In-Network Processing for LoRaWAN Enabled Systems

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November 30, 2017

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Outline

In-Network Processing

Use cases

Algorithms

Hardware considerations

CoC/UofC collaboration

In-Network Processing

- Bringing the computation to where the data is collected
- Motivation:
  1. Efficient use of limited resources (network traffic, power consumption)
  2. Reduce amount of stored data in the data centre
  3. Improved security and privacy
- Other names: in-situ processing, device/sensor-level analytics, edge analytics

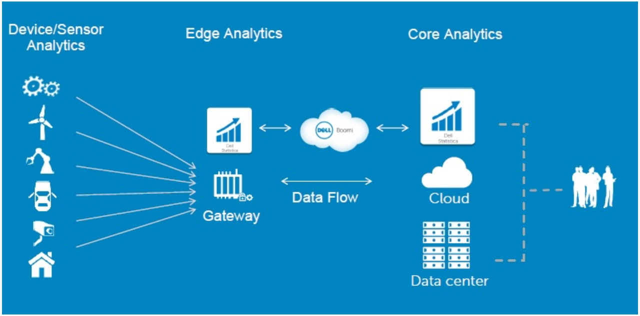
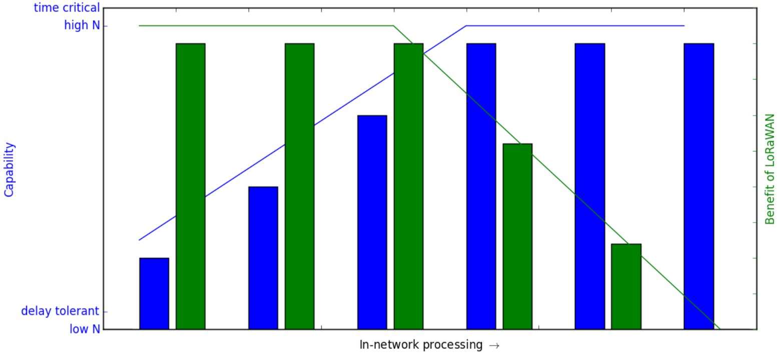


image adapted from "Executing on the promise of the Internet of Things (IoT)" by DellWorld

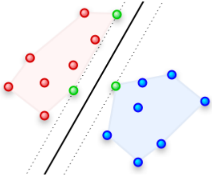
In-Network Processing: LoRaWAN

Recall that LoRaWAN enables low-power, wide area communication at the expense of bandwidth.



Use cases: Event characterization and classification

Problem description: identify to which category a data point/stream belongs to.



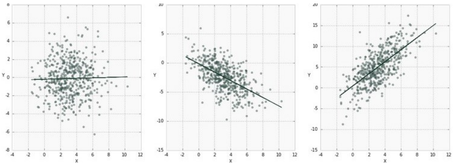
Role of in-network processing:

- pre-process a data stream (filtering, dimensionality reduction, etc.)
- apply classifier or, more interestingly, train classifier using the new observation (unsupervised learning)
- make data transmission decisions based on result

Examples: Identifying noise sources, detecting objects in an image

Use cases: Training spatially distributed models

Problem description: train model parameters to predict future events.



Role of in-network processing:

- pre-process a data stream (filtering, dimensionality reduction, etc.)
- refine model parameters using the new observation
- incorporate results of neighbouring sensors to enhance the model
- make data transmission decisions based on result

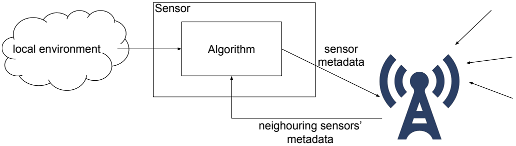
Examples: weather prediction, crime prediction, predictive maintenance

Algorithms: Classical

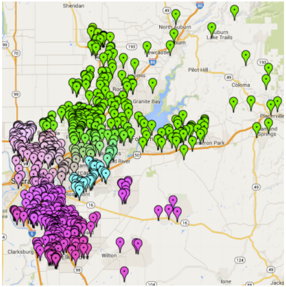
- Thresholding
- Averaging
- Filter banks: Decompose a data stream into multiple frequency bands
- Recursive least squares: incorporate new data to refine a linear model
- Kalman filtering: track the state of a dynamical system

Algorithms: State-of-the-art

Network-enhanced analytics:



- clusters naturally emerge, giving insight into underlying phenomema



Hardware considerations

To fully exploit the benefits of LoRaWAN, your sensor will likely be **battery powered** and **cheap**. Therefore, power consumption balanced with processing power will be your primary consideration.

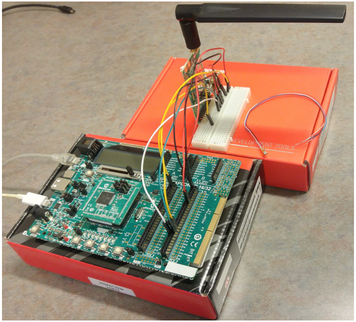
The main hardware components include:

- Microcontroller: respectable computing power with very low current consumption — a lithium-ion battery can power some MCUs for over **10 years**!
  - Most MCUs include the basic peripherals needed to control the transceiver (SPI, UART) and read digital or analog sensors (I2S,SPI,ADC)
- Transceiver: implementing the LoRaWAN protocol. Typical transmit current consumption is 125mA
- Low-power sensor(s)
- High-capacity battery: lithium-ion

CoC/UofC collaboration

Project overview: Design and deploy ≈ 30 acoustic sensors to monitor noise levels and characterize noise sources.

Current status: Working prototype has been designed. PCB design is almost complete. Data analysis and visualization toolbox developed.



Target use cases: Bylaw enforcement (noise pollution), gunshot detection, spatial/temporal modeling, noise reduction.