A multi-hop intermittent wireless sensor network with unmanned aerial vehicles and satellite links for the Arctic

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Several stakeholders have identified a need for communication systems in the Arctic for varied strategic purposes. The presented work, realized by a team of researchers from three different disciplinary fields, is aligned with these needs and considers a robust multi-hop heterogeneous network system in the Arctic, complemented by the use of Cyber-Physical Systems (CPS). It also comprises, partially, the goals of the Coastal and Marine Operations and Surveillance (CAMOS) project, at NTNU, which intends to develop a robust communication framework that integrates subsea, terrestrial, aerial and satellite communications in a dynamic and delay-tolerant network.

A dynamic multi-hop routing approach is considered, establishing a wireless sensor network (WSN) that resorts to a dynamic synergy between surface nodes, Unmanned Aerial Vehicles (UAV) and Satellite links in order to provide a robust communication infrastructure. Rigid methodologies cannot be applied to harsh scenarios where network connectivity is unpredictable. Moreover, the deployment of short-term tailored infrastructures and network solutions for the Arctic is costly and not sustainable on the long run. By considering an energy-efficient heterogeneous communication paradigm, with support for periodically available links, data-aggregation mechanisms and dynamic network management, we intend to optimize the overall network lifetime and resource usage, avoiding unnecessary concurrency and interferences.

The proposed network aims at supporting data from a wide variety of sources, such as weather data from meteorological nodes, ice tracking, biological and chemical sensors and more. This will lead to different traffic requirements and possibly redundant data. Consequently, the proposed approach considers the use of Software-Defined Networking (SDN) to dynamically establish paths between sensor nodes, allowing for data prioritisation and enhanced control or management network resources.

The currently realized prototype considers a multi-hop network of at least 4 sensor nodes, connected to a control centre or sink node. The testbed setup ensures that multi-hop connections to the control centre are required, and each node is equipped with wireless surface radios and with satellite-capable radios. Additionally, one node will be configured to act as a satellite link, mimicking the periodic availability of satellite coverage, while another will be attached to a UAV.

With the defined setup we intend to evaluate the feasibility of such a framework, as well of the proposed routing and management mechanisms in extreme environments with highly intermittent connectivity and several heterogeneous network devices.