

Delay and Disruption Tolerant Networking (DTN)

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Participants

- IETF/DTNRG
- Intel Research
- NASA/JPL
- MCI/Worldcom/Google
- MITRE
- SPARTA
- SICS
- Universidade do Porto
- CMRE/NURC
- Technische Universität Braunschweig



Motivation

- The ubiquitous Internet Protocol was not designed for heterogeneous internetworks with severe performance impairments:
 - Very high latencies/delays
 - Occasionally or predictably-connected links
 - Low and expensive bandwidth
 - Frequent disruption/disconnection
- Interoperability across dissimilar protocol stacks
- While several domain specific solutions may exist, it should be possible to design an extensible software architecture

Examples of Impaired Networks

- Low Earth Orbit Satellites with periodic connectivity
- Sensor networks connected sporadically via “data mules”
- Underwater acoustic networks
- Deep space communication
- Ad-hoc field networks (eg. Military)

Example of Impaired Networks



COMMSNET12

Experimental Module 4:
Testing Delay and disruption-
Tolerant networking with
latest CMRE implementation
of DTN-Lite.

Demonstration of multi-hop
communications within a
heterogeneous underwater
surveillance cluster together
with its integration with a
remote command and
control network

Architecture Assumptions

- Sender and receiver may never have a permanent real-time connection
- End-points may not share the same network and transport protocols
- Retransmitting data may be very expensive
- Round-trip times may range from milliseconds to days
- Persistent storage is well distributed accross the network

Implementation

- User-level daemon (background process)
- Interacts with communication links via Convergence Layer Adapters
 - TCP/IP, UDP/IP, Underwater Convergence Layer (UCL), Bluetooth, AX.25
- Supports different routing/forwarding schemes
 - Static, Epidemic, PRoPHET, Spray and Wait, Custom
- Applications interact with a DTN via the user-level daemon

DTN Experimental Scenario

- One underwater sensor cluster needs to interact with another similar cluster at a remote location;
- No direct or permanent network link exists between the clusters;
- A temporary network can be created, but must be tolerant to delays and/or disruptions;
- An AUV and a Glider can be used opportunistically to close the network;
- All hops are performed using DTN on top of an existing link (TCP/IP, UCL).

DTN Experimental Scenario



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Experimental Module 5:
Testing/demonstrating the
ability to link two separate
clusters of UW assets via
gateway buoys.

Demonstration of
interoperable network-
enabled communication
between two heterogeneous
underwater clusters
(underwater/acoustic <-->
above-water/RF-SATCOM <-->
underwater/acoustic)
through the use of a NURC-
developed platform-
independent DTN- enabled
middleware



DTN Experimental Scenario: Assets



- NRV Alliance
- Littoral Ocean Observatory Network (LOON) with Evologics S2C and WHOI Micromodem acoustic modems

DTN Experimental Scenario: Assets



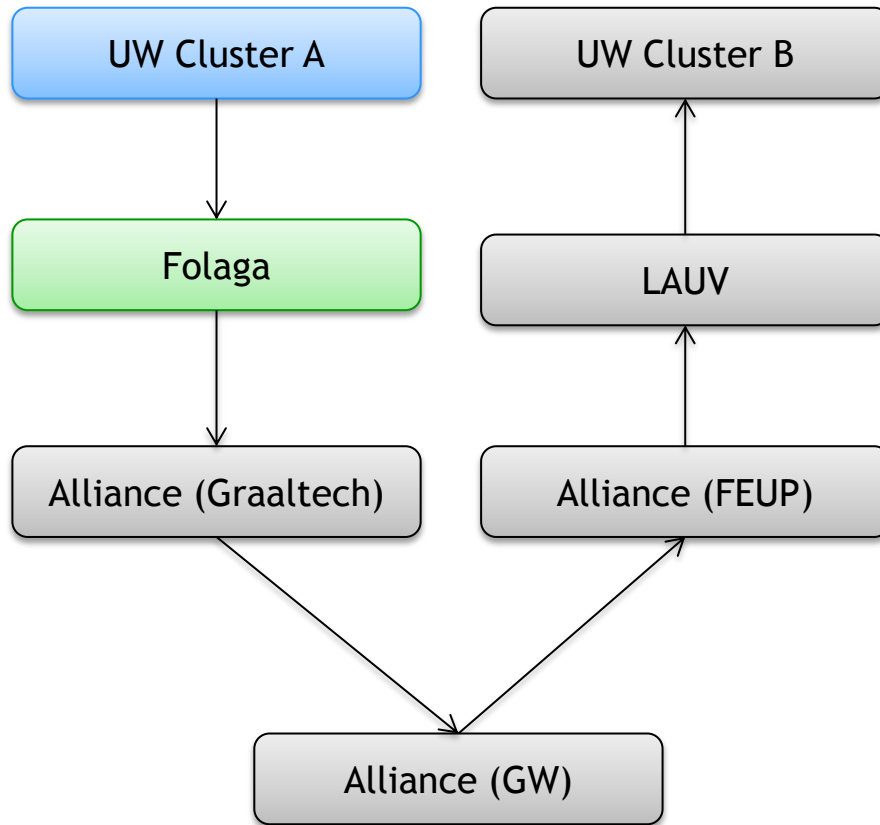
- FOLAGA AUV/Glider
- Equipment developed by Graaltech and CMRE

DTN Experimental Scenario: Assets



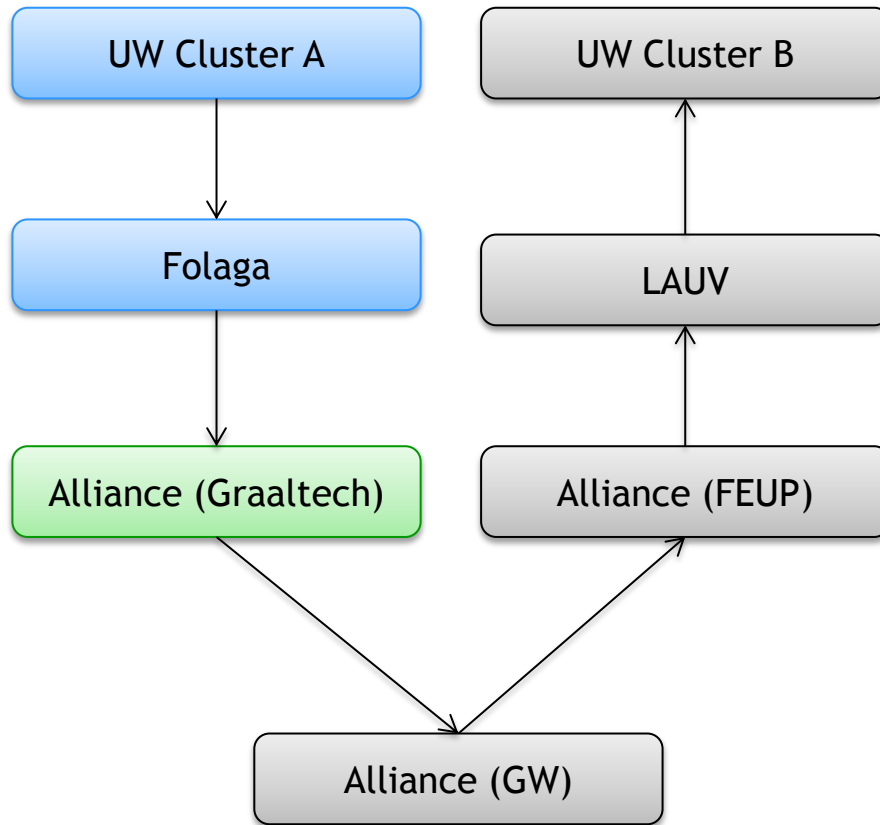
- LAUV Xtreme 2 (Sidescan, Camera, CTD, WHOI micromodem)
- Manta Gateway (802.11BGN, HSDPA, WHOI micromodem)
- Equipment developed by FEUP and OceanScan MST (www.oceanscan-mst.com)

DTN Experimental Scenario: Dataflow



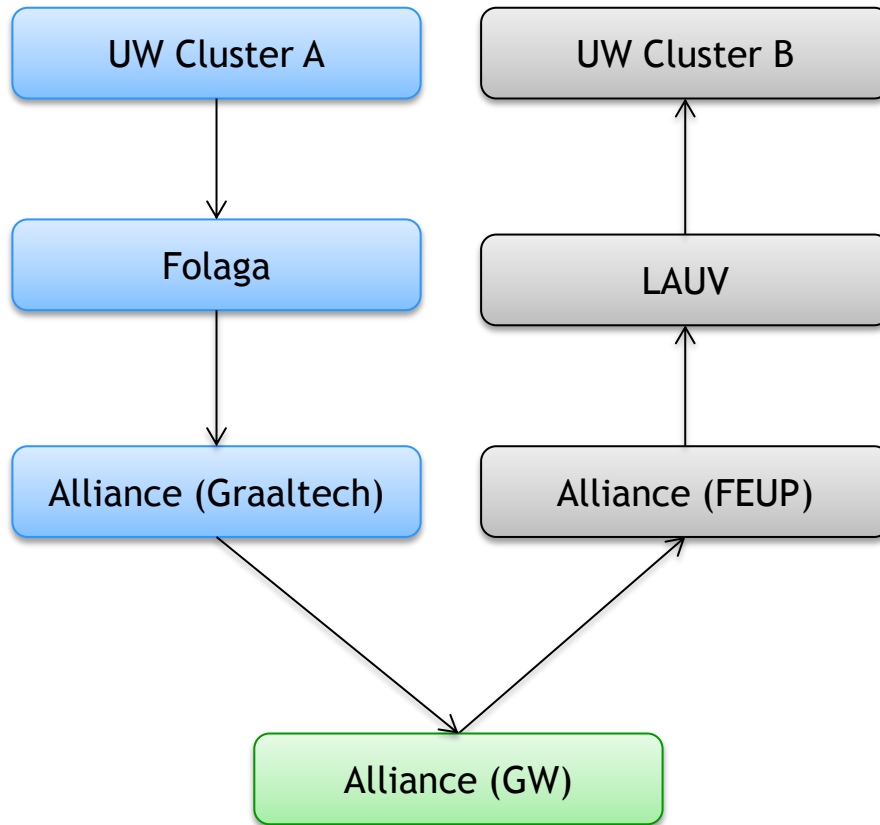
- The UW Cluster A sends a message to UW Cluster B, requesting an acknowledgment;
- The message is delivered to the Folaga AUV, that stores the message until a link to the next hop is available;
- This hop is performed via the **Evologics S2C modem** using the **UCL** developed by CMRE/FEUP.

DTN Experimental Scenario: Dataflow



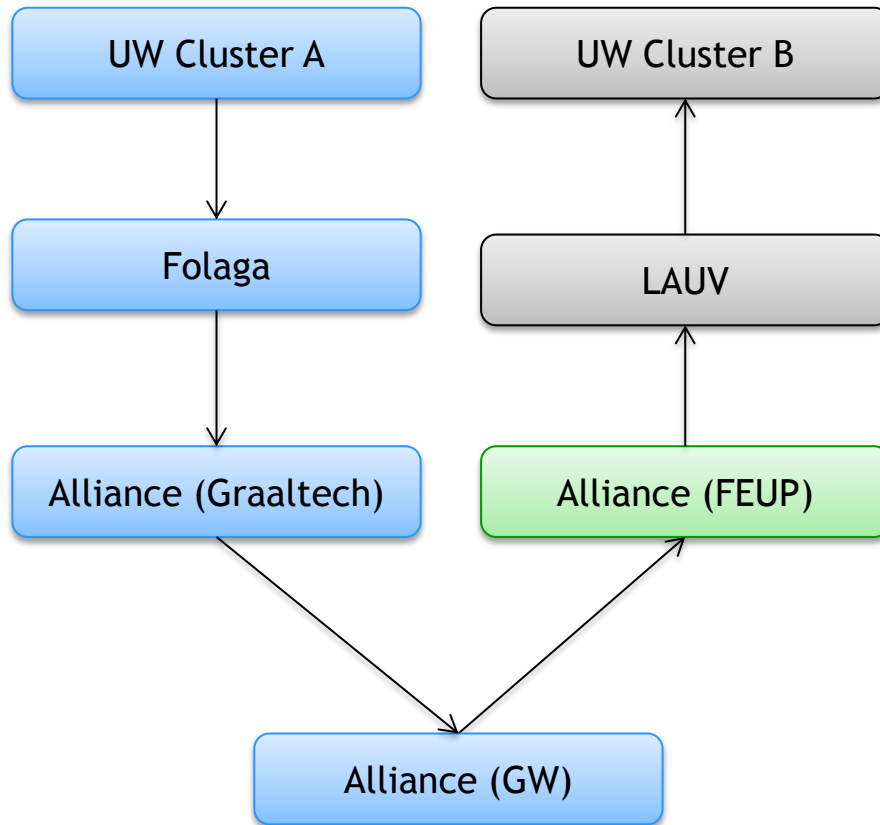
- The Folaga AUV relays the message to the Alliance (Graaltech), a Manta Gateway that is connected to the Folaga AUV access point;
- This hop is performed via TCP/IP over **802.11g wireless**.

DTN Experimental Scenario: Dataflow



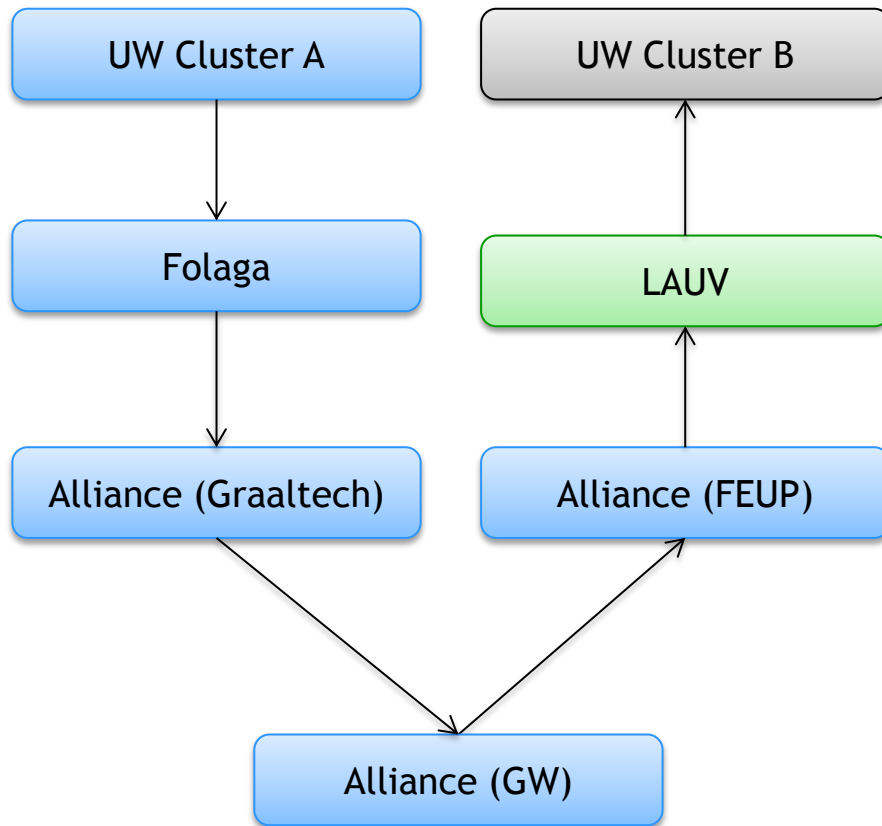
- Alliance (Graaltech) relays the message to Alliance (GW), the latter bridges the Graaltech and FEUP DTN networks;
- This hop is performed via **TCP/IP** over **Ethernet**.

DTN Experimental Scenario: Dataflow



- Alliance (GW) relays the message to Alliance (FEUP), a Manta Gateway that is the wireless access point of the LAUV;
- This hop is performed via **802.11n wireless**.

DTN Experimental Scenario: Dataflow



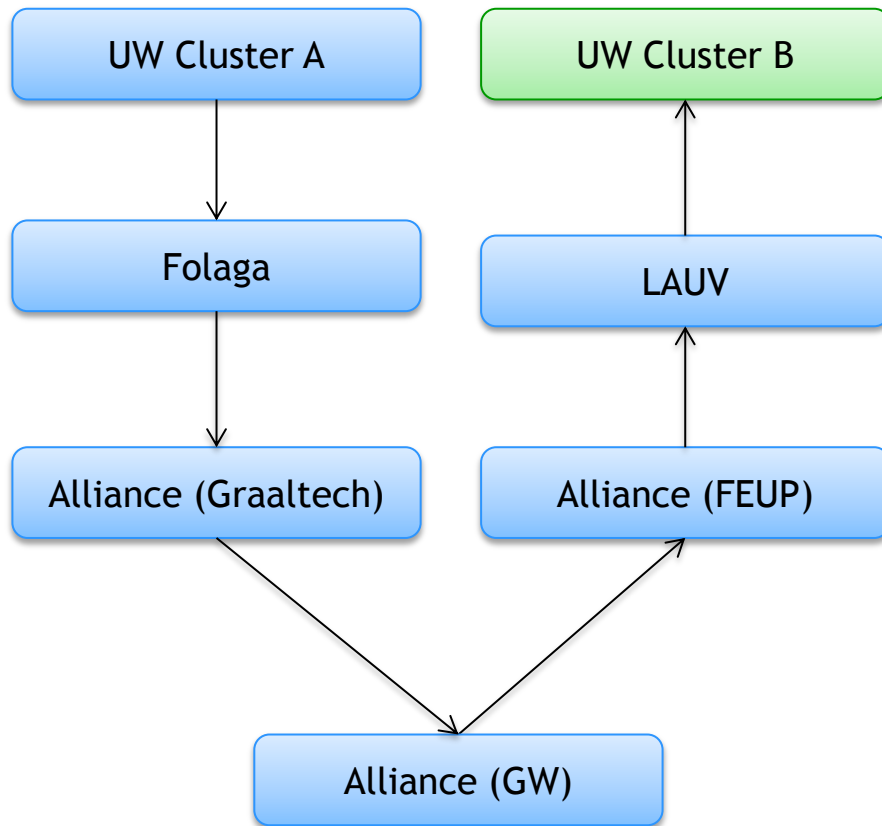
- Alliance (FEUP) relays the message to the LAUV;

- Since the LAUV is not able, at this point, to deliver the message to its destination, the message is stored until a link is available;

- The LAUV is deployed and executes an automatic plan that passes near the UW Cluster B. At the same time it collects CTD and Sidescan data;

- This hop is performed via **TCP/IP** over **802.11g wireless**.

DTN Experimental Scenario: Dataflow



- The LAUV loiters near the UW Cluster B until the message is delivered and an acknowledgment is received;

- This hop is performed using the **WHOI micromodem** using the **UCL** developed by CMRE/FEUP;

- When the acknowledgment is received the LAUV resumes the execution of the plan and brings the acknowledgment back to Alliance;

- When the LAUV is near Alliance the Folaga AUV is deployed in order for the acknowledgment to be delivered to UW Cluster A.

Thank You !

