



Integration of Digital Mobile Radio in a Sensor Network

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Presenter's bio

Anders Fongen

- Associate Professor, Norwegian Defence University College
- Field of research: Distributed Systems, Networking security
- PhD in Distributed Systems, Univ. of Sunderland, UK, 2004
- Career history
 - 6 years in military engineering education
 - 10 years research in defence research (Chief Scientist)
 - 8 years in civilian college (Associate professor)
 - 11 years in oil industry
 - 6 years in electronics industry





Overview

- We have:
 - a sensor network
 - digital voice radio equipment with GPS position reports
- We should:
 - use the radio for interacting with the sensor network
 - receive notifications, send observations
- We obtain:
 - improved situational awareness
 - safety for field operators
 - higher confidence in sensor readings
 - improved equipment ROI



Potential benefits and new services

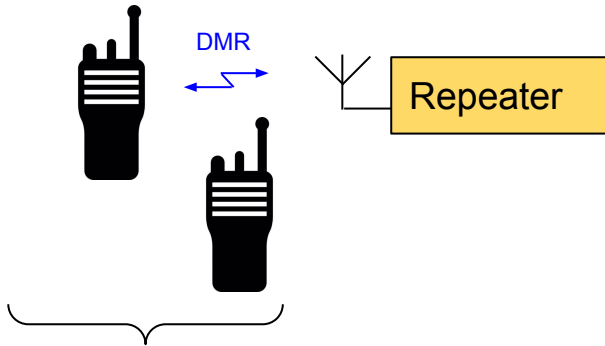
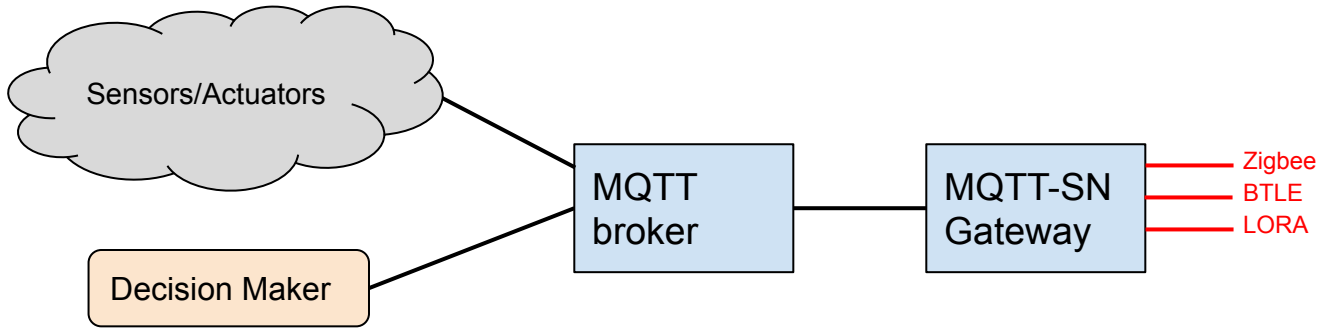
- **Unified user interface** - One unit, one battery, one charger used for personal communication and interaction with the sensor network.
- **Sensor selection** - Based on the location of a field operator, events from nearby sensors are selected for reporting, while others are suppressed.
- **Sensor activation** - Based on location, sensors near the operator may be deactivated to avoid false alarms/events.
- **Automatic geofencing** - Based on sensor readings (radiation, toxins, gases), operators may be warned not to enter or exit certain areas.
- **Based on the velocity of GPS readings**, notification can be sent either as voice or text messages.



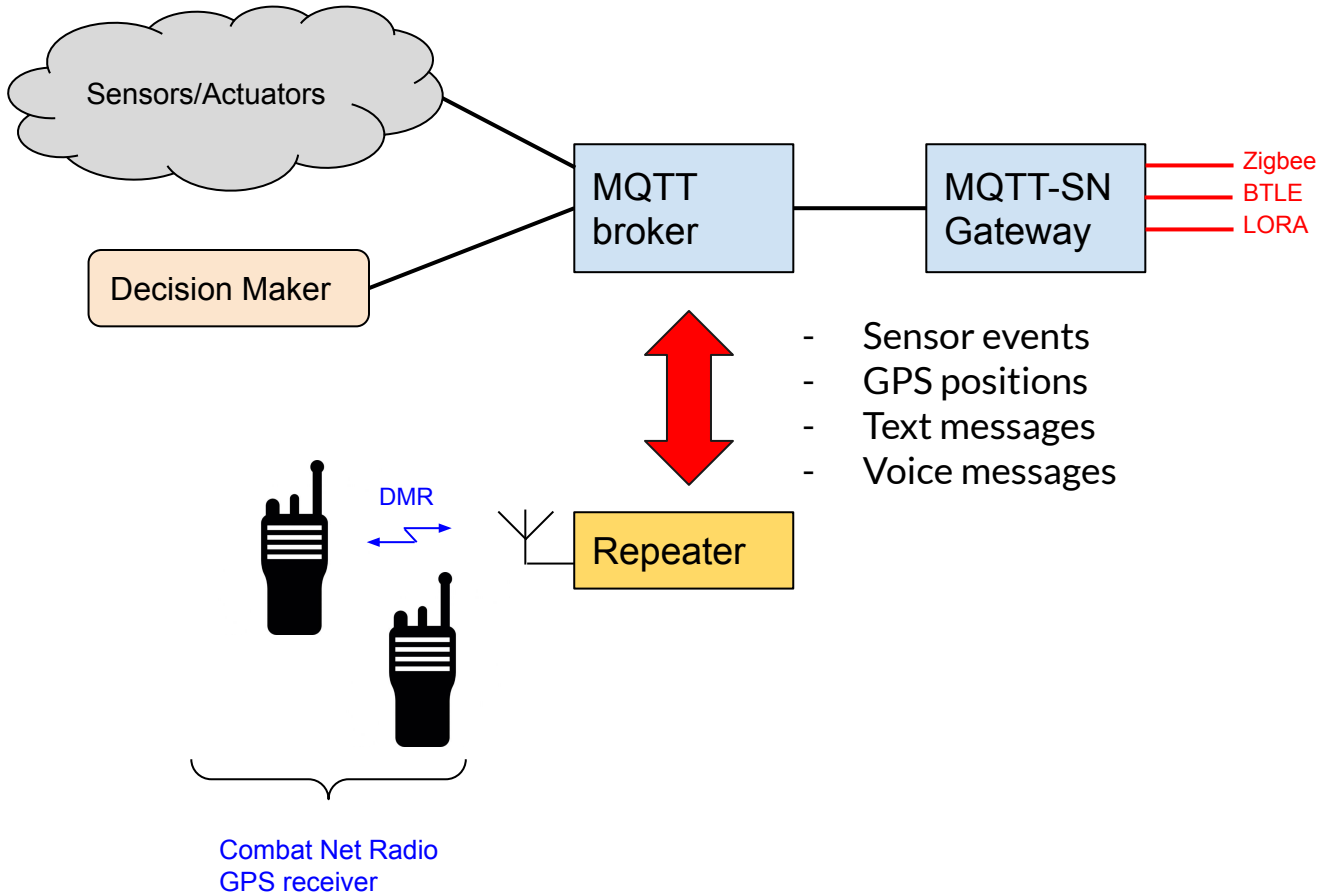
Choice of equipment

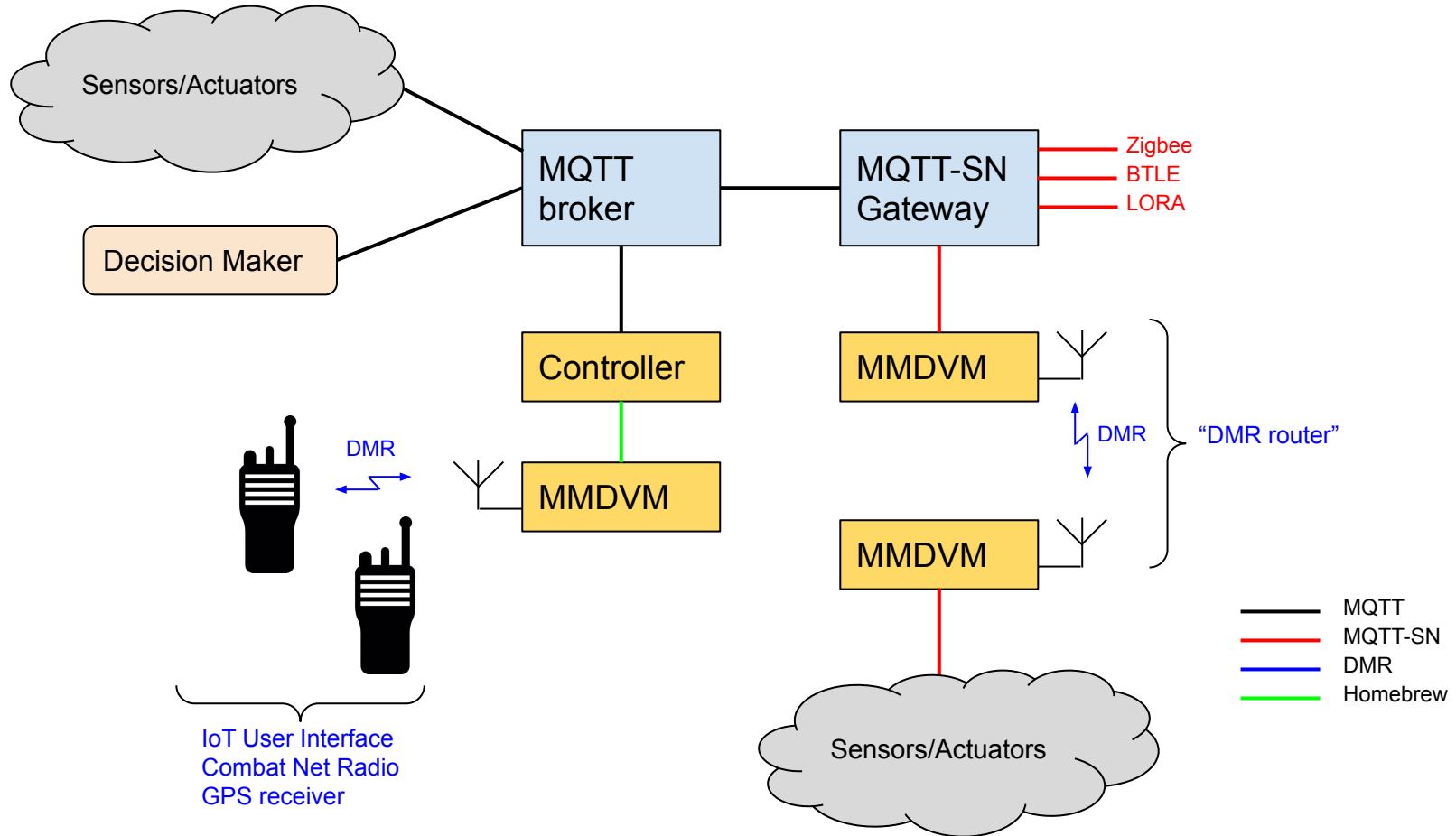
- Digital Mobile Radio (DMR)
 - open specification
 - inexpensive radio handsets
 - software library available (amateur radio community)
 - already popular in the Norwegian Armed Forces
- Pi-star/MMDVM
 - used for creating DMR repeater networks
 - inexpensive hardware, open source software
 - low-level protocol





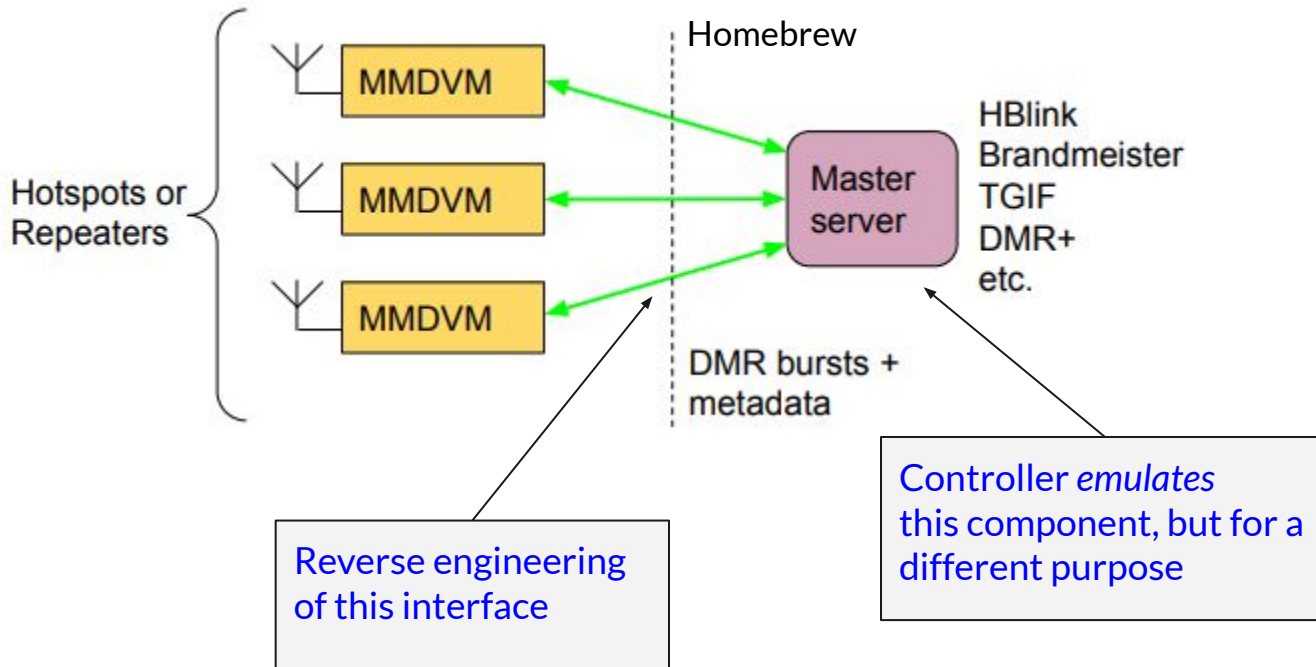
Combat Net Radio
GPS receiver







Structure of the Brandmeister network



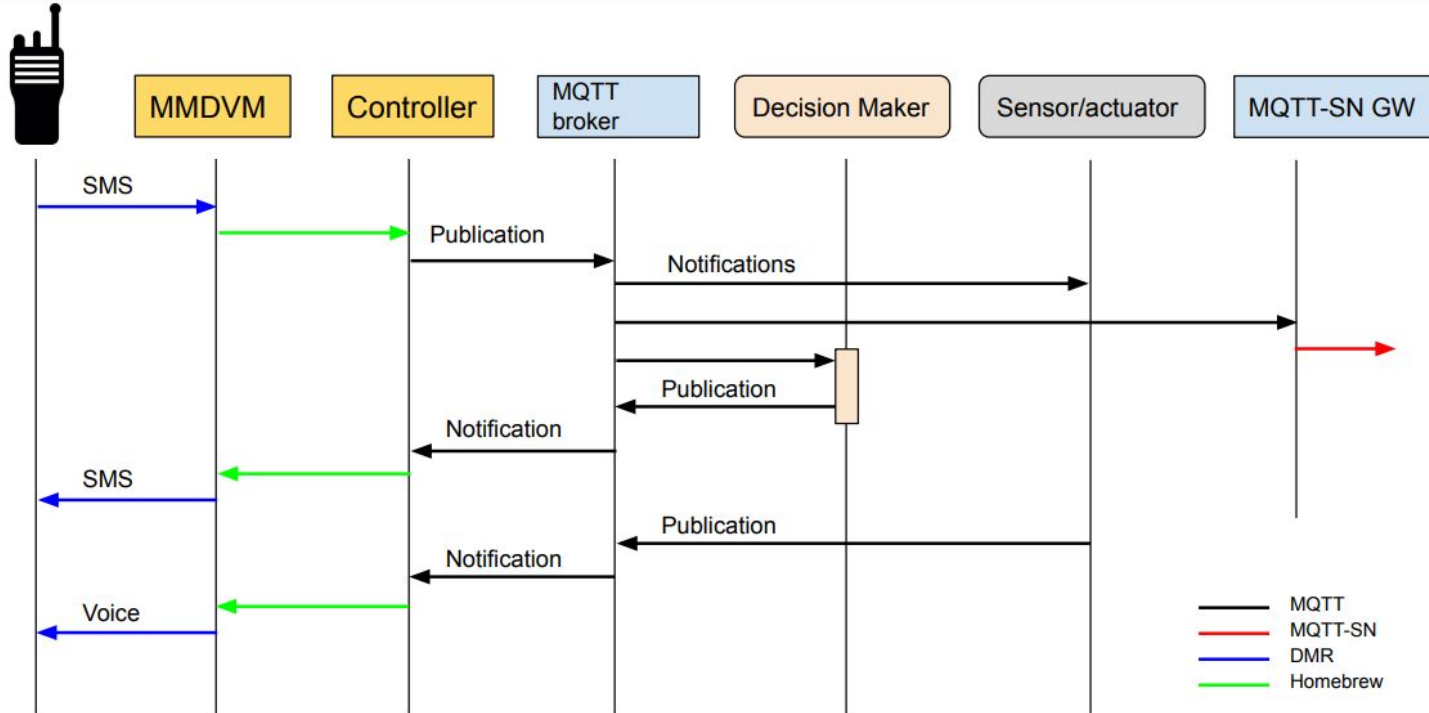


Controller software design

- Emulate the Homebrew protocol to the MMDVM
- Construct and deconstruct the DMR bursts
- Route IPv4 packets between the MMDVM and the connected network
- Present an interface to the MQTT protocol and Mosquitto, the MQTT broker
- Construct text and voice messages from received MQTT publications
- Construct and publish MQTT publications from received text messages and GPS locations
- Record and playback voice messages



Interaction diagram





Addressing the messages

MQTT Topics

- A hierarchy of topics form addresses (e.g., “events/room34/set_temp”)
- Subscriptions can be “wildcarded” (e.g. events/room34/*)
- Topics replace physical address (IP/MAC) with *functions*

DMR Talk Groups

- Flat number system for group comm. (e.g. 242023)
- Physical unicast address (e.g. 2420191)
 - repeated unicast transmissions take up more channel time



Successful?

- DMR offers very low bitrate (approx. 1000 bps)
 - Limits application to short messages (multicast preferred)
- Voice codec is proprietary (AMBE+2)
 - Limits interoperability of voice services (e.g., DMR ↔ SIP)
- Yes, it allows an “integrated” interface to a large system of sensors/actuators
 - A good platform for rethinking notification systems in operational environments
- Yes, but a proof-of-concept should be developed into a “credible” prototype
 - Likely to tap into the DMR repeater backbone

THAT IS ALL, ANY QUESTIONS?