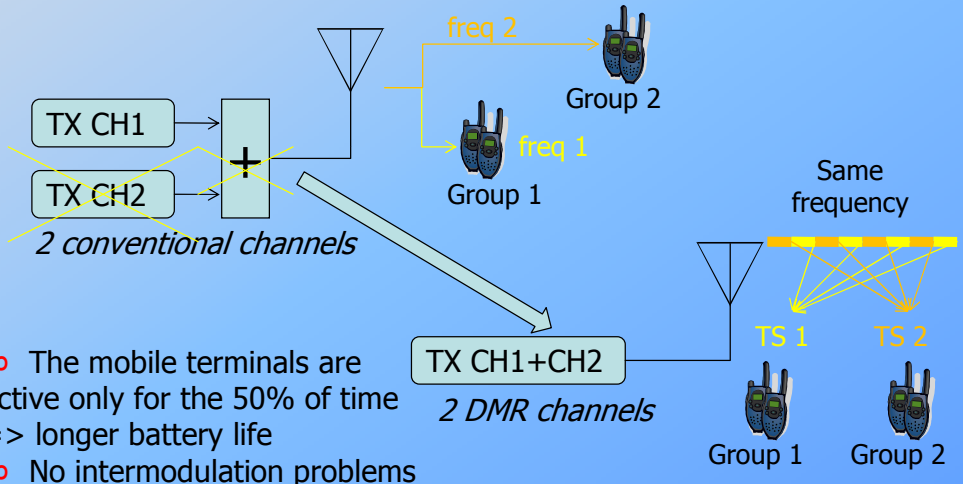
The radio

2 CH TDMA

Just one radio device (only 1 TX) provides 2 channels without any RF coupling system, this giving:

∞Lower plant costs
∞Lower consumption
∞Greater available power



∞ The mobile terminals are active only for the 50% of time => longer battery life

∞ No intermodulation problems

Digital modulation

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The radio

2 CH TDMA

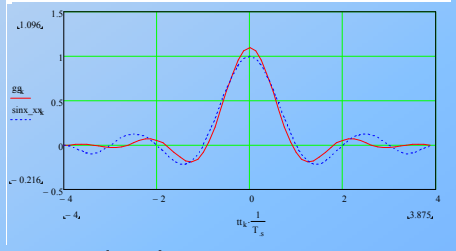
4FSK

∞ The employed digital modulation is 4FSK (Four-level Frequency Shift Key), the best for PMR communications.

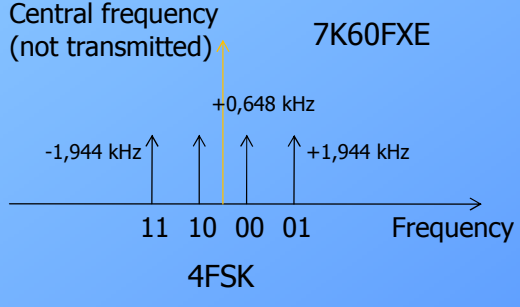
∞ Information bits are transmitted in pairs, each pair assigned to a frequency shift.

∞ Transitions between a status and the following one (that is between a pair of bits and the following) are continue and "smoothed" by a filter which reduces high frequency components.

∞ The shape filter is a "Raised Cosine" function.



Impulse shape vs. time



Constant envelope modulation

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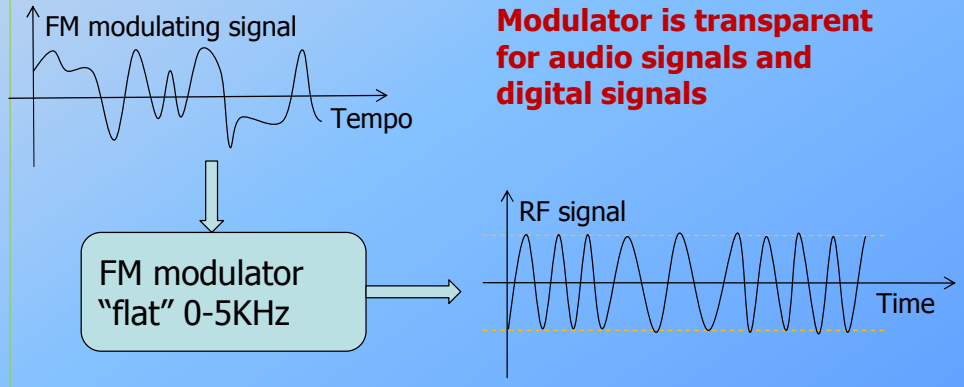
2 CH TDMA

4FSK

∞ Frequency modulation has constant envelope (unlike the TETRA wich do not have a constant envelope)

∞ Transmitters are very similar to their traditional analogical version, because expensive linearization techniques are not needed: they can work in saturation (clipping) mode (C class o superior) with very low consumption => solar panels can be used

∞ Modulator must have a flat band between 0 and 5KHz



Modulator is transparent for audio signals and digital signals

Uplink – downlink RF budget

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4FSK

The up-link has 5 to 15 dB less budget than the down-link: the mobiles have more difficult into the network access

Base station

Radiated Power +40..+43 dBm

About 3..+10 dB sensitivity decrease

Radiated Power +30..+37 dBm

Strong signals from broadcast/GSM stations

Industrial noise

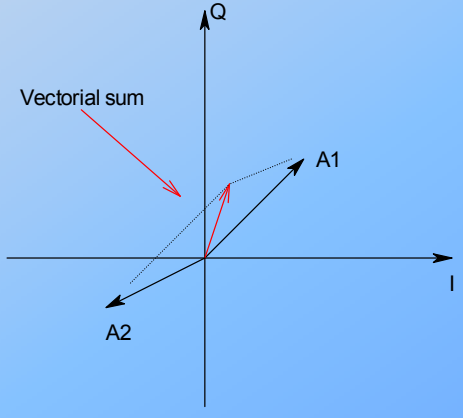
The diversity reception can increase the uplink RF budget

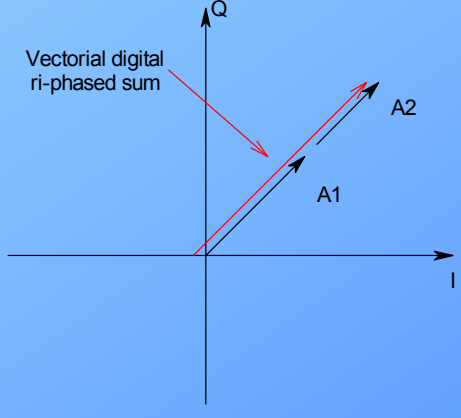
Soft diversity reception

The two received vector signals can be combined by an antenna to obtain the vectorial sum.

By digital ri-phasing, it is possible to achieve the modulus sum of the two vectors.

The mean (statistic) gain over the noise is 3 dB, it produces a benefit of lowering 10 times the B.E.R.





Soft diversity reception

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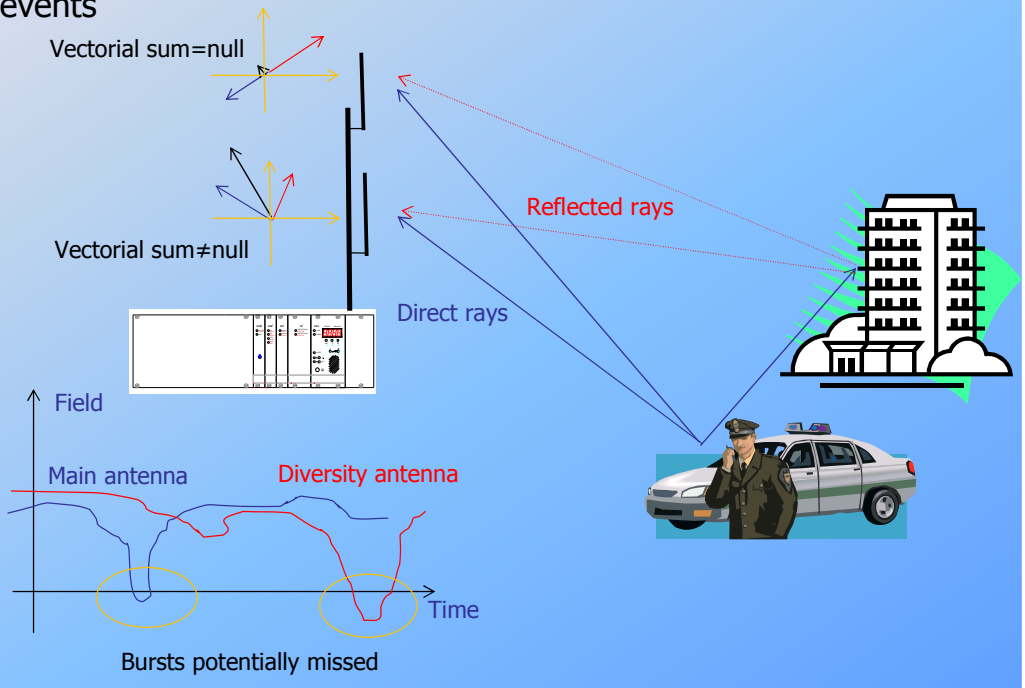
4FSK

Soft diversity dramatically decreases the B.E.R. during fading events



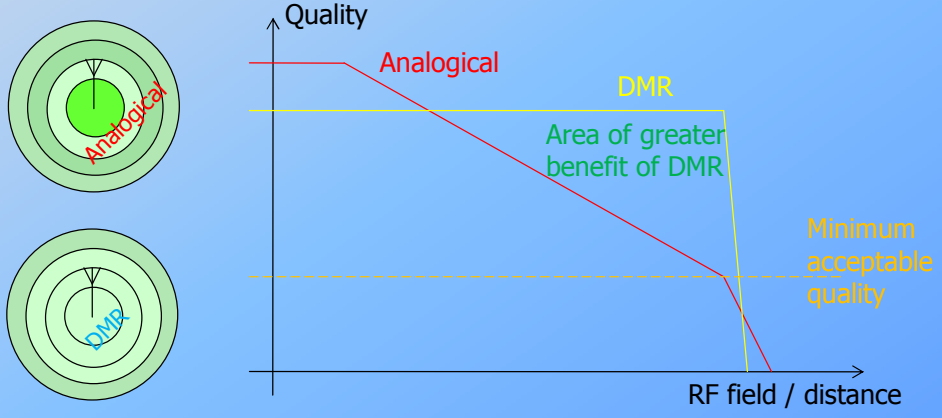
Radio coverage

∞ The RF power level transmitted by a DMR system is the same as the one of a traditional analogical system (constant envelope)

∞ The DMR receiver sensitivity is about the same as the one of a traditional analogical system

∞ The Audio quality is constant up to the sensitivity field level

∞ The coverage is slightly higher than analogical systems with 12.5KHz channeling



Analogical / digital transition

Mobile terminal audio compatibility

∞ Digital mobile radio terminals can work in traditional analogical way also

∞ Mobile analogical terminals (if not provided with TCS in reception) will hear any disturbs in presence of digital signals

∞ Radio Network can automatically recognize the two modulations (analogical / digital) and repeats them with the correct format

Digital audio

∞ Digital audio (Vocoder) is different from analogical one, the quality is good up to the sensitivity limits, no noise can be heard (like SQ turning off), eventual lost voice packets are replaced with like-audio tracks.

∞ Vocoder is not able to play music or tone signaling.

∞ Vocoder is NOT an ETSI standard. Motorola uses AMBE+2™

Direct mode operation on output repeater freq.

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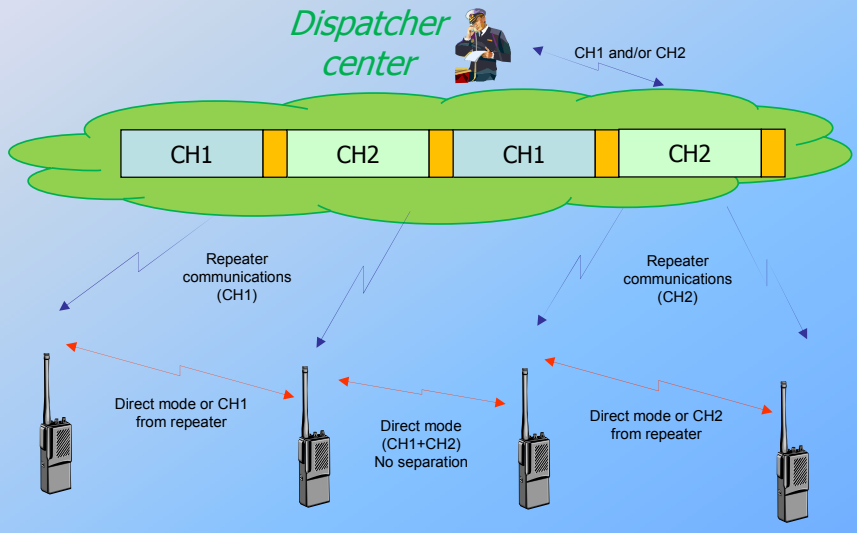
2 CH TDMA

4FSK

System



∞ In direct mode the communications coming from repeater are listen if the CH (timeslot) is the same

∞ The direct mode communications are always listen (timeslot independent)

∞ One channel (timeslot) only is available in direct mode

Analogical / digital transition

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4FSK

System

Selective compatibility between mobile terminals

∞ Mobile digital radio terminals (Motorola) can be provided of selective analogical encoder-decoder card

∞ Selective calling are digitally addressable between DMR equipments and analogically between traditional equipments

∞ In DMR systems individual and group calling are available

Sub-audio tone

∞ Network access of DMR mobile terminals is managed by a "color code" instead of traditional su-audio tone

∞ 16 "color code" are available

Network operability

∞ Mobile DMR terminals can work in "open channel" mode, like traditional systems for emergency

Advantages of DMR solution

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System

Over conventional analogical systems

- ∞ Two contemporary communications over 12.5KHz bandwidth
- ∞ European open standard
- ∞ Lower minister frequency license costs per channel
- ∞ Increase spectral efficiency
- ∞ Fast and reliable data communications
- ∞ Smooth migration from analogical systems
- ∞ Communication security with various level of encryptions
- ∞ Powerful features (ID on PTT, emergency call, text messages, ..)

Over TETRA systems

- ∞ Very low infrastructure costs
- ∞ More coverage area
- ∞ Easy to manage and maintain
- ∞ Very low power consumption (solar panel compatible)
- ∞ Low cost TCP/IP or UHF links between the base stations
- ∞ Same spectral efficiency and same main features
- ∞ Available in all PMR bands (70 MHz, 160 MHz, 450 MHz)

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DMR Operative Center

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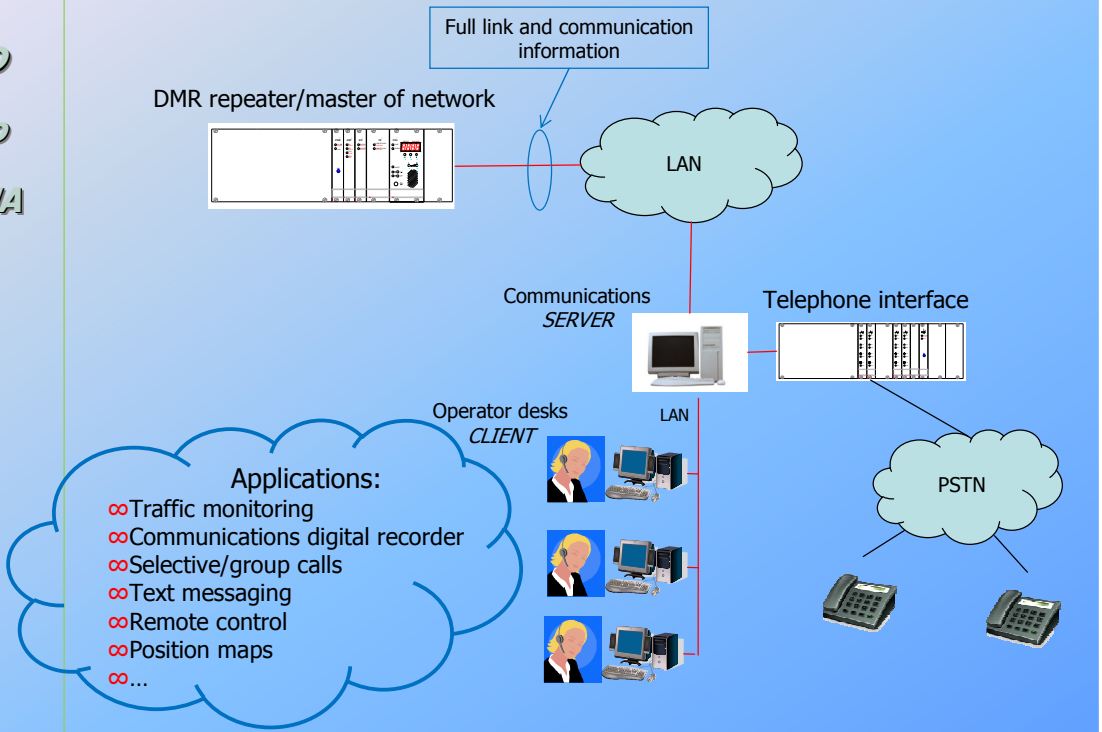
System



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Digital Mobile Radio

Digital radio systems comparison

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2 CH TDMA

4FSK

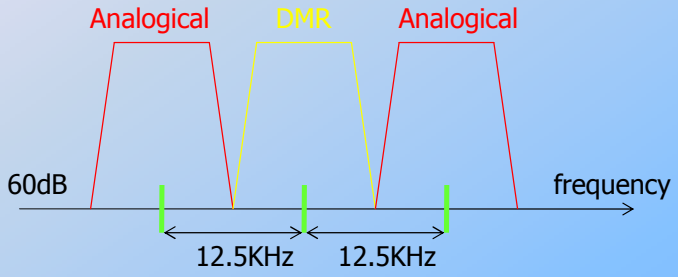
System

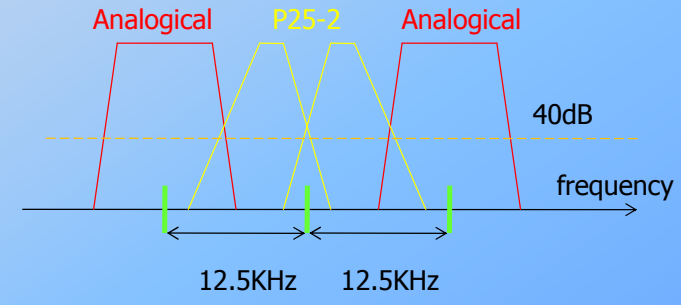
Comparison

	DMR	TETRA	P25	T.POL	P25 ph2
Dual-standard an. / digital	yes	no	yes	no	no
Spectral eff.	6.25 KHz/ch	6.25 KHz/ch	12.5 KHz/ch	10 KHz/ch	6.25 KHz/ch
Consumption	100	300	100	120	100
Analog. Sys. coexistence	yes	no	yes	yes	no
Cost	100	300	200	250	?
Covered area	100	70	100	120	100
Standard	ETSI	ETSI	USA	ETSI	=
Simulcast	yes	no	yes	yes	?
Trunking	expected	yes	yes	yes	?
applications	Low traffic density	High traffic density	Low traffic density	Low traffic density	Low traffic density
Year	2007	1998	2005	1993	2009?

Purely indicative values

Digital radio systems comparison





6.25KHz channelling needs:

- A safeguard channel between analogical and digital services
- Adjacent channel use only on well separated areas

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Radio Activity base station features

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The radio

2 CH TDMA

4FSK

System

Comparison

Unique or more interesting Radio Activity features

- ∞ True 2 channels contemporary DMR communications
- ∞ Dual mode DMR/Analogical
- ∞ Diversity receiver
- ∞ Ethernet port with full traffic available (DMR audio and data) for Operative Center applications
- ∞ Extra low ETH bandwidth (64kb/s) required to connect base stations
- ∞ Software remote upgradability
- ∞ Easy upgradability from single repeater to simulcast network
- ∞ Built-in digital and analogical voting systems
- ∞ A lot of timing/synchronism mode available for simulcast applications
- ∞ Powerful internal GSM/GPRS/TCP-IP/DMR based remote control
- ∞ Automatic mailing of internal status/diagnostics to DMR terminals
- ∞ Multi-key encryption
- ∞ Up to 64 user defined masks of ID access
- ∞ Cross coding ZVEI/CCIR to DMR signaling
- ∞ Modular design
- ∞ Very low power consumption (typ. 8 W @stby)
- ∞ Compact size (1/2 rack 19" 3UT)
- ∞ Internal duplexer

Simulcast network concept

∞ The same RF channel over whole coverage area ➔ no channels change through different repeaters, frequency saving

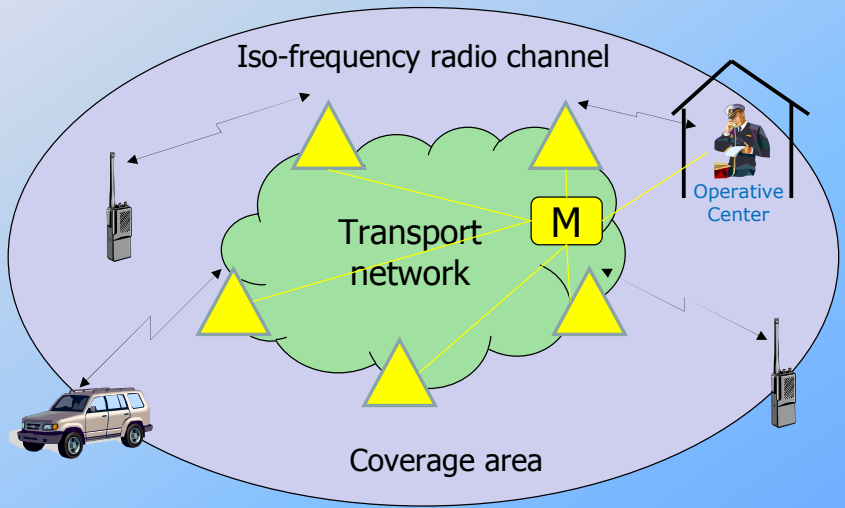
∞ No scanning required on terminals ➔ fast and efficient data and audio communications, lower power consumption on terminals

∞ Equivalent to a "big cell" single repeater ➔ no registration required

∞ Automatic roaming and hand-over ➔ Easy to use, fast set-up call

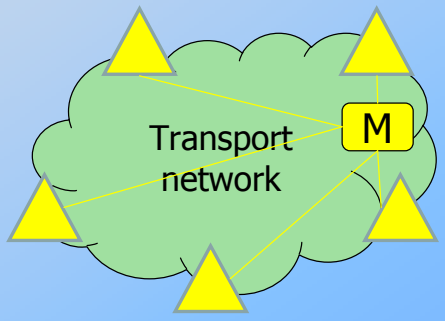
∞ Direct mode on repeater output frequency ➔ local communications plus network communications monitoring

Radio Activity DMR simulcast network



All transmitters send the same information signals on the same carrier frequency at the same time

Radio Activity DMR simulcast network



Transportation network with star geometry made by:

- ∞ Point-to-point UHF link (DMR)
- ∞ Generical TCP/IP network
- ∞ Copper twisted pairs (with IP modem)
- ∞ Mixed UHF/TCP-IP

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DMR TCP-IP simulcast network

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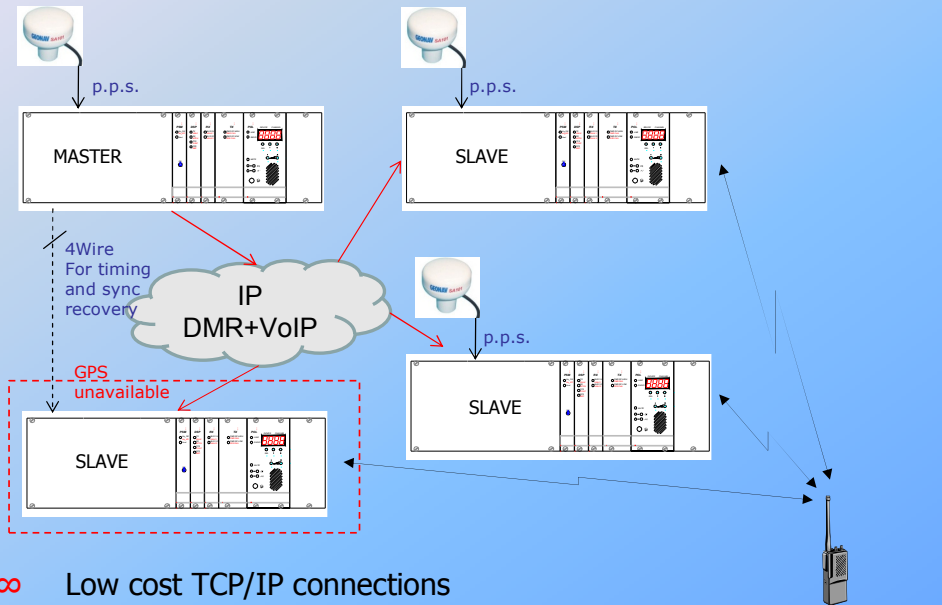
4FSK

System

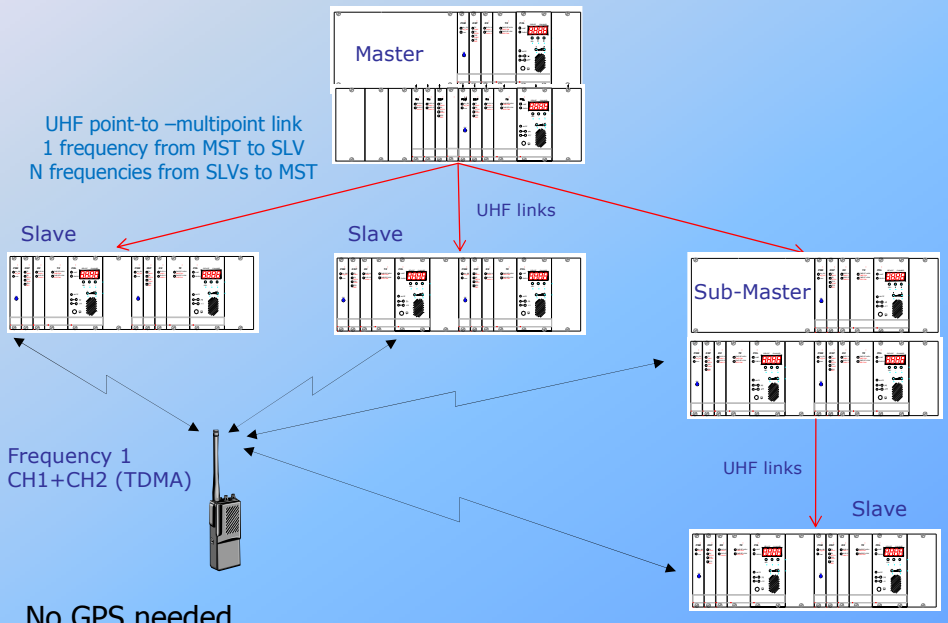
Comparison

RA simulcast



- ∞ Low cost TCP/IP connections
- ∞ Synchronization via GPS and/or 4Wire+E&M
- ∞ Automatic repeater mode on IP failure
- ∞ Up to 32 base stations per master/submaster
- ∞ 2 TDMA simultaneus channels in 1 RF frequency

DMR RF-linked simulcast network



- ∞ No GPS needed
- ∞ DMR UHF rugged long distance connections
- ∞ 2 TDMA independent channels in 1 RF frequency
- ∞ Up to 10 UHF slaves per master/submaster

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DMR mixed simulcast network

- ETSI STD
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- 4FSK
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