EXTENDING THE INTERNET OF SENSORS TO REMOTE LOCATIONS

An Innovate UK Collaborative Project Between
Zynaptic Limited & Silicon Infusion Limited

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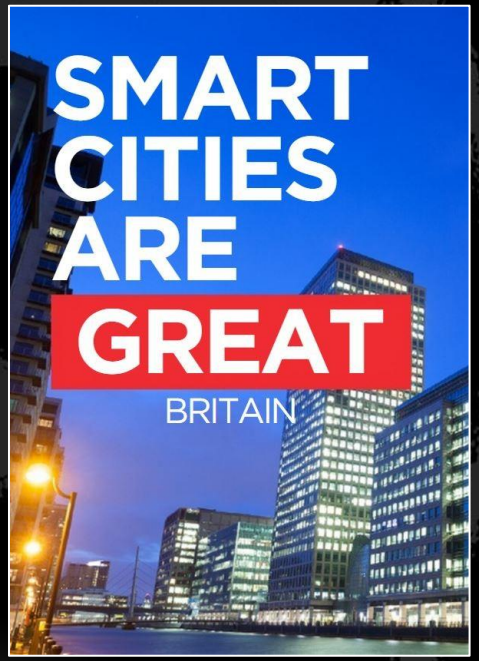
THE INNOVATE UK COMPETITION

- To stimulate innovation at the intersection between connected computing and the use of sensors
- Interoperability : Creating universal sensor platforms that can operate with generic sensors
- Scalability : Allow very large numbers of sensor elements to be added to a network
- Intelligence : On-board processing to monitor and analyse data feeds and respond autonomously
- Low Power : Capture, process and communicate information with minimal power requirements

EXISTING INTERNET OF THINGS PROJECTS

- Strong emphasis on smart city infrastructure and consumer electronics applications
- Assumes cheap and ubiquitous Internet access where devices are accessible and readily powered
- Well defined roles within the application stack
  - Collecting data is a networking problem
  - Storing the data is a database problem
  - Analysing the data is a data science problem
- Significant scope for human / computer interaction



SOLVING A DIFFERENT KIND OF PROBLEM

- How do we take the Internet of Things to places where there is no Internet?
- Inaccessible locations with little or no communications or power infrastructure
- High degree of functional integration required
  - Data collection integrated with…
  - Local data storage integrated with…
  - Embedded data processing capabilities
- Autonomous systems must take care of themselves

THE COLLABORATION PARTNERS

Embedded Software and
Network Protocol Design for
Internet of Things Applications

High Performance
Software Defined Radio Solutions for
Satellite and Terrestrial Applications

UNDERLYING TECHNOLOGIES

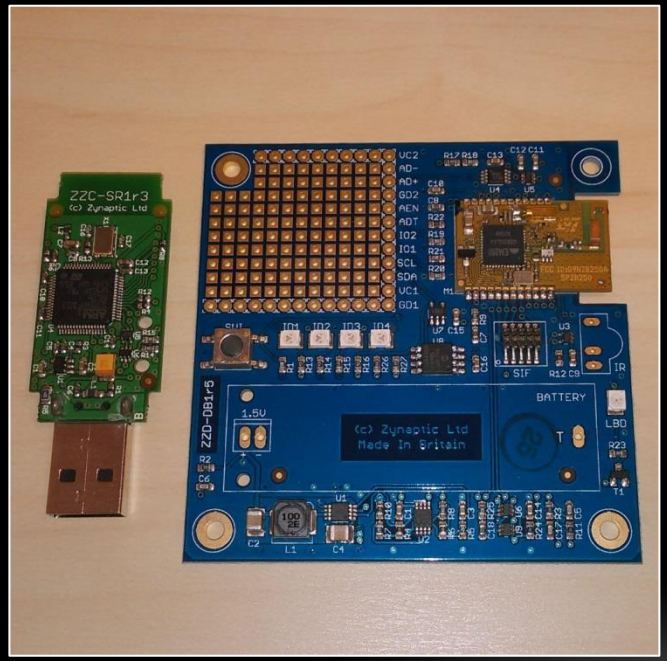
Low Power Mesh Networks

- Short range (several kilometres)
- Very cheap radio technology
- Very low power consumption
- Free to use (license exempt)
- Low transmission bandwidth
- Common standards (IEEE 802)
- Highly integrated SoC solutions

Satellite Communications

- Potential global coverage
- High value modem hardware
- Moderate power requirements
- Charged per modem / unit data
- Limited affordable bandwidth
- Operator specific protocols
- Custom silicon or FPGA

HARDWARE PLATFORM : MESH NETWORK

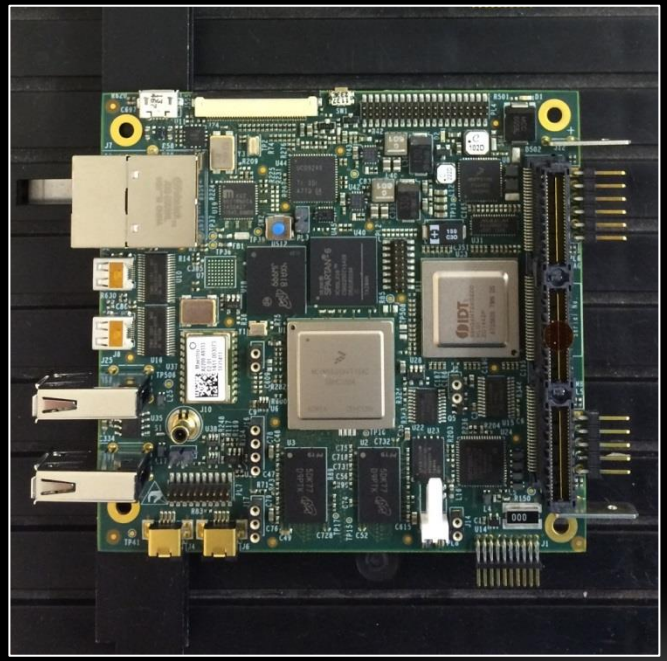


- Development system uses off the shelf IEEE 802.15.4 radios in the 2.4GHz band
- Intelligent USB adapter contains all real time network management functionality
- Sensor board operates from 1V to 3V for energy harvesting experiments
- Low power instrumentation amplifier and I^2C bus support a range of sensors
- Includes low cost infrared link for secure network setup and commissioning

HARDWARE PLATFORM : SATELLITE LINK

- High performance Xilinx FPGA based software defined radio platform
- Standard FMC interface supports a range of analogue front end boards
- PCI Express backplane for high bandwidth applications
- Compact PCIe/104 form factor enables lightweight portable solutions
- One modem to model satellite ground station and two for remote hubs

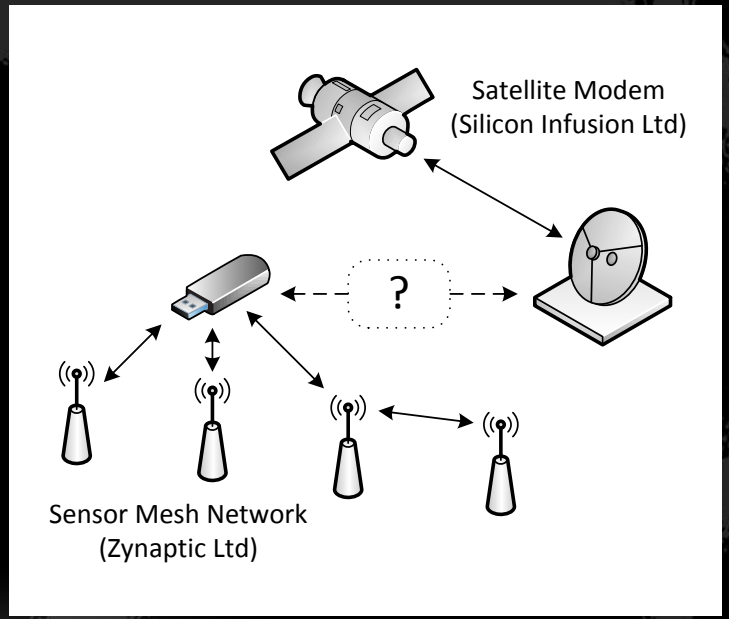
HARDWARE PLATFORM : LINUX SERVER



- Freescale iMX6 controller card provides a complete embedded Linux platform
- Quad core ARM Cortex-A9 for high performance sensor data processing
- SATA support for high capacity local data storage
- Integrated GPS receiver for positioning and precision timing source
- Multichannel PCI Express switch for high bandwidth data transfer

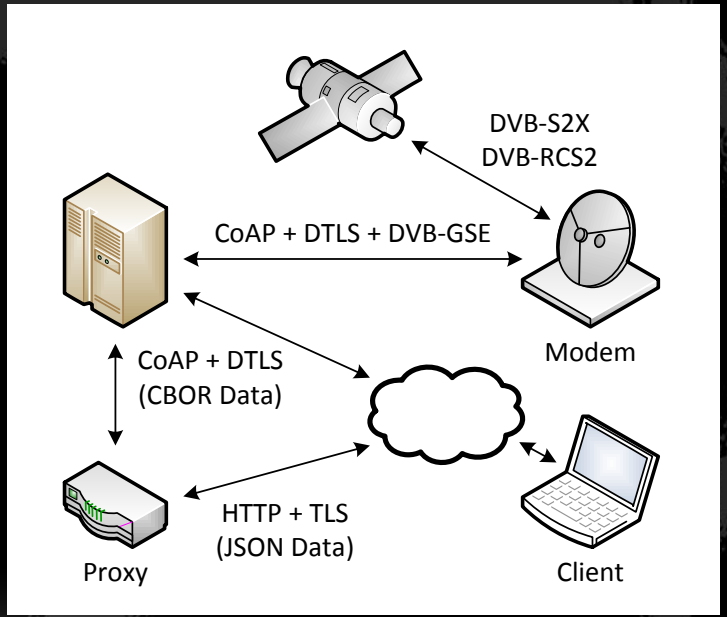
TRYING TO PUT IT ALL TOGETHER

- How do you manage IoT devices via a high latency satellite link?
- How can you generate more sensor data than you can send via satellite?
- How can you build this to work with existing satellite infrastructure?
- How do you secure this type of system to protect data integrity?
- How can you interoperate and share data with other IoT platforms?



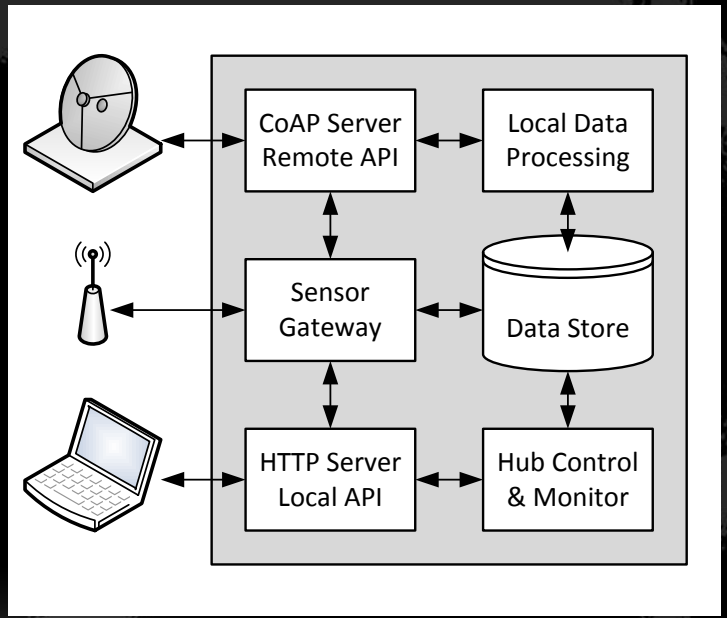
LEVERAGING OPEN STANDARDS

- DVB-S2X / RCS2 : Satellite modulation and coding for bidirectional links
- DVB-GSE : Datagram encapsulation
- CoAP : Connectionless datagram based RESTful interface protocol
- DTLS : Datagram transport security
- HTTP : Standard RESTful interface
- CBOR : Compact binary encoding for payload data (maps to JSON)



REMOTE HUB SOFTWARE COMPONENTS

- Data Store : Embedded time series data store for bulk data collection
- Data Processing : Extracts actionable information from bulk data
- CoAP Server : Low overhead RESTful API for data access via satellite
- Sensor Gateway : Interfaces to the mesh network of sensor nodes
- HTTP Server : Local RESTful API for field maintenance and data collection



DATA PROCESSING REQUIREMENTS

On-Line Monitoring

- Processes data as it is delivered or within a short time window
- Simple processes suitable for a wide range of applications
- Generic processing engine configurable via satellite link
- Generates ‘push’ notifications of significant events and data

On-Demand Data Processing

- Processes historic data over long time periods
- Complex application specific algorithms (PCA, Kalman etc)
- Deployed as OSGi plug-ins during system setup
- Initiated by ‘pull’ requests for specific analysis results

SO WHERE ARE ALL THE SENSORS?

- Proof of concept for a universal sensor platform that connects generic sensors in remote locations
- Scales to large numbers of cheap connected sensors that can be deployed anywhere in the world
- Requires embedded data processing capabilities to monitor and analyse data within the network
- But… generic sensors only yield synthetic data in hypothetical sensing scenarios
- And… low power consumption is not enough on its own – remote sensors need energy harvesting

FUTURE CHALLENGES

- Joining the technical dots – standards compliance, security, APIs, data processing, geolocation etc.
- Selling the concept to satellite operators – especially those who want to disrupt the market
- Integrating third party sensing and energy harvesting technology for a complete solution
- Partnering with Internet of Sensors customers for whom this is an enabling technology
- Interoperability with other IoT systems and platforms – maybe HyperCat can help…

PLEASE VISIT OUR STAND IN THE EXHIBITION AREA TO FIND OUT MORE

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