Activity: 14010 Efficient IoT Content
Segment: Future Networking Solutions
Area: 2b. Action Lines Innovation in ICT

This document offers a brief summary of the activity for the SME grant opportunity and provides additional background on the specific area the sought SME will be involved in.

Expected Outcome

1. A specification of principles for resource efficient, robust and scalable dissemination and addressing of redundant and distributed IoT content.
2. A prototype that operates in resource constrained environments where connectivity is intermittent
3. Outline of new business models for trading IoT content
4. Deployment and usage in the specific conditions of mining
5. Contributions on protocol requirements and architectures to standards bodies

The SME will be particularly involved in 2., 3., and particularly 4.

Outline of the work plan

The activity is focused on five tasks. Task 1 is a solution description (to be submitted as a publication), where energy efficient methods to collect, disseminate, advertise and address IoT content which is available from distributed, autonomously mobile, and redundant sources. Task 2 is a prototype test-bed on resource constrained and heterogeneous nodes, including static and mobile devices, possibly with intermittent connectivity. Task 3 is business modeling, specifically in a single-domain mining scenario, and generically in a multi-domain federated IoT scenario. Task 4 is technology transfer to an SME in the mining industry. Task 5 is providing standards input to organizations focusing protocols or architectures for IoT (e.g., the IETF).

Partners

- Luleå University of Technology (activity leader) - Brings experience from developing an IoT testbed for smart cities and from defining an Sensor-data acquisition grid architecture.
- SICS Swedish ICT - Brings experience from working on ICNs and sensor networks. Will contribute to development and testing of software platform and business modelling for future deployments.
- Ericsson - Brings experience from large scale telecommunications networks and particularly importatnt knowledge in the IoT domain.
- Aalto University - Brings important results in Delay Tolerant Networking to the activity, including experience from working with IoT communication in mining environments.

We are looking for an SME that is committed to take the role as subgrantee for technology transfer. Brings knowledge of requirements of communication in harsh mining environments and an existing software platform to be extended with results from the activity.

List of deliverables

- Solution description report (a publishable paper) on resource efficient collection and addressing of distributed and redundant IoT content (realtime and non-realtime), where addresses are information centric rather than device centric.
- Package with software and documentation for a solution prototype, implemented on resource constrained nodes, using open source OS and open standards protocols (e.g., CoAP). The target scenario will be sensor data collected in mining industry.
- Report on deployment experience and results from experimental evaluation.
- Documentation of technology transfer from the activity to subgrantee. This will cover the transfer strategy as well as details on one concrete and named transfer case.
- Business Considerations Report, including a specific single-domain (mining industry) deployment case and projections for generic and federated (multi-domain) cases.
- Summary report of input contribution(s) to selected key standards body (e.g., IETF, IRTF) and their impact on relevant communities.
- Final Report. Describes the overall results of the activity.

Expectations on the SME

A sub-grantee (an SME) is will have a key role in technology experimentation and technology transfer for underground mines. While the scope will be initially limited to the mining industry and the SME should have experience with IT infrastructure and software for mining or environment with very similar communication challenges. The SME should have access to an operational mine or a similar real-world trials environment for trial deployments.

Scenario and Technology Background

There are three to four thousand operating mines worldwide. The lifetime of a mine depends on the amount and accessibility of ore and may vary from a few years to tens of years. Within these mines there may be between ten to a thousand pieces of mining equipment – drills, loaders, roof bolters and other special purpose machines – as well as personnel operating in two to three shifts per day.

The mining process is often divided into development and production phases. In the development phase the underground infrastructure and the tunnels to the ore body are created. During the production phase the ore is excavated from the solid rock and transported to the surface. Both phases have a cycle where different work methods follow each other and each work method uses (a) dedicated type(s) of machine(s). In underground mines, there are typically tens of active work locations in different stages of the development or the production cycles. Managing the equipment fleet and the locations in an efficient way is challenging.

The need to manage a fleet of equipment and personnel operating in an underground mine necessitates robust communications in an environment where radio propagation is limited by the topology of the tunnels and where communication infrastructure is difficult to build and maintain. Communications are required in two main areas: 1) voice communication (for which various solutions are in operation today) and 2) data exchange for mining operations and monitoring. This Activity focuses on the latter.

It requires transmitting measurement and operations data collected by mining equipment to a control room and conveying instructions from the control room to the equipment and personnel. In some development stages (e.g., production drilling) the mining equipment may be out of reach of any communications for days and the operators for entire shifts. The lack of knowledge in the control room about the current state of equipment and personnel, limits the frequency at which the work assigned may be adjusted based on work done. Being able to transmit data between the work site and the control room during the long blackout times would allow increasing efficiency and control of the operation, which in turn may lower operational costs and improve exploitation of the ore.

Technologies currently used for data communications in mines include: WLAN networks, data over leaky feeders, and manual transfer with e.g. USB memory sticks. Recent research and engineering efforts have applied Delay-tolerant networking (DTN) to a number of scenarios, including monitoring the environment, movement of animals, communication in industrial environments. DTN enables communication between endpoints, unlike IP networks, without requiring an end-to-end path. Specifically, a mining machine (e.g., a drill) may collect data and transmit this to relays (e.g., trucks) whenever such comes in radio range. Relays collect data from mining machines and, ultimately, carry the data to a control station where the data is gathered and evaluated. In the opposite directions, instructions, schedules, etc. are conveyed in a similar fashion. All machine-to-machine communication works without human intervention. The communication uses the DTN architecture (RFC 3848) and bundle protocol (RFC 5050).

A simple setup illustrating the scenario is shown in the figure below.