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Massive scale, long battery life, direct to orbit connectivity for the internet of things

David Haley*, Andrew Beck, André Pollok, Alex Grant, Robby McKilliam

Myriota Pty Ltd, 25 Chesser Street, Adelaide, South Australia, 5000, Australia

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ABSTRACT

Applications delivered by the internet of things have the potential to increase operational efficiency, reliability and safety. However, a challenge exists to deliver connectivity to industries with remote operations at a cost, battery life and form factor that is able to close the business case for deployment. This is especially true in cases where the system must scale to support large numbers of devices. Typical applications include sensor telemetry, low-value asset tracking, and device monitoring and control. Myriota provides global reach for the internet of things by securely delivering high-value small-data direct to a constellation of low Earth orbit satellites. This paper provides an overview of the Myriota communications architecture, and the process taken to transfer Myriota foundation technology into a highly scalable commercial product and service. Recent results from customer facing pilot deployments are also presented.

1. Introduction

The Internet of Things (IoT) is expected to surpass mobile phones to represent the largest category of connected devices in 2018 [1]. By 2025, the total number of connected devices is forecast to reach 27 billion, with 11% of these connections expected to be Low Power Wide Area (LPWA) [2].

A widespread trend towards increased monitoring of remote sensors and assets is being driven by the need to reduce operational costs, increase productivity and decrease risk. Additional drivers are compliance, regulation, and environmental considerations. As a result, many farmers, utilities, resource companies, environmental agencies, governments and defence agencies with remote operations have a need for remote machine-to-machine connectivity. The potential applications are broad and cover all sectors of the economy. Examples include:

- Extending the footprint of smart utility meters to rural and remote areas;
- Tracking of fishing vessels for compliance and licensing;
- Inventory management for large populations of lower cost hire equipment;
- Livestock tracking for traceability, mustering, animal health and feed optimisation;
- Remote monitoring of meters for agricultural water and wastewater flows;
- Monitoring marine aids to navigation and remote assets for preventative maintenance;
- Retrieving data from environmental monitoring marine drifters; and
- Retrieving data from ground-deployed sensors for defence applications.

In addition to connecting existing machines, IoT will expand the number of connected points in the environment using sensors, actuators and devices that would never have been developed nor deployed without the underlying connecting infrastructure [3]. In order to enable new applications in remote areas IoT should have:

- **Global connectivity** enabling communication with a device at any point on Earth;
- **Long battery life** that is measured in years; and
- **Low cost** allowing the business case to be closed for high-volume deployments.

Low cost and long battery life requirements are consistent with the drivers for terrestrial LPWA systems. LPWA, however, is not expected to offer truly global connectivity as it is not economically viable to deploy the infrastructure required for blanket coverage of every point on Earth. A low Earth orbit (LEO) satellite communications system can provide truly global coverage, however, for commercial applications that require very low device costs, low power consumption and low maintenance costs, the existing means of direct satellite to device connections are not suitable [4]. The challenge presented by remote IoT is to

* Corresponding author.
E-mail address: david.haley@myriota.com (D. Haley).

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combine the battery life, small form factor, and cost features of LPWA, with the direct-to-orbit global coverage offered by satellite systems. Moreover, in order to enable new high-volume deployments, the system must support massive scale connectivity.

The remainder of this paper is organized as follows. Sec. 2 provides background on Myriota's foundation. Sec. 3 describes Myriota's connectivity platform and its key components. Pilot deployments are described in Sec. 4, with real-world results presented in Sec. 5. An overview of the long battery life enabling features of Myriota's technology is presented in Sec. 6, and Sec. 7 concludes the paper.

2. Background

From 2011 to 2013, the Institute for Telecommunications Research at the University of South Australia led an AU$12 million project, with federal government support through the Australian Space Research Program. The project delivered technology enabling a Global Sensor Network (GSN) for remote sensor data gathering via LEO satellites. Project outputs included a Phase A mission study, communication system design, and ten patent filings enabling spectrally and power efficient data communication with very large numbers of remote devices. Real-world system validation was successfully performed via LEO satellite trials conducted in Australia and Canada [5] using the exactView-1 satellite and the NTS satellite [6].

Myriota was founded in 2015 to offer a new category of global IoT service leveraging the outcomes of the GSN project and exactEarth's existing constellation of LEO satellites. Since foundation, Myriota has transferred its foundation technology into a working product, and has developed new technology for low power terminal operation, global position determination, and data security.

3. Connectivity platform

In this section we provide an overview of the Myriota connectivity platform, and its key elements.

3.1. System architecture

The connectivity platform includes the following components, each of which is described in the remainder of this section.

- Small, low power, sensor-to-cloud interface
- Constellation of low cost nanosatellites
- Ground station network
- Cloud based
  - ○ Receiver signal processing
  - ○ Customer network service portal
  - ○ Rich web applications

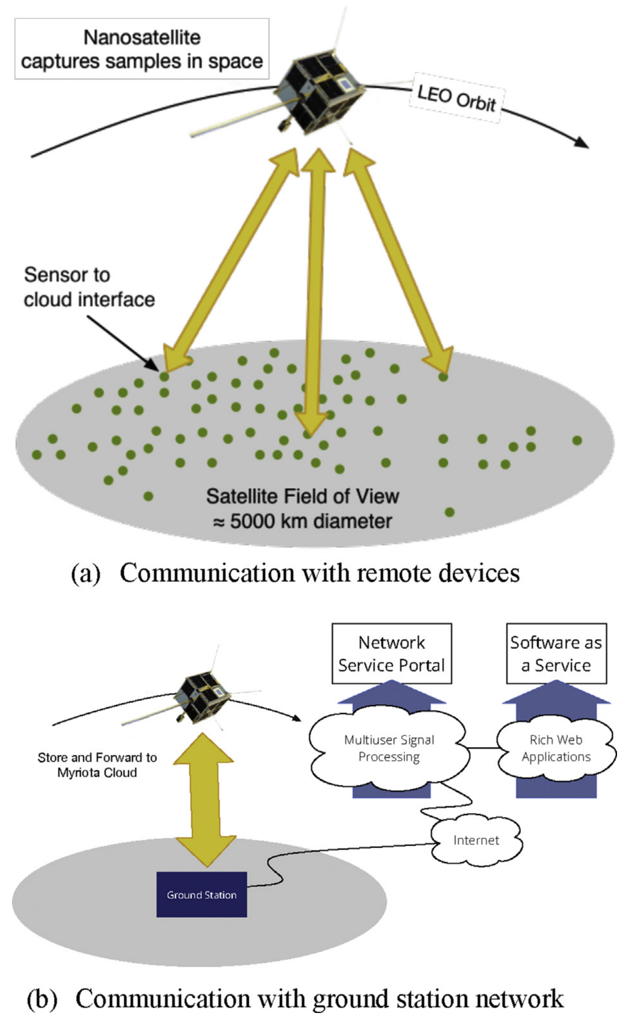

Fig. 1. IoT connectivity platform architecture. (a) Communication with remote devices. (b) Communication with ground station network.

The architecture of Myriota's IoT connectivity platform is shown in Fig. 1. Data is captured from large numbers of remote sensor-to-cloud interfaces, stored on the satellite, and forwarded for processing and delivery via a network of ground stations. The system currently supports a 1-way service for remote data collection, with a 2-way service that will enable control of remote devices to be offered in 2018.

Data is encrypted end-to-end using AES-128, with keys that are unique to each sensor-to-cloud interface. Moreover, the identity of each device is hidden, and the sender is authenticated at the receiver. These security features are achieved using novel techniques that support 1-way implementation and minimise over-the-air overhead to data.

3.2. Sensor-to-cloud interface

The Myriota sensor-to-cloud interface provides connectivity between sensors (connected to the interface) and the Cloud, via the satellite and ground station network. It has dimensions 57 mm × 46 mm x 11.5 mm, and is shown in Fig. 2. It communicates with remote sensors and devices, as shown in Fig. 1(a), allowing data to be transferred between these devices and the constellation of LEO nanosatellites.

Fig. 2. Myriota sensor-to-cloud interface.

On-board sensors are provided for position (via GNSS); vibration and temperature; and an accelerometer, magnetometer, and gyroscope. It also supports connection with external sensors and devices via USB, I2C, SPI, GPIO, Analog, RS-232, RS-485, SDI-12, and CAN interfaces. The design incorporates a sophisticated software-defined radio that implements Myriota's transmit waveform, which has been purpose built for long battery life IoT. The radio supports VHF transmission, and both VHF and UHF reception.

The sensor-to-cloud interface includes an ARM Cortex-M4 processor that runs use-case specific remote applications. These applications can