DTN-Of-Things: Reindeer Tracking in Sweden

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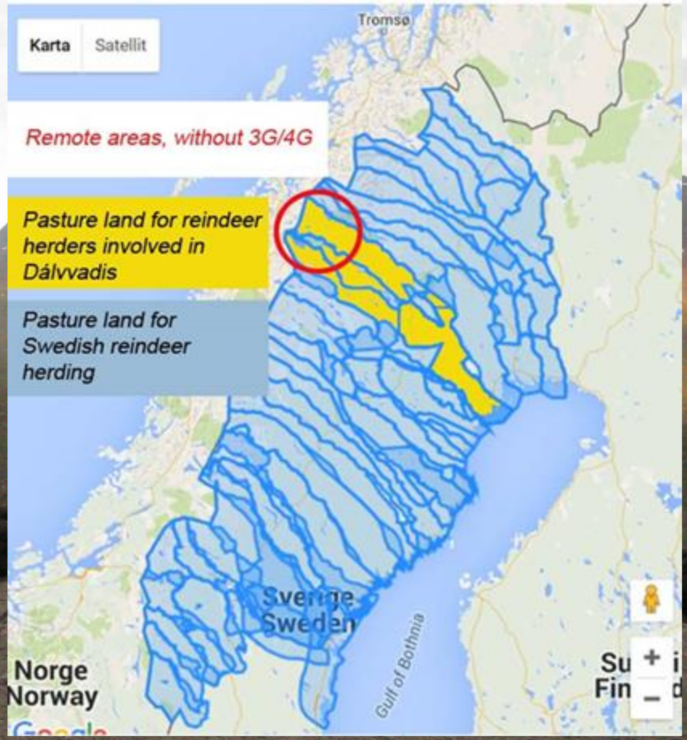
Background

- Collaboration between Sami reindeer herders (Dalvvadis), LTU and IPNSIG
- Located in northern Sweden, above the Arctic circle
- Lack of any ICT infrastructure (national park)
- Lack of road infrastructure
- Completely off-the-grid (polar winter)
- Reindeer roam freely, gathered twice per year
- GPS Tracking service needed (on and off-line)



IoT Solutions on the market

- GSM based GPS trackers
  - Short battery life
  - Requires Internet connectivity
- Satellite GPS trackers
  - Short battery life
  - Sparse updates
  - Subscriptions
  - Requires Internet

- LoRaWAN
  - Lack of suitable GPS trackers
  - End-to-end encryption
  - Requires Internet
  - No LoRaWAN infrastructure
  - Relative high-power consumption

Why DTN?

- Decentralized architecture
  - Applicable for Online and Offline use scenarios
- Network made of sensors, base station and users
- Base stations can be chained
- Can run over varios communication links
- D is for Deep Sleep
  - Ultra Low power Infrastructure
  - Synchronized (5 communication opportunities per hour)
- Flexible and efficient protocol
- Efficient CBOR encoding (approx. 60 bytes + payload)
- Open and established standard

Implementation: Sensors

- Reindeer GPS Tracking collar
  - Long battery life (non-rechargeable) between 2 to 5 years
  - Transmits positions only when it is in range of a base station
  - GPS Update time can be adjusted from 15 minutes to 1 day (over beacon)
  - Weight approx. 220 grams
  - Key challenges: power management, antenna, waterproofing
- Ice Thickness Buoy
  - Submerged ice Buoy measures Ice Thickness
  - Uses a set of ultrasonic and pressure sensors
  - Anchored to approx. 80 cm under water surface
  - Signal received by base station or “pocket” node

Implementation: Base stations

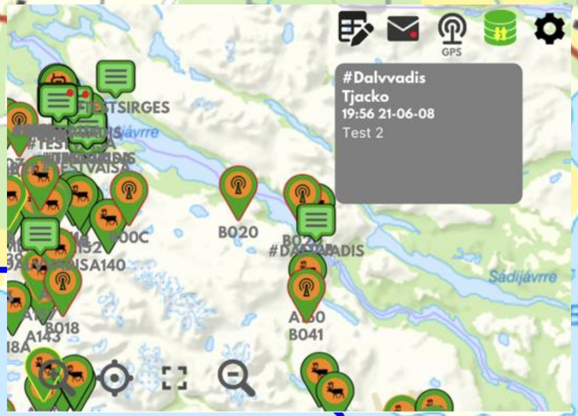
- Fixed or Mobile
- Uses a sturdy high gain antenna (range up to 60 km)
- Solar powered (battery life more than two years)
- Uses GSM mobile network (over the MQTT protocol) to upload/download data when available
- Connects with other base stations
- Key challenges: antennas, power management, batteries, current spikes

Implementation: Pocket Node

- Pocket Node:
  - Designed to be carried around while working in area without mobile coverage
  - Interfaces the LoRa-DTN network and Nomatrack App over the Bluetooth
  - Based of NRF52 chipset, built in GPS
  - Same function as base station, can be attached to the drone
  - Challenges: size, antenna, battery life in the cold
  - Now, LilyGo T-Echo
  - 30 km range using drone

Implementation: Mobile App

- Mobile App:
  - Developed using QT Framework (runs on Android, IOS, Windows, MacOs, Linux)
  - Uses SQL Lite to store data (all the data is stored locally, server used only as a backup)
  - Uses MQTT/Node-Red for server communication
  - Displays GPS positions of the reindeer herd and other work collages
  - Allows exchange of short messages (including geo tag), possible to sent SMS



Main Challenges

- Timing issues (despite GPS time)
  - Initial plan to use Time-Division Access method dropped
  - Issues with timing due to software issues and high temperature fluctuations
  - Slotted Aloha used instead (more robust, easier to implement)
- Assuring backward compatibility (for already deployed equipment)
- Base stations placements (high peaks vs. low peak methods)
- Expensive on-site maintenance
- Local competence
- Ice damage, Handling equipment in the cold
- Economic model

Second generation of DTN-Of-Things Stack

- Developing an open-sourced software (and hardware) stack
  - TinyDTN for sensors
  - DTN Arduino Library
  - Pocket Nodes based on off-the-shelf devices
  - Implementation of BPv7 into Node-Red
  - IONe running on back-end
- Only Bundle Protocol v7 (moving away from proprietary protocols)
- From epidemic forwarding to PRoPHET
  - Addressing the current issue with long range links
  - Duty cycle
- Expanding current DTN in Sweden and planning a deployment in Nepal
- Integrated into the IPNSIG global DTN network

Thank you for your attention!

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