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SEASPORT Project

Sistemi Evoluti per l'Ambiente e la Sicurezza dei Porti Turistici

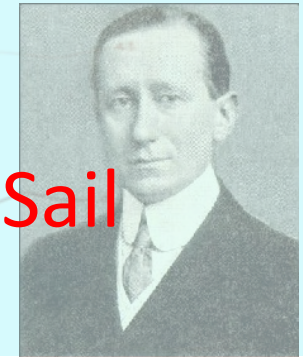
Systems for Environment and Advanced Security for Ports

Prof. Michele Luglio

luglio@uniroma2.it

Miami International Boat Show & Strictly Sail

February 11-15 2010



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Team

- Marina di Nettuno
  - Nennolina GST
    - CRESM
      - ELMAN
      - CNR
      - INSEAN
      - GEM
    - ITI Sistemi

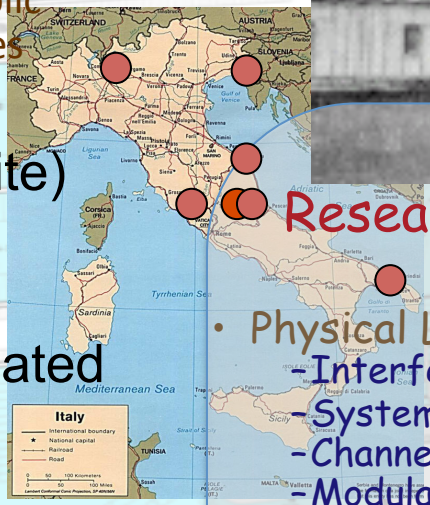
Centro Radioelettrico Sperimentale Guglielmo Marconi (CReSM)

Instituted by G. Marconi himself in 1933, at Torre Chiaruccia (Civitavecchia) as Research Center of Italian National Research Council (CNR)

- Legal location at Rome at the Ministry of Communications
- Five locations, developing research activities in cooperation with public companies and private enterprises

Main research activities

- Wireless systems (satellite)
- Special antennas
- E-learning
- Oil spill detection and related communication systems
- Cryptography



Governance

Administration board nominated by

Ministry of research

Ministry of Communications

Ministry of Industry

Ministry of Defence (3 members)

Army, Navy, Air Force

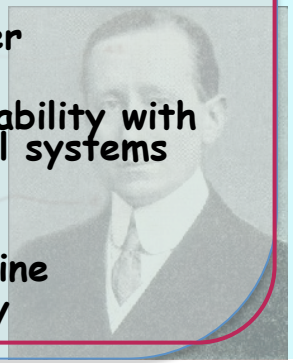
CNR

DIE Tor Vergata Research areas

- Microelectronics (baseband)
- Electronics (high frequency)
- Circuit theory
- Automatic control
- Telecommunications

Telecommunication group Research Areas and Field of Interest

- Physical Layer
  - Interference
  - System dimensioning
  - Channel modeling
  - Modulation and coding
- MAC Layer
  - Bandwidth allocation
- IP layer
  - IP QoS
  - Security
- Transport Layer
  - TCP/IP performance
- Virtual reality
- Navigation
- Systems
  - WiFi
  - WiMax
  - Bluetooth
  - Satellite
  - UWB
  - Optical systems
- **Satellite**
  - **Resource management**
  - **TCP**
  - **Cross layer**
  - **Mobility**
  - **Interoperability with terrestrial systems**
  - **Security**
  - **DVB RCS**
  - **Telemedicine**
  - **Emergency**



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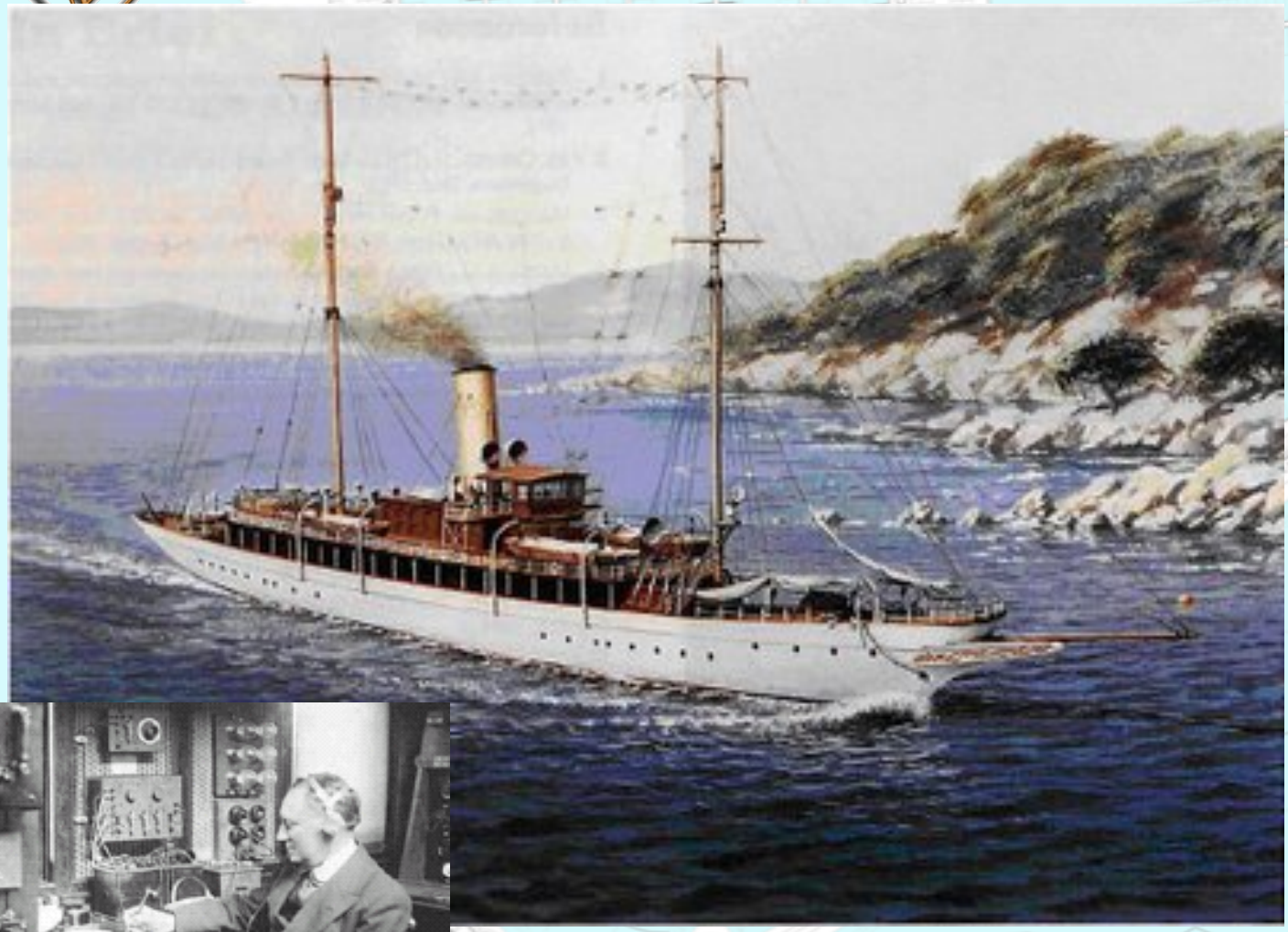
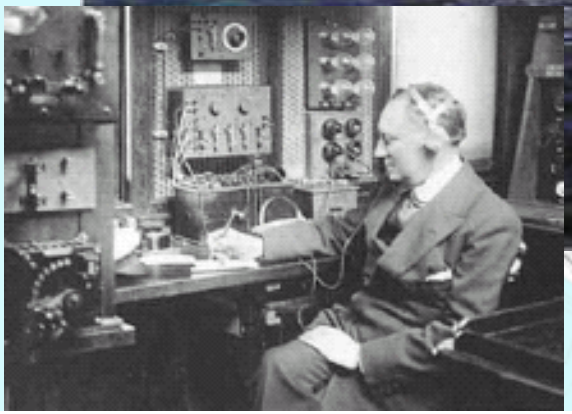
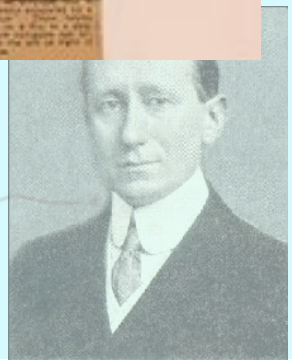
Marconi and radionavigation



Daily Mail del
31 luglio 1934





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CRESM LIST OF DELIVERABLES

- VHF communication system
- AIS (Automatic Identification System)
- Integrated radar system to monitor the portion of sea in front of the port, outer port and basins.
- Sensor network to monitor depth contour at the entrance and detect variation and sounding depth reduction
  - Application of mathematical predictive models to provide forecasts
- Sensor network to detect fuel and detergent spill
- Hardware and software interface between sensors and data network

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ITI

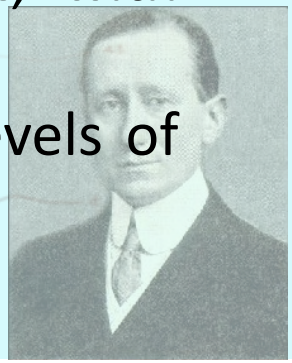
Innovazione Tecnologica Italiana

ITI is a consulting company specialized in the following sectors:

- **Networking**
  LAN, MAN, WAN, Wireless, VoIP
- **IP Security**
  Firewall, VPN, IPS, AntiVirus, AntiSpam, Content Filtering
- **Network Optimization**
  Traffic Management, Load Balancing, Accounting, Network Management

ITI was founded as a company dedicated to the deployment of **Advanced Technological Solutions** for the Enterprise market. **ITI** is composed by professionals in **Data Communication**, with proven experience and skills.

ITI is able to provide **value-added solutions** with high levels of **integration**, **customization** and **technological innovation**.



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take IT easy!

THE MISSION

- To **design** and **deploy** integrated networking and security solutions, in order to enable users to enjoy all the benefits of technological innovations
- To **customize** and **simplify** the network management, in order to decrease the Total Cost of Ownership (TCO) and the time-range for Return Of Investment (ROI)
- To made up a **technology partnership** with the customers. Our goal is not only to deploy a technological infrastructure, but also is to provide technical trainings to the customers, in order to keep technical teams up-to-date with the latest technologies, and help to manage and handle the infrastructure at maximum of performance and reliability

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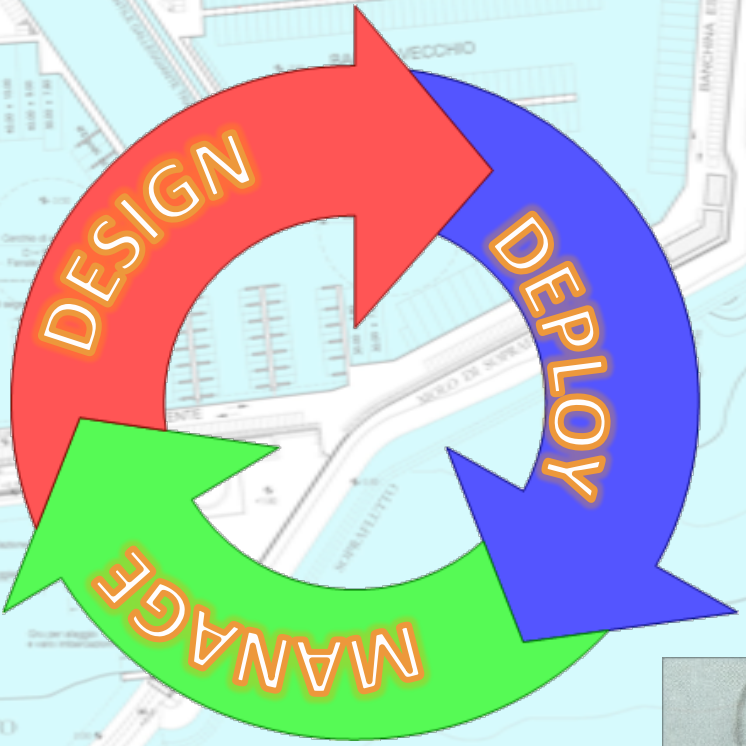
THE SOLUTION

ITI is a **System Integrator** that meet the needs of customers in terms of:

- ***Design***
  - Analysis
  - Assessment
  - Technology Scouting
- ***Deployment***
  - Supply
  - Implementation
  - Optimization
- ***Management***
  - Maintenance
  - Troubleshooting
  - Training



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ITI LIST OF DELIVERABLES

- Deployment of a capillary fiber optic network (one point of access for each boat and port facility)
- Video surveillance of the entire port area
- Vehicles Access Control (driveway)
- Basic infrastructure for Mooring Control
- Centralized internet access (wired and wireless)
- State of Heliport and Hyperbaric Chamber (free/busy)

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ELMAN

- ELMAN is active in the fields of electronics and telecommunications
- ELMAN was established 1975 and is headquartered in Pomezia (Roma)
- The internal activity management system of ELMAN complies with the UNI EN ISO9001:2000 regulation (certified by DNV)
- ELMAN is an Industrial Member of IALA (International Association of Aids to Navigation and Lighthouse Authorities) since the 1st of January 2007
- The products of ELMAN are designed to meet the requirements of customers who especially research reliability, support and maintenance, in addition to the high quality reached through the use of state-of-the-art technology

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Products and technologies

- The long-standing experience in the defense sector has enabled ELMAN to gain valuable experience in the design and manufacturing of:

- **AIS systems** and AIS data exchange infrastructure
- **VoIP systems** and VoIP communications networks
- Fixed and portable synthesized **transceivers** in the **VHF** and **UHF** band
- Analog and digital **radio links** the VHF and UHF band
- **GMDSS** systems
- **GPS**-based receivers and positioning systems
- **NAVTEX** systems
- **Air Traffic Control** systems
- Linear and switching stabilized **power supplies**
- VHF and UHF ground-plane **antennas**
- VHF and UHF coaxial dipole multiple antennas
- Antenna towers for radars, radio links and radio broadcasting

ELMAN Marine VHF

SPECIFICATIONS

- Frequency range 146 ÷ 174 MHz
- Narrowband frequency/phase modulation (J3E)
- RF power 25 W max
- DSC function, compliant to recommendations ITU-R M.493-10 e ITU-R M.541-8
- Secure voice function (dedicated and/or custom firmware)
- Dual watch function
- Remote control through RS232/422 port
- Built-in test equipment (BITE)

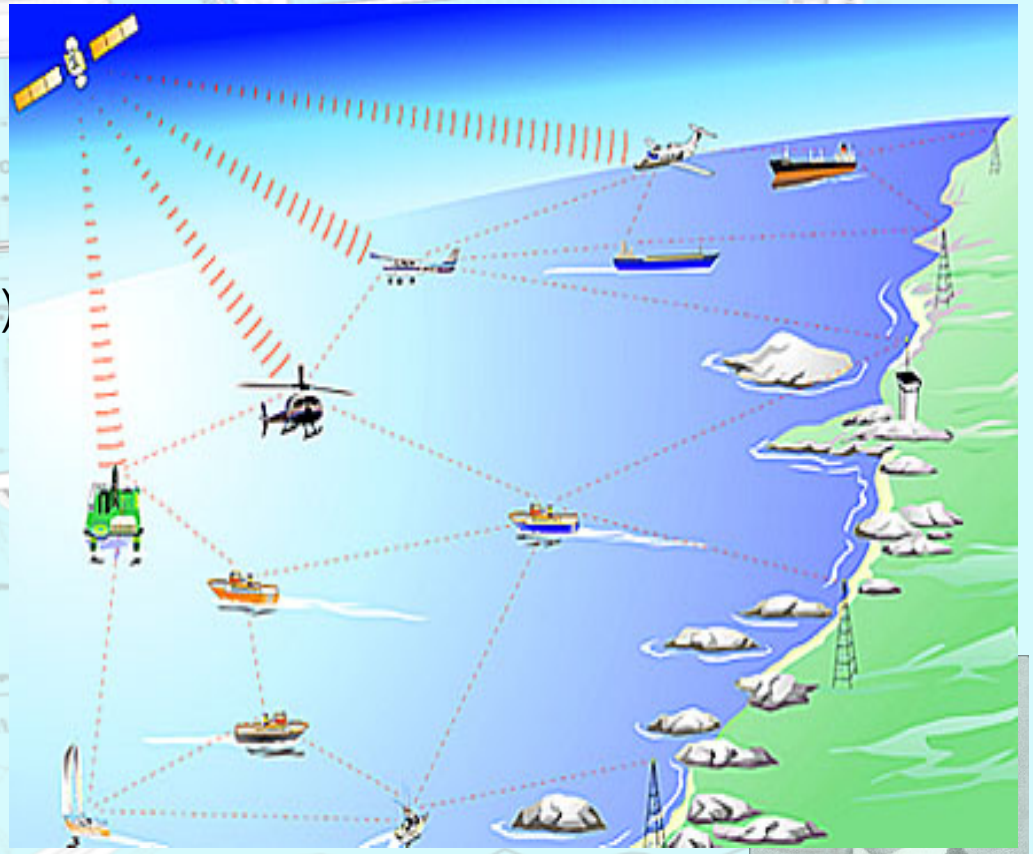
The **RTV-1077D** is a vehicular transceiver for ship-to-ship and shore-to-ship radiotelephony communications in the 146 ÷ 174 MHz frequency band in narrowband FM mode compliant with MIL and NAV regulations, fit for use aboard ship units.

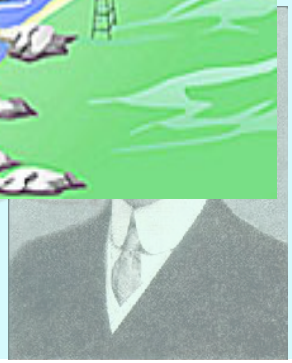
The transceiver is provided with three independent receivers:

- Receiver for radiotelephony communications (plain or encrypted)
- Receiver for DSC function (also available for Dual Watch function)
- Receiver for data communication (VHF Data Link) for the messaging and radio tracking service (153 ÷162 MHz). The Data Link function also enables point-to-point data communication at a speed of 9.6 kb/s.

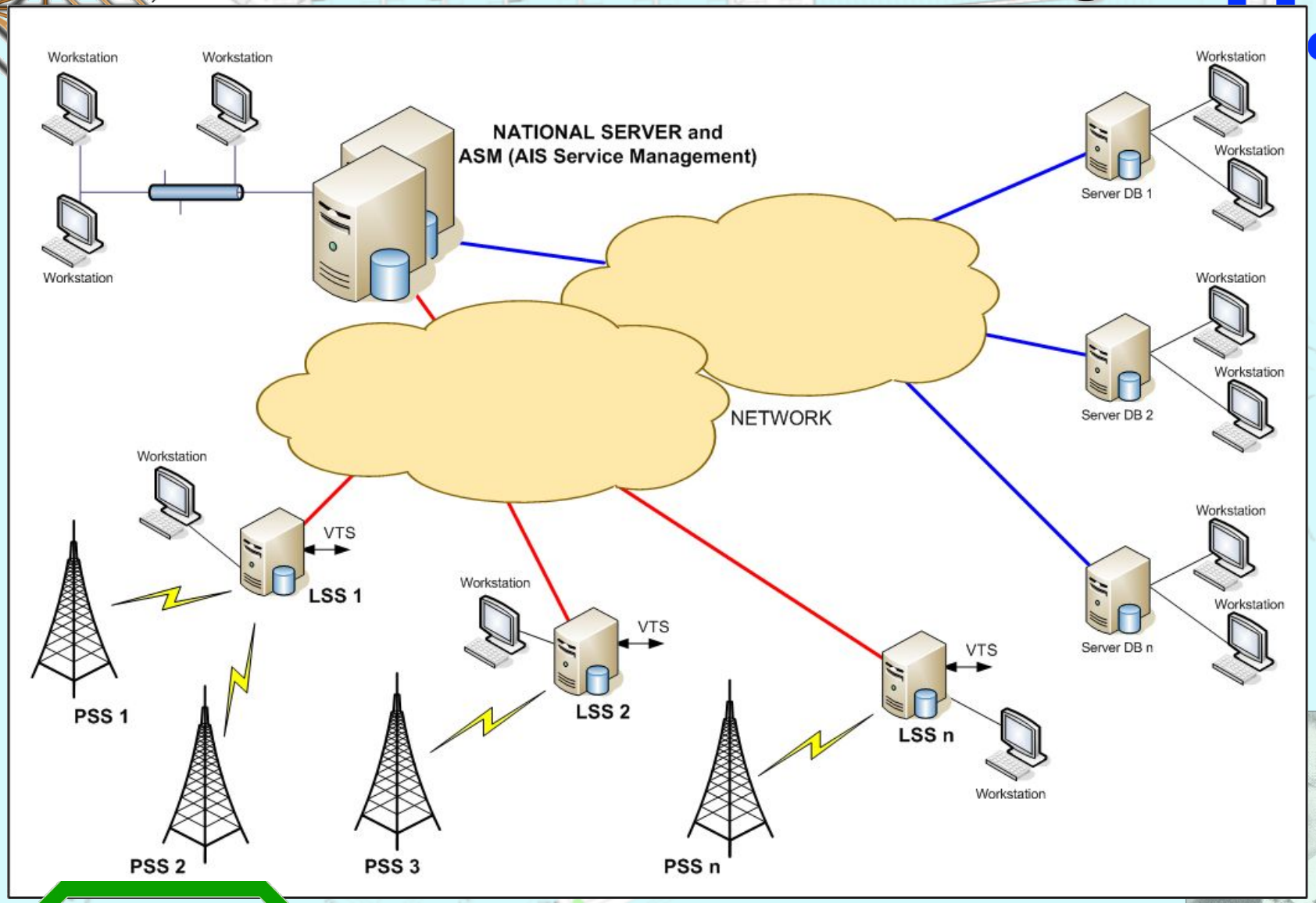
The AIS system

- Radio-based automatic identification system
- Working frequencies: Marine VHF (156.025 - 162.025 MHz)
- Channel width: 12.5 / 25 kHz
- Power transmitted: 2 / 12.5 W
- Modulation: GMSK (9600 bit/s)
- Access protocol: Dynamic TDMA
- Positioning system: DGNSS (DGPS)
- Communication types:
  - broadcast
  - ship ⇔ ship
  - ship ⇔ base stations



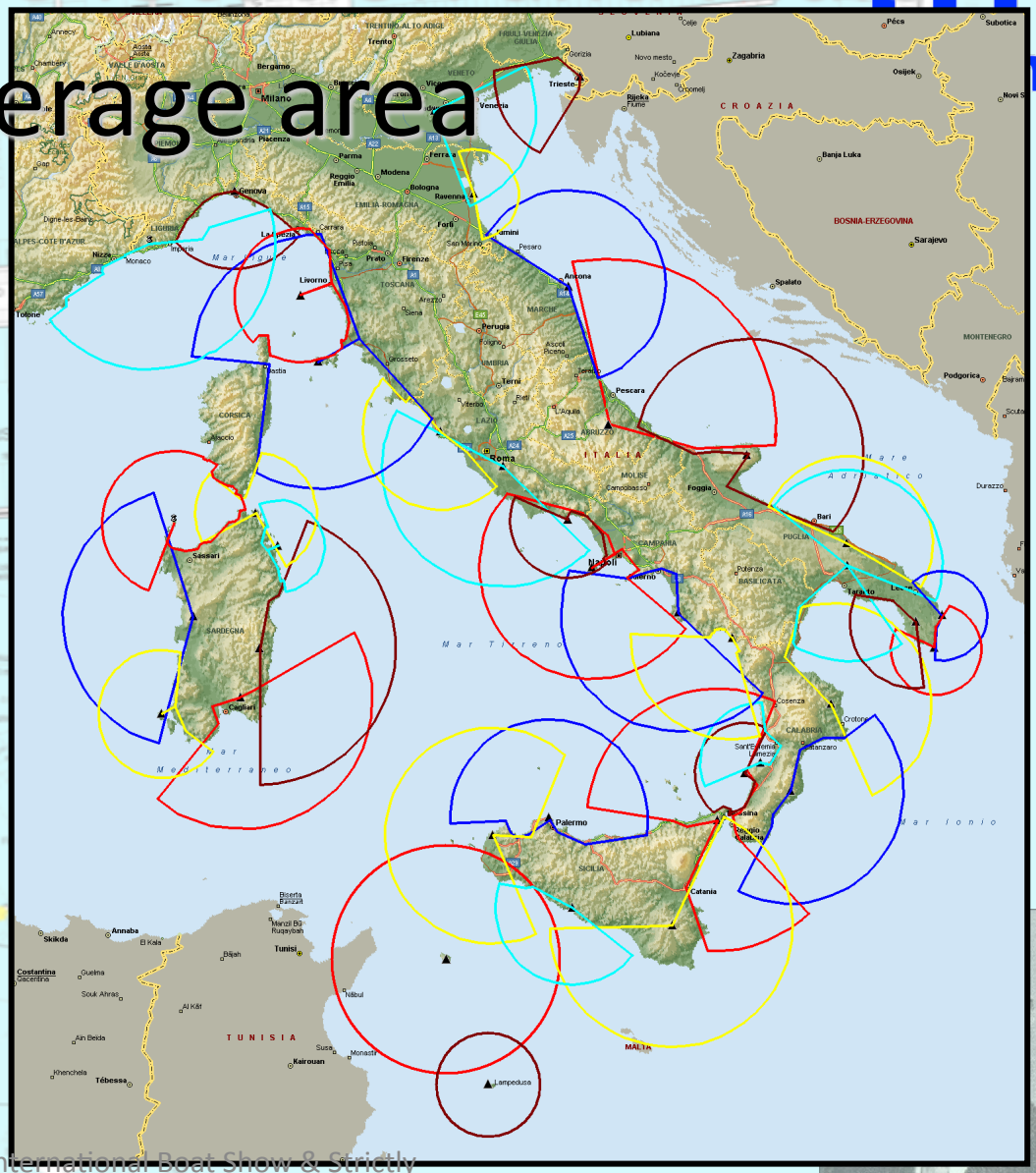


The Italian AIS Network diagram



The Italian PSS location and radio coverage area

- The PSS are installed on mountain sites to extend the coverage area
- The connection between the PSS and the AIS Network is built with dedicated point to point digital radio links
- The AIS coverage exceeds the GMDSS A1 area
- 40 PSS and 40 LSS installed and fully operational as of December 2006
- The National Server has been set up in the Italian Coast Guard headquarters in Rome



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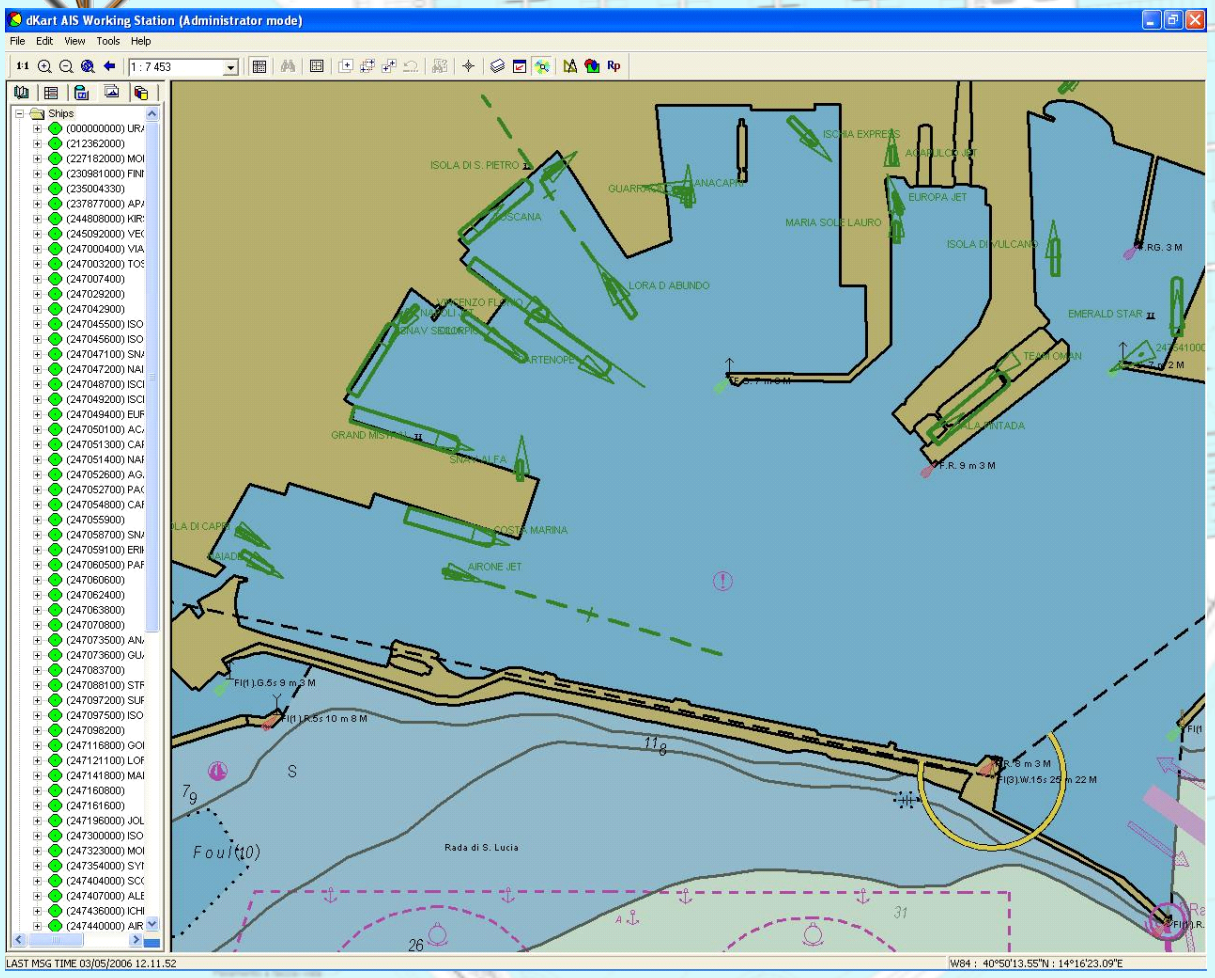
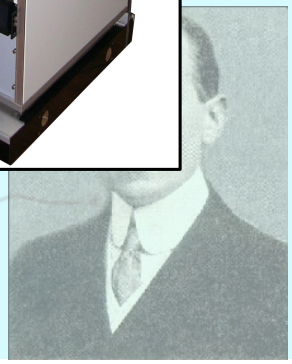
Visualization of AIS targets





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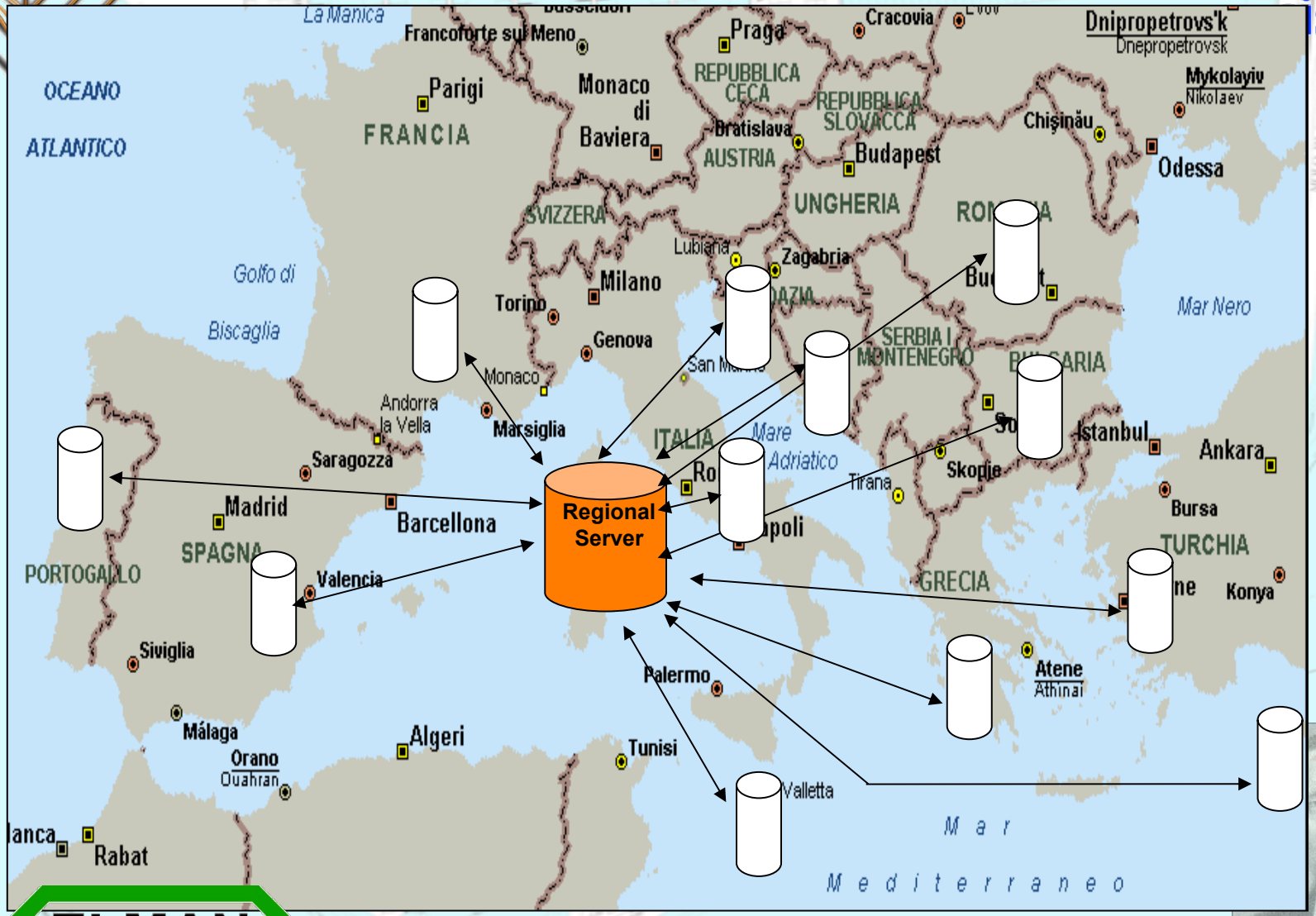
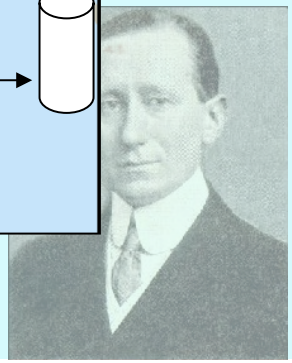
Mediterranean AIS server



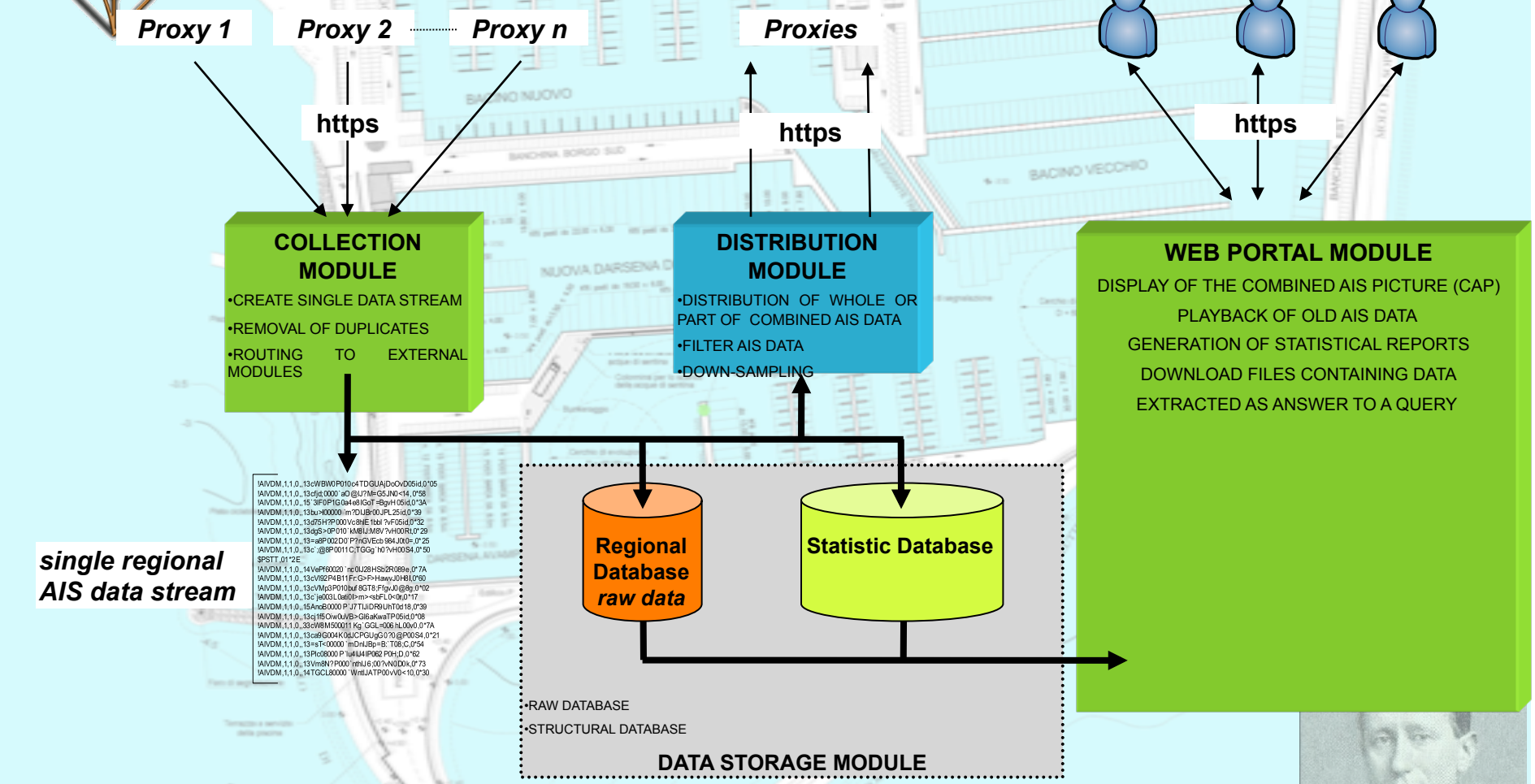


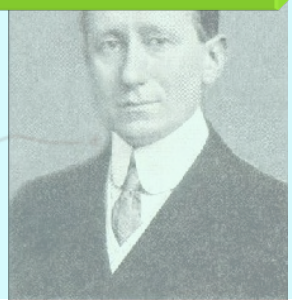
MED system Architecture

The MED server architecture includes two main modules:

- Proxy – the proxy is a software installed on hardware located at the Member States premises, enabling:
  - *AIS data exchange between the national systems and the regional server*
  - *Filtering and down-sampling on the AIS data*
  - *Management of the connections to the national AIS system, the regional server and the subscriber applications*
- Regional server – the regional server includes software modules installed at the regional center, enabling:
  - *The collection and distribution of AIS data from/to the Member States*
  - *The storing of AIS data on a database*
  - *The visualization of AIS targets on a WebGIS application and of statistics built upon stored data*

Diagram of the MED regional system





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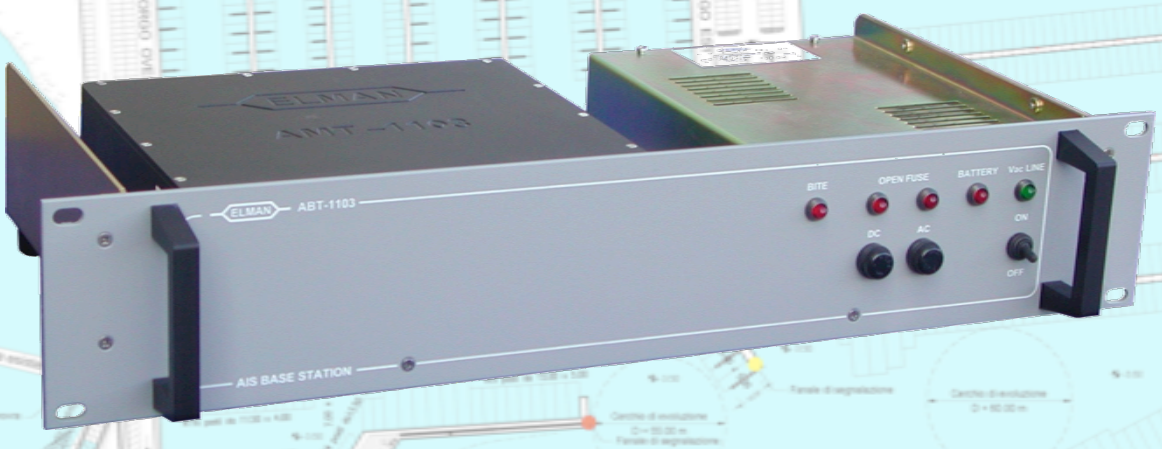
AIS Base station



- The base station is made up of a transponder whose hardware is the same as the mobile transponder, with different software, and by a power supply
- The AIS base station may be easily installed thanks to the 19” standard form factor

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RADAR

RAdio Detection And Ranging

Real time detection of position, route and speed of the targets (stationary or in transit) in the portion of the scanned sea.

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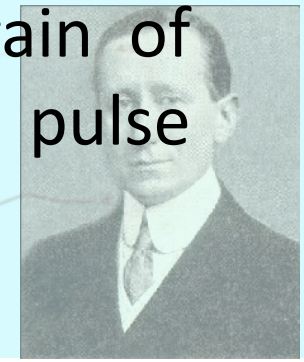
RADAR

Datasheet

- Working frequencies: 9410 ± 60 MHz (X band);
- Wawelenght: λ = 3.2 cm;
- Speed rotation: 22 o 33 r/min;
- Number of targets: 50 +;
- Peak power: 4 kW;

Capability to use 2 main parameters to adjust the sensitivity of the radar, in addition to the gain of receiving: the duration and frequency of pulse repetition in transmission (PRF and PRI).



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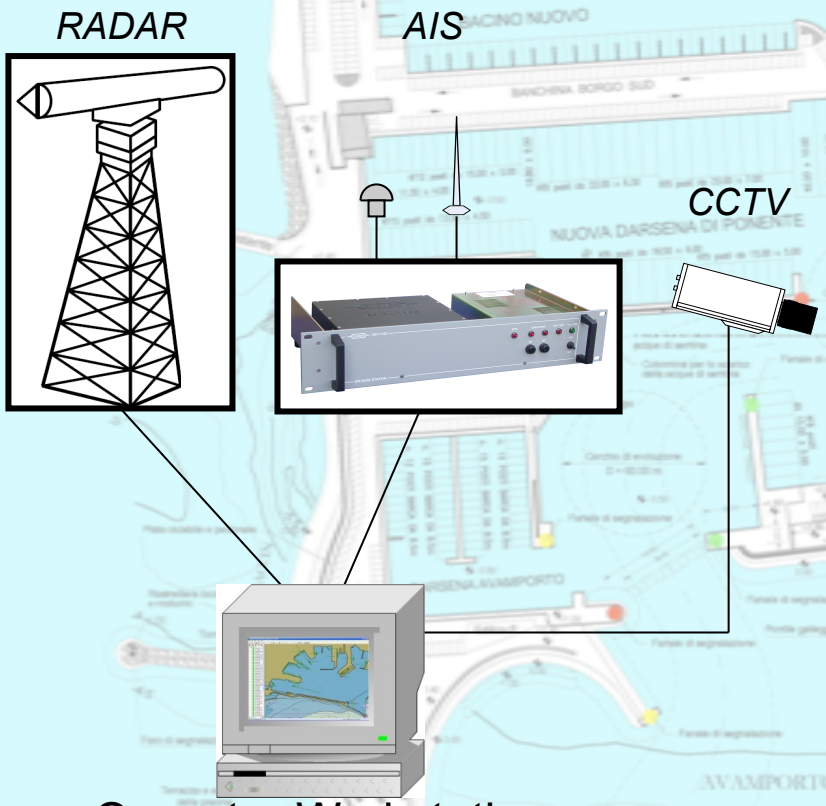
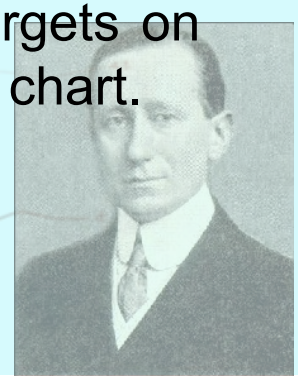
AIS and RADAR integration

TYPICAL SURVEILLANCE RADIO COAST STATION



- The Automatic Identification System (AIS) is considered a "cooperative" vessel tracking technology.
- It will be used with other sensors; particularly non-cooperative sensors such as RADAR.
- The software can display AIS and RADAR targets on the same electronic chart.



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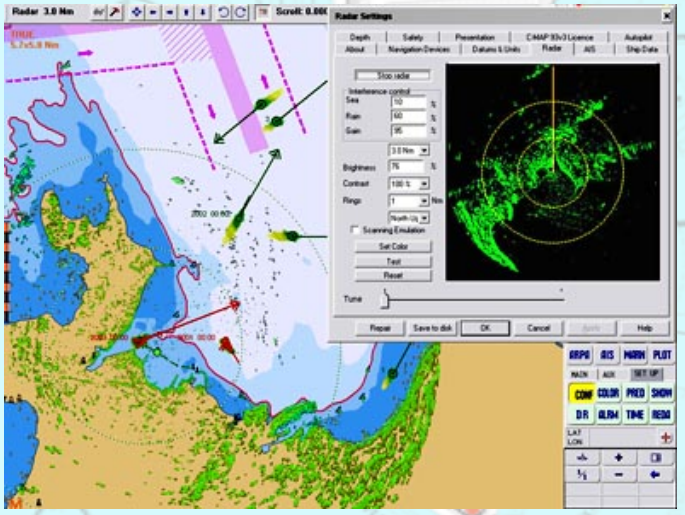
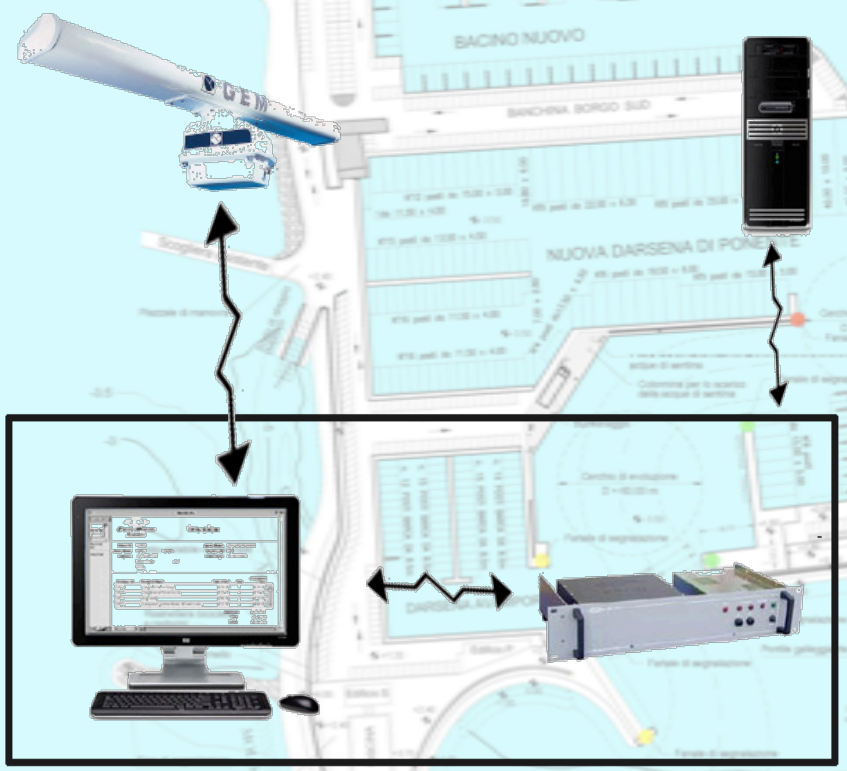
AIS and RADAR integration

The system contributes to resolving the following problems:

- Improving safety of life at sea
- Improving safety of vessel traffic
- Ship traffic control
- Improving environmental protection
- Prevention of prohibited transactions, such as smuggling, illegal immigration etc



RADAR AIS INTERFACING (1)



Both systems are interfaced via software.

The result is displayed on a single monitor on which are superimposed mapping of the concerned area, with the targets identified.

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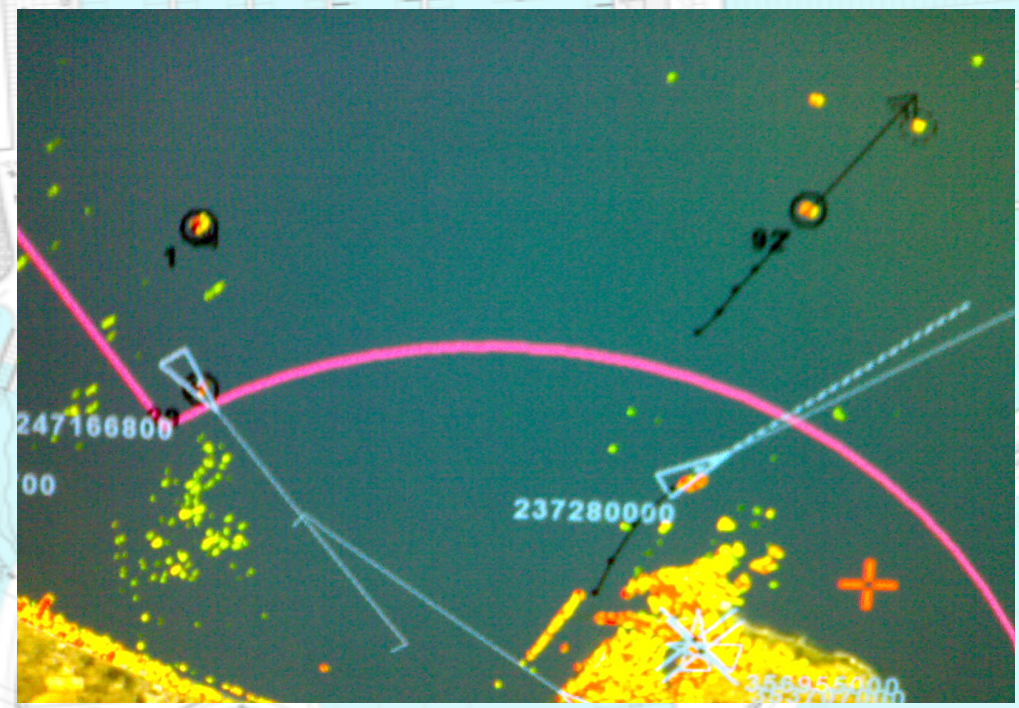
RADAR + AIS INTERFACING (2)



The figure shows targets detected by radar (colored dots with black borders) overlapping the targets identified by the 'AIS (blue triangles) with the directional velocity vector and identity of each vessel.

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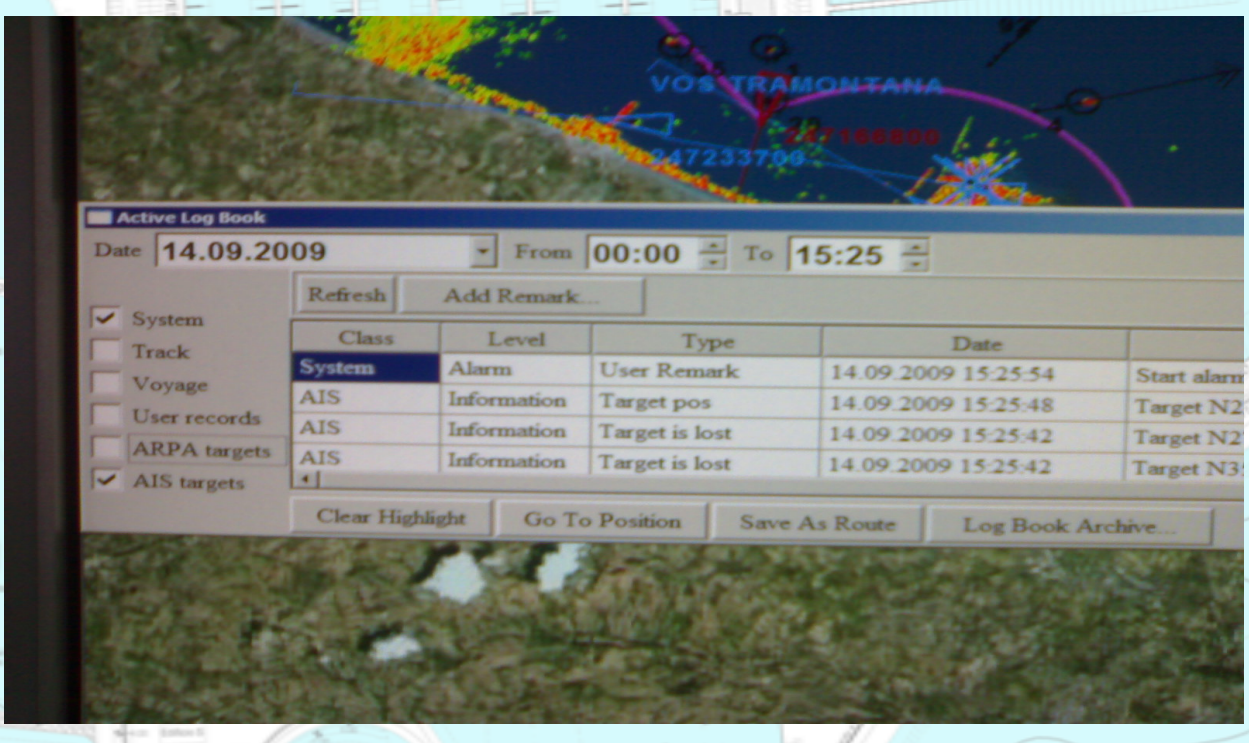
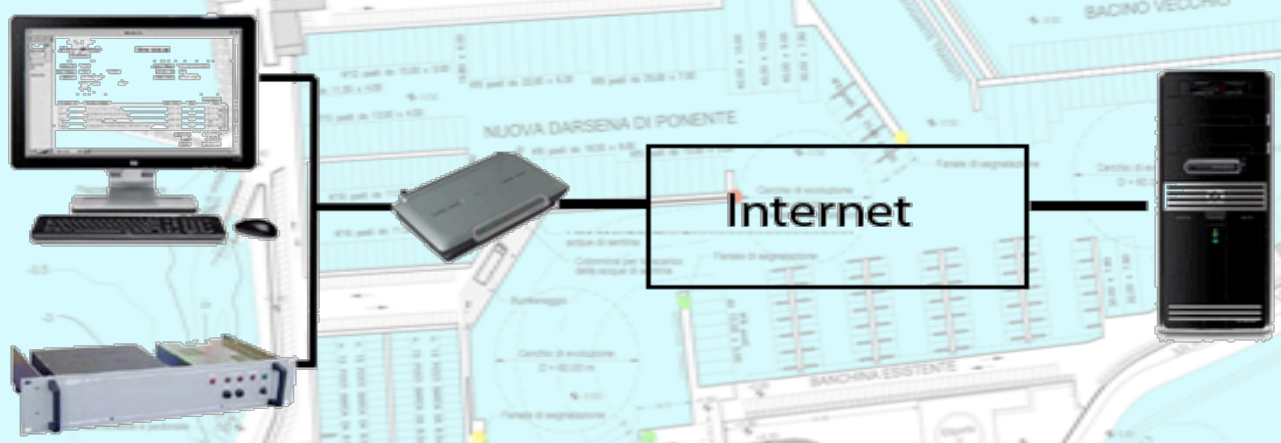
RADAR + AIS INTERFACING (3)

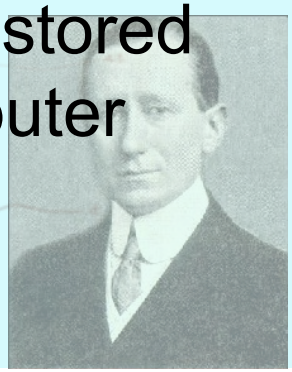


The selected type of target and information needed are automatically formatted into a simple graphical interface.

Operations Center - Server



Information can be collected and sent to a server, stored in a ordinary text file and also available on a computer network for whom it may concern.



Consiglio Nazionale delle Ricerche

Institute of Acoustics "O. M. Corbino" (CNR-IA)

Istituto di Acustica "O. M. Corbino"

The institute was founded in 1936 by O. M. Corbino, at that time head of the Physics Institute in Roma, Via Panisperna, where Enrico Fermi had made his first experiments a few years before.

Since its beginning, research done at IA has dealt with all main aspects of the propagation of elastic waves in air, solids and liquids.

IA scientific staff currently amounts to about 15 researchers plus about 35 external collaborators divided into 4 main groups: environmental acoustics, acoustic sensors and devices, geoacoustics and geosciences, underwater acoustics.

CNR – Institute of Acoustics "O. M. Corbino"
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Via Fosso del Cavaliere 100 – 00133 Roma – Italy
Ph.: +39 06 4548 8482 – Fax: +39 06 4548 8061
segreteria@idac.rm.cnr.it **www.idac.rm.cnr.it**

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SIT Calibration Centre N. 194

CNR-IA hosts the only Calibration Centre within CNR, which is also the only accredited calibration centre for underwater acoustics in the mediterranean area.

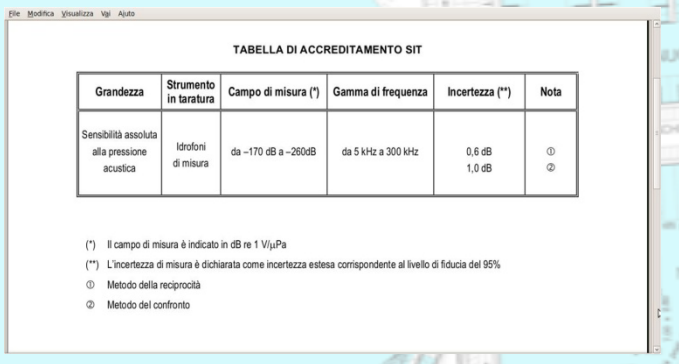


TABELLA DI ACCREDITAMENTO SIT

Grandezza	Strumento in taratura	Campo di misura (*)	Gamma di frequenza	Incertezza (**)	Nota
Sensibilità assoluta alla pressione acustica	Idrofoni di misura	da –170 dB a –260dB	da 5 kHz a 300 kHz	0,6 dB 1,0 dB	① ②

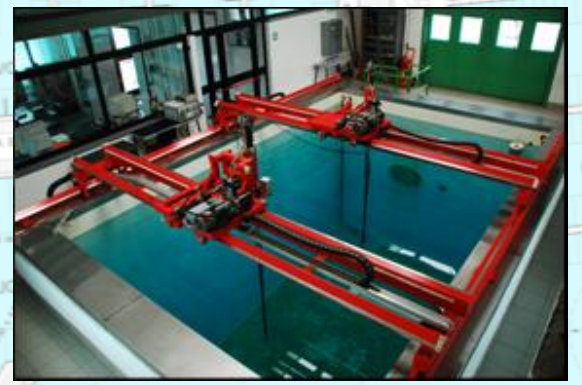
(*) Il campo di misura è indicato in dB re 1 V/μPa

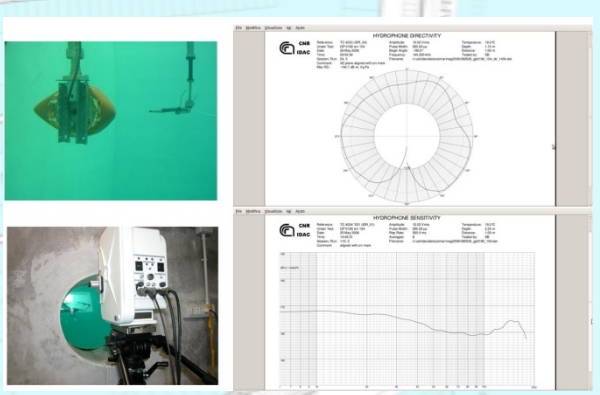
(**) L'incertezza di misura è dichiarata come incertezza estesa corrispondente al livello di fiducia del 95%

① Metodo della reciprocità

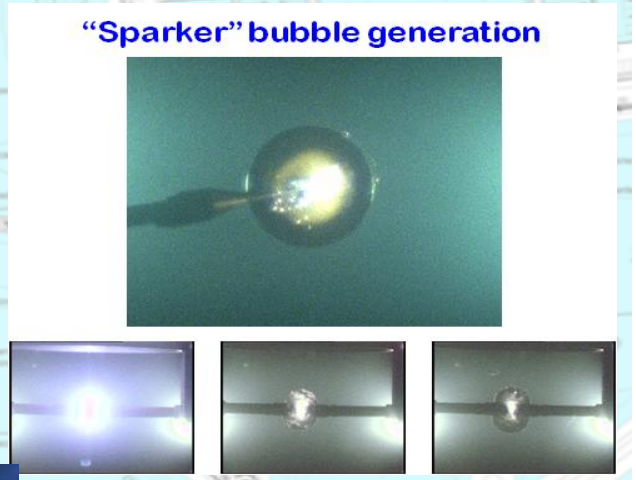
② Metodo del confronto

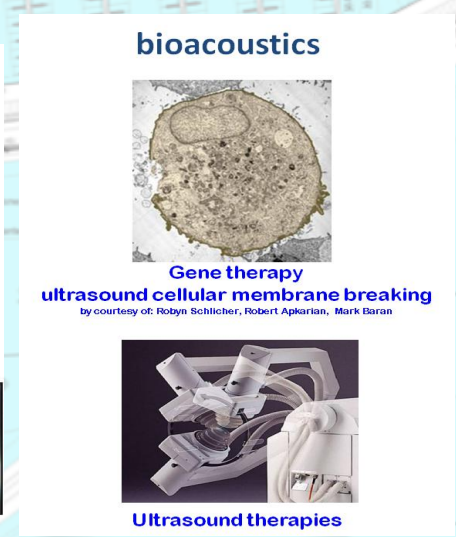
Schedule of accreditation





SIT centre facilities and operations





Research currently under way at the underwater acoustics laboratory

Motivation for the use of an underwater acoustic system

- Sound waves are the only type of wave capable of traveling long distances underwater (light is limited to about 50 m), provided that a suitable frequency is selected (order of 1 MHz is for distances of a few m, order of 10 kHz is to reach littoral distances, order of 100 Hz is capable of reaching intercontinental distances).
- The technology of acoustic transducers (sources, hydrophones) is well developed, relatively low-cost with respect to other type of sensors and reliable.
- For moderate distances (up to a few tens of m) acoustic frequencies may be employed whose wavelenght is of the order of a few mm, which gives an estimate of the resolution of an echo-based image.

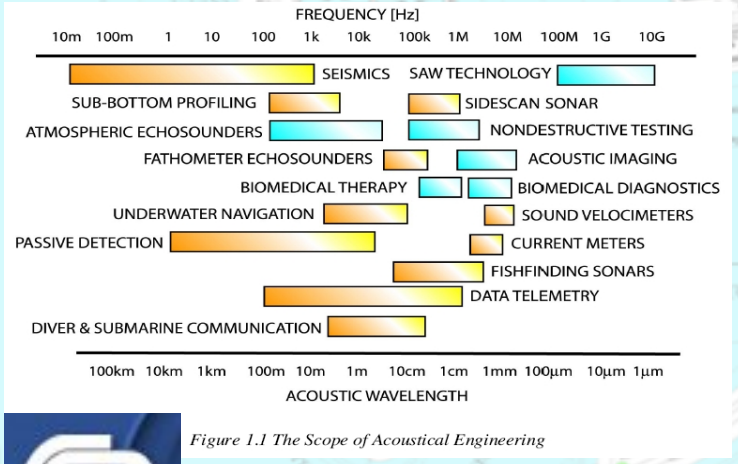


Figure 1.1 The Scope of Acoustical Engineering

Applications

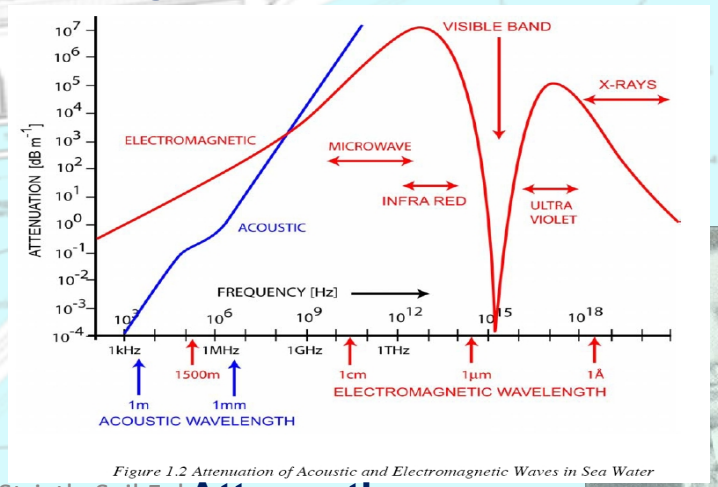
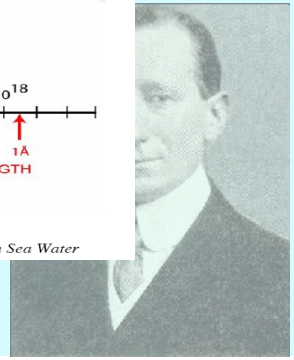


Figure 1.2 Attenuation of Acoustic and Electromagnetic Waves in Sea Water

Attenuation



Istituto di Acustica "O. M. Corbino"

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Involvement of CNR-IA in SEASPORT Project

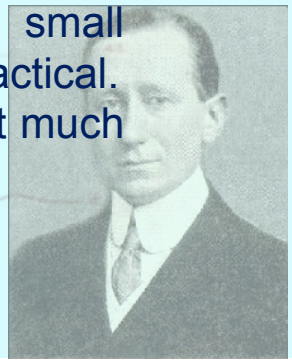
CNR-IA will develop an underwater acoustic system to monitor the state of the sea bottom in the internal waters of the Nettuno harbor

Main objectives are:

- To obtain the time evolution of bathymetric data as an input to hydrodynamic modeling of currents inside and near the harbor, to be performed by other participants.
- To give an early warning of a bottom change over some definite threshold in order to plan corrective actions (i.e. dredging).

Several possible technical solutions are available, each giving advantages and disadvantages:

- Traditional vertical profiling offers high resolution but operating even a small vessel in very short distances and shallow waters may be not feasible or practical.
- Fixed installations employing tomographic techniques are less sensitive but much simpler to operate: they also leave the passage free for vessel traffic.



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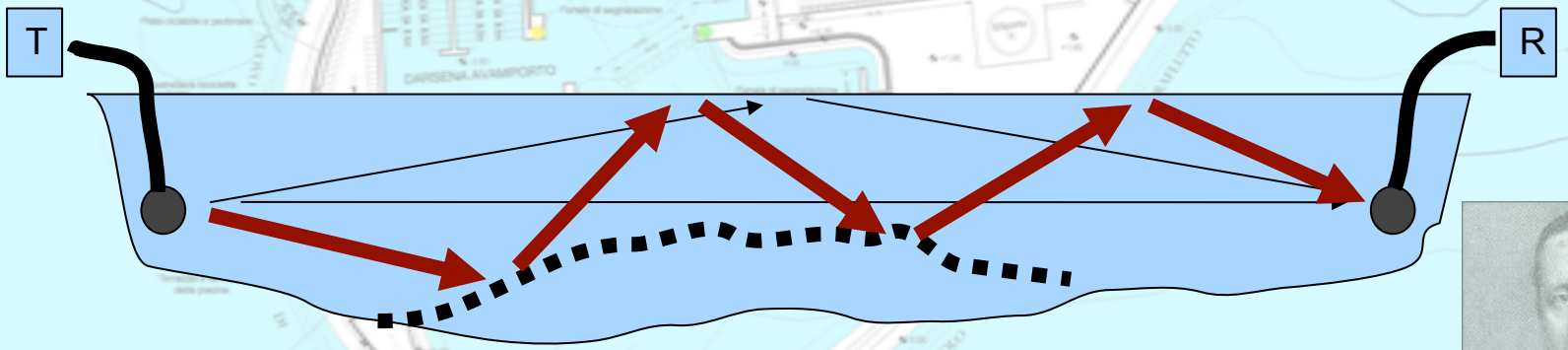
Principle of operation of the proposed system

The acoustic system will operate between two definite locations inside the harbor, delimiting a segment along which changes in the bottom due to transport of sand and sediments were found to be more evident.

One fixed station (transmitter) will emit a sound pulse traveling horizontally, and another fixed station (receiver) will receive the resultant of a series of waves, each traveling along all possible acoustic paths (multipath)

A suitable signal processing will determine, from the characteristics of the received signal, if the propagation channel has changed from a given initial state over some threshold. If this condition is met, an alarm will be given to the operator.



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Advantages of the proposed system

Main advantages are:

- The system can operate continuously with minimal input from an operator.
- With minimal changes to the hardware it is possible to create multiple simultaneous segments by adding only one transmit station or one receive station.
- The repeatability of measurements is very high, whereas traditional vertical profiling is subject to larger errors in georeferencing data.
- Dual operation mode: active (transmit-receive) for normal bottom monitoring, and passive (receive only) to detect underwater noise arising from passage of vessels through the segment of observation (can be used as a safety warning against undesired intrusions).

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INSEAN: Istituto Nazionale per Studi ed Esperienze di Architettura Navale

Public research institute in naval hydrodynamics.

Main research lines:

- Hydrodynamic phenomena of ships and sea environment (… but not only)
- Development of mathematical models and of numerical simulation codes.
- Development of investigation techniques for experimental research in fluid dynamics and structure analysis fields

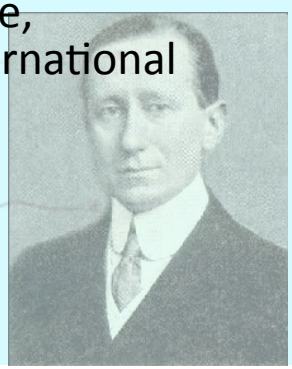
Test facilities are among the greatest in the world for their dimension:

- Basin 1 (470 x 13.5 x 6.5 m)
- Basin 2 (220 x 9 x 3.5 m with wave maker)
- Recirculating channel (test section 10 x 3.5 x 2.5 m).

People employed 140: 40 researchers and technologists

Involved in research projects sponsored by: Ministeri Difesa and Infrastrutture, European Defense Agency, EU (FP5, FP6, FP7), ONR US Navy, national and international private industries

Involved in America's cup activities by: Azzurra, Moro di Venezia, Luna Rossa



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Sediments: availability and transport

- The concentration of the Suspended Solids and their sedimentation ratio are related with the availability of solid matter and with its transport along the coast (coastal sediment transport).

- SEDIMENTS AVAILABILITY
  - It is mainly driven by meteorological forcing, with stochastic nature. E.g.: wave action, river sediment discharge.

- SEDIMENTS TRANSPORT
  - It is mainly driven by deterministic forcing. E.g.: tides action, density currents.

  - Concerns also stochastic forcing. E.g.: actions of the wind, currents at river mouth.

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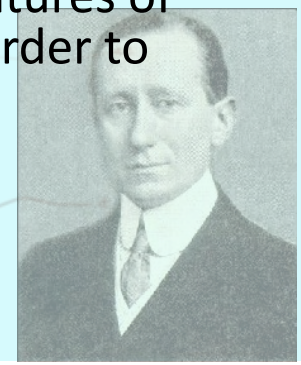
Predictive models

- DETERMINISTIC MODELS (PROCESS BASED)
  - They reproduce, in a “virtual laboratory”, natural processes that are characterized by a variety of spatial and temporal scales, with the aim to obtain a prediction of their effects on the morphological evolution of the coastal areas.

- MODELS DRIVEN BY DATA (DATA DRIVEN)
  - Those models are trained with data from time histories and, after a calibration and tuning phase, they are able to predict the evolution of a specific state of a system starting based on the previous training.

- EXPERIMENTAL MODELS
  - They reproduce, in a laboratory scale, the main (simplified) features of the analyzed context. They use proper physical similarities in order to take into account the different spatial and temporal scales. Answers are given in a short time



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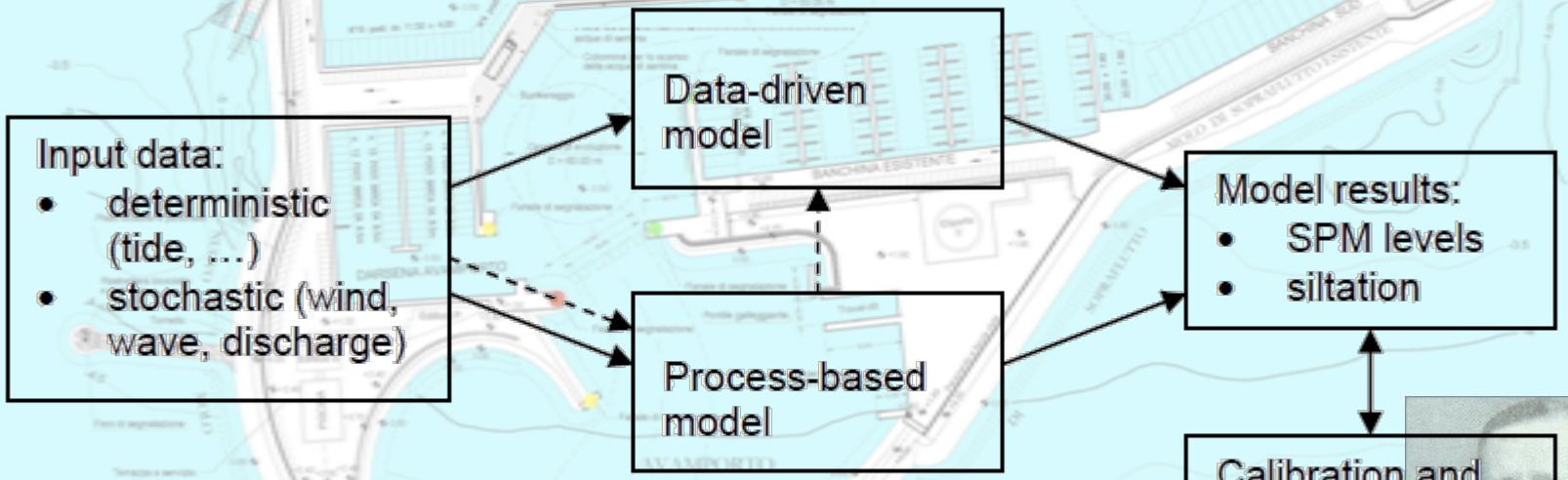
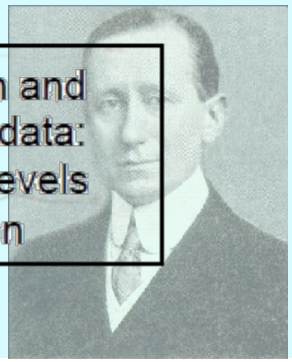
Integrated models

- Previous definitions emphasize the advantage that can be obtained from the integration of the data-driven models with the algorithm-based models, after validation of those latter with experimental evidences. In this way, the physical nature of the process under investigation is embedded in the data driven model.
- One of the main results concern the integration of the stochastic and deterministic nature of the transport and the sedimentation of the suspended solid matter.





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Integrated models

.The most relevant features concern:

- Domain definition (good spatial resolution)
- Physical process description (realism in the description of the solid matter provenience and transport in numerical models)
- Forcing description (influence of deterministic and stochastic components in the physical process)
- Analysis of the relationships between input data, physical processes, results from models and field data.

- The application of the integrated model could make available, with high accuracy, a predictive criterion for the estimation of the bathymetric variations due to the solid matter transport near the mouth of Nettuno's harbor.
- At present, the technical-economical state of the project suggests to involve the **INSEAN team** in the production of a **data-driven model** that, as further, advisable and future development, could be integrated with both a physical and an experimental ones.

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Water pollution detection

Indicators	Units	Level 1	Level 2	Level 3	Level 4	Level 5
Dissolved oxygen	% of saturation	100	85	70	60	<60
pH	Background variations	0	0.5	1	1.5	2
Temperature	Background variations	0	2	4	6	>6
Dissolved solids (Conductivity)	mg/l	<500	1000	2000	5000	>5000
Hydrocarbons	Oil coat	Absent	Absent	Poor	Significant	Extended

Typical water basins pollution levels

LEVEL 1: Unpolluted water;
LEVEL 2: Lightly polluted water;
LEVEL 3: Polluted water;
LEVEL 4: Very polluted water;
LEVEL 5: Highly polluted water;

Sensor monitoring system (1)

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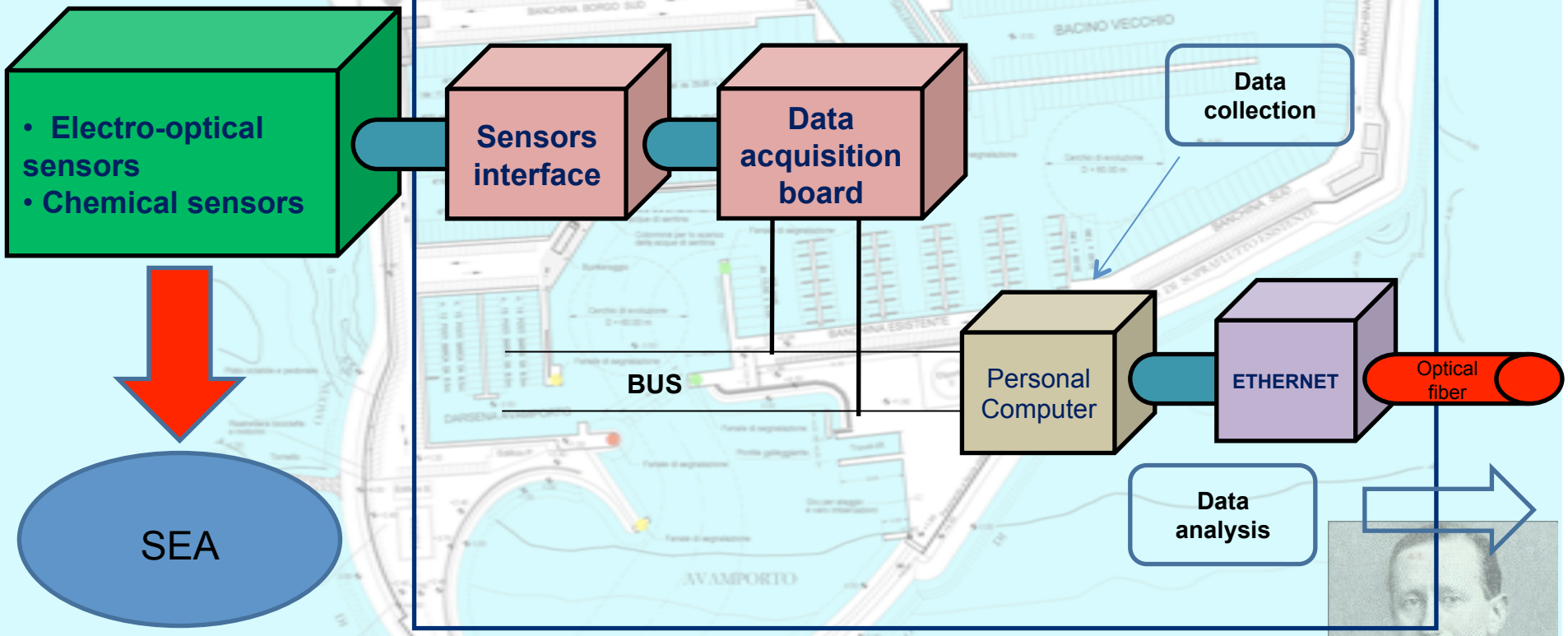
centro marconi

iTi sistemi



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Sensor monitoring system (2)

- pH (0-14)
- Conductivity (0-200 mS)
- Dissolved Oxygen (DO) (0-20 ppm)
- Temperature (-10 to 80 °C)
- Hydrocarbons or other pollutants

(Qualitative analysis)

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Sensor monitoring system (3)

Sensors for **T, pH, DO, σ**.

Optical sensor based on different reflected wavelength of unpolluted water and hydrocarbons coating.

Data acquisition

ELECTRODES

pH (electrochemical electrode)

T (thermoresistance detector)

σ (inductive sensor)

DO (electrochemical electrode)

Multispectral Imaging

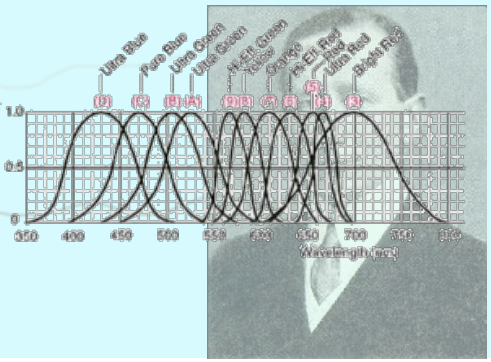
Linear displacement

Camera

colored LED

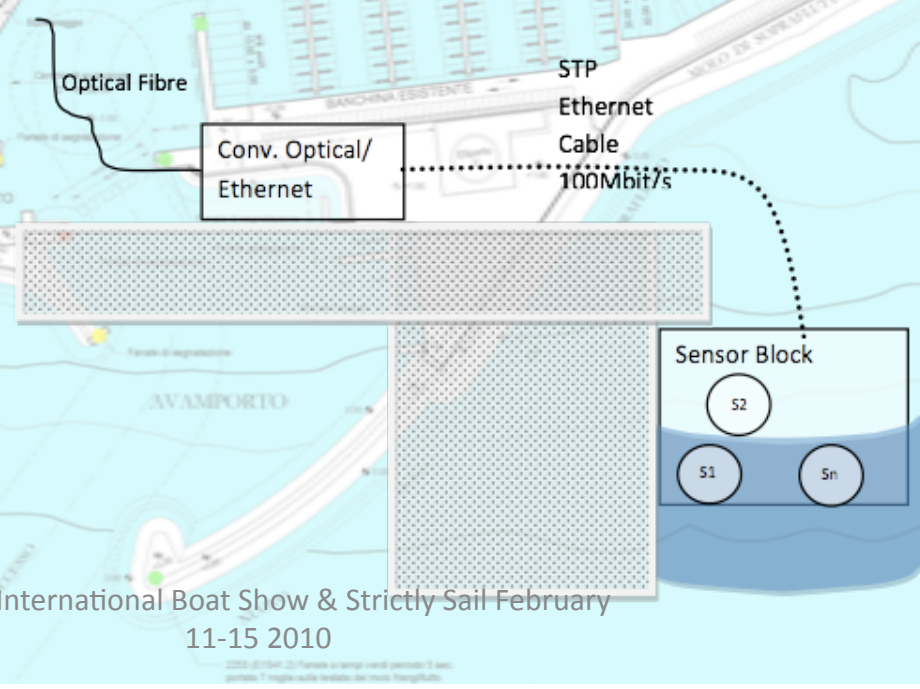
Side view

Bottom view



Sensor Network Interfaces

- Sensor block includes a “motherboard” (IPv4 address) with
  - 10/100 Ethernet interface towards network
  - Various interfaces towards sensor devices
    - I2C/Mbus/2wires
    - USB
    - RS-232
    - Parallel port



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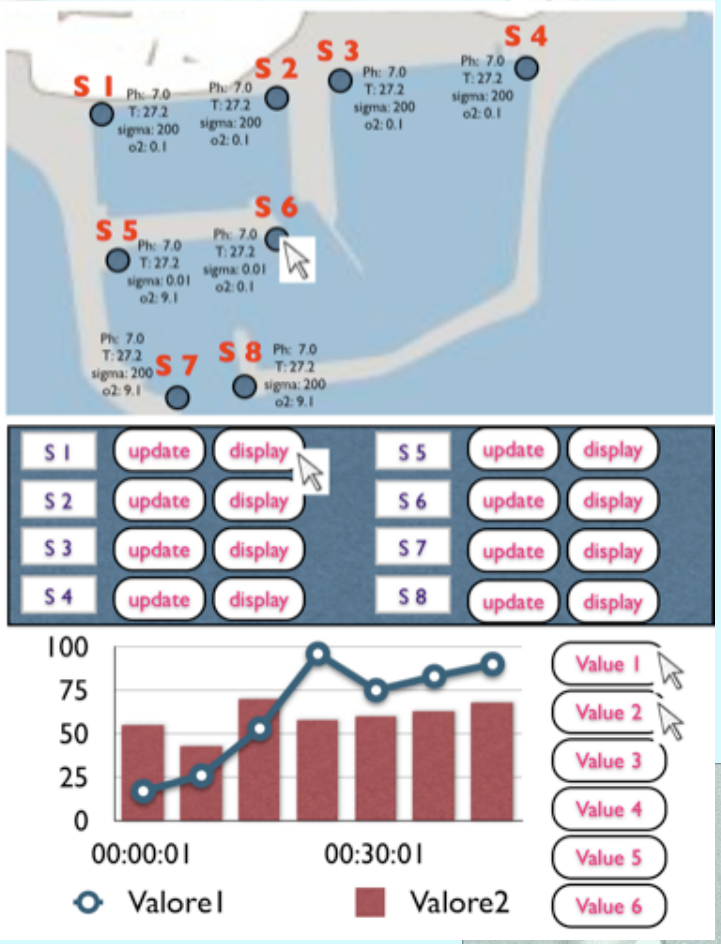
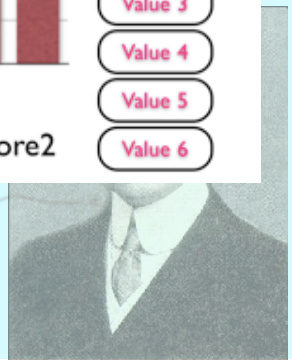
Sensor Network data management

- Sensor block envisages SW to communicate with a control center
- For each sensor, it will possible:
  - periodically get measurements values
  - update current values (operator-driven)
  - display measurement trends





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SECURITY NETWORK SET UP

Entrance

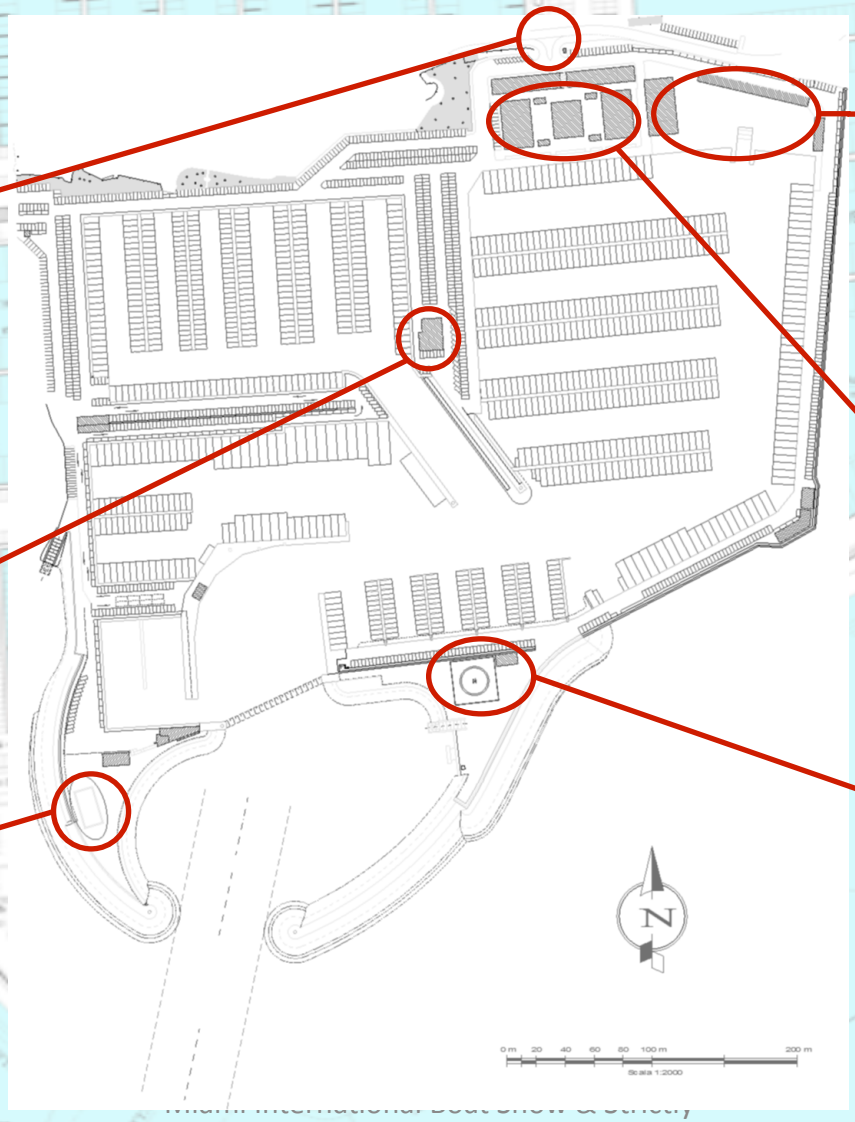
Control Tower

Swimming Pool

Shipyard Area

Shopping Area

Heliport & Hyperbaric Chamber



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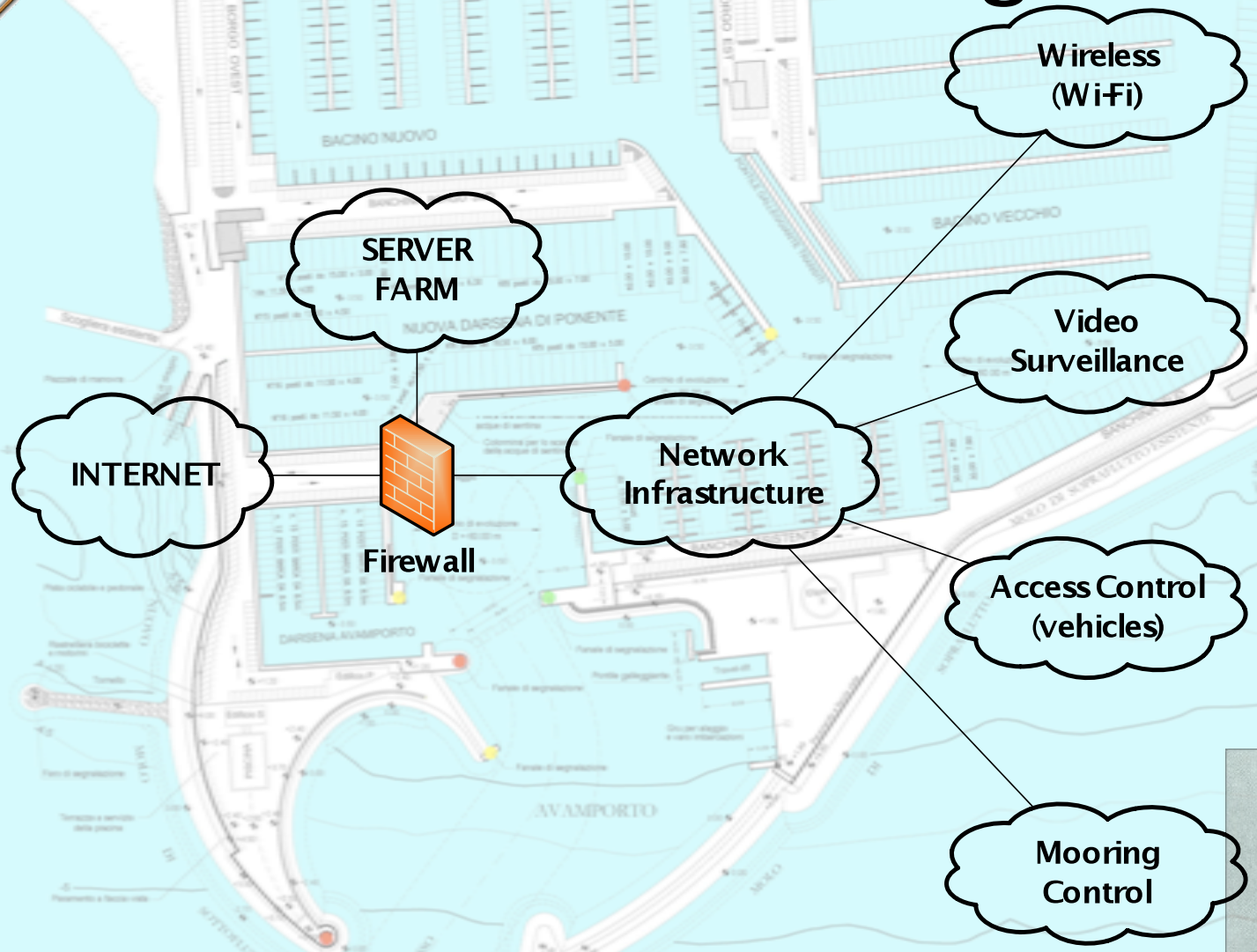
Basic Network Design



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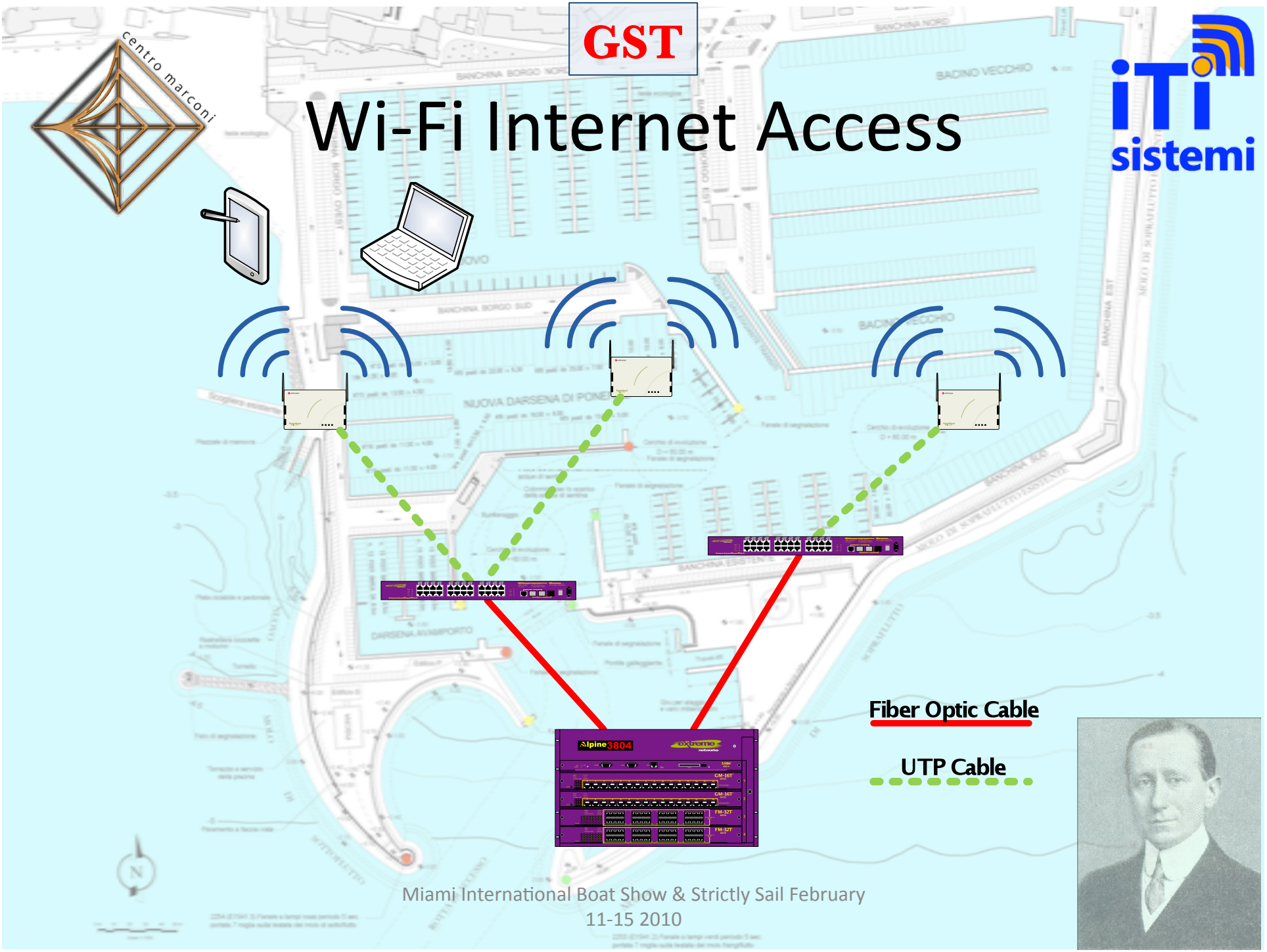
Wi-Fi Internet Access



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VIDEOSURVEILLANCE

- H24 Active Control
- Increased staff efficiency
- Accuracy
- Real-Time Alarms
- Possible integration with third party sensors/ systems
- IP based infrastructure
- Automatic Recognition of "dangerous behavior"
- Automatic escalation management

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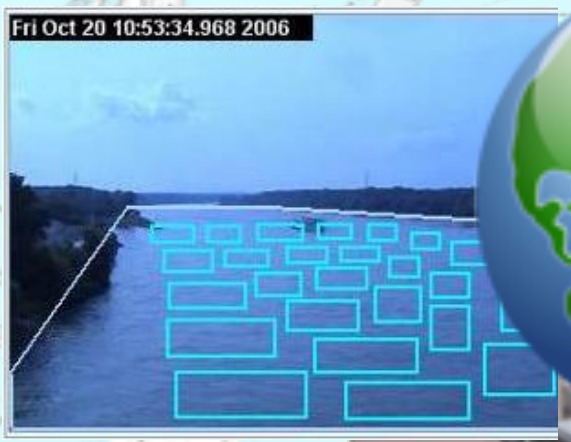
SMART VIDEOSURVEILLANCE

- Parking Control
- Traffic Control
- Vehicle Classification



Miami

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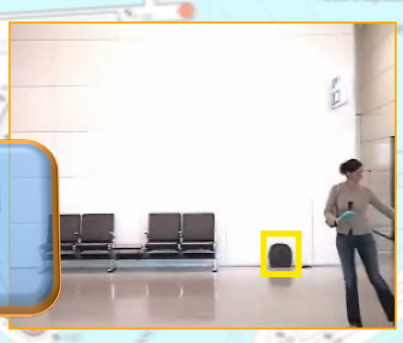
BEHAVIORAL ANALYSIS

Intrusion

Loitering

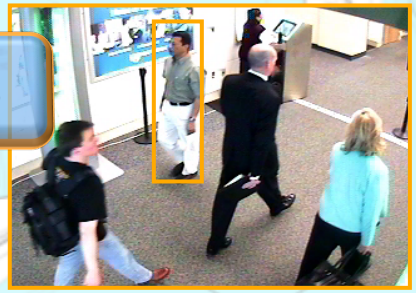
Unattended Objects



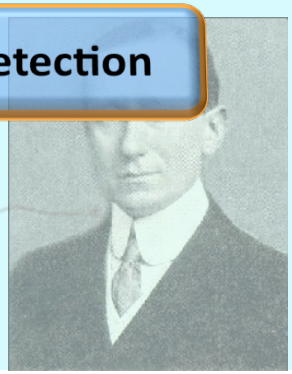
Unattended Objects

Tailgating

Directions



Crowd Detection



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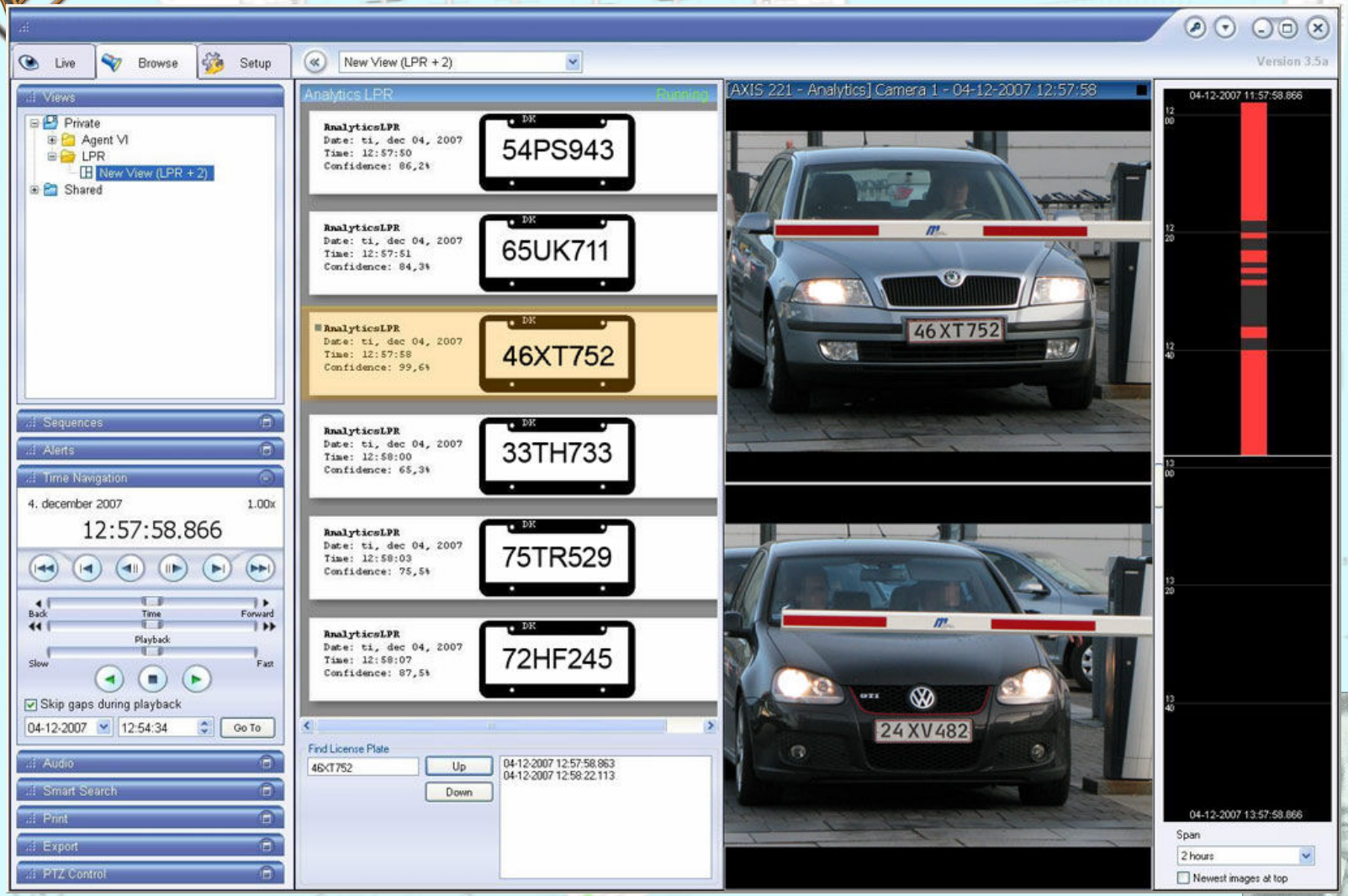
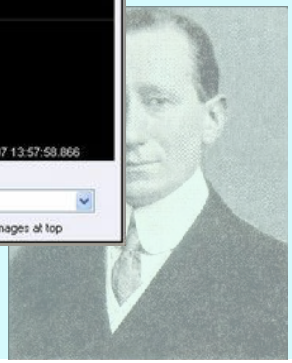
VEHICLE ACCESS CONTROL





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License Plate Recognition (LPR)

- Automatic barrier gate with LPR
- Centralized Management (remote monitoring and control)

- For visitors:
  - Pre-defined and customized time-range
  - Optional automatic payment machines
  - Security Database (ticket - license plate)

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MOORING CONTROL

- Optional onboard transponder needed

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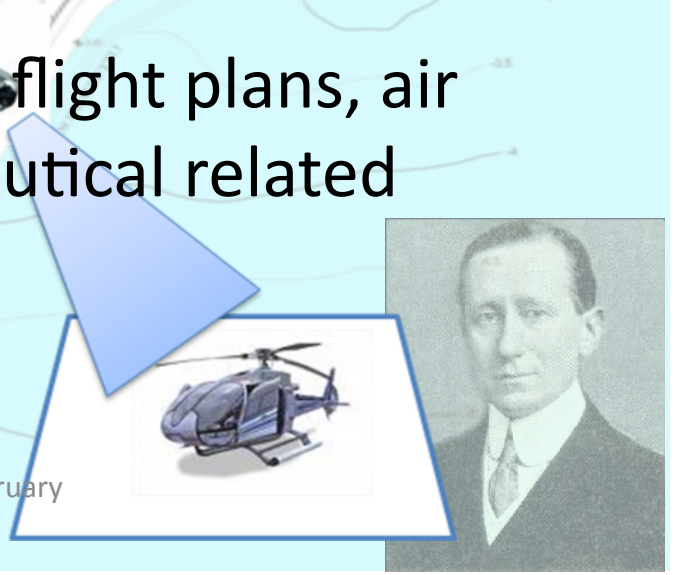
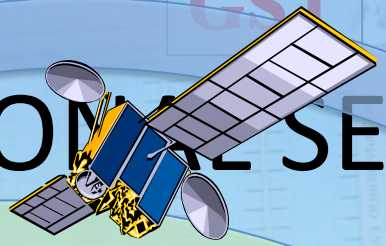
HELIPORT AND HYPERBARIC CHAMBER

- Possibility to check, via Web, the status of Heliport and Hyperbaric Chamber (free/busy)
- Technical staff is needed for management purposes:
  - Medical unit to manage the Hyperbaric Chamber
  - Air Navigation Experts to handle flight plans, air traffic services and other aeronautical related services



ADDITIONAL SERVICES (1)



- ☑Broadband communication for boats when located off shore

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ADDITIONAL SERVICES (2)

- Service web portal for information and operations (banking, shopping, restaurant reservation, entertainment, gambling, transportation, medical assistance, weather forecasts, mooring availability, real time billing and credit card payment, etc.)

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Thank you

- References:
  - Prof. Marco Bucarelli (marco.bucarelli@virgilio.it)
  - Prof. Michele Luglio (luglio@uniroma2.it)
  - Dott. Paolo Pucci (paolopucci2@virgilio.it)