MATLAB and the Internet of Things (IoT): Collecting and Analysing IoT Data

Gabriele Bunkheila
Technical Marketing, MathWorks
What is the Internet of Things?
A popular IoT story
What is the Internet of Things?

- **Data Aggregator**
  - Deploy analytics to aggregator

- **Edge Nodes**
  - Deploy algorithms to nodes/devices

- **Exploratory Analysis**
NOT covered in this session
Agenda

- Two all-in-MATLAB IoT examples
- Scaling up MATLAB to IoT – the whole picture
Example 1: Monitoring Weather

Objectives
- Measure, explore, discover weather patterns
- Provide niche weather service

Solution
- Arduino station with weather sensors
- Cloud-based aggregation and analysis
- Full example available at makerzone.mathworks.com
Example 2: Monitoring Traffic

Objectives
- Measure, explore, discover traffic patterns
- Provide live local traffic information service

Solution
- RaspberryPi + webcam
- Automated deployment of vision algorithms on embedded sensor
- Full example available at makerzone.mathworks.com
Traffic sensor – step 1
Design a car counter in Simulink
Traffic sensor – step 2
Port it to Raspberry Pi

(Recorded Video)
IoT Solutions Examples

- Exploratory Analysis
  - Historical analytics
  - Algorithm development
Customer Study: BuildingIQ

Predictive Energy Optimization

Opportunity
• **Real-time, cloud-based system** for commercial building owners to reduce energy consumption of HVAC operation

Analytics Use
• **Data:** 3 to 12 months of data from power meters, thermometers, and pressure sensors, as well as weather and energy cost, comprising billions of data points
• **Machine learning:** SVM regression, Gaussian mixture models, k-means clustering
• **Optimization:** multi-objective, constrained

Benefit
• Typical energy consumption reduced 15-25%
Customer Study: BuildingIQ
Predictive Energy Optimization

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MATLAB EXPO 2015
UNITED KINGDOM
Customer Study: iSonea

Cloud and Embedded Analytics

Opportunity
• Develop an acoustic respiratory monitoring system for wheeze detection and asthma management

Analytics in cloud and embedded
• Captures 30 seconds of windpipe sound and processes the data locally to clean up and reduce ambient noise
• Invokes spectral processing and pattern-detection analytics for wheeze detection on iSonea server in the cloud
• Provides feedback to the patient on their smartphone

Benefit
• Eliminates error-prone self-reporting and visits to the doctor
Customer Study: iSonea

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Signal Processing and Machine Learning Techniques for Sensor Data Analytics (Webinar)
MATLAB & Simulink Capabilities for IoT

Physical Component Modeling
- Electronic
- Mechanical
- Hydraulic, etc.

Communications Protocol Modeling
- LTE, Zigbee, 802.11, etc.

Automatic Code Generation
- Programmable chips (MCU, DSP, etc.)
- FPGAs

Verification/Validation and Process Support
- Model- and Code proving
- Lifecycle management tools

Deployment
- .NET, COM components
- Java components
- Multicore and GPU systems
- Spreadsheet plug-ins
- Database plug-ins
- Hadoop
- Cloud services (AWS)
- ThingSpeak Apps
- Smartphone/tablet integration

Communication Protocol Modeling
- LTE, Zigbee, 802.11, etc.

File I/O
- Text
- Spreadsheet
- XML
- CDF/HDF
- Image
- Audio
- Video
- Geospatial
- Web content

Real-Time Sources
- Sensors
- GPS
- Instrumentation
- Cameras
- Communication systems
- Machines:
  - embedded systems
  - fieldbus
- Financial datafeeds

Analysis, Modeling, Design
- Data visualization
- Statistics
- Regression
- Machine learning (supervised & unsupervised)
- Neural networks
- Optimization (gradient-based & stochastic)
- Symbolic computing
- Image analysis
- Financial analysis
- Geospatial computing
- Object recognition
- Speech recognition

Repositories
- Databases (SQL)
- NoSQL
- Hadoop

Repositories
- CAN
- DDS
- OPC
- XCP

Data Clean-up
- Filtering
- Image processing
- Signal processing
- Telemetry
- RF sampling

Communication Protocols
- CAN
- DDS
- OPC
- XCP
Summary

- Develop lightweight IoT systems entirely in MATLAB
- Integrate MATLAB algorithms within professional IoT systems