A Master/Slave Approach to Command Acoustic Modems during Underwater Networking Sea Trials

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The interest for underwater network applications is increasing in both academia and industry, often translating into joint efforts to implement research solutions on actual devices. Not only does this activity help researchers validate theoretic and simulation results via experimentation: it may also guide the design of reliable prototypes and, eventually, of commercial products, by pinpointing practical issues that cannot be easily observed in simulations. Recently, [1], [2] and [3] propose the idea of reusing the same software already written by researchers for simulation purposes in real world experiments. In particular, the well known network simulator ns2 [4] and its extension NS-Miracle [5] are the basis upon which both the SUNSET framework [6] and the DESERT Underwater libraries [7] have been developed. These two tools are now freely available to the research community to move from network simulations to actual prototypes.

However, experimenting in the real world implies technical and logistic issues typically ignored in network simulations. First of all, ns2/NS-Miracle simulations are performed by means of a single script that, once fed with the desired input parameters, creates and controls all network nodes in a centralized fashion; in network prototypes involving SUNSET or DESERT, instead, the nodes are controlled by different scripts, one per node. To perform an experiment, such scripts must be started almost simultaneously on all nodes. Furthermore, depending on the experiment, it may be necessary to run different scripts several times (or the same script with different input parameters) in a given order. If a cabled or remote connection to all nodes is available, this can be easily achieved. Unfortunately, it is often impossible to access all the nodes of an underwater network after its deployment, especially in networks of large size. In fact, for logistic reasons, it may be necessary to have such nodes as buoys or Autonomous Underwater Vehicles (AUVs) run on battery power, and to leave them in the water during the sea trials (see Figs. 1 and 2). Hence, alternative means of remote control must be employed.

In this work, we demonstrate a solution to this issue, that can be employed when direct access to at least one node is available throughout the experimental campaign. In detail, we implemented a Master/Slave mechanism for distributing experiment management commands. Our solution is based on two entities: a Master process (which continuously runs on the accessible node, referred to as the Master node hereon, see Fig. 3) and a Slave process (running on board all the remaining nodes). Through the Master, a human operator can: 1) check the network connectivity; 2) set a route for control packets (this control route must mandatorily end on the Master node, and can include either all other nodes or only part of them);

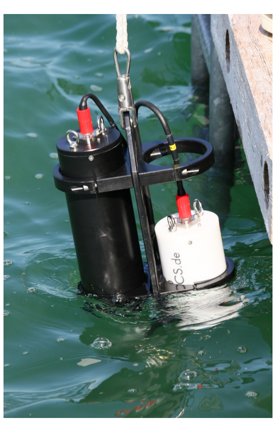

Fig. 1: One of the EvoLogics Acoustic Modems used during the field experiments in the Werbellin lake, Germany.

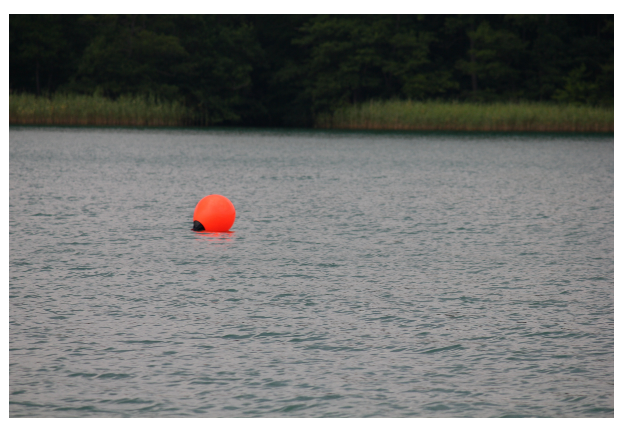

Fig. 2: One of the buoy nodes used during the field experiments in the Werbellin lake, Germany.

Fig. 3: Terminal used to remotely control the master process during the field experiments in the Werbellin lake, Germany.

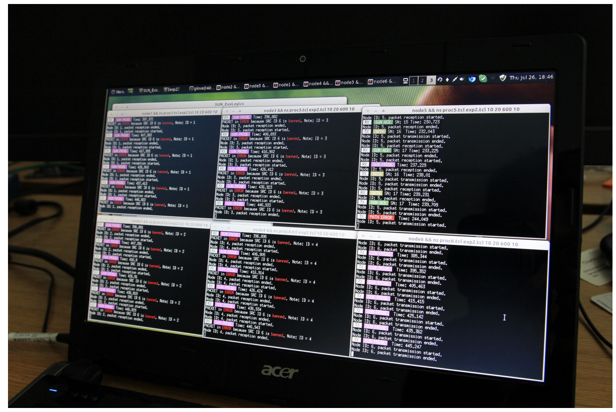

Fig. 4: Screenshot of the demo.

3) once the control route is set, send control messages to the other nodes. These messages can either carry the information required to start an experiment (i.e., the indication of the experiment to run and the corresponding input parameters) or abort a running experiment. The control messages sent by the Master include the control path information, and are source-routed along this path. When a control message is received by a node running a Slave process, the node executes the corresponding command (i.e., kill or run an experiment) and forwards the command along the control path. The event of a control message returning back to the Master guarantees that the control command has been received and executed at all nodes. The same command is then executed also by the Master node, completing the experiment setup.

The proposed Master/Slave mechanism has been successfully adopted during the field experiments conducted in the Werbellin lake, near Berlin (Germany) in August 2012 [8]. During these experiments, exploiting the DESERT Underwater libraries [3], we tested SUN, a dynamic Source routing protocol for Underwater Networks in a network composed of six S2C EvoLogics acoustic modems [9]. Our demo (see Fig. 4) will illustrate the execution of such experiments using the proposed Master/Slave mechanism. To this aim, we will replace the six real modem used in the experiment with six virtual modems running in the S2C Modem emulator [10]. The latter is a software framework designed to simplify the integration of acoustic modems into underwater infrastructure. The S2C Modem emulator is running on one machine located in Berlin, Germany. Therefore, for the actual realization of our demo we just need a desktop computer with our software solution installed on it and Internet connections to remotely access the EvoLogics emulator.

REFERENCES

[1] C. Petrioli, R. Petroccia, and J. Potter, "Performance evaluation of underwater MAC protocols: From simulation to at-sea testing," in *Proc. of OES/IEEE Oceans*, Santander, Spain, Jun. 2011.

[2] C. Petrioli, R. Petroccia, J. Shusta, and L. Freitag, "From underwater simulation to at-sea testing using the ns-2 network simulator," in *Proc. of OES/IEEE Oceans*, Santander, Spain, Jun. 2011.

[3] R. Masiero, S. Azad, F. Favaro, M. Petrani, G. Toso, F. Guerra, P. Casari, and M. Zorzi, "DESERT Underwater: an NSMiracle-based framework to DEsign, Simulate, Emulate and Realize Test-beds for Underwater network protocols," in *Proc. of IEEE/OES Oceans*, Yeosu, Korea, Jun. 2012.

[4] "The Network Simulator - *ns-2*," Last time accessed: October 2012. [Online]. Available: http://nsnam.isi.edu/nsnam/index.php/User_Information

[5] "The Network Simulator - *NS-Miracle*," Last time accessed: October 2012. [Online]. Available: http://dgt.dei.unipd.it/download

[6] "The Sapienza University Networking framework for underwater Simulation, Emulation and real-life Testing - *SUNSET*," Last time accessed: October 2012. [Online]. Available: http://reti.dsi.uniroma1.it/UWSN_Group/index.php?page=sunset

[7] "The DESERT Underwater libraries - *DESERT*," Last time accessed: October 2012. [Online]. Available: http://nautilus.dei.unipd.it/desert-underwater

[8] G. Toso, R. Masiero, P. Casari, O. Kebkal, M. Komar, and M. Zorzi, "Field Experiments for Dynamic Source Routing: S2C EvoLogics modems run the SUN protocol using the DESERT Underwater libraries," in *MTS/IEEE Oceans*, Hampton Roads, Virginia, US, Oct. 2012.

[9] "Evologics," Last time accessed: October 2012. [Online]. Available: http://www.evologics.de/

[10] O. Kebkal, K. Kebkal, and M. Komar, "Development of upper-layer protocols with S2CR acoustic modems emulator," in *UComms 2012*, Sestri Levante, Italy, Sep. 2012.