

# DMR Telephone Interface

An automatic radio to telephone and telephone to radio interface for DMR RA-XXX base station



**Radio Activity**  
**∞ Solutions**

Via Ponte Nuovo, 8 - 20128 Milano — Italy  
Tel. +39.02.36514205 - FAX/Voicebox +39.1782242408  
[radio.activity@fastwebnet.it](mailto:radio.activity@fastwebnet.it) - [www.radioactivity-tlc.com](http://www.radioactivity-tlc.com)

## About Radio Activity

Radio Activity S.r.l. is a young and dynamic engineering company, operating in Milan since 2003. The main activities are projects, developments and supplying of integrated telecommunication systems for Professional Mobile Radio market.

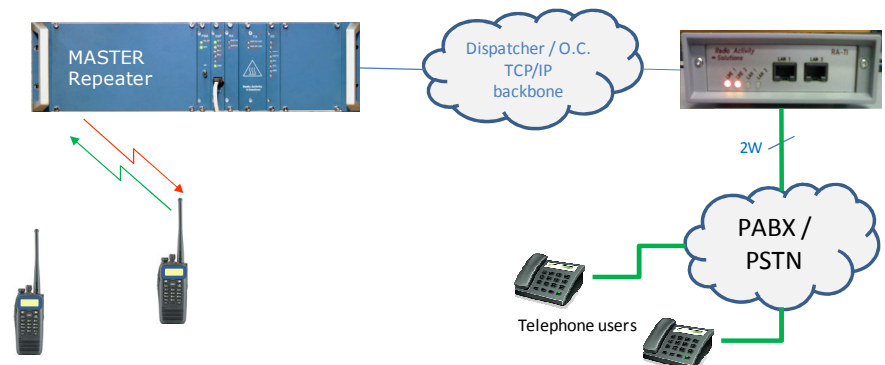
Radio Activity is **a node of a network of excellence's partners**. The research and the development carried out inside the Company involves Radio Frequency, Digital Signal Processing and IP networking fields. The Company, taking advantage of external professionals of highest level with multidisciplinary skills, is able to create, each time, work groups in order to solve the most complex projects and to satisfy the most demanding Customer's requirement. The result is a flexible and light structure, to reduce the fixed costs and to allow to always take advantage of the best available technology.

The productive activities are entrusted to various companies specialized in electronic components supplying, electrical and mechanical assembling. The final inspection of equipments and networks comes carried out inside Company, following high quality standards. The internal processes are ISO9001:2008 certified.

The installation activities and the first level technical assistance are entrusted to local Companies to quickly answer the demands of assistance. The second level technical assistance is carried out from the Company that, through remote control opportunities, can guide the local staff to the correct operations of restoration.

## General aspects

The RA-TI-01 and RA-TI-02 modules perform an automatic radio to telephone and telephone to radio interfaces for DMR (Digital Mobile Radio see ETSI TS 102 361) systems. Radio Base Stations RA-XXX in conjunction with the RA-TI-XX, are able to automatically link a group of radio terminals with a telephone line.



These modules operate in standalone mode (no PC needed) and they can be used in conjunction with any RA-XXX DMR base station family or network.

The RX-TI-XX is compatible and can inter-operate with the Mototrbo terminals but it can't be applied to the Mototrbo DR3000 base station.

These modules contain a full LINUX RISC processor and two DSP for audio coding and decoding. A lot of applications may be available by using the extremely compact coded bandwidth and the powerful built-in functionalities. The main applications are target to the DMR radio communication operative centers.

Due to the double channels available from a DMR system, the module can perform 1 (RA-TI-01) or 2 (RA-TI-02) telephone interfaces. In case of double telephone lines (RA-TI-02), two different lines (and relative numbers) are required for the connections. Each line should be connected with a fixed timeslot (e.g. Line 1 to timeslot 1 and Line 2 to timeslot 2).

The RA-TI-XX modules are available in two mechanical realizations: a single unit for desk placement and a 19" 3TU standard rack to realize digital audio matrix up to 32 lines or up to 8 lines integrated in the same rack of an RA-XXX base station.



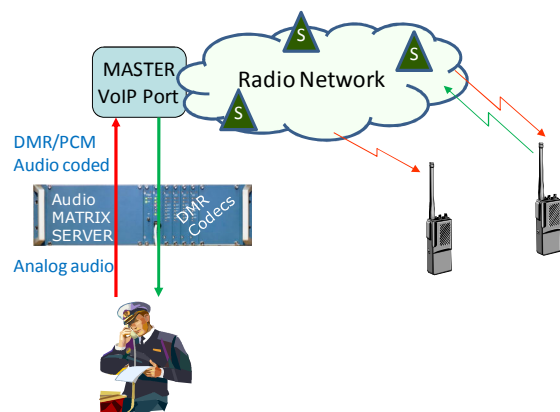
## Functioning

The functioning is very similar of the conventional analog mode of operation in which the telephone line is connected to the base station through a 2/4 wire interface. The main differences to keep in account are:

- ∞ the delay of DMR audio path requests duplex operation
- ∞ the reflection of the telephone line could produce poor DMR coded audio quality

It is to underline that **it is mandatory that the telephone user has to communicate in full duplex mode.** In fact, due to the very large delay in the audio communication over a DMR path, a semi-duplex communication with VOX may produce many understanding problems during a call. A contemporary activation of a telephone VOX originated and a PTT from the mobile may produce long instability in the exchange of communication between mobile and fixed user. Considering that the telephone user hasn't normally a radio half duplex confidence, the communication quality may be unacceptable.

In the case of direct access to our RA-XXX repeater/master of the telephone interface (in our case through an IP connection), the telephone user is able to perform a full duplex communication. RA-XXX base station performs a specific "on air" DMR protocol to connect each other the users. The mobile user has the priority over the "on air" output of the repeater, in any case he can't receive a communication from telephone line during transmission. Vice versa the telephone user continue to receive the communication from a terminal during his transmission also. This fact improves dramatically the quality of the communication.



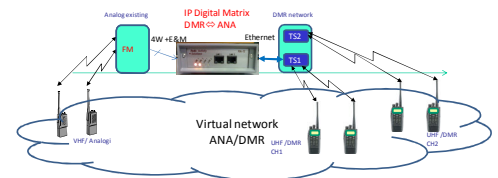
The communication from the mobile terminal is continuously sent to the telephone user (green path in the figure above). The network/repeater sends back the terminal

communications until a communication is coming from the telephone user (red path in the figure above).

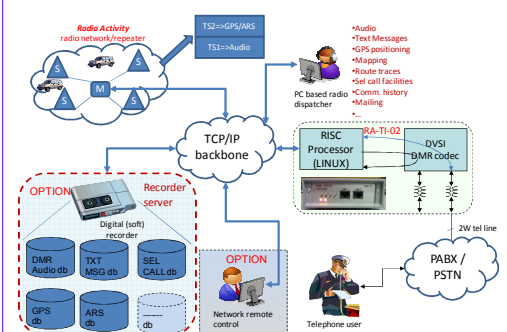
## Main applications

The modules RA-TI-0X are very flexible, customizable and permit a lot of applications like:

- ∞ automatic DMR to telephone line junction with DTMF $\Leftrightarrow$ DMR signalling transcoding
- ∞ the connection of a base station or a radio network to a local operator desk with an analog console. In this case it performs a remote full duplex audio connection to the base station. A standard console could be used to perform the appropriate audio interface. Note that there isn't DMR console that currently implements the selective call or messaging protocols.
- ∞ junction between radio network of different origins. For example it is possible to connect an urban TETRA or Analog network with a rural DMR one



- ∞ the transcoding from/to DMR coded audio to PCM linear audio to realize an integrated PC based operator desks. In this case it is possible to easy implementation, in a standard PC platform, all the DMR services needed as audio, selective calls, messaging, GPS positioning, telemetry data, digital audio recording.
- ∞ extra-low bandwidth VoIP telephony

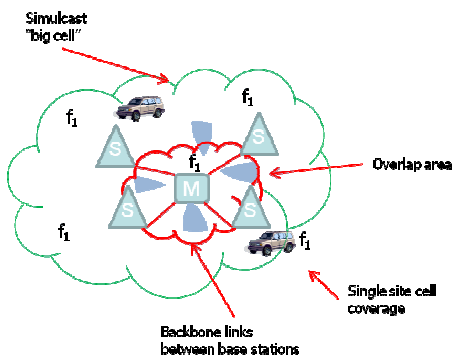




## About SIMULCAST

A simulcast network is a very powerful and professional solution for multisite radio systems. In simulcast network 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, fast setup call
- ∞ 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, frequency saving



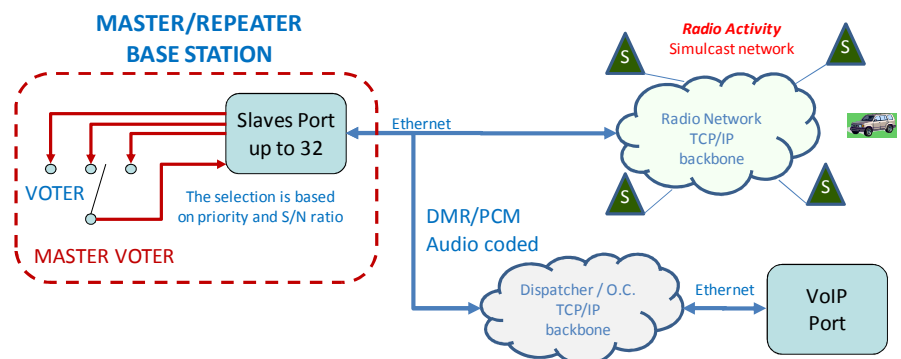
The simulcast solution is the best in case of emergency due to easy and fast "open channel" mode of operation:

- ∞ 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

No scanning required.  
Forget your previous trouble experience on simulcast networks.

## Connection to the network/repeater

The following picture illustrates the audio path in a Radio Activity network/repeater. It is referred to the most complex case of a multi site network but it easy to extend the example to a single repeater considering the master station as the repeater.



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 "best signal" selected from the voter system is then passed to a soft switch to select from "the best" or the Dispatching Center. The communication from the Dispatching Center has the priority over the communications coming from the terminals.

The master station sends back the ultimate selected communication ("the best" or Dispatching one) to all the slaves via the Ethernet interface through the LAN backbone utilizing a multicast IP protocol.

Note that the simulcast approach in a multisite system is to be preferred because it permits a real time hand over and roaming without loss of communications or loss of calls over the entire area of services, during a change of the cell also. For the scope of this document, there is no practical difference between a simulcast network and a single site "big cell" repeater. For this reason the RA-TI-0X can operate in the same way with a single repeater or with a master of a network.

## Technical specifications

### Audio interfaces

Interface type	2/4 wires isolated on RJ45 socket
Line isolation	1500 V
Used audio bandwidth	300÷3400 Hz
Input/output Impedance	600 Ohm
Side tone reflection	< - 20 dB
Output nominal level	-20 .. 0 dBm
Input nominal level	-20 .. 0 dBm
Hang line current	10..50 mA
Level adjust	software by 0.1dB step
Ring detect	60..120 Vpp @25Hz
Ring generator (option)	90Vpp @25Hz
Release tone detection	4 pulses of 425Hz @50% duty

### Codec VoIP

Uncoded audio source	64 kbps – 8bitx8KHz
Net bit-rate (1CH)	2450 bps
FEC Coded bit-rate (1CH)	3600 bps
Audio frame block	20ms
Coder algorithm	AMBE II+™
DMR compatibility	Motorola Mototrbo series

### LAN protocol

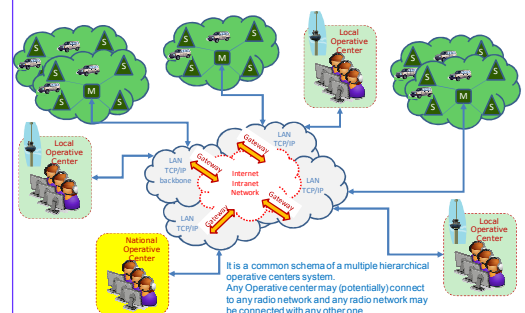
Traffic audio and messages	UDP/IP (ipv4) with flags “low delay” and “maximize throughput” set
Traffic audio and messages to	UDP/IP (ipv4) Unicast
Traffic audio and messages from	UDP/IP (ipv4) Multicast
Network control information	TCP/IP (ipv4)

### Ports and connectors

UTP LAN Port	2x Ethernet 10BT/100TX (auto MDI/MDI-X)
Optical LAN Port (option)	Ethernet 100FX on SC-SC socket
Serial control Port	RS232 V.24 asynchronous 600 ÷ 115200 bps on a DB9 female connector
BUS control Port	TTL on a dual-in-line 10 pins male

## DMR Control Office application

The RA-TI-XX module performs the audio trans-coding from DMR to PCM standard. This function permits to implement a Central System with PC based operator desks. This solution permits to create a number of applications target to Communication Center purpose. The IP protocol used to transport audio and data information gives a standard platform to implement easy several solutions spreading from a single dispatcher desk up to national wide Communication Centers network. The simplified schema above illustrate a common approach to realize a large size infrastructure.



The radio networks will serve local area like a town, a province or a region. Each Operative Center can manage the communications of one or more radio networks. The communications will be easy transported and managed through the IP backbone with standard IP network elements. Using appropriate server/client solutions it is possible to associate any radio network to one or more Operative Center. These associations can be moved in few seconds following the needs of the User: e.g. to use an Operative Center only during the night or to moving the control operation from a site to another site during an emergency.

**For more information contact us at [radio.activity@fastwebnet.it](mailto:radio.activity@fastwebnet.it)**