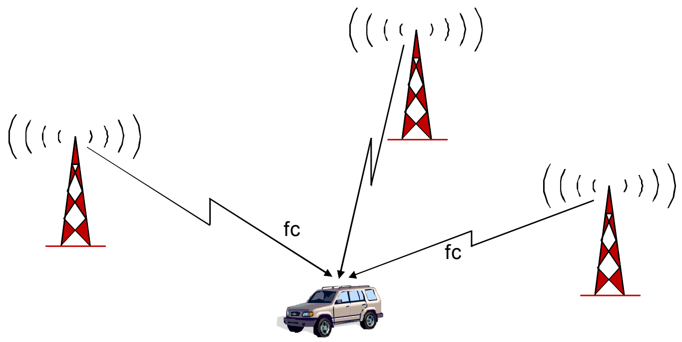
Radio Activity S.r.l.
Simulcast Networks Overview

Index

SIMULCAST NETWORK OPERATION (BY USER POINT OF VIEW)

What is a simulcast network?

Normally the public cellular system (GSM) doesn't work in emergency because all access channel of the cells saturates and the traffic reach zero communications. Due to this reason Civil Protection and emergency Entities have got a proprietary radio communications network.
A simulcast network is a very powerful radio network in which all the repeaters are active on the same frequency and at the same time.



Main advantages:

- ∞ Automatic and continuous roaming and hand-over => Easy to use
- ∞ Functioning like single "big repeater" => automatic and simple conference call operation
- ∞ All stations directly connected to the network => Integrated communication sys
- ∞ The same RF channel over all Network => no change of channel in the coverage area, one communication per channel

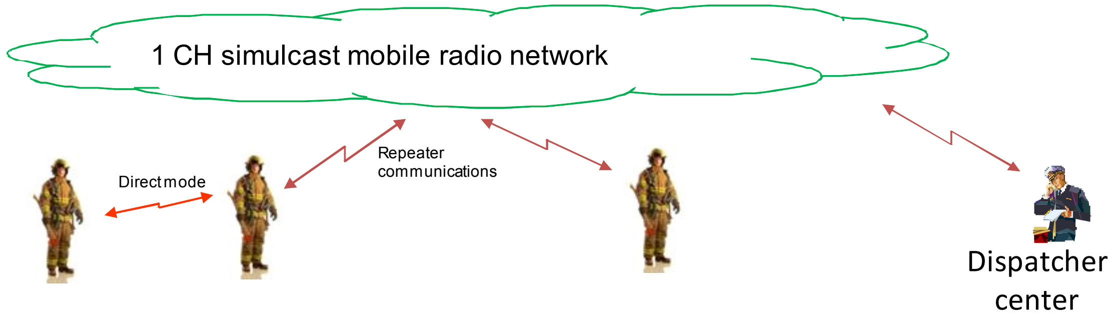
<u>The simulcast network removes the need of scan on mobiles and portables, assures real time roaming and hand over during the call and reduces frequency license costs.</u>

The simulcast solution is the best in case of emergency due to easy and fast "open channel" mode of operation:

- ∞ all people involved in emergency can listen all communications so they are continuously informed about the critical situations
- ∞ the regulation of network access is made by user, absolutely more intelligent and efficient than a trunking SW logic

The communications may be:

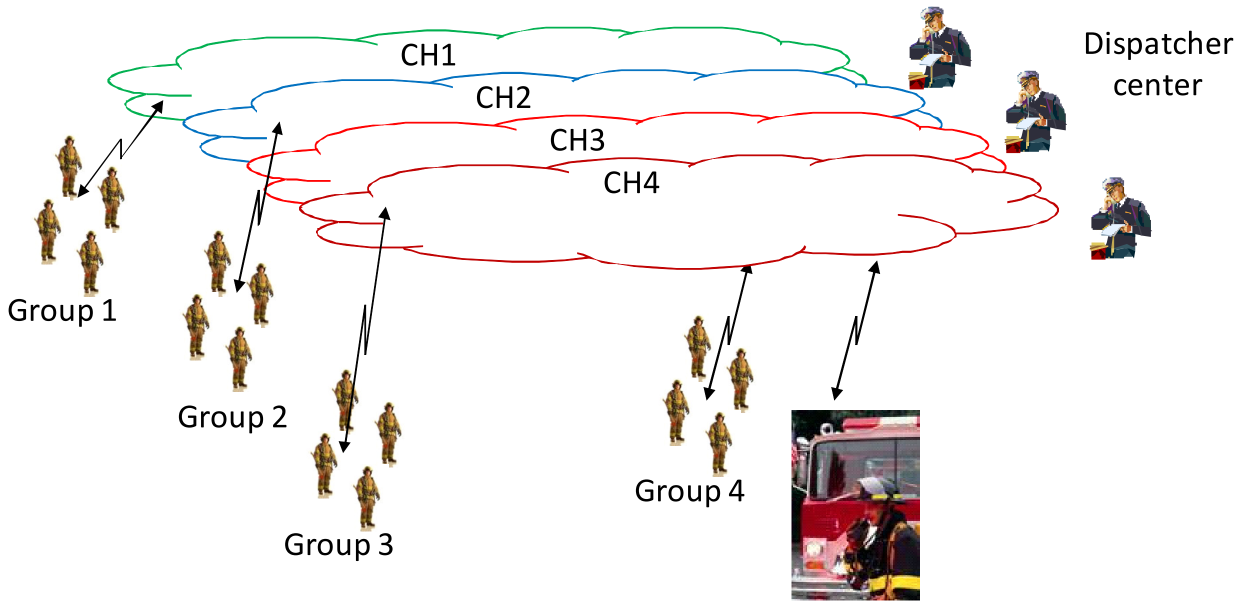
- ∞ mobile to mobile in direct mode (short range). Normally they operate in the output frequency of the network so they can speech among them and, at the same time, they can listen the communications coming from the network
- ∞ mobile to mobile in repeater mode (long range). The mobile equipments use a frequency to access the network and a second frequency to listen the communications coming from the network (semi-duplex). The network is equal to a single "big" repeater.
- ∞ mobile to dispatcher in repeater mode. The communications are in semi-duplex mode as the previous case. The dispatcher has the priority in the communication. All the communications from the mobile and from the dispatcher could be listen by all equipments.
- ∞ mobile to dispatcher in exclusive mode. It is the same of previous case but the communications from the mobile could are listen only by dispatcher.



The communications in the network are repeated in "transparent mode". It means that no specific signaling is required by the network to govern the mobile terminal. The only signaling required is the access key that could be a sub-audio tone coded squelch (analog) or color code (digital DMR). Often the user requires some specific signaling like a digital (FFSK) message, a super-audio tone (analog) or defined groups access, users filtering and similar in DMR environment.
The network is largely independent from the mobile radio vendors: e.g. Motorola, ICOM, Tait, Simoco, … analog terminals. Radio Actvity tested successfully the DMR protocol compatibility with Motorola Mototrbo^{TM} terminals.
Selective calls are often used for alert a specific group of terminals. Rarely the terminals work in mute mode without selective call alerting.

Expandability

Every channel of the system is independent from the other channel. The communications in one channel can be transfer to another channel only by a junction at master/Central Office level.
A system with N channel is the easy overlap of N separated simulcast networks. Note that a channel may be a single frequency (analog) or ½ of frequency (digital DMR). The following drawing explain this concept:



Every group of users communicate in exclusive mode in the own channel. In every channel can operate more than 1 group but, normally, they should have similar operative functions.
Every new simulcast channel can be added (with the necessary RF branching operations) without modify the other existing channel and without service interruptions.
There are virtually no limits in the number of channel of a system, the problem could be the branching system and the number of antennas required on sites.

The area of coverage of every single simulcast channel could be expand easily by adding some simulcast base stations. These simulcast base stations will be integrated in the network with few operations at network level only (nothing is request on mobile terminals).

SIMULCAST NETWORK OPERATION (BY SYSTEM INTEGRATOR POINT OF VIEW)

Technical aspects

To perform a simulcast radio network it is not enough to set the same frequency over all the repeaters of a multisite network. Due to the non-linear characteristic of the FM demodulator (extracts the arctangent of the arrival angle), it is mandatory that <u>the emissions from two or more repeaters must be exactly the same</u>.

To work properly, an analog simulcast radio network requires:

- Frequency difference between RF carriers < 10Hz
- Amplitude response between +/- 0.5 dB over all audio band
- Signals band coherence (not guaranteed in case of FDM channels)
- Absolute delay spread less than 20µs
- Phase error less than 10deg

A digital simulcast system requires also:

- Bit exactness transmission
- Absolute delay spread less than 1/10 of symbol duration (20µs @4.8Ks/s for DMR)

The analog requirements are well known and the absolute symbol delay is similar to the analog one. It is important to note that the bit exactness involves special attention on DMR protocol aspects. In fact DMR protocol is typically asynchronous and the actual value of some bits depends of the previous history of the communication.

At the end, to build a digital (DMR) simulcast network, it is necessary a special design of the base stations that assures the possibility of fine delay adjust (10µs step), perfect synchronization in frequency and timing, with special algorithms for protocol alignment. It is very hard to obtain these features from a standard repeater.

Another essential function of a simulcast network is the voting process which is the method by which the best signal received from the network is continuously selected. In analog the Master station is able to "extract the good" of each signal received from RBS and to create a summary one with an improvement of input signal to noise ratio. In Digital mode (DMR) every timeslot received from all the base stations is selected to found the error free timeslot or the maximum likelihood one in absence of CRC (e.g. voice). A high performance, real time voting system performs a “very large diversity reception” over all the base stations involved in the call. The global effect on quality compared with the multi-frequency approach is superb.

The best signal (analog or digital) is sent back to all base stations in “multicast” mode. This procedure reduces significantly the bandwidth required to the backbone interconnection network.

Forget the past experiences of trouble simulcast

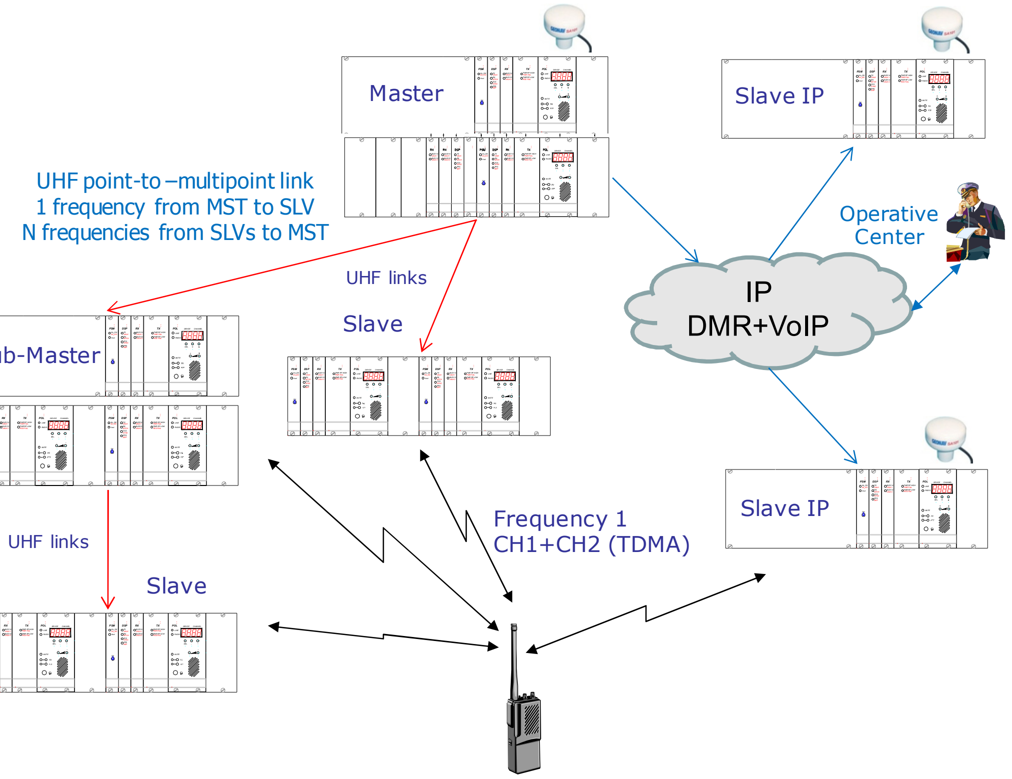
The simulcast networks are not very popular in the entire world due to the difficulty in achieving the precise technical requirements illustrated previous. A lot of system integrators tried to assemble simulcast network from conventional repeaters adding synchronizer and (analog) delay line. The result was often a network with a lot of difficulties during set-up operations, with frequent and onerous maintenance operations, and, at the end, with low customer satisfaction.

In Italy, like other countries, the geographical constitution and other factors forced the constructors and the system integrators to find good simulcast solution. The revolution in simulcast performances was built in the 90’ with the use of Digital Signal Processor (DSP) devices directly inserted in the analog base station. The performances of the network were so good that the most part of professional mobile radio networks in Italy are simulcast one!

The latest challenge is digital simulcast network. Starting from analog experiences, Radio Activity modified its DSP based software radio, to perform DMR protocol. All development was done to achieve optimum performance of digital simulcast and the field confirms this design. Sophisticated algorithms recover accurate sync (time and frequency), allowing (automatically) for adjustments of the delays and the alignment of the Protocol to achieve emissions at the bit accuracy. DSP includes the real time voting system and the network base station control layer.

The digital communications has the advantage respect to the analog one of forward error correction and adaptive filtering functions. These functionalities reduce the amount of bit error rate with a consistent improvement of audio and data quality in the overlap areas.

Digital or analog mode is automatically selected from the incoming signals modulation for facilitate a smooth transition from analog to digital. A lot of base station configurations permit to realize simulcast networks with various backbone Links: TCP/IP (also wireless one), E1/T1, twisted wires, narrowband radiofrequency link, and mixed also:



All necessary functions (synchronism, voting, VoIP, remote control, network management, call control, etc.) are integrated in the base station without the need of external expensive and tedious to cabling devices.

The Radio Activity simulcast network is really “plug and play”.

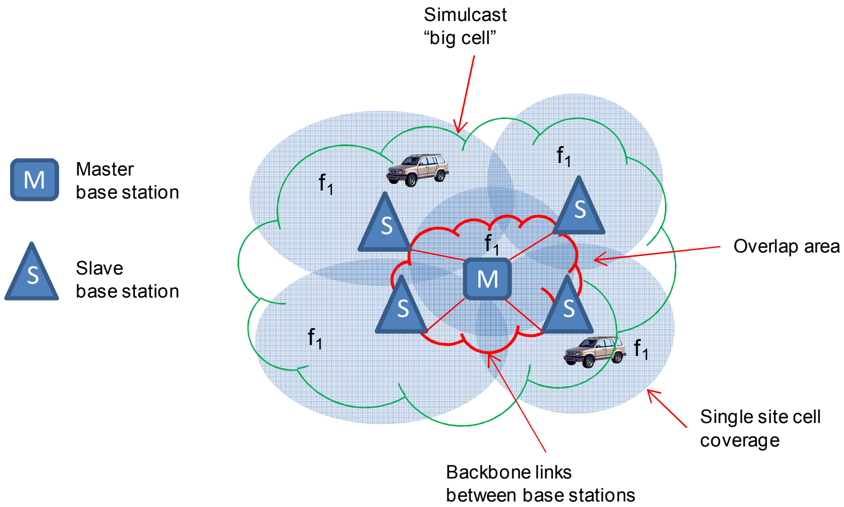
TYPICAL NETWORK CONFIGURATIONS

Radio Activity has a very powerful product to make simulcast network. The networks are based on the standard radio product RA-080 / RA-160 / RA-450. These radio implement all the necessary functions for high performance simulcast networks (timing and synchronization recovery, delay and response equalization, voting system, …).

The Radio Activity base station is the ideal "basic block" to build simulcast or multicast radio networks based on the most common media supports. The network will operate in analog or digital (DMR) or in both (dual) mode with automatic selection.

It is configurable to work in simulcast network with different connection links (backbone network):

- TCP/IP (microwave, fibre optics, LAN, WAN, …)
- Radio links duplex (UHF/VHF)
- Leased lines with 4 Wire (possibly with E&M) audio interface (example: from multiplexer thought GHz T1-2Mb/ dedicated links or thought optical fiber)
- Mixed TCP-IP / radio link / wired



The audio bandwidth available from radio terminals is 300 to 3000 Hz in TCP-IP backbone networks also.
In the following paragraphs it will explain the basics about a simulcast network. For simplicity the descriptions are made for 1 channel network. The full system is the sum of all desired channel.
See the Radio Activity technical related document "**ENB7-Simulcast network 1v0.pdf**" for more detailed descriptions about the simulcast applications.

TCP-IP LAN backbone

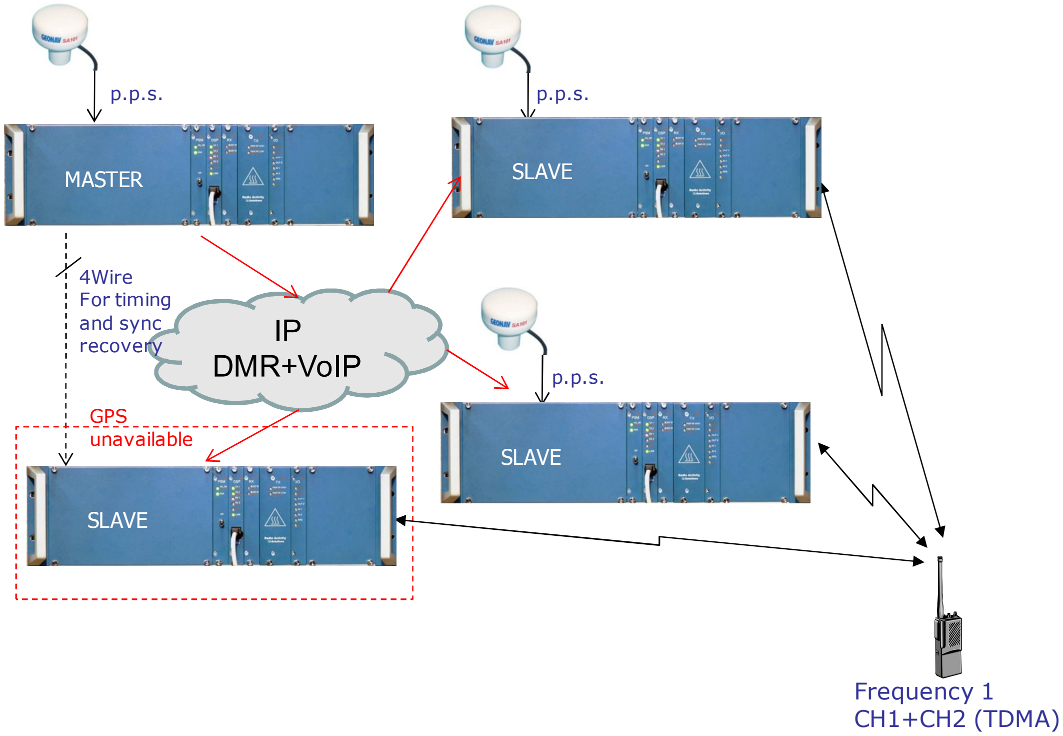
This is the most common application of the Radio Activity base stations. Every base station has got an Ethernet port to connect to a LAN backbone network. An important distinction between an over-IP system and a conventional (switch-based) one is that with a IP system there is no central switch, thus eliminating a critical point of potential failure. Instead, full use is made of IP (Internet Protocol) network technology to provide reliable data routing between network components. This combination of IP technology and the advanced DMR communication standard produces a feature-rich solution with a surprising degree of flexibility and resilience.

One base station of the radio network works as "Master" station. It require a fixed IP address. The other base stations are configured as "Slave" stations with an IP static or not.

Through the LAN, the Slave base stations search the Master one and then they log themselves to it. The master governs the radio network sending timing and related information to the slaves.

The incoming signal from a terminal equipment is received from one or more base stations. All base stations receiving a valid signal send it to the master station via the Ethernet interface through the LAN backbone. The master station waits the arrival of all signals and then performs the selection of the best signal. The master selects the incoming signals continuously on the basis of signal/noise (analog) or maximum likelihood (digital DMR).

The master station sends back the best signal to all the slaves via the Ethernet interface through the LAN backbone utilizing a multicast IP protocol.



All the slaves synchronize the signals received from master on the local GPS signaling base. All the base stations synchronize also their timing, protocol history and carrier frequency to the GPS. The synchronization procedure requires less than 1-2 minutes to reach the requested precision after a “cold start up”. Thanks to the very high stability of internal clock sources in conjunction with sophisticated network algorithms, the synchronism remains good enough up to 8 hours after GPS missing.

Where the GSP signal is not available or it is “too evanescent”, it is possible to recover all precise synchronisms via a twisted pair of copper or a 4Wire interface (e.g. from a fiber optics MUX). Radio Activity develops other methods for synchronism recovery, contact Factory for details.

In the event of a radio site becoming isolated from the network it can continue to operate in standalone mode until such time as normal network communications are restored. Any sites still able to communicate with each other can also continue to work together whilst temporarily isolated from the main part of the network.

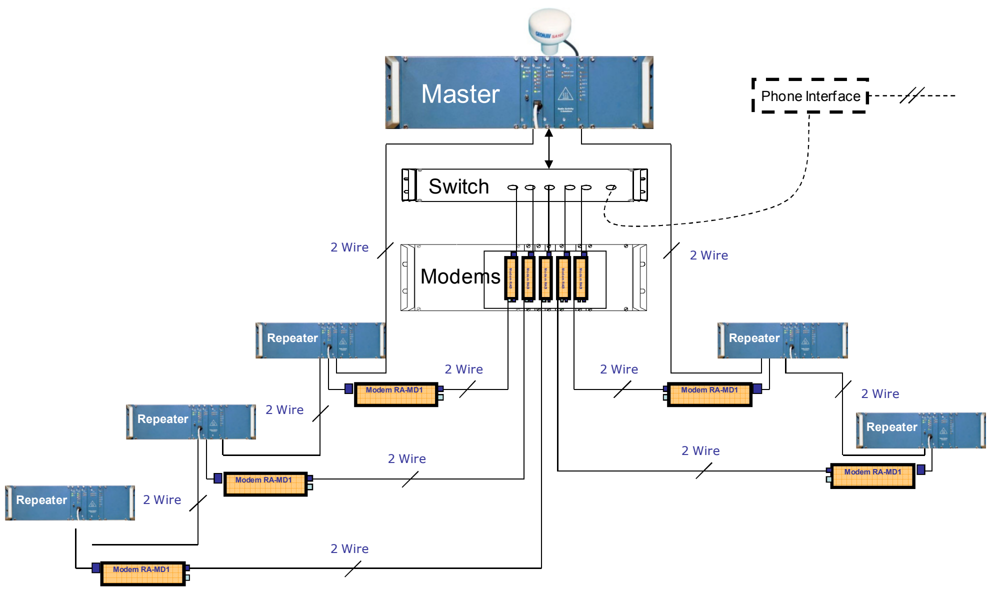
The GPS is not needed in the case of multicast (non simulcast) applications. In this case the algorithms based on the TCP-IP time stamps, corrected by Radio Activity “fine timing over IP” methods, perform a sufficient synchronizations of the base stations.

The simulcast or multicast network can work in dual mode, that is, it can recognize if the incoming signal from a terminal equipment is analogical or digital and configure itself as analogical or DMR simulcast network. In the first case the voice will fill the entire channel (no other contemporary communication is allowed) and it will be compressed in quasi-linear format to be exchanged between stations through Ethernet connection. In the latter case the network will support two contemporary DMR communications (both data and voice) over the two timeslots. Full DMR features are supported.

If DMR terminals are programmed in scan mode, they can perform communication both with analogical terminals in analogical mode and with DMR terminals in digital mode.

A special case should be describe when some link between the slaves is not available (it is difficult to have a LAN connection). A Radio Activity IP modem model RA-MD-1 may be used to perform a LAN connection over a twisted pair of wires or a 4Wire interface (e.g. from a fiber optics MUX). The resulting LAN may have a reduced bandwidth (e.g. 33.6Kb/s or less) and introduces a significant delay (about 50-60 ms). Thanks to the low bandwidth requirements of the DMR Radio Activity base stations, it is possible to use this solution but in digital mode only.

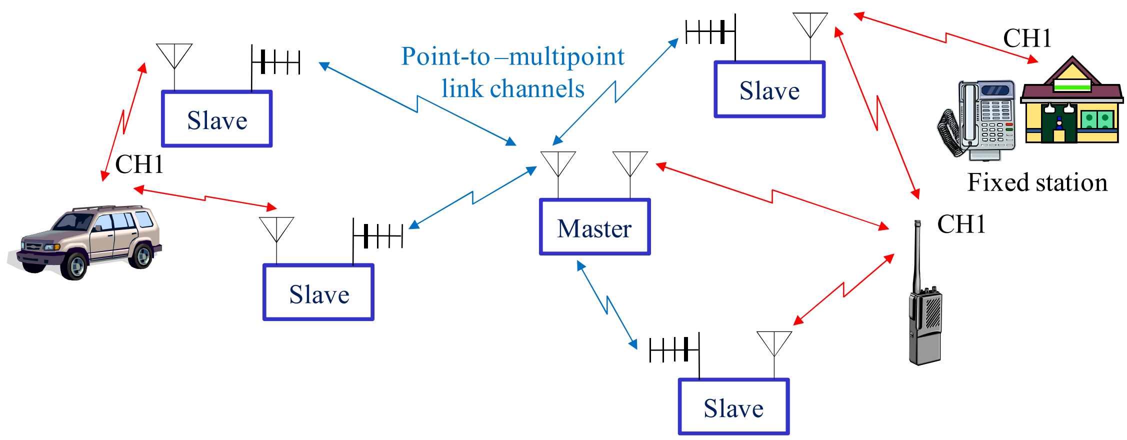
The following figure illustrates an example of DMR simulcast network full realized with wired lines.



RF linked backbone

A lot of users need narrowband radiofrequency link to connect the base stations of the network. These links operate typically in licensed UHF band, they can perform rugged and stable communications in "non visibility" conditions also.
Radio Activity base stations have got simple interfaces (Ethernet or 4Mb/s) to joint each other.

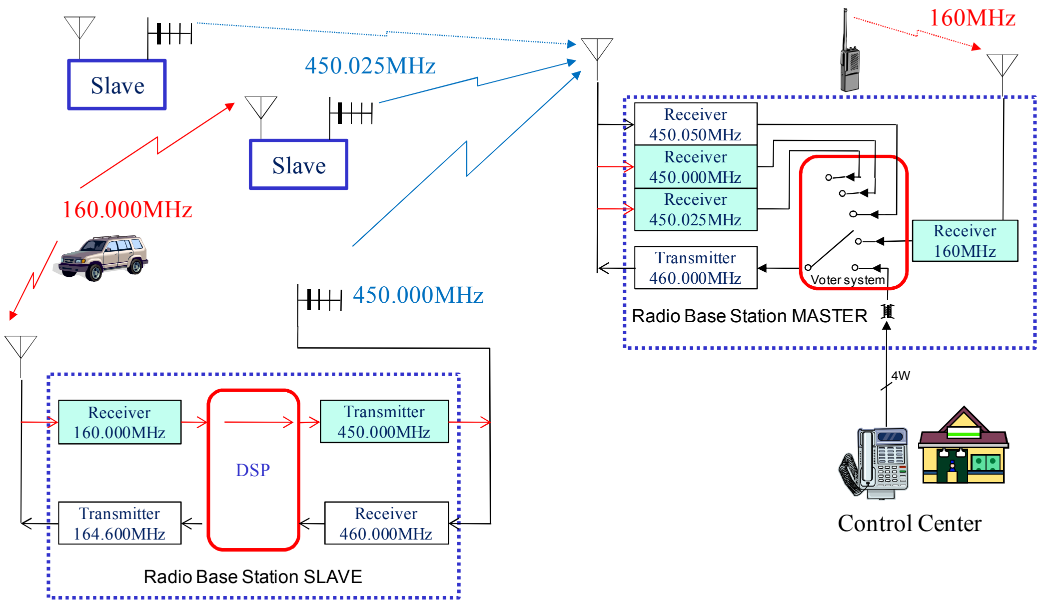
The "RF linked" solution has the following geometry:



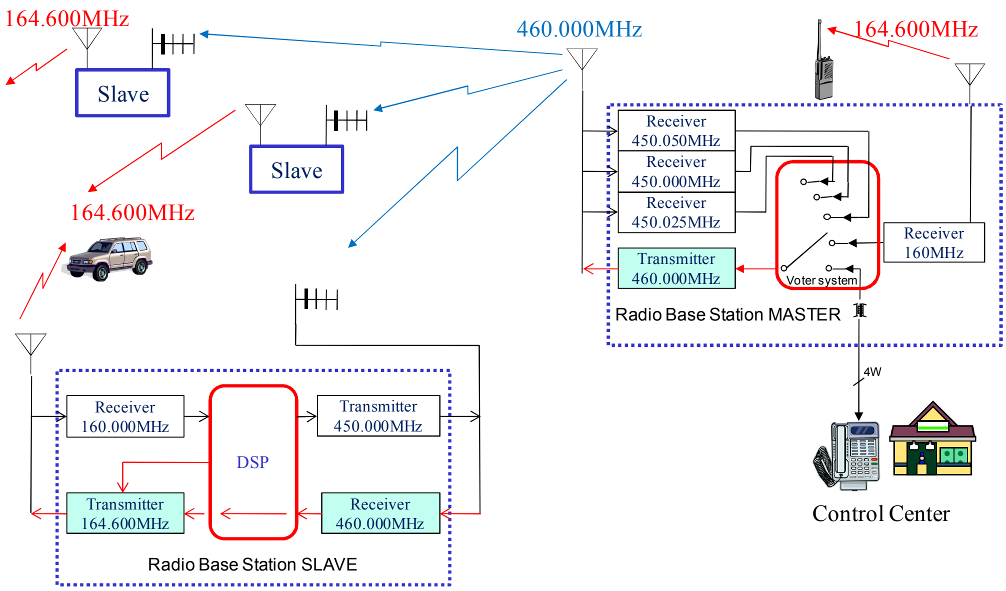
The operation of this type of network may be summarized as follows:

the radio signal emitted by a peripheral device is received by one or more receivers on the network, all tuned on the same frequency, and sent via UHF links to a comparator, which is located on the master (or sub-master), which in turn shall continuously select the best one in terms of signal/noise (analog) or maximum likelihood (digital DMR).
Selected signal is then sent back simultaneously on a frequency, obtained by the digital synchronism clock worked out by DSP, to the various transmitters of the network which provide to broadcast to the area of coverage of the system. Radio mobile coverage areas become in this way very wide, well beyond the capabilities of a single repeater, offering at the same time to users of the network the same operational ease as a single repeater.

In more detailed view, it can be see the up-link signal path in the next example:



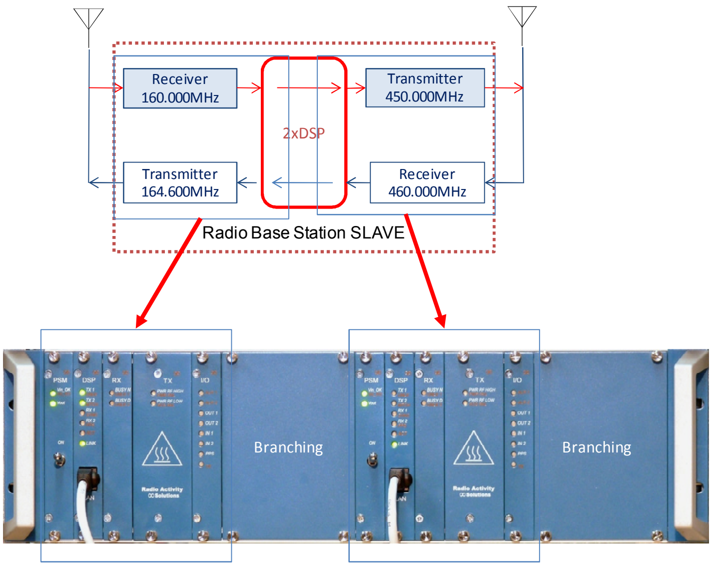
The real – time DSP voting selector on the master station chooses the best signal (greater S/N for analog or maximum likelihood for digital) incoming from the SLAVEs and sends it back to all the SLAVE stations. One different frequency is needed in the links from every slave station. Only 1 frequency is needed from the master station to the slave ones (the information is the same for all slaves) :



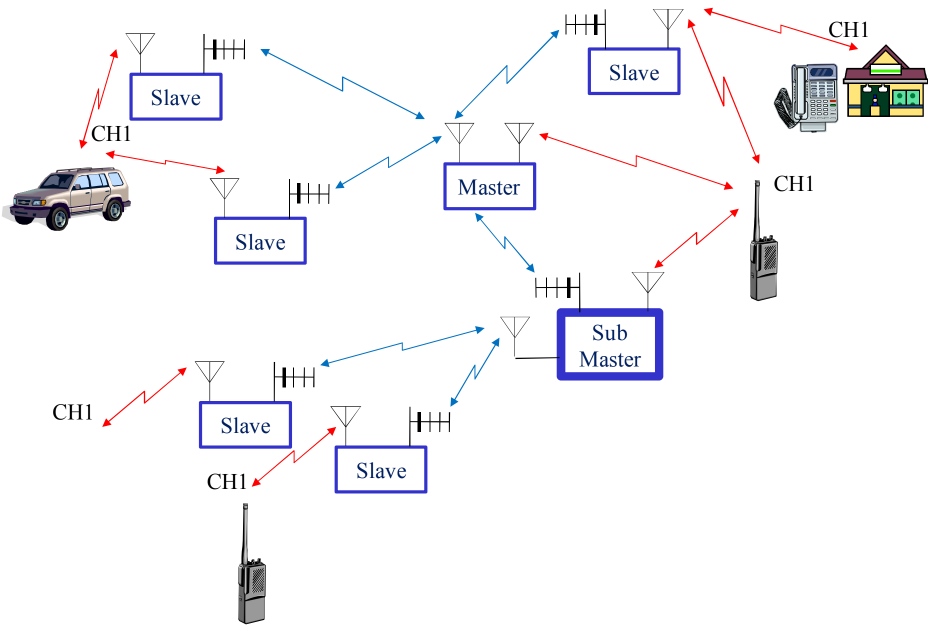
The DSP on the SLAVE stations perform automatic carrier and timing synchronization (it is recovered from a short digital burst from the master station), delay compensation and audio equalization. The GPS receiver is not required in this application due to the constant delay offered from the digital radio links.

The master station could be equipped up to 9 receivers (it can "see" up to 9 slave/secondary master stations).

A very integrated base station with two transceiver in the sample 19" rack is available for this applications.



It is available the sub-master station for very large coverage area:



The sub-master station operates like a master station with an additional transceiver that perform the link with the primary master station. The sub-master send the best signal selected from its salves to the primary master and it sends back to its salves the signals receiving from the primary master.

The sub-master recovers and regenerates all synchronism and signaling for correct simulcast operation.

Wired/leased line solution (analog only)

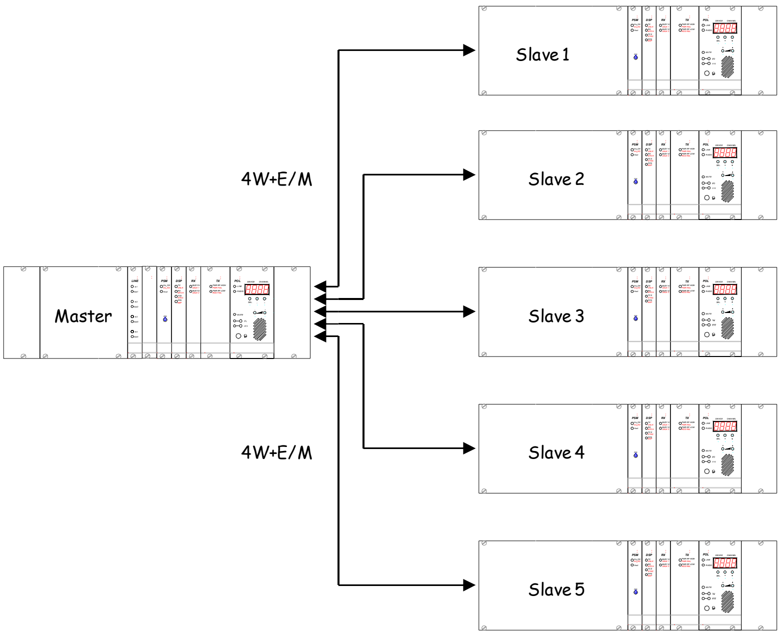
The "wired" solution for simulcast requires link connections between the base stations with 4 Wire balanced (possibly with E&M) audio interface (example: from multiplexer thought GHz T1-2Mb/ dedicated links or thought optical fiber).

There are two main geometries for "wired" simulcast:

- Star network
- Pipeline network

The functioning is similar so we start the description with the "star" type.

The "star wired" solution has the following geometry:

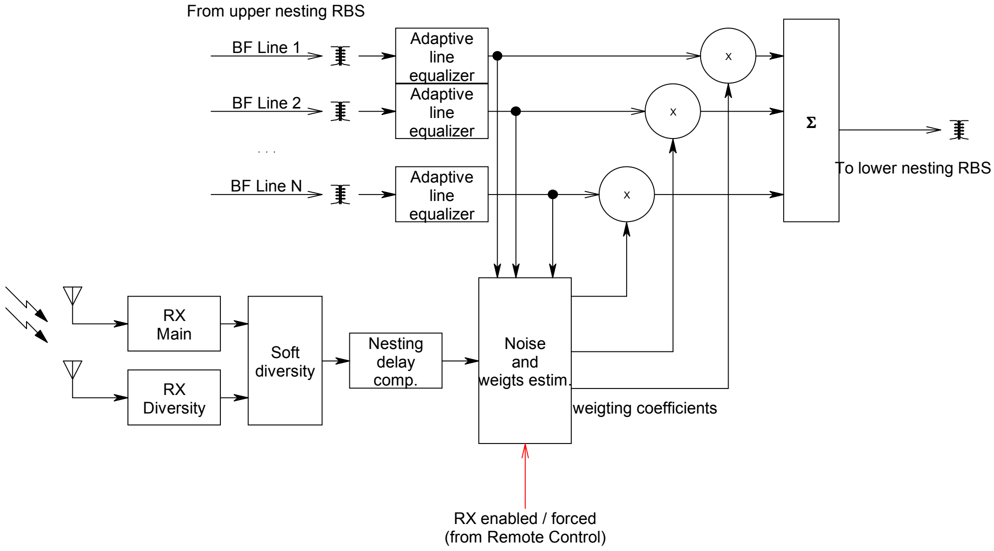


Star network

Each slave station sends the received signal to the master one. The master station performs the selection of the best signal (voting system) and send it back to all the slave stations.

The RF signal received by antennas is summed in phase (soft diversity) and then demodulated. This signal is then compared with other signals coming from the lines of RBS downstream.

For each signal the quality is continuously calculated and the weight to give to each signal is extracted.



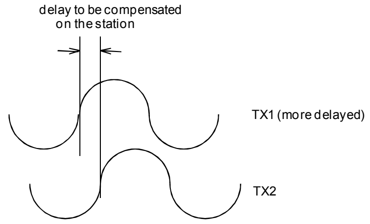
Basic scheme of Soft Voting

The Voting implementation is based on a comparison of noise measured in real time on each input channel. The measuring band is between 2700 and 3400 Hz in such a way to magnify the components of harmonic distortion and noise of FM receivers, known to have a trend proportional to f^2.

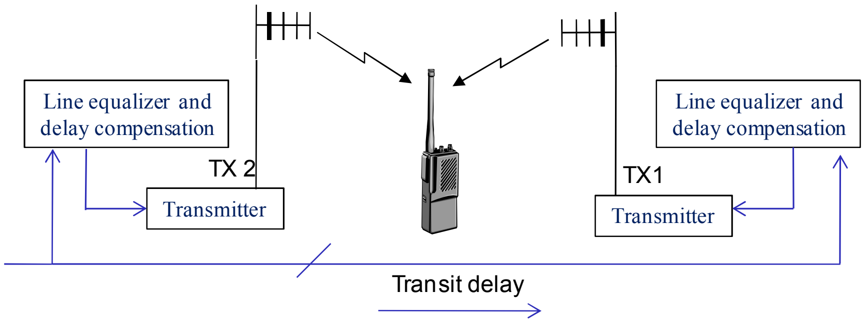
The best signal between input lines and local receivers is selected and sent towards the master station upstream. A "macro diversity" effect is obtained so the overall reception quality is better than a conventional network. The selection process is repeated at every RBS until the master station who compares the signal from the whole network with the signal received from the local RXs. The "Soft voted RX" signal of the network is sent to central office and to the stations downstream to be transmitted. The Central Office is able to intercept the signal and has the priority over the signal to be transmitted.

The signal from Central Office to be transmitted, is sent to the master station which forwards it to other RBS of the network. In turn, each RBS receiving a signal from up-stream, forwards it to all lines towards RBS further downstream.
Before sending a signal to the transmitter every RBS equalizes the path in amplitude, phase and delay.
Line equalization is performed with an adaptive filtering algorithm. The Master station, when a signal to be transmitted is not present, sends over the lines a particular digital signal, synchronized with the UTC clock, obtained from GPS receiver. Every station measures the received signal spectral density and synthesizes the optimum filter to equalize the channel amplitude/phase response (Adaptive line equalizer). The complete procedure requires few seconds.

The delay compensation is automatically performed from the DSP internal device together with a GPS receiver:

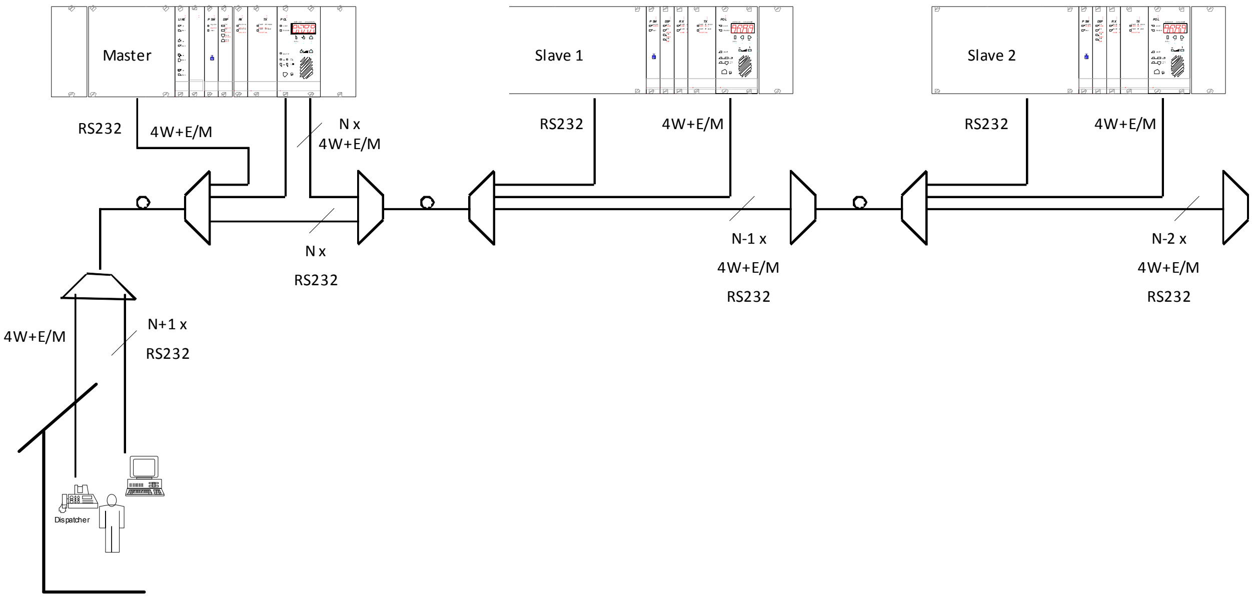


The process is described in the following figure:



The DSP line equalizer provides the necessary amplitude, phase and delay compensation. It extracts also the synchronism for the RF carrier. After the equalization a delay block is inserted to compensate for Km in the RF carrier path before reaching the planned equal field strength area.

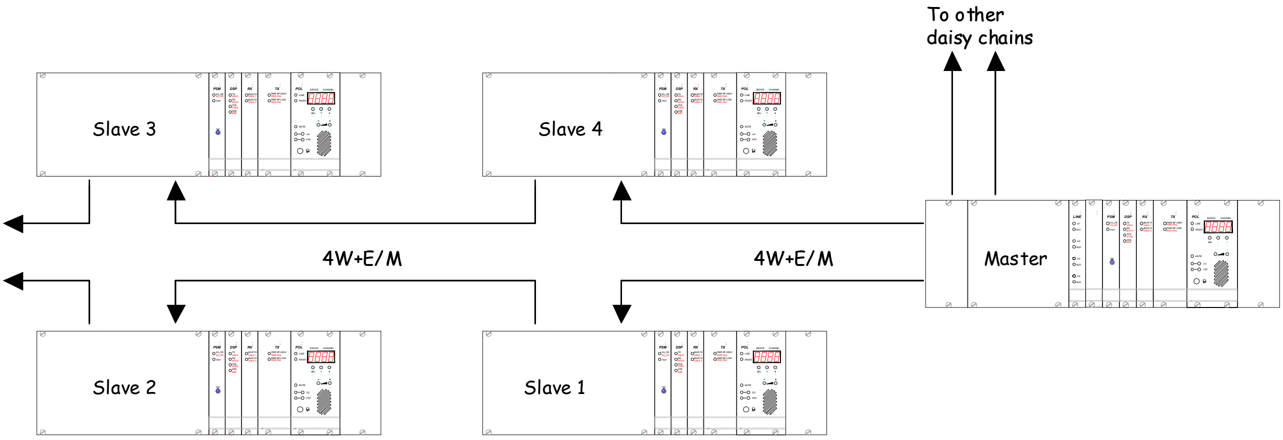
This geometry is available also in “linear” structure where it is present a MUX (optical fiber or microwave) connection between the base stations. In this case every base station uses a dedicated audio channel for the connection to the Master station:



Control Center

In the drawing it is shown the typical connections of the base stations through a linear MUX support. Note the audio 4 wire + E/M interface for communication and the RS232 (optional) port for remote control purpose.

The slave station can also be equipped with one or more other line interfaces to realize “pipeline” or “tree” network configuration.



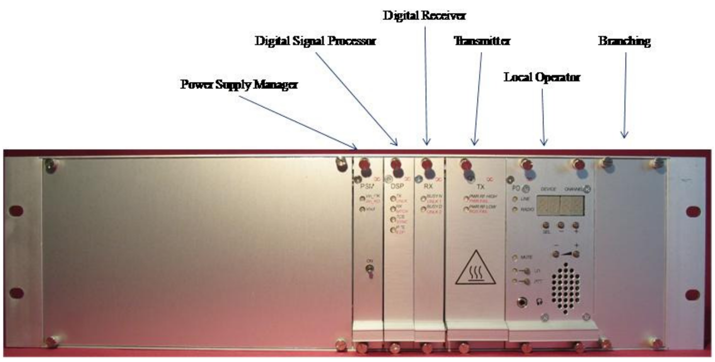
Pipeline / Daisy chain network

In this case every base station performs a voting system that select the best signal from two source: the local receiver and the signal coming from the previous (respect to the Master) base station. The best signal is sent to the following station in the Master direction. The result is a distributed voting system.

This type of geometry is used typically where the link connection between the base stations are twisted copper pairs. The typical applications are motorway, railway, gas/petroleum pipeline, electricity distribution, and similar ones.

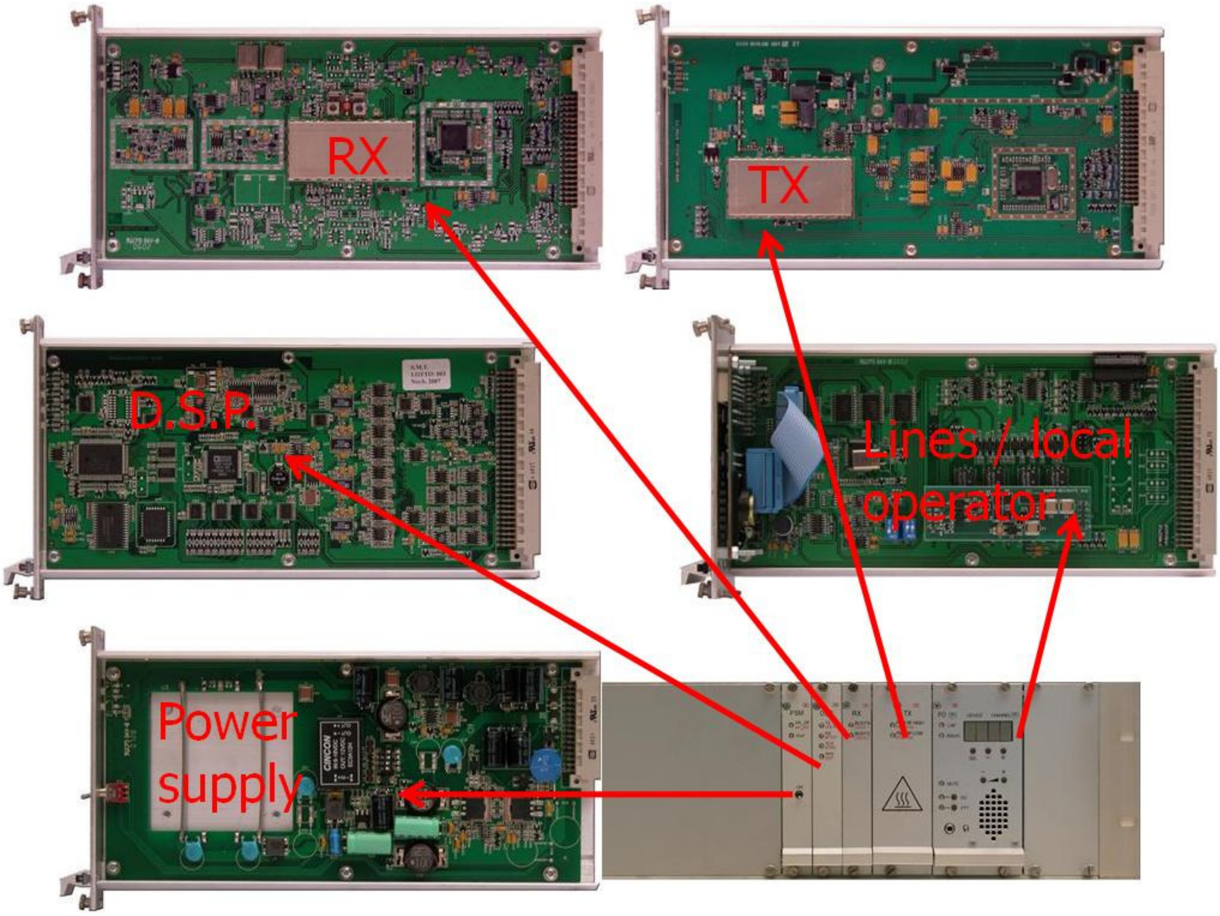
OVERVIEW OF RADIO ACTIVITY BASE STATIONS

The base station family RA-XXX has been designed using the latest technologies in the Radio Frequencies and Digital Signal Processing fields. The transceivers are "fully digital " developed following the theory of "soft radio" in which the modulation and demodulation processes are performed by algorithms of Digital Signal Processing (DSP) .



The radio modularity, as well as the other functions like remote control, self test, self calibration, over temperature protection, etc, minimizes the management and maintenance costs of the equipment. The receiver section has excellent linearity characteristics, which allow that more radio stations work on the same frequency band.
These devices are fully programmable and easy to configure both in Hw and SW, consequently this will provide optimum solutions for any radio communication exigencies from a single fixed station to complex networks with tens of base stations.
All DSP module have a AUDIO LAN connection bus that easy permits very flexible composition of system building blocks to realize virtual infinite solutions.
The transceivers of RA-XXX family can support a wide set of options for analogical line interfaces (2/4wires +E&M, telephone interfaces, echo canceller, tone decoder, …), digital audio matrix, signaling encoder/decoder (CCIR, ZVEI, DTMF, …), fast modem for data transmission, double receivers for "soft antenna diversity", voting system, multi-mode synchronism recovering and automatic phase and amplitude line equalization for simulcast application, etc.
Using a PC, via optional SW, it is possible to set-up most of the parameters (fine frequency adjust, corner frequency of digital filters, RF deviation, audio level in/out, PTT pilot tone, …). This SW permits also a large view of the status of the transceiver (audio loop test TX=>RX, current consumption, temperature, …) and a set of measurements (audio level, frequency, distortion, delay, received field, RF power, …).
The radio electric functions of the device comply with the requests foreseen by the legislations ETS 300-086 e ETS 300-113.

The transceiver RA-XXX has a compact structure, is made up by single modular units inside metallic shielded modules so called EUROCARD with 220 mm format, assembled in SUBRACK 19”. The dimensions of the sub-rack are : 3HEx84TE, width 280 mm.



The function units are implemented as plug-in modules which are interconnected on the back plane located at the rear of the unit. It consists in some PCB (depend of use) provided with signal and supply connectors.
The shielding system is very efficient and allows a quick access to the PCB, removing the slipping cover without screws.
The standard power supply of the device is by battery at 13,5Vcc, 5A negative grounding. In case of functioning with other energy fonts are available more types of isolated DC/DC or AC/DC converters with battery charger.

Remote control

The base station has a first useful level of remote control: it sends automatically alarm messages to the terminals directly. Every base station sends to the selected “maintenance group” of terminals a short message to inform in real time the user about the major failure happened (low power supply, IP connection fail, synchronism fail, etc.). In most cases this feature is enough to survey the correct functioning of the network by the final users.

In addition, Radio Activity had developed a powerful tools for Network Management and remote surveillance and control based on Windows (XP/VISTA). A lot of functions are implemented: software download, RX/TX disable, alarms report, audio level control, radio measurements, RF power, telephone to radio setup, and much more …
All the parameters setup are remotely modifiable by the user through the remote control SW pakage.

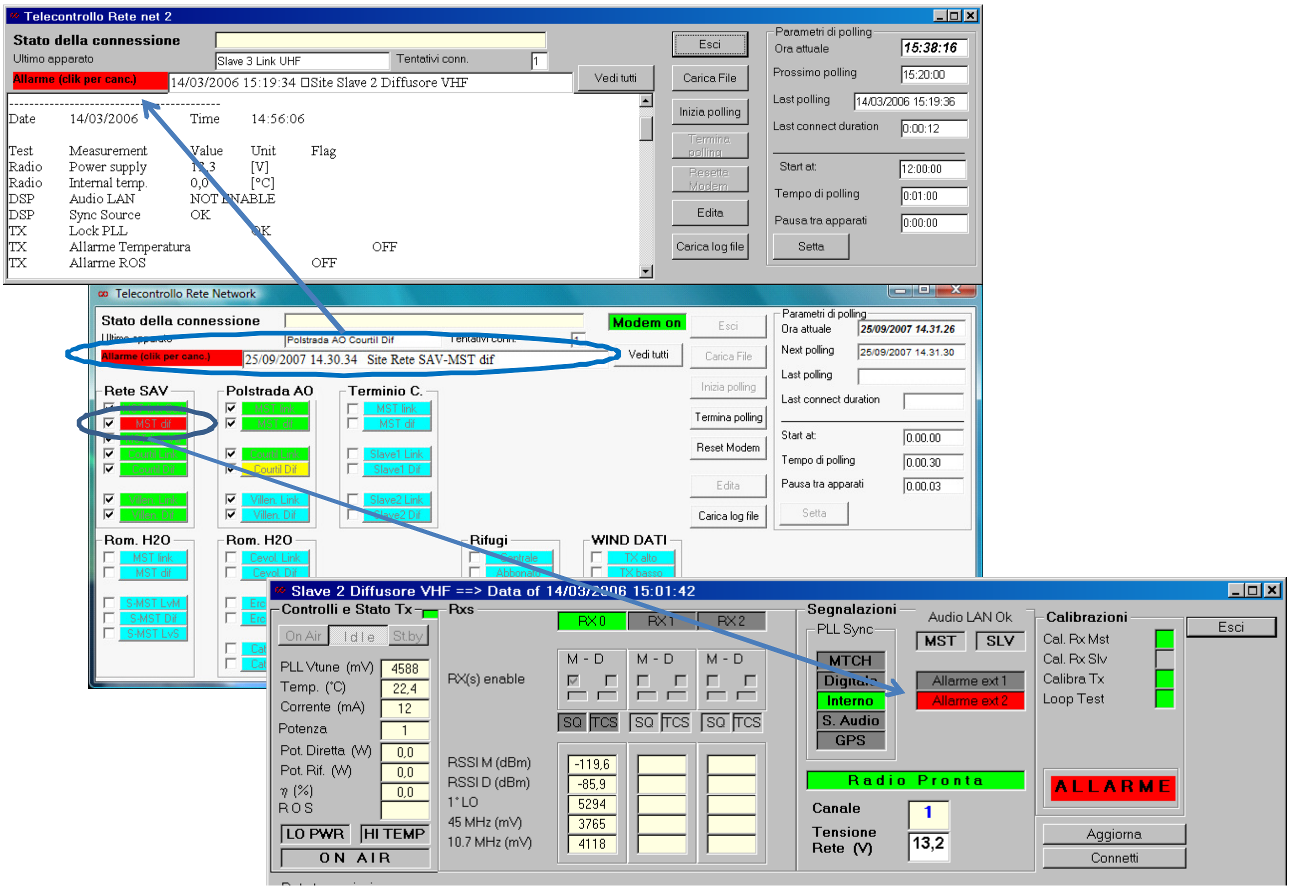
The transceiver has a serial port RS232 for control purpose. It can be optionally remote controlled by the “RA_MANAGER” (analog) or “DMR_MANAGER ” (digital) SW packages, using internal or external modem (typical a GSM data module).

These package supports the remote controlling functions for the supervision of network made by transceivers RA-XXX. This software includes the package for local TRX parameters set-up and diagnostic.

The main functions of the remote control are:

- Transceiver calibration and self test
- Full transceiver control (RF Channel, RF Power, equalization parameters, …)
- Audio lines supervision (nominal level monitoring, break detect, audio quality analysis, equalization control, …)
- Robust software down-load capability on **all** microcontrollers and DSP of the base station
- Mobile modulation analysis
- Interference monitoring

The following windows explain few remote control operation.

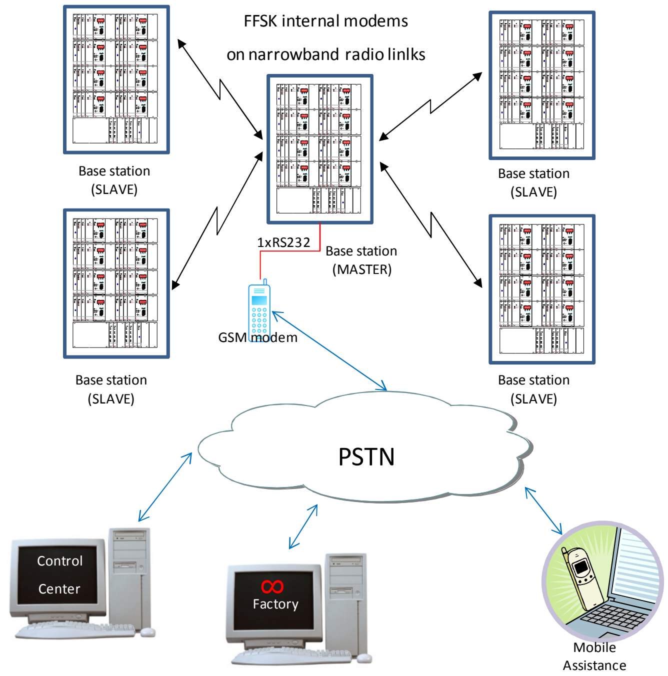


The Remote control facility permits the remote connections with some different way:

- Local serial port
- TCP/IP with specific interface
- through GSM / PSTN modem directly connected to the stations. In this case the remote control doesn't disturb the current communications and is available also when the main connection links are out of service.
- through the internal audio modem FSK in the same audio channel of the simulcast network
- in mixed mode, through GSM / PSTN modem or through serial port or through TCP/IP and, from that, bouncing with the internal FSK modem to the desired station.

The following drawings explains some of the most common remote control configurations.

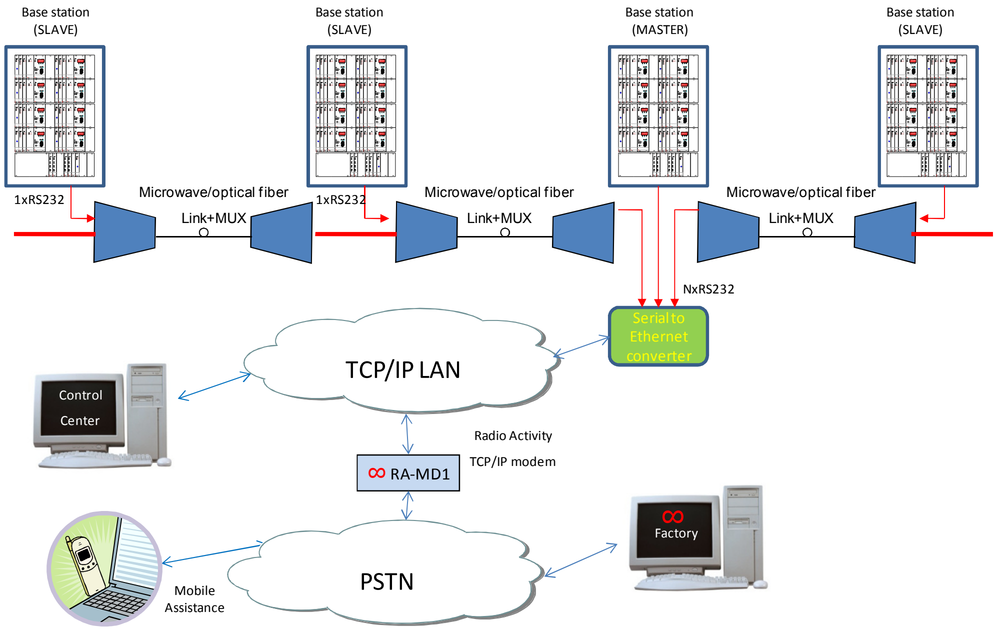
GSM on master station



Typical star network “RF LINKED” controlled via one GSM Modem placed on Master station.

The control signals coming through GSM / PSTN modem and, from that, bouncing with the internal FSK modem to the desired station. The control signals from Master to slave are audible on the mobile terminals as short (300-500 ms) data telegrams. The telegrams appear only when the remote control poll the stations (for example every 6/8 hours).
Mobile assistance or (if required) Factory can directly access the base station control port via telephone line.
Software downloading is available on master station only.

Wired station on MUX links



Typical simulcast analog network “WIRED” controlled via serial ports carried out by MUX.
The serial port control signals coming through the MUX link to the master (or another) station. A serial to Ethernet converter connects the serial ports to the LAN /TCP-IP internal network. The PC with remote control package is connected via LAN to the serial converter and, from that, it can test the desired station. <u>The control signals are not audible on the mobile terminals</u>. Mobile assistance or (if required) Factory can directly access the base station control port via telephone line with the benefit of Radio Activity TCP-IP modem RA-MD1.
Software downloading is available on all stations.

ENGINEERING SPECIFICATIONS

Frequency bands

UHF – HH	865-925 MHz
UHF – H	410-440 MHz
UHF – L	440-470 MHz
VHF – H	146-174 MHz
VHF – L	68-88 MHz

Channels managements

Bandwidth	12,5/20/25 KHz
Number of channels	199

Commutation band (without duplexer)

Band	TX	RX
UHF – H	30 MHz	14 MHz
UHF – L	30 MHz	12 MHz
VHF – H	28 MHz	28 MHz
VHF – L	20 MHz	20 MHz

Climatic conditions

Functioning temp.	-20 / +55° C
Storage temp.	-40 / +70° C

Power supply

Nominal voltage	12/24/48 Vcc
Protections	Reverse Voltage Over Voltage Under Voltage Short circuit
Transmission consumption	55 W @20W RF
Reception consumption	8 W

Dimension

Rack	128 x 426 x 280 mm 19" x 84 TE x 280 mm
Single transceiver	½ Rack 19"

Special functions

- Frequency synchronism recovery from many source: audio tone, GPS, digital, external source
- Time synchronism recovery from GPS (pps) for automatic adaptive line equalization
- Multi-channels audio voting system
- Multi-receivers assembly
- Radio to telephone automatic interface via selective call
- Audio line interface 2/4 wire + E&M
- Echo cancellation on audio line
- Telephone interface user or line side
- Digital diversity receiver with soft diversity reception
- Internal remote control modem FFSK 2Kb/s
- Start up auto calibration and internal test
- Tone generator and audio analyzer for audio lines test

Transmitter

Module output power	1/5/10/15/20/25 W
RF final transistor protection to high temperature	85°C +/- 5°C progressively reducing the RF power
Possible modulation	FM, PM, GFSK,4FSK
Modulation bandwidth	300 .. 3400 Hz
Synthesis step	6,25 KHz
Transmitting duty cycle	Continued 100%
ROS protection	Min.10' in short circuit as well as in open circuit
Adjacent channel noise	-75 dBc @25KHz -65 dBc @12.5KHz
FM distortion	< 1.5 %
Noise	-56 dBp @25KHz -50 dBp @12.5KHz

Receiver

Maximum sensitivity	-113 dBm @20 dBp SINAD -121dBm @5% BER (with diversity)
Operating maximum input	-10 dBm
Maximum input without permanent damages	+20 dBm
Reception mode	Vectorial I e Q
Received signal band	0..3400 Hz +/- 1 dB
Synthesis step	6,25 KHz
Co-channel protection	8 dB @25 KHz 12 dB @12.5KHz
Adjacent channel selectivity	73 dB @25 KHz 62 dB @12.5 KHz
Blocking protection	80 dB
Intermodulation protection	75 dB
Intercept 3° order IP3in	+15 dBm
Distortion	<2 %
Noise	-53 dBp @25 KHz -47 dBp @12.5 KHz -60 dBp (with voice search option)

Remote control connections

- through local RS232 V.24 serial port
- through TCP/IP port
- through GSM / PSTN modem directly connected to the stations
- through the internal audio modem FSK in the same audio channel of the simulcast network
- in mixed mode, through GSM / PSTN modem or through serial port or through TCP/IP and, from that, bouncing with the internal FSK/4FSK modems to the desired station