A wireless network for off-shore marine research

Krzysztof Gierłowski, Gdańsk University of Technology (Poland), krzgierl@pg.edu.pl
Michał Hoeft, Gdańsk University of Technology (Poland), michal.hoeft@pg.edu.pl
Marcin Wichorowski, Institute of Oceanology PAS (Poland), wichor@iopan.pl

This paper presents functionality, the most important technology developments and potential use cases of digital communication system, developed to facilitate selected tasks commonly required during off-shore operations and marine research, including: broadband information sharing between platforms isolated from an on-shore communication infrastructure, acquisition of large data-sets from variety of off-shore data sources (e.g. fleet of drones) as well as remote access and control to the research infrastructure exploited in environment with limited communication between neighboring devices.

The shortage of well-developed, easily accessible communication infrastructure at sea makes the data acquisition and exchange tasks challenging [1], but often limits research conditions or generating significant costs [2] In contrast, the on-shore ubiquity of access to variability of inexpensive communication networks is driven by agile popularization of ICT support for numerous tasks – from home automation to critical infrastructure management. To change this situation the system design aimed to deliver a solution addressing the most common research communication needs and providing maximum all-purpose capabilities of deployment and ease of use feature to end-users. We have based the system design on the results of the netBaltic research project [3].

The building block of the system is the mobile appliance to which radio communication devices are connected with the standard Ethernet interface (Fig. 1). Any communication device can be used, if it supports IP communication, making it possible to choose a communication technology the most appropriate for the use-case, constrained to available resources (energy/space constraints on small vessels such as RIBs). These resources could be VHF data links, popular Wi-Fi technologies and solutions dedicated for marine environment. It has been verified that, with high quality Wi-Fi hardware, it is possible to maintain a 3 Mb/s link between vessels about 10 km distance.

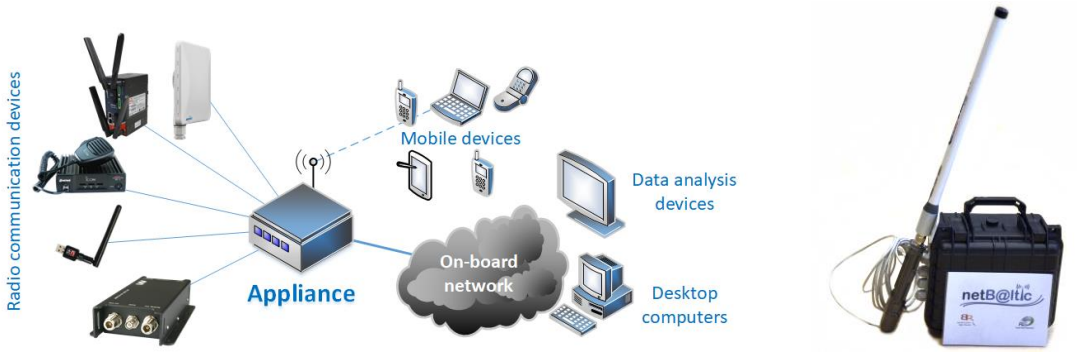

Figure 1: Deployment of marine data sharing appliance and picture of a portable, battery powered prototype

The appliance is capable of automatically utilizing its connected radio communication devices to detect similar units operating in the communication range and establishing cryptographically secured data transmission links to these units. Linked devices automatically create a self-organized mesh network capable of data exchange not only between direct neighbors, but between any pair of devices as well, as long as any connecting path traversing other devices can be found.

Administrator is able to control access to the system easily, by granting interaction only between the authenticated devices of dedicated group, each of them uniquely identified with an automatically

generated cryptographic certificate. The process is transparent to users and allows creation of well-protected private systems assuring that connecting new device to the group is an easy task.

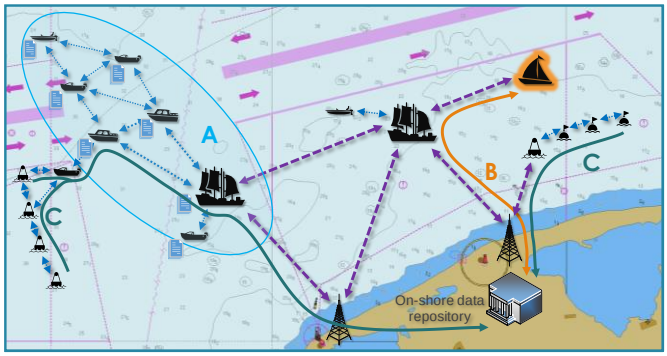

Figure 2: Common use-cases of marine data sharing system
(long-range communication links – purple lines; short-range, energy efficient links – blue lines)

One of the tested services is distributed file repository. The system utilizes this communication capability, combined with Delay Tolerant Networking (DTN) mechanisms, to provide set of shared file repositories synchronized between vessels even if data links between vessels are available only temporary – data in repositories are synchronized as soon as the vessel reconnects with the system (Fig. 2 - A). This service proves usefulness of the system during multi-vessel research activities - for example to facilitate collaboration between groups of researchers on different vessels, global monitoring of measurements conducted by the fleet of platforms, and to foster fast dissemination of updated measurement plans. It can also be useful for hosting on vessel-on-route an up-to-date replica of the data repository hosted on-shore (Fig. 2 - B).

The second service offered by the system is a reliable data acquisition capability, specifically designed to operate in limited-connectivity environment. Gathered information is organized into protected data packages, which are forwarded between devices towards a selected destination, where it is aggregated (Fig. 2 - C). Packages can wait extensive time periods for opportunity to be transmitted, which makes this service especially useful for isolated sets of measuring devices. In such case the vessel acting as a carrier has to enter a communication range of any device in the interconnected set and gather data to be transferred further.

The third service, command and control of research infrastructure, operates in a similar way – a configuration package is delivered to a remote device connected to elements of research infrastructure (located on a ship, buoy, drifter, etc.). The status of this operation is returned in encrypted package to commander.

Users can connect to the appliance by built-in Wi-Fi access or it can be connected to on-board Ethernet (Fig. 1). The ability to select different radio options make the appliance suitable for a wide range of platforms: small drifters, RIBs, buoys and large vessels, while the set of services provided to end users fits the requirements of the off-shore research.

This work has been partially supported by Grants: PBS3/A3/20/2015 and POPC.03.03.00-00-0008/16.

References

1. J. Wozniak, K. Gierlowski and M. Hoeft, Broadband communication solutions for maritime ITSs: Wider and faster deployment of new e-navigation services, *2017 15th International Conference on ITS Telecommunications (ITST)*, Warsaw, 2017, pp. 1-11.

2. Lighthouse, Maritime research and innovation for the future, https://www.lighthouse.nu/sites/www.lighthouse.nu/files/attachments/160630_eng_lighthouse_programomraden_webb.pdf

3. M. Hoeft, K. Gierlowski, J. Rak, J. Wozniak, NetBaltic System-Heterogenous Wireless Network for Maritime Communications, 25(2), 2018, pp. 14-26.