Continuous Software Engineering for Designing and Operating an Autonomous Ocean Observation System

Alexander Barbie\textsuperscript{1,2}, Wilhelm Hasselbring\textsuperscript{2}, Stefan Sommer\textsuperscript{4}, Sascha Flögel\textsuperscript{1}, Frank Wenzhöfer\textsuperscript{3}

\textsuperscript{1}GEOMAR, \textsuperscript{2}CAU Kiel, \textsuperscript{3}AWI

Helmholtz Future Project ARCHES (Autonomous Robotic Networks to Help Modern Societies)

Demo Mission 2020

Abstract
The ocean is the largest ecosystem on earth, facing dramatic changes like deoxygenation, warming, acidification, and contamination by industrial pollution to name a few. To resolve major changes of the marine realm in space and time a highly cooperating network of robotic and synchronized autonomous multiple sensor systems is needed. In 2018 the Helmholtz Centres DLR, AWI, KIT, and GEOMAR formed a research alliance to investigate how robotic networks can be build to autonomously explore these environments.

The vision of this Helmholtz Future Project ARCHES, is a network of heterogeneous, autonomous and interconnected robotic systems. To operate the network we develop an underwater communication framework. The centrepiece of our framework is the middleware Robot Operating System (ROS). ROS provides us interfaces and services to develop a microservice architecture with loosely coupled nodes. This project is designed using a continuous delivery workflow with automatic testing and releasing of software. We containerize the entire framework using Docker. Hence, we totally control all dependencies of our nodes, and by running the nodes in separate sandboxes, they cannot crash the entire robotic system upon failure of a single system component.

Used Tools
- GitLab
- ROS
- Git
- Python
- Docker

Challenges in Underwater Communication
- underwater acoustic interferences (multi-path propagation, Doppler-Effect, etc.)
- limited energy
- limited computational power
- slow transmission speed (1500 m/s)
- low bandwidth for data transmission
- high bit error rates
- temporarily losses of connection

Envisioned Demo Mission Setup

Contact
Alexander Barbie
GEOMAR Helmholtz Centre for Ocean Research Kiel
Washhoffstraße 1-3
24148 Kiel, Germany
abarbie@geomar.de

Hardware in the Loop

Continuous Delivery Workflow

Master-Branch
Development-Branch
Feature-Branches
All Branches

Envisioned Microservice Architecture

Sensor A
Sensor B
Sensor C

Acoustic Modem
RS232
RS232

Sensor XYZ
Sensor XYZ

Data Collection
Data Collection

Controlcenter
Controlcenter

Bakens Eck Data
Weather Data

Challenges in Underwater Communication
- underwater acoustic interferences (multi-path propagation, Doppler-Effect, etc.)
- limited energy
- limited computational power
- slow transmission speed (1500 m/s)
- low bandwidth for data transmission
- high bit error rates
- temporarily losses of connection