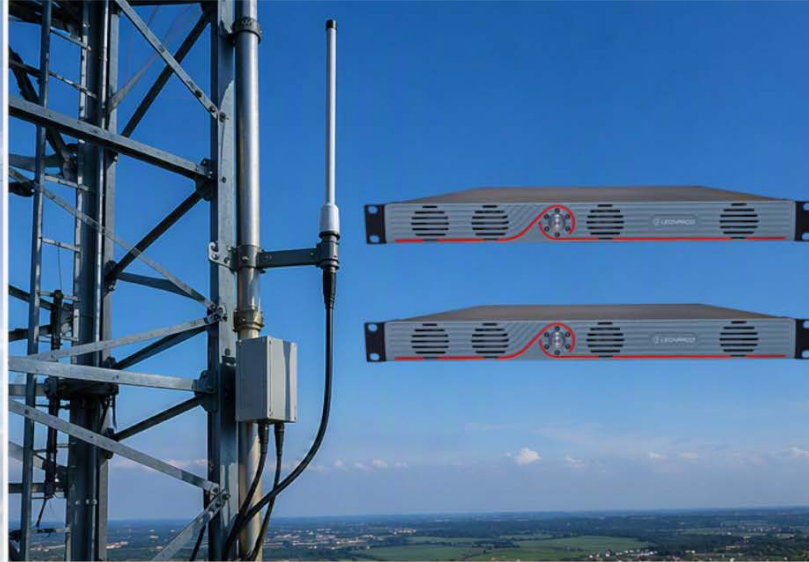




CYBER & SECURITY SOLUTIONS

ECOS

DIGITAL MOBILE RADIO SOLUTION

 **LEONARDO**

TRENDS IN PROFESSIONAL RADIO COMMUNICATIONS

In the age of 5G LMR still play an important role for many organizations both in Public Safety and industrial sector worldwide. During the years since the beginning of radio communications, technological evolution has always tried to support users with increased performance ensuring clear communications, enhanced coverage and increased number of users with optimized spectrum use. Professional users rely on licensed radio spectrum in order to enforce reliability and quality of service (e.g. no interference with non-authorized users); regardless of economic crisis, worldwide market of professional communications is expected to grow. The installed base of analogue and digital Land Mobile Radio (LMR) all over the world is expected to increase in next years. Digital radio communications provide clearer voice together with the capability to deliver data supporting for instance location based services.

THE ROLE OF DMR

Among digital radio technologies, some are characterized by providing interesting features at lower cost than the digital systems traditionally used by Public Safety and industry users such as TETRA and P25; this is the case of DMR (Digital Mobile Radio), a technology standardized by ETSI that can provide effective communications through a rich set of features and capability to support low and high traffic volumes on small and large territory extensions. Mobile applications based on the DMR digital standard are steadily growing in the world, thanks to the significant advantages of the DMR standard, compared to analogue FM radio systems, and to the low cost, compared to other digital systems previously developed. Analysts say that DMR will be the most widespread radio communications in the world in the coming years. Leonardo is a global leader in electronic and information technologies for defense systems, aerospace, data, infrastructures, land security, protection and sustainable solutions. Leonardo has extensive experience in PMR digital systems and deeply knows the operational needs of the Public Safety and industry organizations that operate on a local and national scale.

ECOS (Extended COmmunications System)

ECOS is Leonardo's DMR solution, a smart radio network system, at the forefront of DMR technology for critical operations; ECOS solution is one of the most comprehensive and state-of-the-art DMR solution available today on the market. The Leonardo's ECOS solution includes:

- Radio networks characterized by "multipurpose" base stations meaning that they can work as :
 - Analogue
 - Tier II Conventional DMR
 - Dual-Mode analogue / Tier II
 - DMR Trunking Tier III
- Embedded logic for system architectures with distributed Core Network functionality (traditional centralized architectures can be supported as well)
- Web based Network Management System (NMS) application providing network health information, subscriber management and performance analysis
- Interface (AIS or AISIP based) towards Control Room applications (dispatchers) providing all the relevant



services for both voice and data communications monitoring, message exchange, GPS radio localization, cross-patching among radio channels, radio-telephone communications and voice recording

→ Multi technology enabled control room dispatchers

DMR AND SIMULCAST

Leonardo has a wide DMR product portfolio covering both Tier II and Tier III network infrastructure together with control room solution providing multi-technology interoperability and command and control tasks. Synchronization, equalization and voting procedures in Leonardo simulcast networks are completely automatic and performed with special DSP (Digital Signal Processing) algorithms in the Radio Base Station without any extra box to be added, allowing the highest qualitative level of radio communications in the whole coverage area.

In addition Leonardo SoIP (Simulcast over IP) protocol takes care of all issues connected to the use of a conceptually shared and not deterministic network in a system requiring strong synchronization and quality of diffused signal, incorporating mechanisms to handle jitter and packet loss.

Leonardo DMR solutions are characterized by a high degree of scalability and flexibility that allows selecting the

configuration that best matches Customer's requirements. Conventional Tier II Leonardo solutions employ the simulcast technique that allows the coverage of large areas with a reduced set of frequencies; for high traffic demand Tier III configuration may be deployed.

In DMR Tier III, multiple frequencies are used in the same network and frequency selection is automatically managed by a network controller.

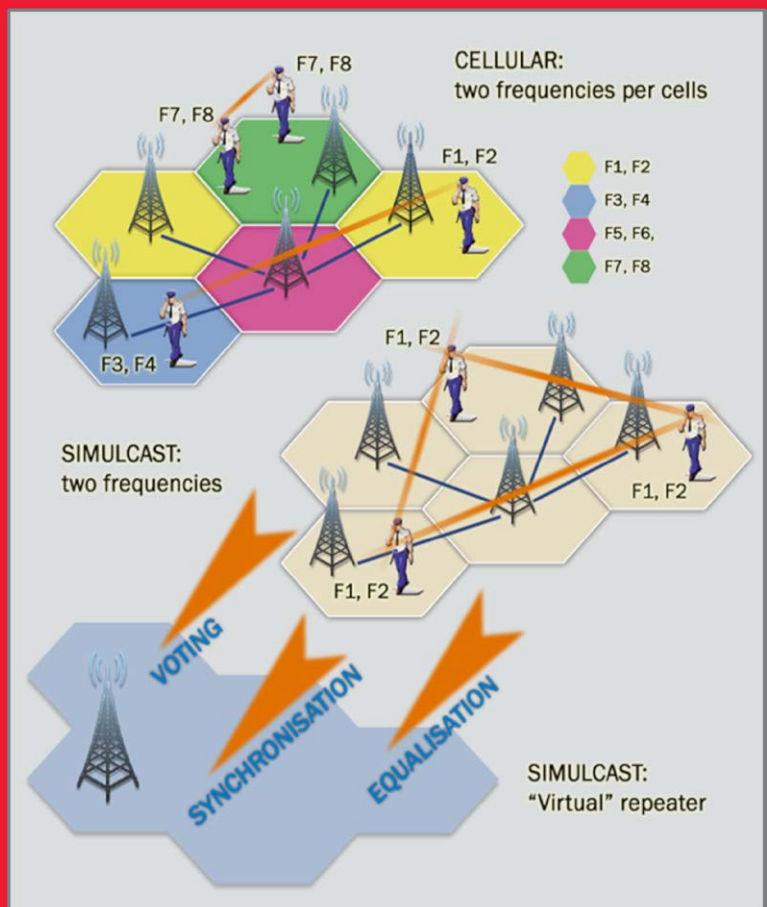
Leonardo DMR Tier III solutions support cellular deployments (that employ a large number of frequencies) and trunked simulcast deployments (virtual macro cells consisting of multiple frequencies automatically managed that cover large areas).

The ECOS family encompasses radio base stations in various frequency bands and RF power; Leonardo control room solutions feature the CSP (Communication Service Platform) that allows multi technology communications including DMR, TETRA, LTE/5G, Analog and VoIP phones for efficient and effective network integration.

Leonardo products are complemented by a set of services that allow customers and partners to design and deploy long lasting and efficient DMR infrastructures; these services include network planning, design and configuration, training warranty and post-sales support.

SIMULCAST TECHNIQUE

Simulcast systems, both analogue and digital, represent the best solution for LMR applications when it is necessary to have more than one repeater for the radio coverage and few frequency pairs are available. Each Radio Base Station (RBS) of a simulcast network uses a single transmission frequency (F1) and a single receiving frequency (F2): therefore, the whole simulcast network can be considered as a "single virtual repeater". Fast call set-up, dedicated channel access and open-channel communications are guaranteed, along with automatic hand-over and roaming, as required for LMR applications.



ECOS BASESTATION: DTA7000

DTA is the new family of Leonardo convergent multi technology radio base stations, designed to meet and exceed the requirements of professional mobile radio systems. Complex DMR networks can be implemented by combining the same building block, called DTA carrier, housed in a 1U rack case, that can realize a complete carrier in terms of computational power, synchronization capabilities, radio and wired interfaces.

A set of DTA carriers, specialized by uploaded software are combined to realize complex infrastructures according to network requirements.

The same DTA hardware implementing with suitable configuration is used for all needed architectural elements providing functions that include simulcast (master and slave) trunking controller and gateway.



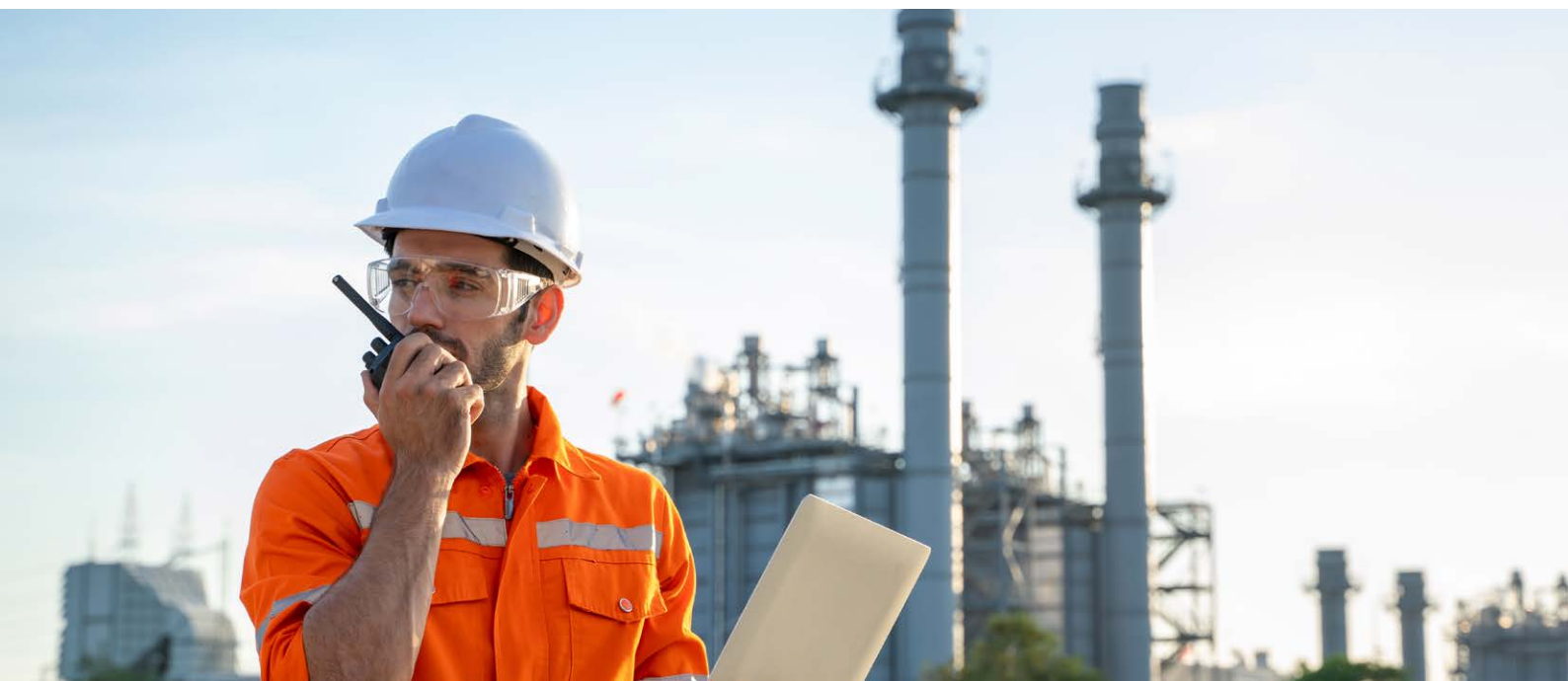
Key feature of DTA 7000 include:

- Multimode Capability: Simulcast and Multicast DMR, P25 and Analog FM are supported.
- Secure Communication: an embedded firewall increases communications security against possible cyber attacks
- Increased availability, reliability and maintainability with intrinsic redundancies, protocol error correction and remote maintenance.
- Adaptive Networking: dynamic networking capabilities optimize connectivity and adapt to changing operational conditions, ensuring reliable communication in challenging environments.
- Robust and Compact Design: engineered to withstand harsh environmental conditions, it delivers high RF power in a compact form factor.
- Intuitive Interface: user-friendly controls and interface design streamline operation, reducing training requirements and enhancing usability.

DTA700 form factor is 1U rackmountable chassis, and can operate in VHF (136-174 MHz), UHF (380-470 MHz) or UHF2 (420-512 MHz).

Simulcast support includes the possibility to operate as master, sub master and slave within the same hardware and software and featuring reliable fallback capabilities such as automatic master replication in the same cabinet in case of fault.

ECOS DTA7000 are fully compatible with Leonardo previous generation DMR systems (RBS 4000) supporting mixed configuration for incremental evolution of existing networks.

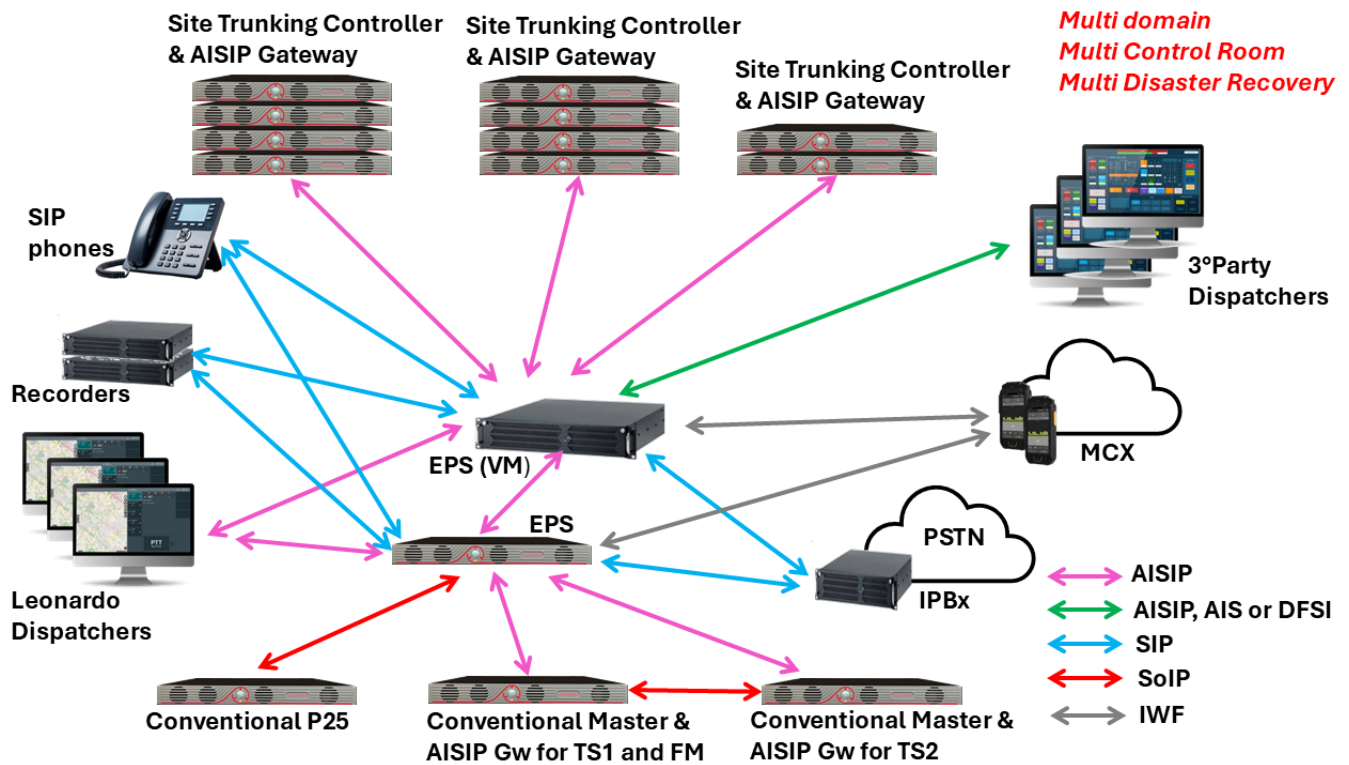


EMBEDDED CORE NETWORK: EPS SYSTEM

A complex configuration composed by several trunked sites, different conventional channels and even external networks, may be thought as a set of inter communicating domains: each domain is homogeneous in terms of characteristics, functions and management (i.e. a simulcast configuration, a trunked site, a conventional radio channel) and is communicating with other domains by means of a Leonardo protocol called AISIP.

AISIP protocol supports PTT conversations, PTTs, data transfers and signaling and ensures the correct flow of communications among domains making a complex heterogeneous configuration to behave as a single uniform entity.

AISIP protocol runs on a server/gateway architecture where gateway and server functionality are allocated on domain network elements according to the needed configuration. AISIP Gateways and Server are logical roles that can be implemented in physical servers as virtual machines or embedded in ECOS radio base stations. This allows



the deployment of flexible configuration ranging from centralized core network to fully distributed approach.

The choice to deliver EPS functionality as a virtual machine or as an embedded software component in ECOS radio base stations, depends on the communications traffic to be supported that is linked to the number of simultaneous communications streams to be managed. An EPS implemented as a virtual machine on a server is able to deliver more traffic than the one embedded in the radio base station.

EPS functionality can be intrinsically redounded in an ECOS network. An EPS domain contains one EPS main element and one or more backup element. A suitable control protocol is used to exchange information among EPS elements and elect a new main in case of failure. The distributed architecture, due to a mesh full interconnection among domains, allows remaining EPS Domains to properly operate and manage both intra-Domain and inter-Domains calls in case of failure or unreachability of one EPS Domain.



BROADBAND INTEGRATION

ECOS solutions can be integrated with broadband networks leveraging LMR-IWF (LMR Interworking Function) developed by Leonardo according to 3GPP specification.

DMR subscribers, provisioned on Leonardo DTA base stations can interoperate with smartphones running an application implementing the MCX protocol such as Leonardo MC_linX. Leonardo Mosaic hybrid network solution allows the seamless integration among TETRA, DMR and MCX supporting multi technology voice communications, messaging and location.

MULTI TECHNOLOGY ENABLED CONTROL ROOM: MCCR

Mission Critical Control Room (MCCR) is the Leonardo enhanced dispatcher solution enabling agencies and organizations to manage day-to-day operations and above all co-ordinate emergencies much more effectively. MCCR web based dispatchers are able to communicate and connect seamlessly through our multi-vector server with standard narrowband communication systems (TETRA and DMR), analogue systems and broadband networks (via MCX smartphone app). Leveraging AISIP protocol, 1 or 2 screen configuration can be supplied providing complete range of professional services

- Voice (individual & group calls, supplementary services)
- Messaging
- Location (map based resource geo-location and tracking)
- Gesture based communication control (click-to-call,)
- Recording services

In addition leading third party dispatchers taking advantage of AISIP or AIS (DMR association) protocol can be employed.

WEB BASED MANAGEMENT: E-CONNECT AND E-WATCH

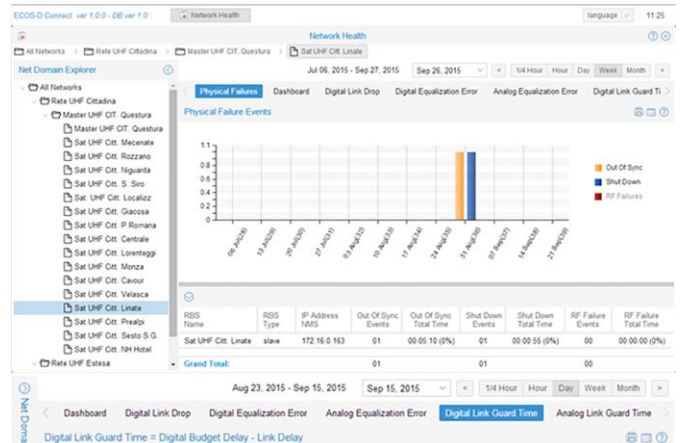
DMR networks play an important role in mission critical and business critical sectors, having the constant management and control of the infrastructure is vital to keep the network operational, provide effective services to users and support operations.

E-Connect is a suite of web based applications that improves the user experience and the management of ECOS apparatus and systems. E-Connect can be used both to manage simple systems (a single radio channel) or to manage complex systems such as EPS-based systems, conventional radio systems composed of several radio channels (Analogue FM,

DMR, APCO P25), DMR trunked radio systems (single site or multi-site)

E-connect allows to keep the whole network under control verifying the correct behavior, monitoring key performance parameters and performing device programming operations in a secure way. A set of APPs implement main tasks and operation supporting network administrators in their work:

- system provisioning
- network health
- EPS service analysis
- subscriber management
- OTAP (over the air programming)
- encryption keyloading
- license management
- firmware uploading and restoring
- mail ticketing



E-Watch, a component of the E-Connect suite, is an investigation and report APP that allows the system's managers to deeply understand how the service is provided. E-Watch connects to the Leonardo EPS core network to receive all available SIP information and data from any TierIII trunking controller.

Received information is processed and stored for reporting and analysis purposes, or directly routed to web pages for textual or graphical representation.

E-Watch dashboards provide either an at-a-glance overview of the status of services (subscribers, calls, channels, ...) as well as an in depth live monitoring of the running system allowing to drill down on interesting situations of possible problems.

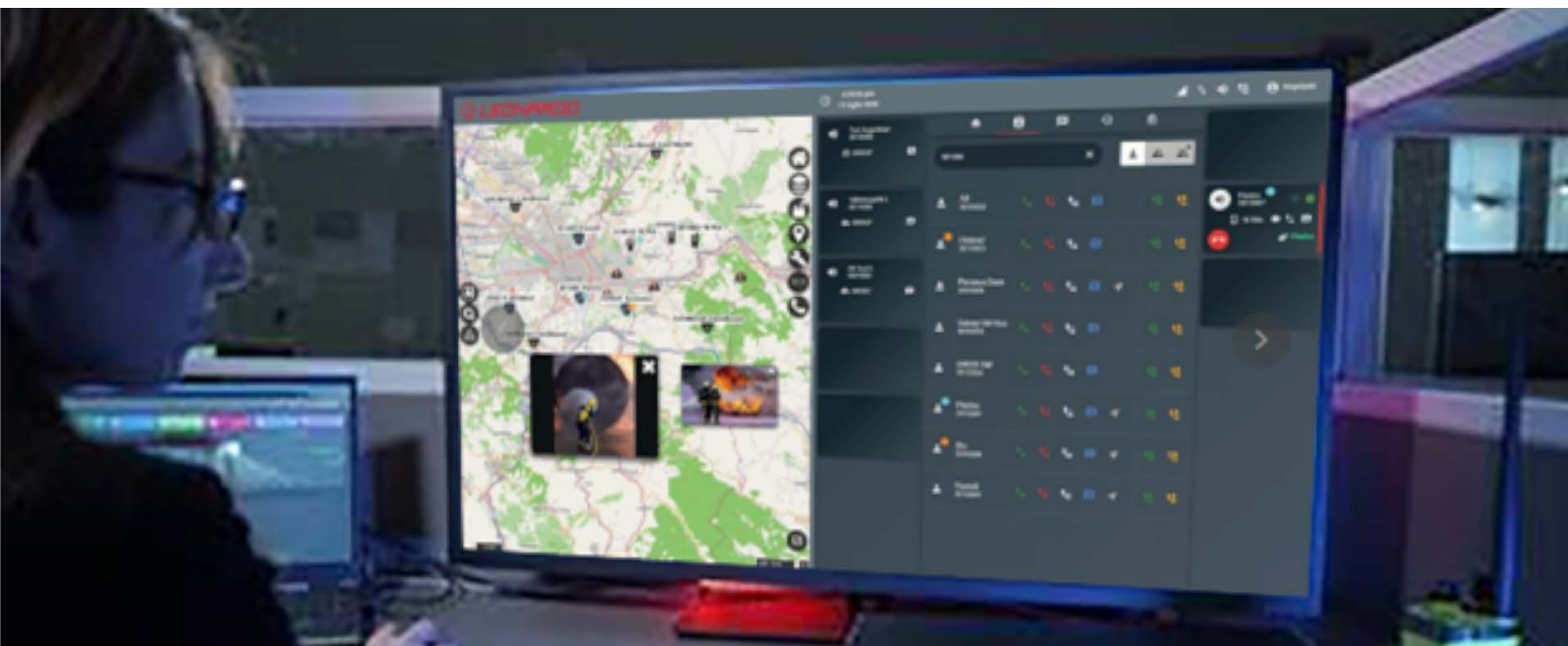
Extensive reporting functions allow to track problems, highlight functions and identify potential issues supporting informed decisions.



ECOS KEY FEATURES AND ADVANTAGES

DMR ECOS solutions grant flexibility, scalability and reliability: from a small area with low density traffic that can be served by a conventional Tier II Simulcast DMR, to a heavy traffic urban area served by a Tier III Cellular DMR to a region on nationwide network that can be served by Tier II and Tier III technologies. Leonardo can supply the solution according to the Customer's needs.

- Leonardo DMR solutions natively support all the available configuration modes (FM, Tier II, Tier III, simulcast, cellular) without the need of adding hardware modules. Leonardo Tier III doesn't require a high cost network controller.
- Intelligent protocols take care on one side, of all issues connected to the use of a conceptually shared and not deterministic network in a system requiring string synchronization and quality of diffused signal incorporating mechanisms to handle jitter and packet loss and, on another side, to manage complex multi system interactions and external systems interoperability
- Reliability is intrinsic in Leonardo solutions: in case of failure of critical network elements (i.e. master station for simulcast or control-channel manager for Tier III) other network elements automatically take over without any network impact.
- Our network solutions address security as a main requirement: conventional Tier II infrastructures implement a registration mechanism to prevent unauthorized users from accessing the network (Tier III solutions use the standard DMR authentication). In addition, the solution supports AES as well as the standard ARC4 encryption.
- Our solutions are open to multi technology integration, leveraging our MCX platform and 3GPP LMR-IWF (Interworking function) we can deliver DMR-broadband integrated solutions seamlessly managed by our multi technology dispatcher MCCR.



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