SWING Project: Short Wave critical Infrastructure Network based on new Generation of high survival radio communication system		
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SWING project

2nd Plenary Meeting

Rome, *February 14th 2013*

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On February 14th, 2013 the SWING project 2nd Plenary Meeting is held in Rome at INGV.

Participants:

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11:30-12:30 Welcome and introduction

The Co-ordinator Bruno Zolesi welcomes all the participants, asks to all to introduce themselves, adopts the agenda and anticipates the topics to be covered in the afternoon.

12:30-14:00 Lunch

All the participants are invited to have lunch in the INGV canteen.

14:00-14:30 Opening

The coordinator, Bruno Zolesi, opens the meeting following the items reported on the agenda. In the first part, the first year activities (from January 2012 to January 2013) and the obtained results are explained to all participants. In the second part, the activities of the second year are planned and special attention is given to the discussion on the realization of the demonstrator constituted by 4-terminals HF network (activity nr. 19).

14:30-15:30 Status of the project, short report on the first year activities

Cesidio Bianchi lists the nineteen activities and shows the summary timetable to highlight what activities are already finished and what part is still to be completed. After pointing out that the deliverable nr. 1 concerns the interface between EU authorities and coordinator, he begins to explain the technical analysis of the communication problems related to the identification and designation of ECIs in the interested area (activity nr. 2, deadline: September 2012).

The Council Directive of the European Union has established, by means of the promulgation of the Directive 2008/114/EC of 8 December 2008, the requirements for the identification and designation of European Critical Infrastructures (ECIs), mainly taking into account threats of terrorism. One of the point of the Directive is the interest to focus only on the energy (electricity, oil, gas) and transport sectors (road transport, rail transport, air transport, inland waterways transport, ocean and short-sea shipping and ports). Hence, on this basis, the energy and transport sectors have to be considered strategically important and identified and designed as ECIs which protection responsibility falls on the Member States and the owners/operators of such infrastructures. At this stage for this purpose, three marine ports are identified as suitable ECIs and which are located in Barcelona (Spain), Cefalu' (Italy) and Pireo (Athens-Greece), while the Controlling Governmental Agency (CGA) is Rome. So, he shows the coordinates of the ECIs and the CGA (Table 1) and the reference scenario and radio links connection amongst ECIs and CGA (Figure 1).

Selected site	Latitude (degrees)	Longitude (degrees)	Azimuth (degrees)	Distance from CGA (*km*)
CGA – Rome	41.88	12.48	0	0
ECI – Cefalù	38.03	14.05	163	452
ECI – Pireo	37.95	23.63	111	1059
ECI – Barcelona	41.38	2.17	270	867

Table 1 *CGA and ECIs coordinates*

Figure 1 *Reference scenario and radio link connection among ECIs and CGAs*

After the ECIs are identified, the kinds of threats and intrusions to the web services are analyzed. They include a huge variety of Malware (viruses, worms, Trojan horses, spyware, trap doors and logic bombs) which infect user computers, leakage of personal information, phishing by means of subtle messages and other kind of attacks like Denial-of-services (DoS) and Distributed Denial of Services (DDoS).

Bianchi introduces the activity nr. 3 (deadline: September 2012): determination of the topology of high survival radio communication network.

The study for this activity are been made taking into account the two aspects of the topology (physical and logical) because the network topology is the arrangement of the various elements (links, nodes, etc.) of a computer or HF radio network. In this presentation, Bianchi shows how the physical topology deals with the placement of the network's various components (HF device location and radio link's establishment); while the logical topology will be dealt by Giovanni Dore in the next presentation.

Concerning the physical topology, a reduced HF network will be employed in the demonstrator, as shown in figure 2.

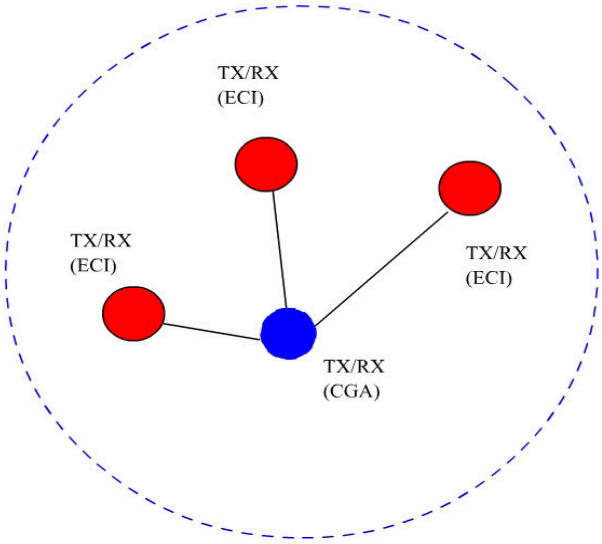

Figure 2 *HF reduced network*

At the end of his presentation, Bianchi discusses on the characterization of the minimal amount of information necessary for the survival of the ECIs communication (activity nr. 4, just finished in January 2013). The main aspects are detailed in the following:

- recognition of the activities, function and organization of the ECIs and CGA
- risks assessment and simulation of the scenario in case of internet fault
- minimum amount data to transfer in case of internet fault

In the first point, an organization pattern of the Italian Coast Guards (CG) and Maritime Direction (MD) is shown, where they are controlled by the General Command of Marina Militare - CDO (Hellenic and Spanish Coast Guards have approximately the same organization).
For the second point, Bianchi shows which are the analyzed aspects for the risk assessment: identify assets and determine the most critical; identify, characterize, and assess threats and the vulnerability of critical assets to specific threats; determine the risk (i.e. the expected consequences of specific types of attacks on specific assets).
Using the obtained risks assessments, it's necessary to identify and characterize ways to reduce those risks and to prioritize risk reduction activities based on a risk reduction strategy.
Finally, for determining the minimum amount data to transfer in case of internet fault, the considered function of the CDO and CG is the control of the maritime traffic. In this context the Operative Room (OR) of the CGA receives data from 100 VHF transponders concerning the traffic of the vessels in the Mediterranean Sea under the control of Italian CGA (or CDO).
Bianchi shows the minimum information content between a vessel and OR of the Coast Guards (table 2).

AIS-VTS /Vessel information	**Average length in alphanumeric characters (and bit number)**
Alphanumeric Identifying Code of the AIS-VTS	10 (80)
Vessel name	10 (80)
Coordinate of the vessel	10 (80)
Nationality	10 (80)
Vessel owner	10 (80)
Port of departure	10 (80)
Port of arrival	10(80)
Cargo of the vessel	10(80)
Captain Commander	10 (80)
Emergency supplementary text	8 (80)
Estimate amount including control characters	≈ 100 Byte (1kbit)

Table 2 *Minimum information content between a vessel and OR of the Coast Guards*

After the presentation of Cesidio Bianchi, Giovanni Dore explains the activity nr. 6 on the analysis of the existing architecture of HF communication based on internet protocol access with reference to the above considered infrastructures. This activity was completed in June 2012 and the studied topics are needed for the activities already mentioned above (nr. 2, 3, 4).

Dore begins his presentation discussing about the network issue: considering the topology of the high-survival HF radio network, and according to its general requirements and communication scenarios, each ECI only communicates with its CGA. This means that communication from one ECI to another one, in the same area, is not required, and data exchange between different areas involves communication from ECIs to CGAs or among CGAs. Consequently, single-hop communication is always considered and no routing functionalities are really needed. In this case, the main network issues concern Medium Access Control (MAC) layer aspects, which are crucial to allow possible concurrent transmissions in the system. The considered MAC techniques are: HFTP (Wireless Token Ring Protocol) and DCHF (Distributed Coordination Function). Dore shows three studied different possible scenarios and the performance of a MAC protocol in both the techniques. At the end of the study, the conclusions are the following:

for a short turnaround time, independently of the mode and type of data managed, the contention based technique DCHF shows better performance with respect to the contention free mechanism consequence of the introduction of an overhead in the token management. For a long turnaround time, the HFTP exhibits improved performance than DCHF. The main reason for such a behavior lies in the different weight of the double handshake in DCHF, that causes a double turnaround, with respect to the token overhead, which is able to generate a single turnaround per passage/transmission. In HF communications the realization of a network with a long turnaround time is more feasible. So, a medium access control technique without contention based on a token protocol seems to be a suitable solution for the implementation of the SWING network. The use of a token-based mechanism to avoid contention might affect the delay in case of a single node transmission.

Dore ends by making a general comment about the SWING network topology: an internet failure caused by a terrorist attack will unlikely involve a single ECI and, rather, it will probably cause the contemporary access of several nodes to the SWING network.

Anna Lisa Saverino begins introducing the activity nr. 8. She presents a characterization of the HF channel (budget link), through the study of the ionospheric channel properties and the effects of the Doppler spread, delay spread and Doppler shift. She shows the main channel parameters characterizing the ionospheric links connecting the CGA located in Rome with the corresponding ECIs in Barcelona, Cefalù and the Pireo region. Simulation results indicate that in any considered situation the delay spread is less than 0.3 ms, while the sum of the Doppler shift and Doppler spread does not exceed 0.3 Hz.

After this presentation, Fabrizio Berizzi explains the activity nr. 10 on the criteria of early warning alert and procedures to activate the back- up for a high-survival radio network operating in the HF band. The early warning processes are analyzed by the description of the scenario, the supervision and the reactivation of the internet links. His presentation begins with the description of the possible scenarios of the backbone HF radio network, assuming two different potential terroristic attacks: the first involves only one ECI, and in the second case another ECIs or/and CGAs are involved. The CGA must decide if the HF link must be established with only one ECI or if a global terrorist attack is ongoing and then the SWING network must evaluate, establishing HF links among all CGAs and ECIs. He shows one of the main internet supervision methods (figure 3).

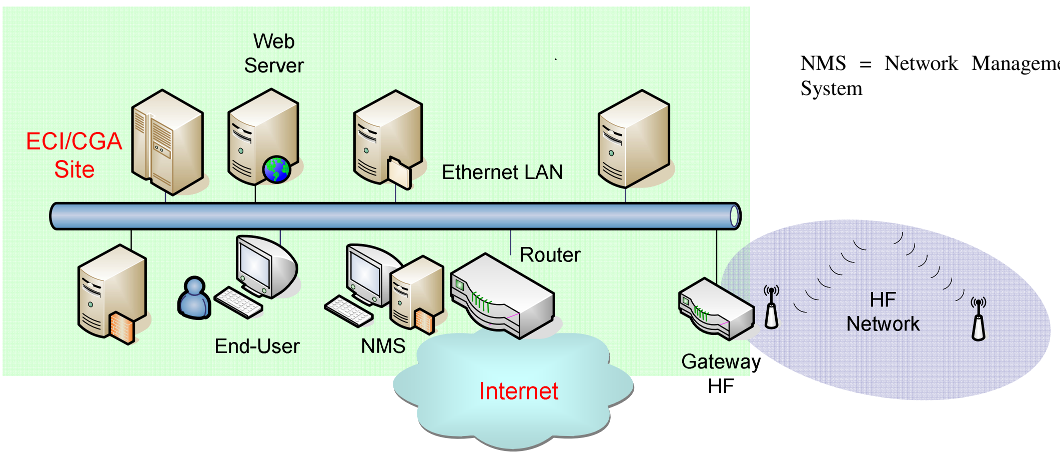

Figure 3 *Reference scenario for each ECI/CGA site*

Finally, the reactivation of the traditional internet links and the consequent interruption of the HF links cannot be directly operated by any ECI, but they should be controlled by the interested CGA. When in the CGA an internet connection has been reactivated, it just needs to transmit a message to the other CGAs, notifying that its normal operational status has been re-established and to switch from the HF link to the restored broadband Internet connection.

Michele Morelli shows the last presentation of this meeting first part. He speaks about the physical layer architecture of the SWING system, explaining the work to reach the activities:

- nr. 7 (deadline: June 2012), analysis of existing HF connection system in terms of software and hardware for internet connection;
- nr. 8 (deadline: June 2012), definition of the High survival HF radio network technical requirements;
- nr. 9 (deadline: December 2012), radio network system design.

To understand SWING physical architecture layer, he explains the selection of the modulation technology and the system design both for voice and data transmissions. Morelli shows that many military HF standards employ a serial-tone waveform with a powerful FEC code and temporal interleaving to exploit the time-diversity of the HF channel, but the use of a temporal interleaver with an interleaving depth greater than the HF channel coherence time poses a serious problem in terms of overall link latency. So, the alternative approach to increase the system reliability is to exploit the frequency diversity offered by the multipath phenomenon and the most appropriate technology for low-complexity multipath mitigation is the multi-tone transmission in the form of Orthogonal Frequency-Division Multiplexing (OFDM).

After having listed the advantages of OFDM technologies, Morelli shows the requirements of a digital voice link and the guidelines for the link design. In particular the signal bandwidth must exceed the channel coherence bandwidth so as to capture most of the frequency diversity offered by the HF channel and, moreover, the subcarrier spacing must be much smaller (<< 500 Hz) than the channel coherence bandwidth so as to make the channel response nearly flat over each subcarrier and much larger (>> 5 Hz) than the Doppler spread in order to avoid significant channel variations over one OFDM block.

Then Morelli shows the main system parameters and the significative data is the signal bandwidth which is 9600 Hz. For the voice link, he explains two different modes of subcarrier allocation. The first one in case of harsh channel: a total of 136 coded bits are mapped onto 68 channel symbols, which are next repeated and allocated over each sub-band. The second one in case of better channel conditions: a total of 272 coded bits are mapped onto 136 channel symbols, which are next allocated over the 136 available data subcarriers without any repetition.

The same points are processed for data transmission. Morelli explains the requirements of the data link and the main system parameters: the signal bandwidth for the data link can be 97,25 kHz.

Morelli shows the pilot grid for the data link where the available subcarriers are divided into clusters. Each cluster contains 9 subcarriers and spans over 3 adjacent OFDM blocks. In each cluster there are 8 pilot symbols and 19 data subcarriers. Finally, a total of 192 clusters are present in three adjacent OFDM blocks, corresponding to 3648 data subcarriers.
At the end Morelli shows the HF channel model, reporting the delay spread and the Doppler spread in different channel type, as reported in table 3.

CHANNEL TYPE	MID-LATITUDE DISTURBED	MID-LATITUDE MODERATE	MID-LATITUDE GOOD
Delay spread (ms)	2.0	1.0	0.5
Doppler spread (Hz)	1.0	0.5	0.1

Table 3 *HF channel model*

In conclusion, the coherence bandwidth can range from less than 100 Hz to more than 20 kHz, while the coherence time can range from 1 second to more than 10 seconds. Morelli concludes indicating the bit errors rate (BER) in the three considered conditions.

15:30-16:15 Open discussion on the second year activities

Participants begin the discussion of the planned activities starting from activity number 11. Zolesi shows some concepts concerning "Monthly prediction of the hourly HF set of frequencies over the n radio links given by the network, based on the available ionospheric model and methods". A procedure to calculate the interval of the frequency From the Minimum Usable Frequency (LUF) to the Maximum Usable Frequency (MUF) in the interested area, was presented. Zolesi recalls that the deliverable is expected at the end of April from INGV and EO working groups. In the same date and from the same and teams, activity N.12 "Daily forecasting of the hourly HF set of frequencies based on the Mediterranean ionospheric measurements" is also expected. This activity will take into account the particular time periods and, possibly, the ionospheric measurements for more accurate analysis. Participants discussed how to afford activity number 5 "Operative supervision of the network architecture" whose deadline is in April. Such a system must have a control on the employed data transmission protocol, a supervision on the Internet connection and a frequency management system. Activity number 13

"Ground wave propagation analysis when required" and 14 "Frequency management system for HF communication link optimization" are planned for the end of the current year as well as activities from number 15 to 19 in which all the WGs are involved.

In particular for the activity number 14 it was recalled that the automatic link establishment technique would be the main subject. For what concerns activity number 15 "Identification of the professional profile able to maintain and operate network" participants propose to assign this special task to the scientists of INGV and CNIT while the four WGs will be involved in the number 16 "Dissemination of deliverables within communities informing about initiatives organized in the context of the project" and number 17 "Professional training activities trough courses, workshops and conferences". These last two activities have to enter in the second phase. The first phase ended in December 2012 as it will be reported in the relative TR. Activity number 18 "Assessment of the potential impact and feasibility of the project for ECIs and CGAs and final recommendations for the EC", will be an essential summary with the final recommendations for the EC, at the end of SWING project.

16:15-17:15 Experimental activities

James A. Baskaradas shows this presentation about the activity number 19 and explains that the realization of the demonstrator concerns a HF radio network in a reduced simulated scenario where the ECIs are placed on the three Coast Guard spots (Cefalu', Pireo, Barcellona) and the unique CGA (Rome). He shows the four HF terminals in the Mediterranean area (figure 4).

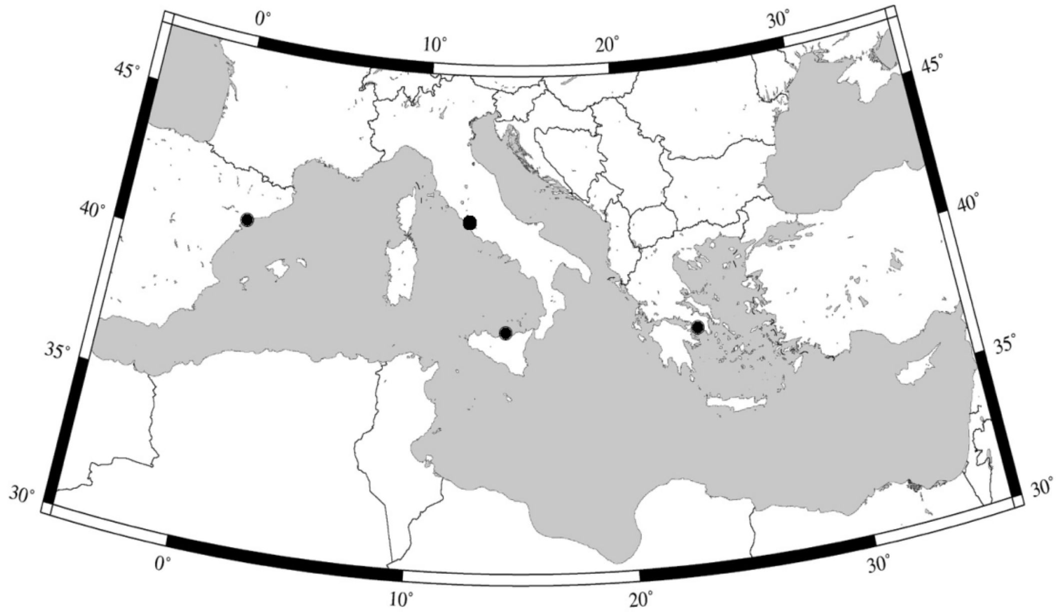

Figure 4 *4 points HF network with a central node*

The demonstrator we be implemented by means of the Universal Software Radio Peripheral (USRP) N210 motherboard both for the transmitting (TX) and receiving (RX) apparatus. The figure 5 shows the block diagram of the TX HF radio realized by means of an USRP .

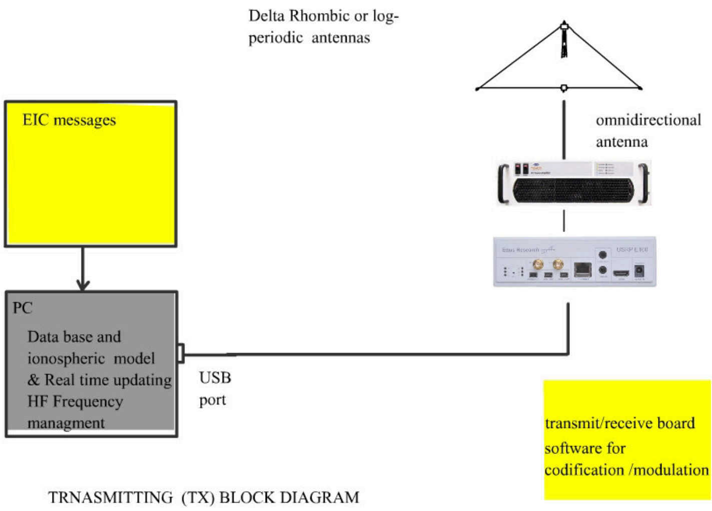

Figure 5 *Example of block diagram of a single* TX HF *point of the HF network.*

The planned connection between the point in the previous figure, ECIs and the unique CGA will be realized by the following techniques detailed below.

Connection type: point-to-point;

Frequency carrier: single;

Modulation: PSK

17:15-17:30 Next meetings

Bruno Zolesi opens the discussions about the final meeting date. All the participants agree to organize the final meeting after the successful experiment of SWING link amongst the four terminals HF network (three ECIs and one CGA) is undertaken. For this reasons, it would be good that the demonstrator is already implemented for June 2013 and the experiment ready for the field in about September 2013.

In this way the final meeting will be used to present and discuss the whole project results including what obtained during the experiment.

17:30 Welcome cocktail

Bruno ZOLESI thanks all the speakers and attendants at this SWING project 2nd Plenary Meeting in Rome, congratulates for the progress, thanks the organizers and INGV for hosting the event, and looks forward to expected positive continuation of all activities planned for the next months. Finally Zolesi invites all the participants to a welcome/farewell cocktail organized by INGV.

INGV, *Rome* - February 14th, 2013