TECHSOURCE
Dynamic Solutions Precise Results

Track Breakout Sessions (Time: 14.30 - 15.30)

TIME/TOPIC	DATA ANALYTIC (ROOM 324)	DESIGN AUTOMATION (ROOM 325)	ACADEMIA (ROOM 326)	COMPUTIONAL FINANCE (ROOM 327)
Time: 14.30	Developing IoT Applications with MATLAB & SimuLink	ADAS algorithm design and prototyping using MATLAB: Sensor fusion example	How a Differential Equation Becomes a Robot	Advanced Portfolio Construction (Smart Beta and Stock Selection models)
Time: 15.30	Predictive Maintenance with MATLAB – A Machine Learning Case Study	Robotics Algorithm Design with Robotics System Toolbox	Part 1: Mechanical and Electrical Systems Modelling Part 2: IoT-based Monitoring and Control Applications	Part1: MacroEconomic Stress Testing Part 2: Fixed Income Analytics (price and analyze fixed income securities)

TECHSOURCE
Dynamic Solutions Precise Results

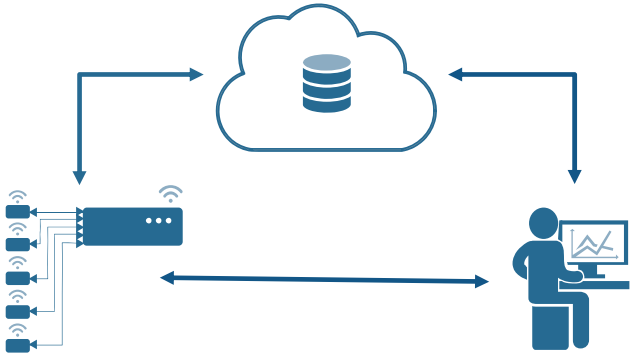
Developing IoT Applications with MATLAB & Simulink

Yi Wang, Application Engineer Manager at MathWorks

Supported by MathWorks

Southeast Asia's sole distributor of MATLAB® & SIMULINK®

Developing Internet of Things (IoT) Applications with MATLAB and Simulink



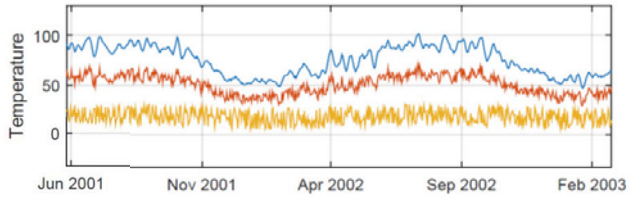
Yi Wang
Application Engineering Manager, MathWorks USA

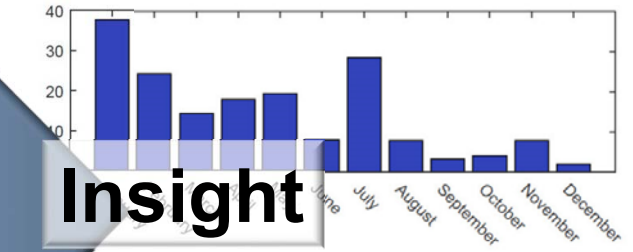
The Challenge of IoT

Devices

?

Insight





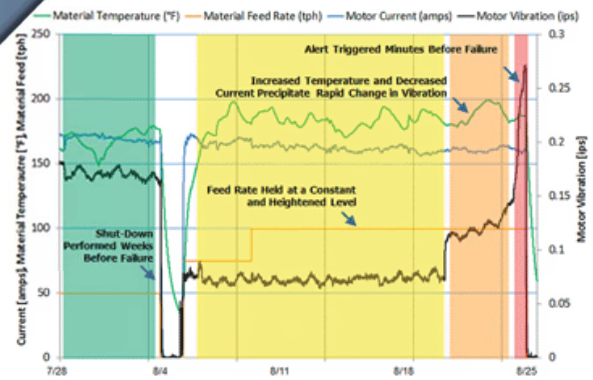
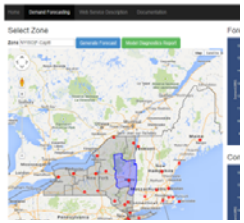


Figure 3. Vibration analysis: Data processed by the company's vibration analysis tool, and leading up to the fan's catastrophic failure, provides an ambiguous indication of the asset's degrading condition.

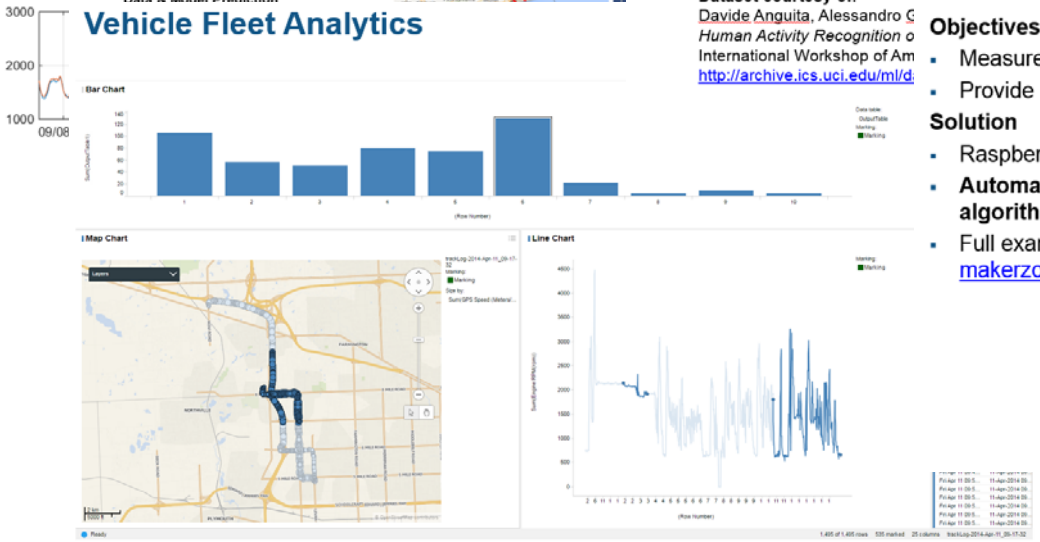
IoT System Examples

Case Study: Day-Ahead Load Forecasting

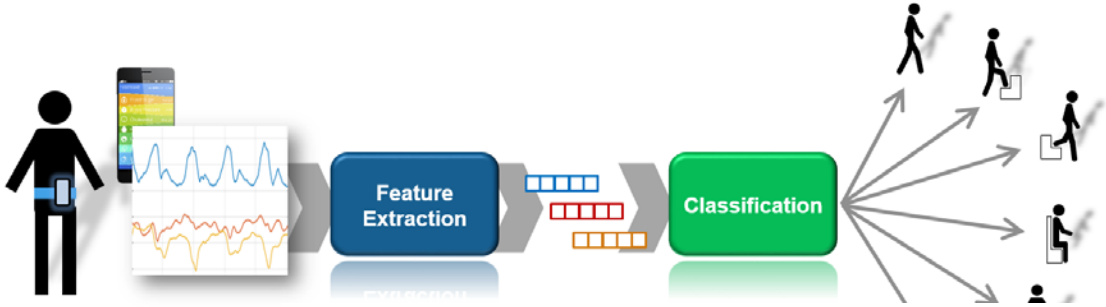
- Goal:
  - Implement a tool for ***easy*** and ***accurate*** computation of ahead system load forecast
- Requirements:
  - Acquire and clean data from multiple sources
  - Accurate predictive model
  - Easily deploy to production environment



Vehicle Fleet Analytics



Case Study: Human Activity Analysis and Classification



Dataset courtesy of:
Davide Anguita, Alessandro G
Human Activity Recognition o
International Workshop of Am
http://archive.ics.uci.edu/ml/d

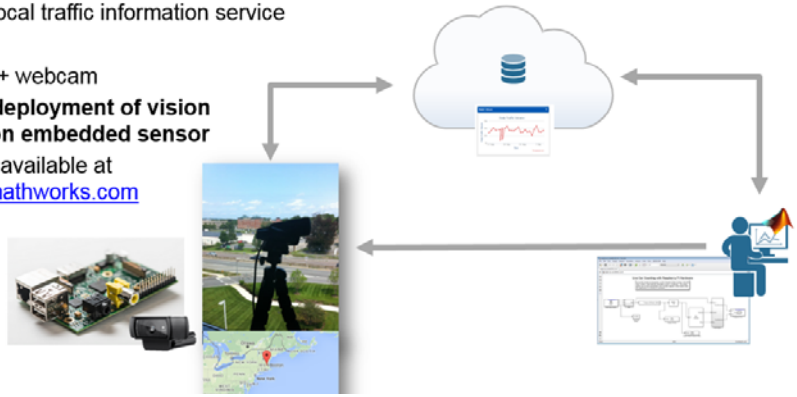
Monitoring Traffic

Objectives

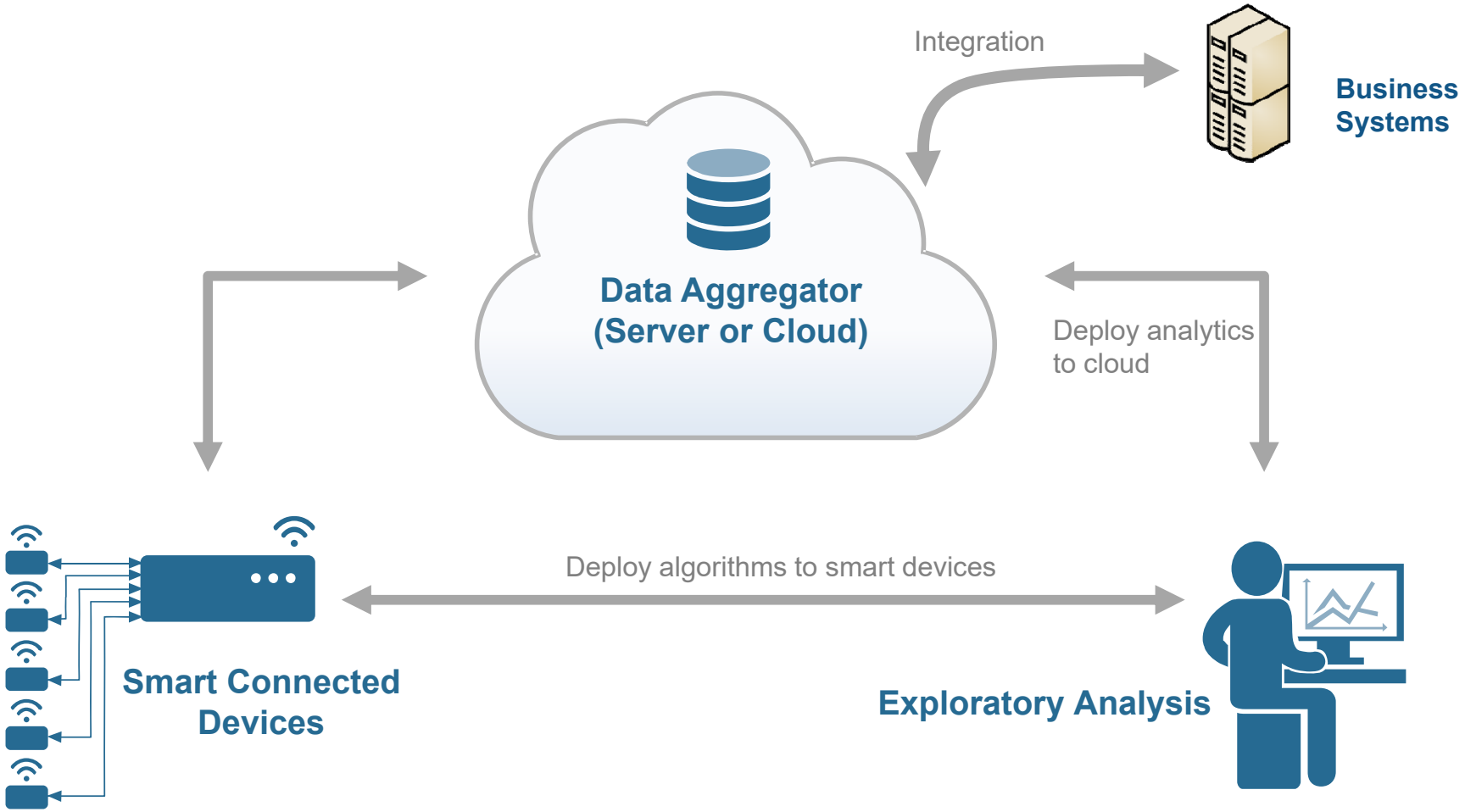
- Measure, explore, discover traffic patterns
- Provide live local traffic information service

Solution

- RaspberryPi + webcam
- **Automated deployment of vision algorithms on embedded sensor**
- Full example available at makerzone.mathworks.com

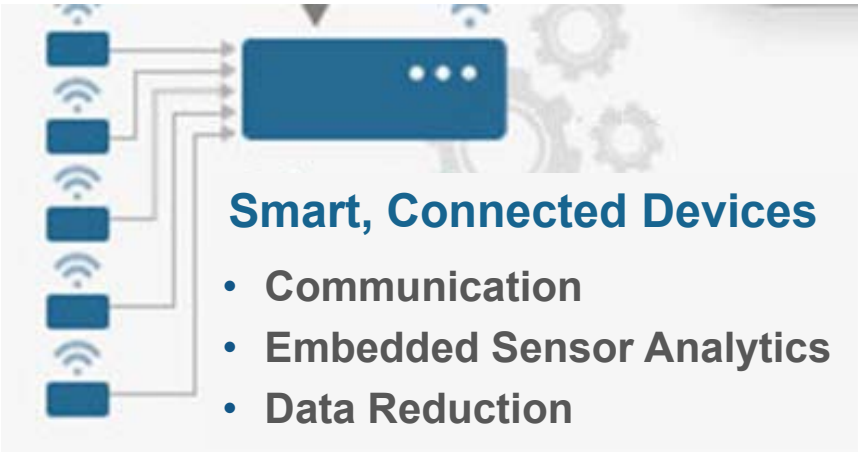


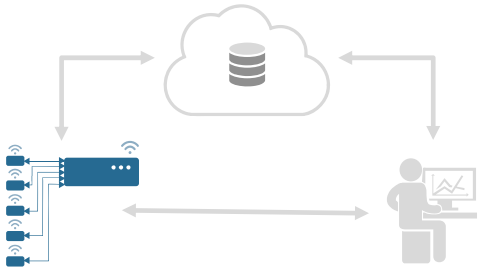
What is the Internet of Things?



Look at the Pieces: Devices

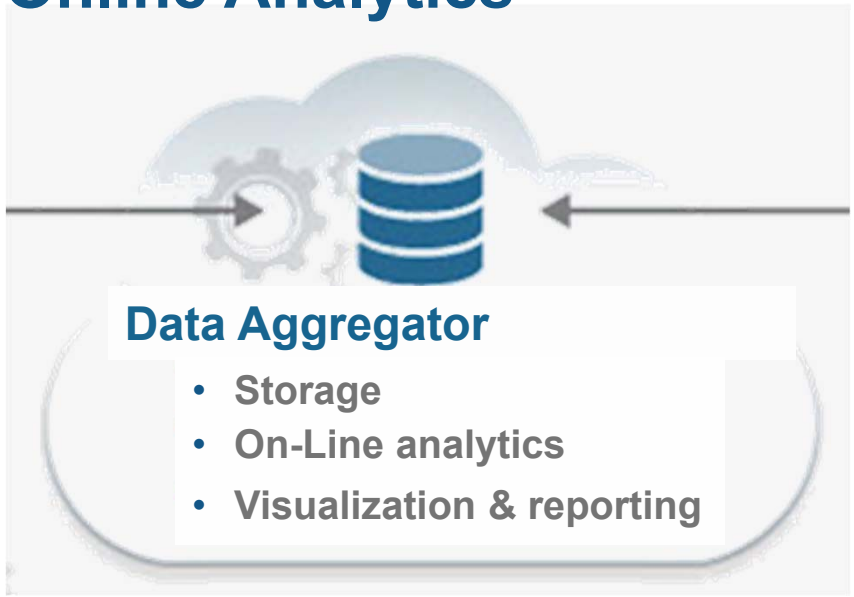
- Sensors and Human Interaction
- May have strict energy budget
- Required embedded programming skills
- Bandwidth is expensive in power and dollars
- Goal for device is to do as much data reduction locally as possible

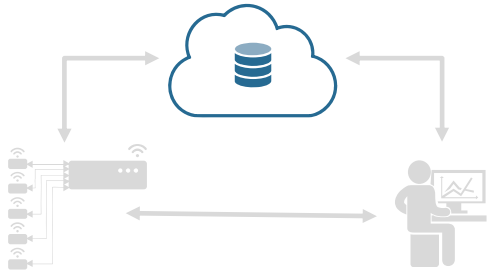




Look at the Pieces: Data Collection & Online Analytics

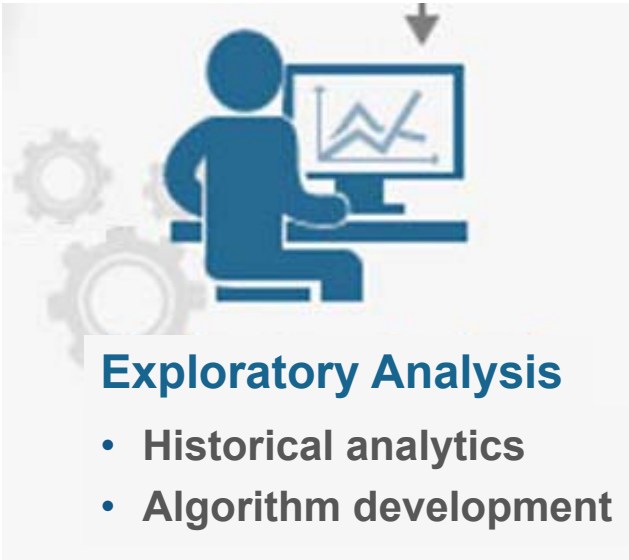
- Server or Cloud-based
- Log and analyze information across collection of devices
- Real-time information for situational awareness
- Requires cloud/web development skills and operations support
- Data Intake must be scalable and reliable
- True “Big Data”

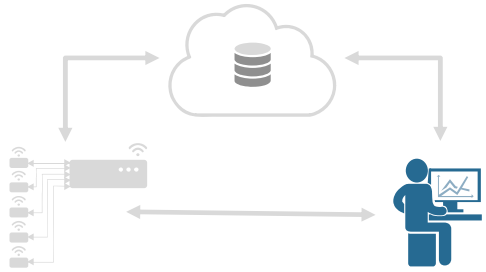




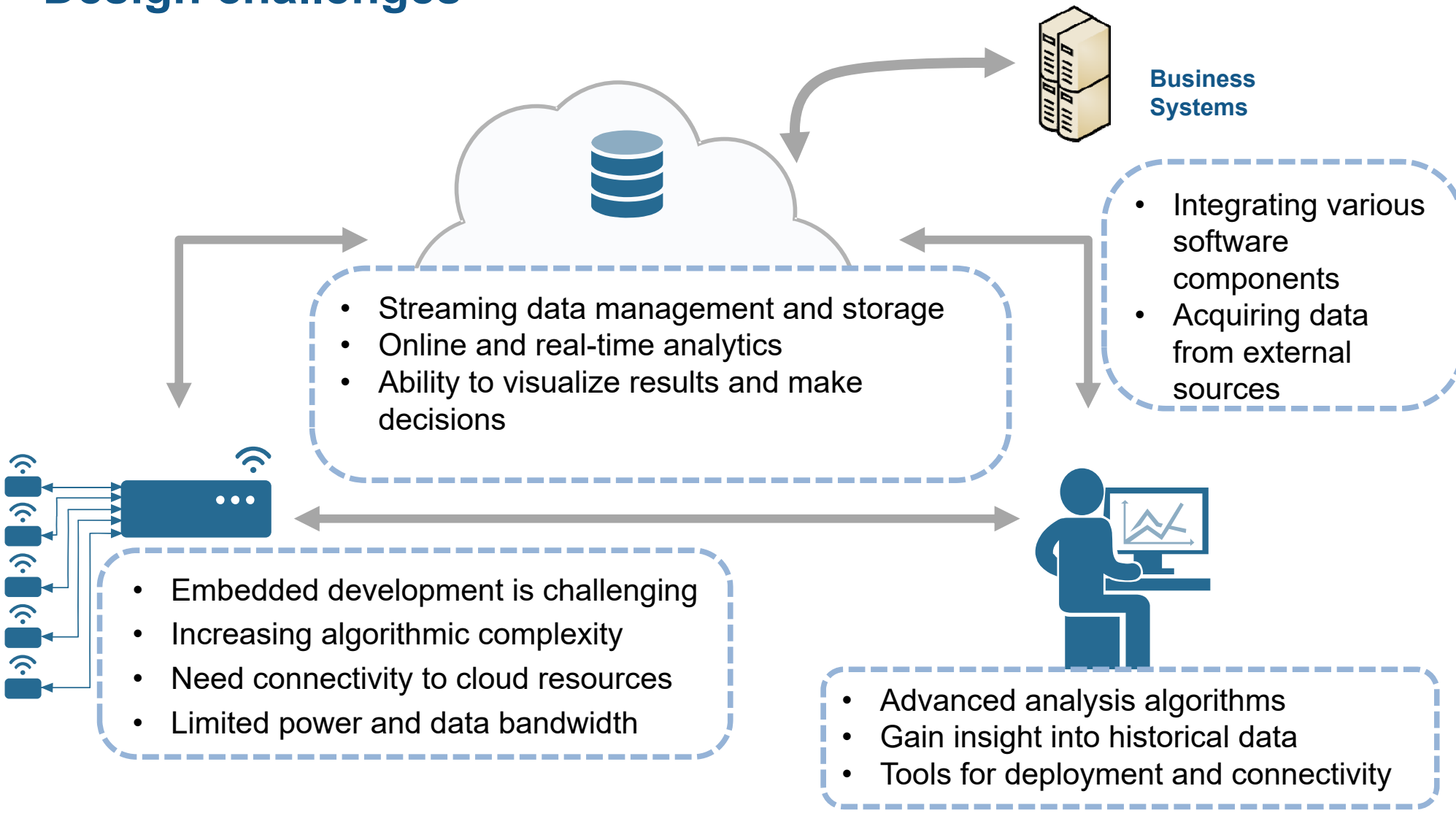
Look at the Pieces: Exploratory Analysis

- Desktop-based
- Access historical device information
- Analyze past performance for predictive modeling and deep insight
- Requires data analysis / data science skills
- Heavy use of statistics and signal processing techniques
- **Deploy complex algorithms to both cloud and edge devices**





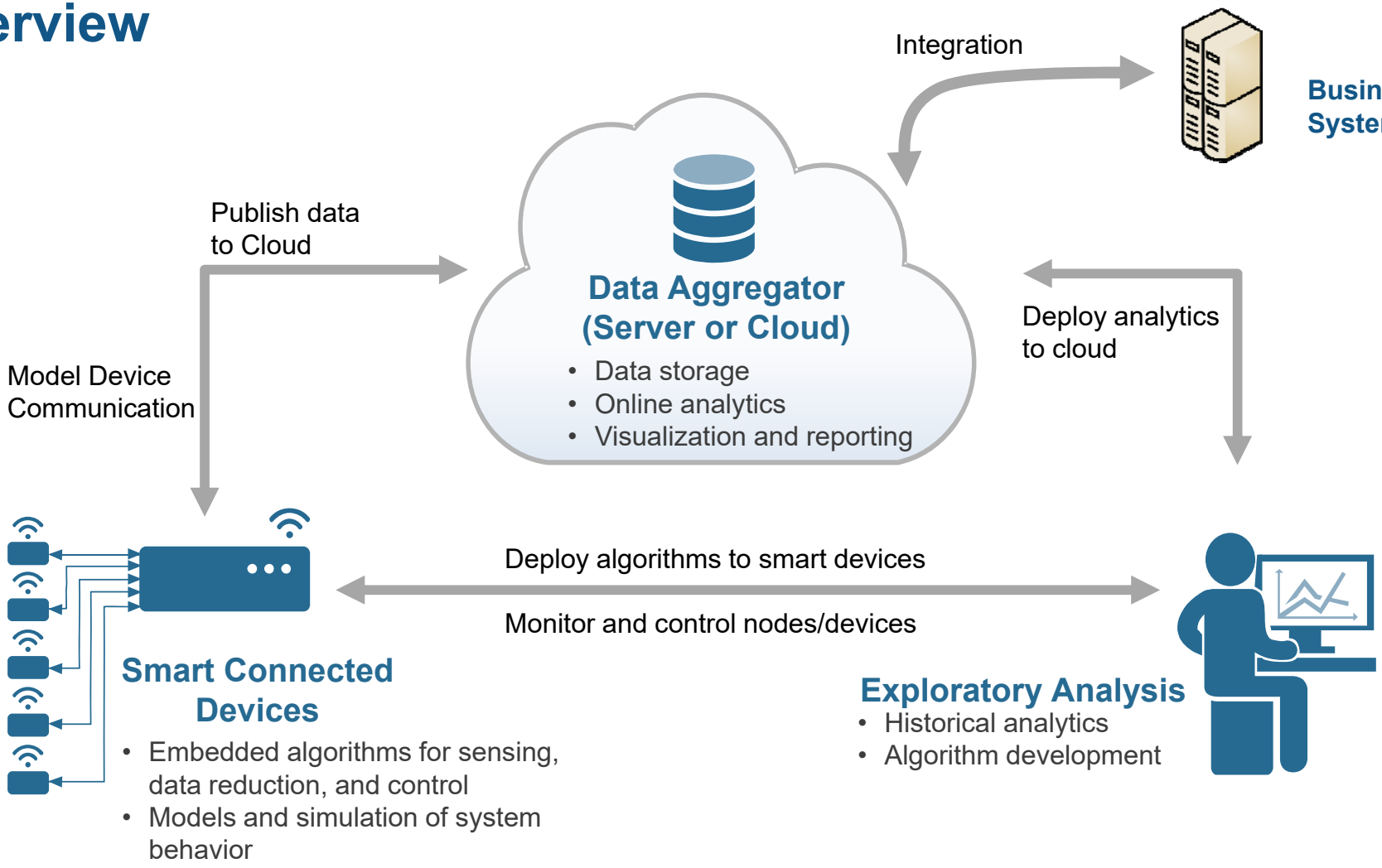
IoT – Design challenges



MathWorks Capabilities for IoT

Leveraging MATLAB Analytics and Model-Based Design

Overview



MathWorks Provides Capabilities for All of these Steps

MATLAB & Simulink Capabilities for IoT

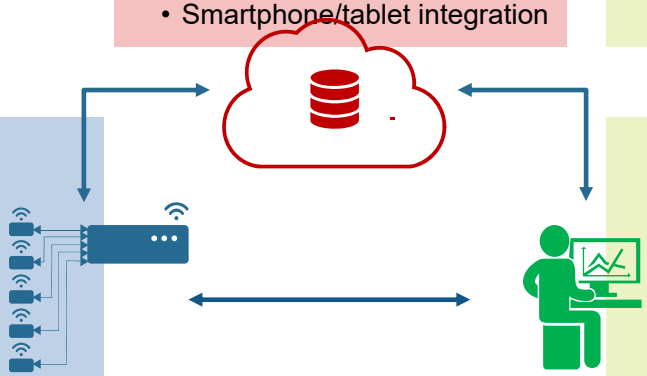
Deployment
- .NET, COM components
- Java components
- Multicore and GPU systems
- Spreadsheet plug-ins
- Database plug-ins
- Hadoop
- Cloud services (AWS)
- ThingSpeak Apps
- Smartphone/tablet integration

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

Repositories
- Databases (SQL)
- NoSQL
- Hadoop

Communication Protocols
- CAN
- DDS
- OPC
- XCP



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

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

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

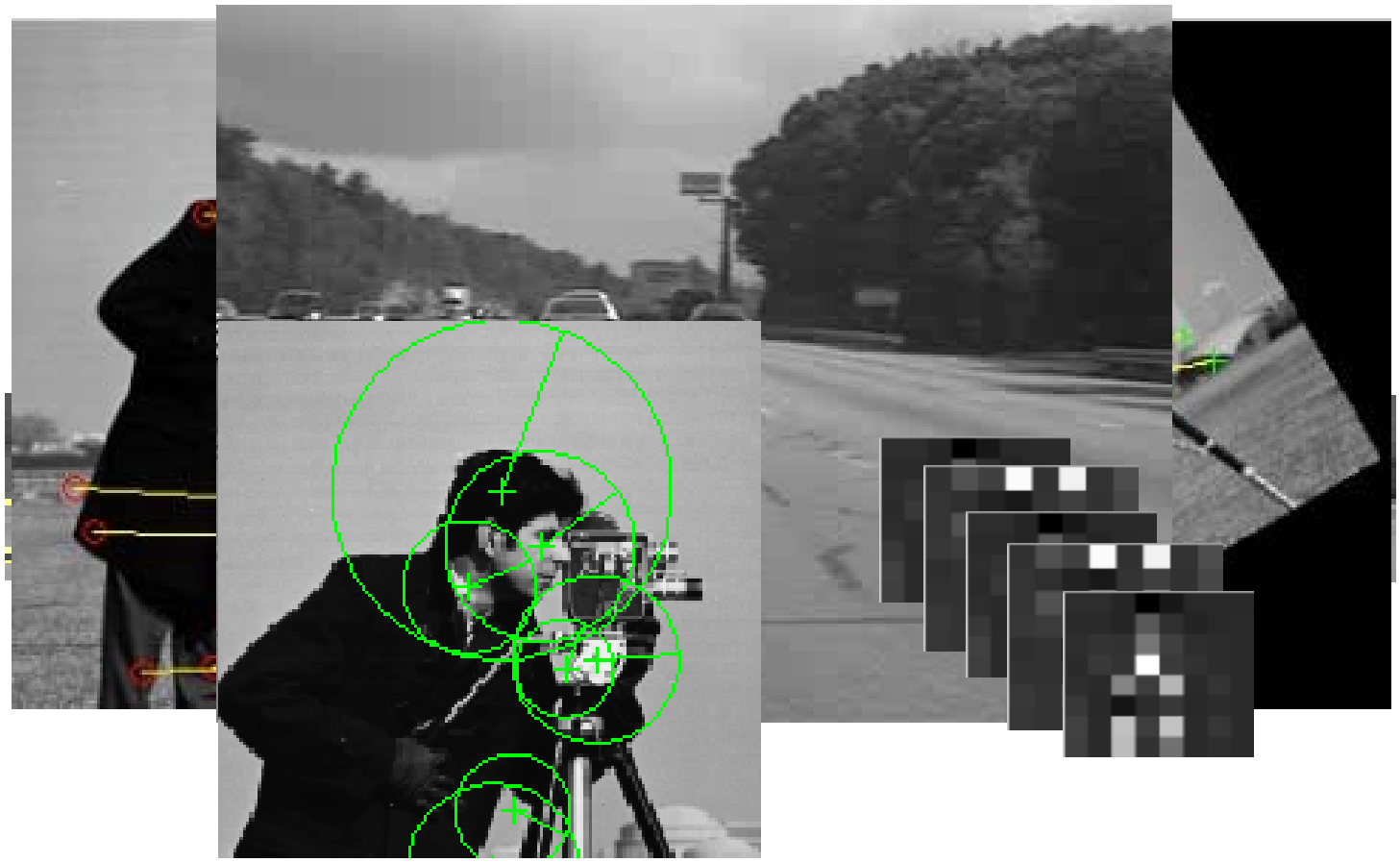
Verification/Validation and Process Support
- Model- and Code proving
- Lifecycle management tools

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

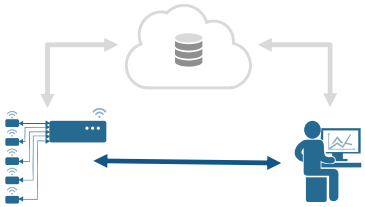
Analysis, Modeling, Design
- Data visualization
- Statistics
- Regression
- Machine learning (supervised &unsupervised)
- Neural networks
- Optimization (gradient-based & stochastic)
- Symbolic computing
- Image analysis
- Financial analysis
- Geospatial computing
- Object recognition
- Speech recognition

Sensor Analytics for IoT

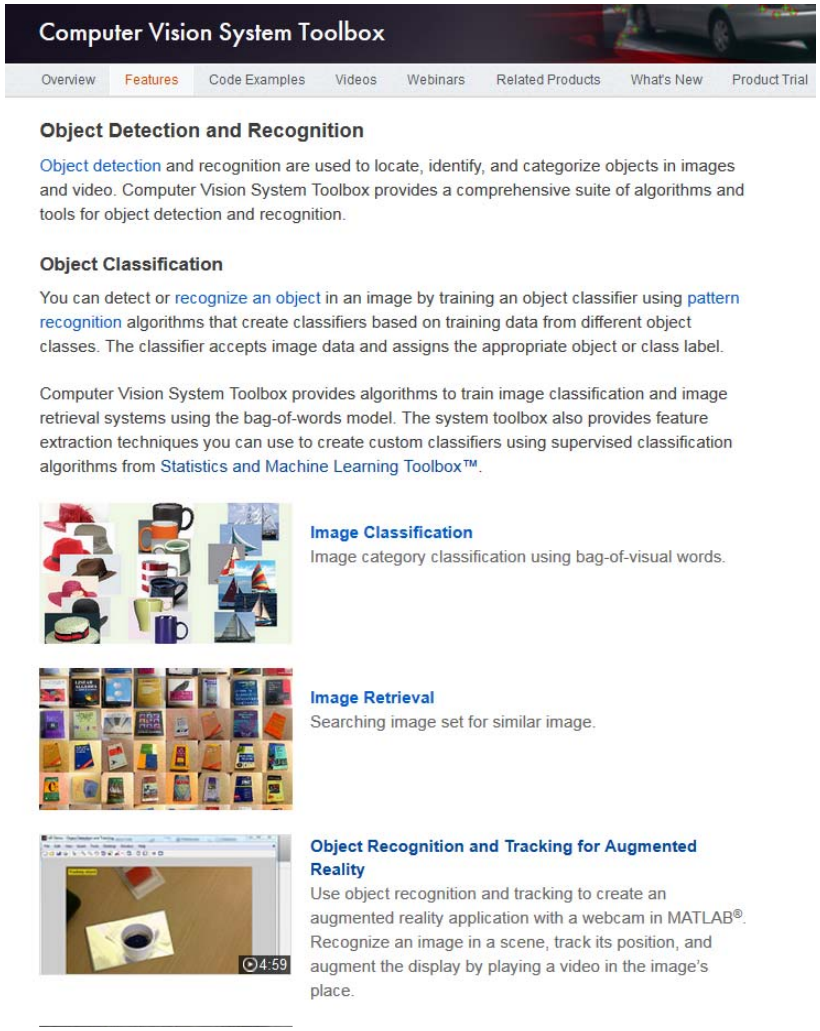
Computer Vision is all about analyzing and understanding images at a higher level



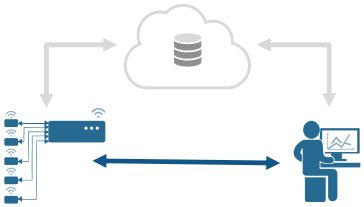
Computer Vision for Sensor Analytics

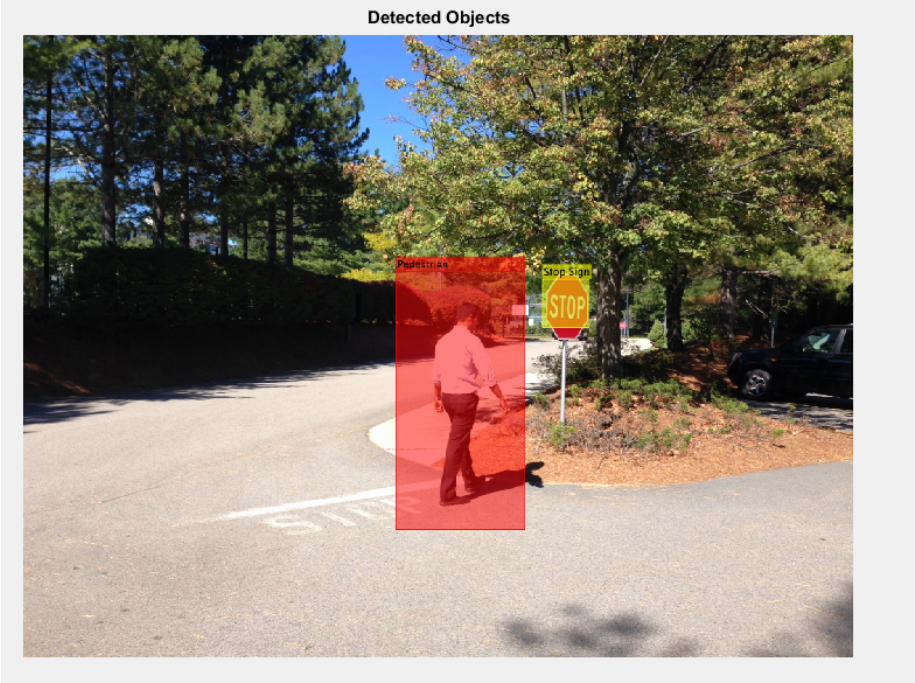


- Data reduction is the key!
- Typical image capture data rate:
  - 640 x 480 resolution, 30 FPS
  - 1-2 MB/sec *(compressed)*
- With object detection/recognition
  - Example: Traffic monitoring
  - 10-20 KB/min *(object counts)*



Object Detection with MATLAB

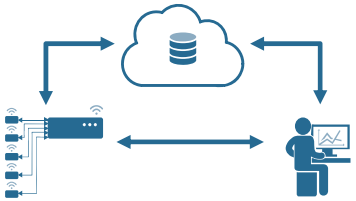




Multiple approaches available:

1. Feature detection, extraction and matching
2. Pre-trained models
3. Out-of-the box frameworks
4. Design and construct custom detector

IoT Example: Monitoring Traffic



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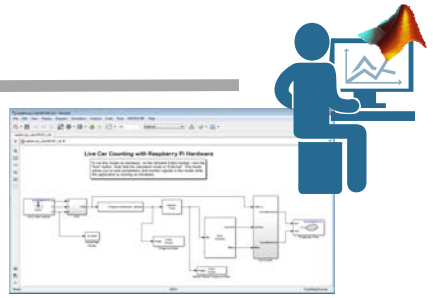
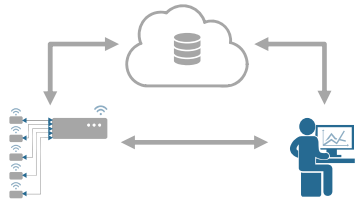
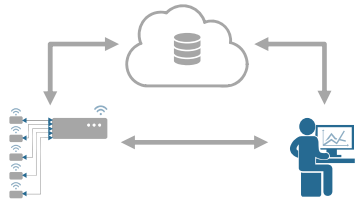


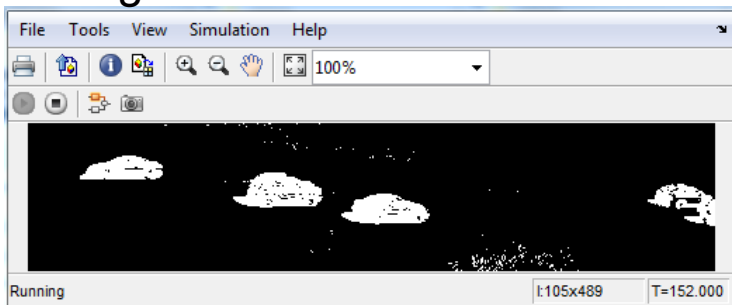
Car Counter Setup



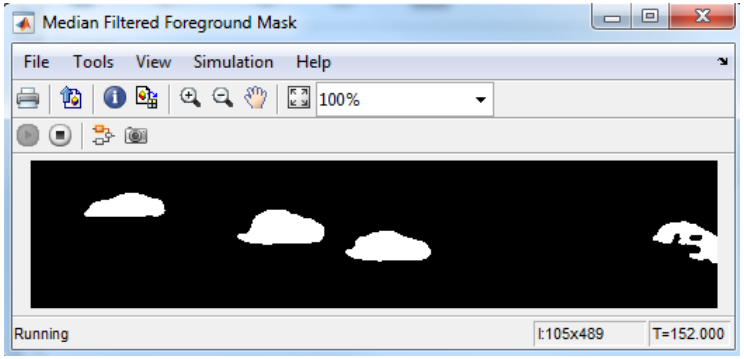
Detecting Cars

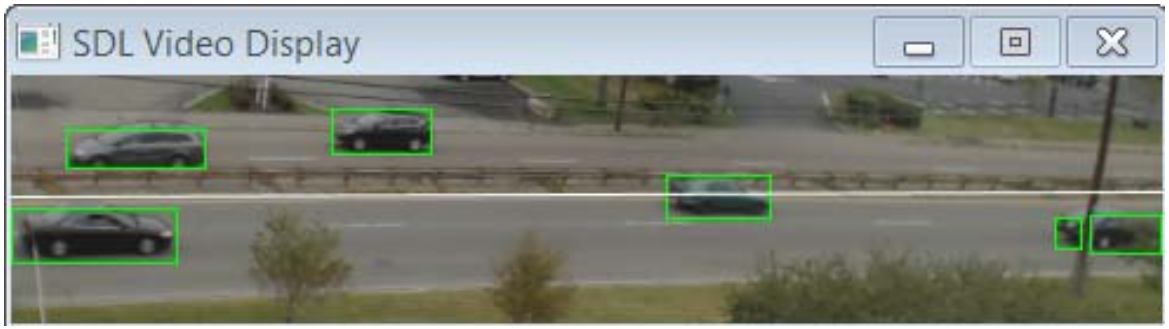


Foreground Mask



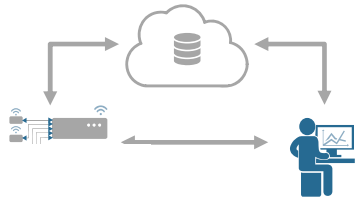
Filtered Foreground Mask

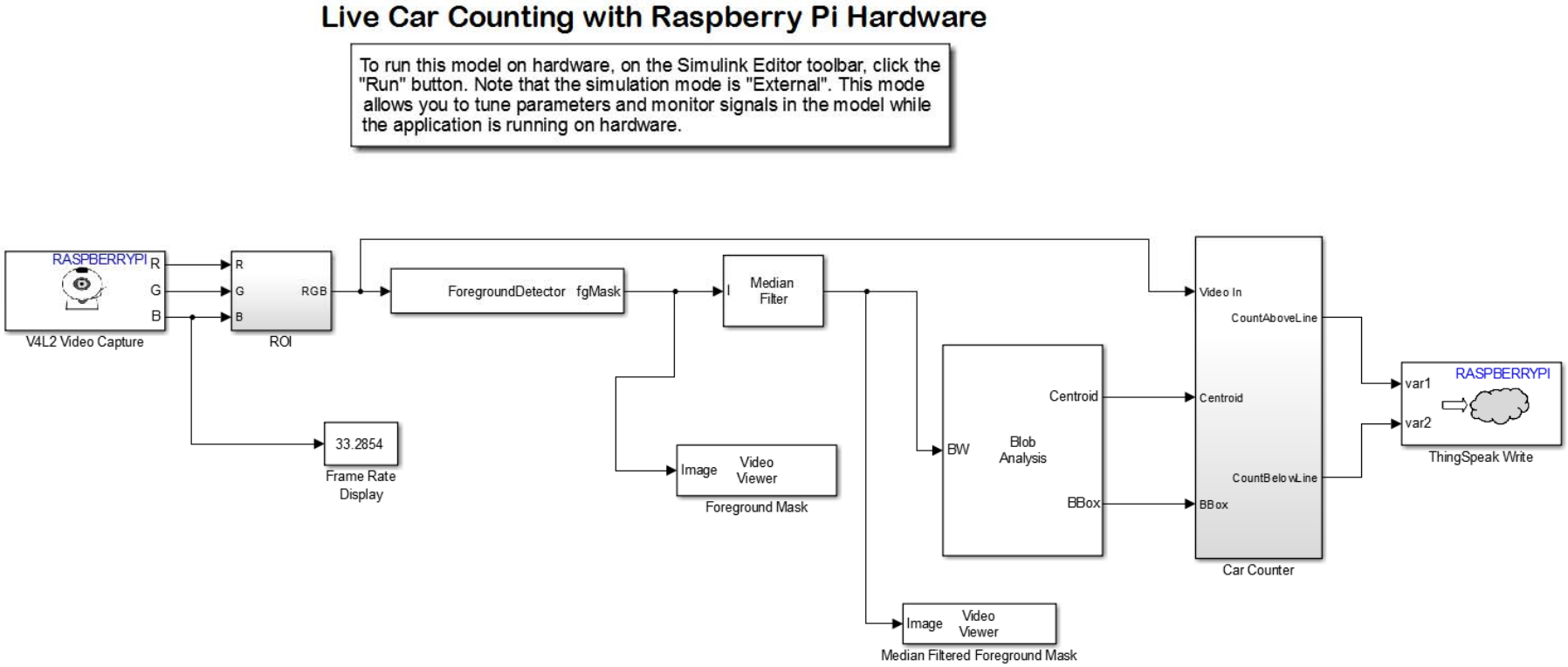




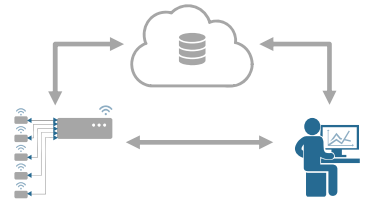
[Link to ThingSpeak Channel]

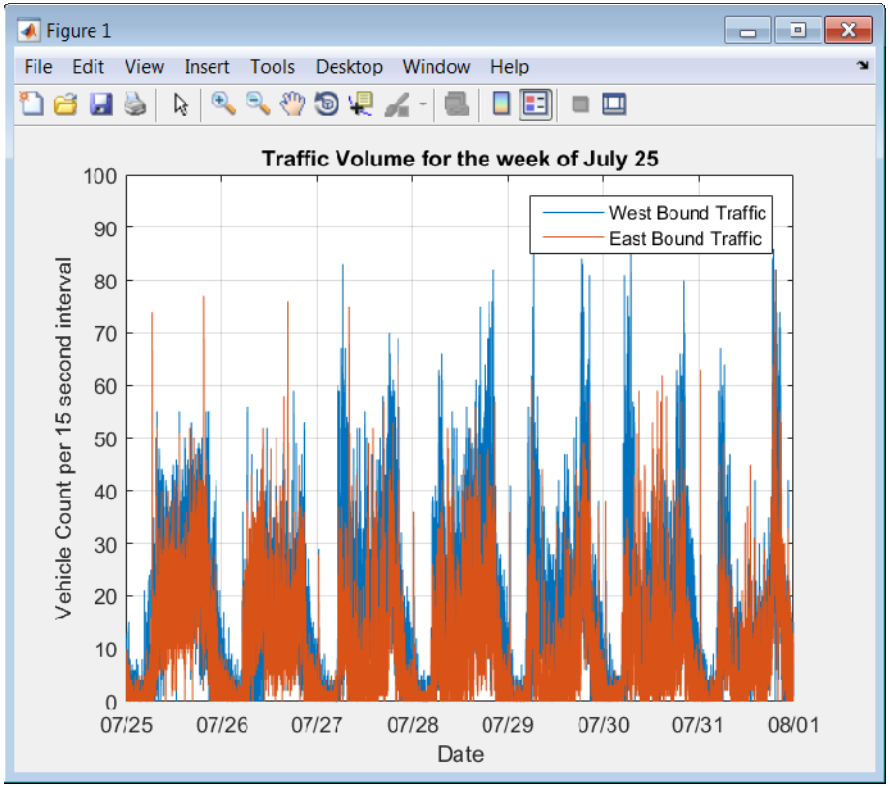
Car Counting Algorithm

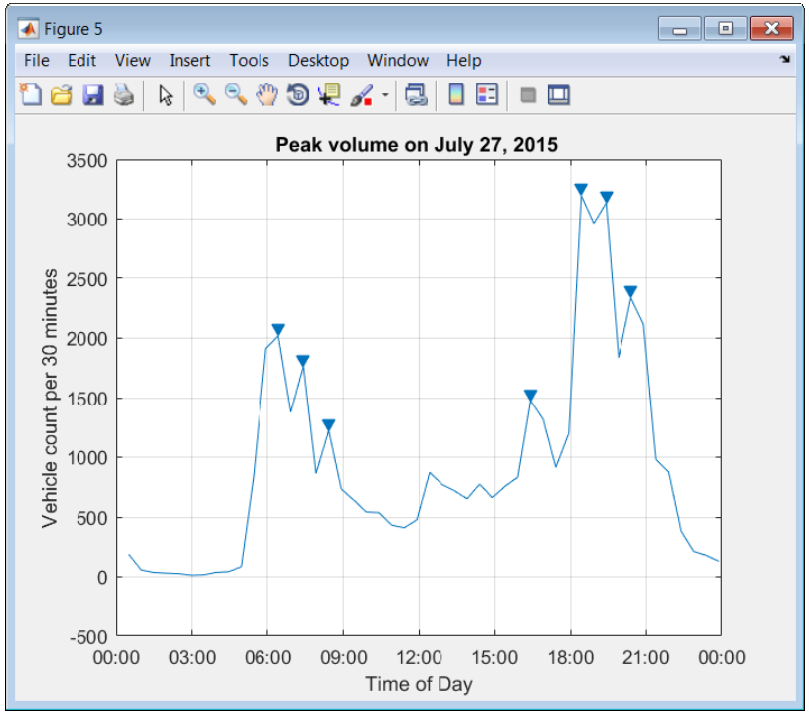




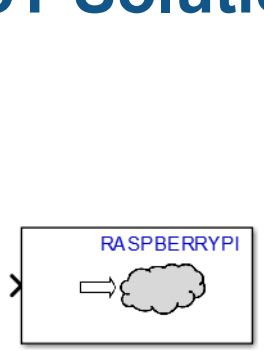
Analyzing Data from ThingSpeak In MATLAB

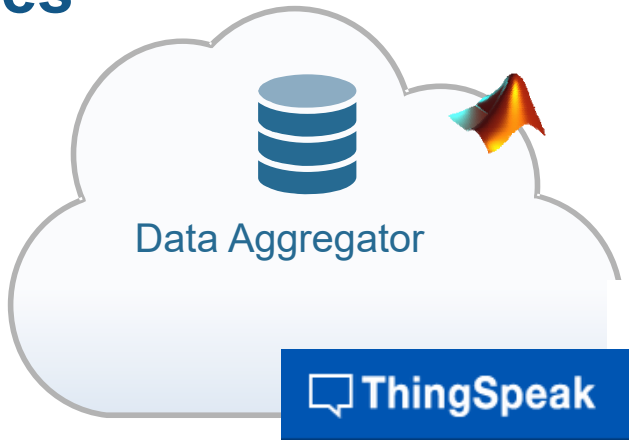






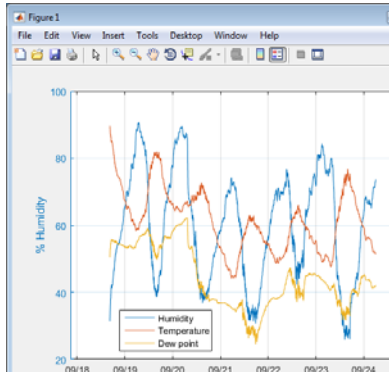
IoT Solutions Examples





Analyze

Analyze and visualize your data.

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thingSpeakRead(12397,'
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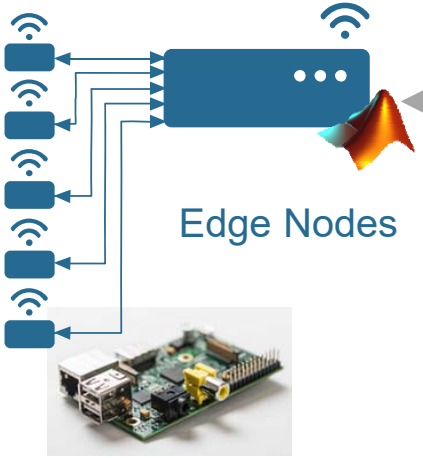
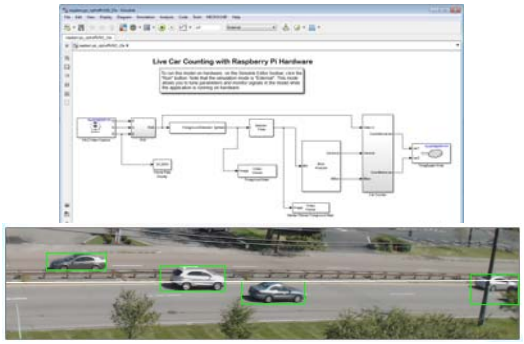


Edge Nodes

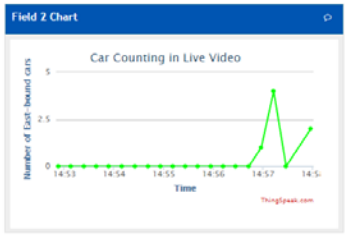


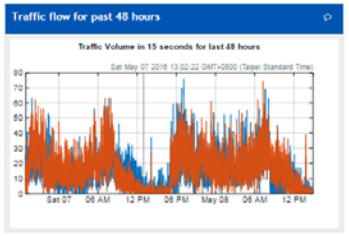
Exploratory Analysis

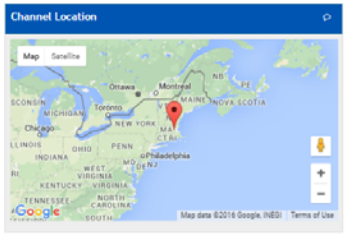
- Historical analytics
- Algorithm development

Key Takeaways

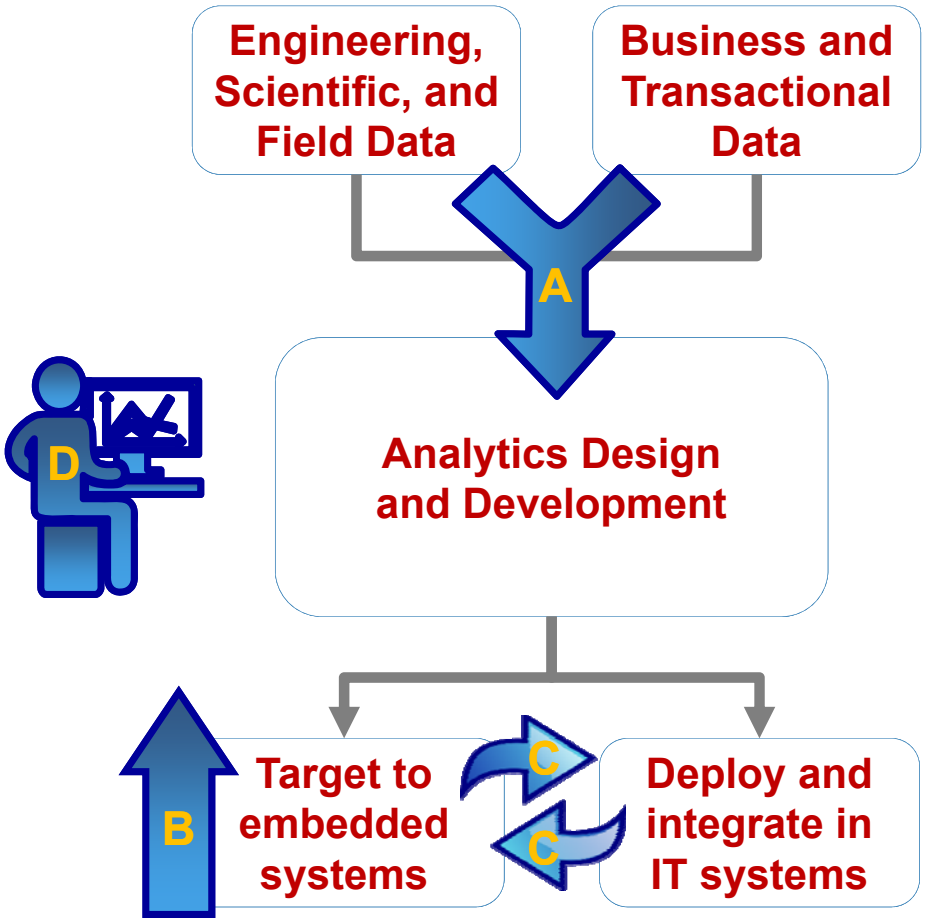
- Data reduction through computer vision
- Custom object detection and recognition methods
- Algorithm implementation on edge device
- Efficient data transfer to backend aggregator







Why MATLAB?



MATLAB and Simulink are well positioned for:

A. Analytics that increasingly require **both business and engineering data**

B. Developing **embedded systems** which have increasing analytic content

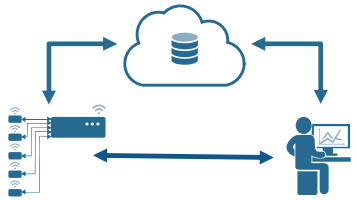
C. Deploying the increasing number of analytic-rich applications that run on **both traditional IT and embedded platforms**

D. Enabling **domain experts** to do **data science**

Customer Case Study

Customer Study: iSonea

Cloud and Embedded Analytics



iSonea

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

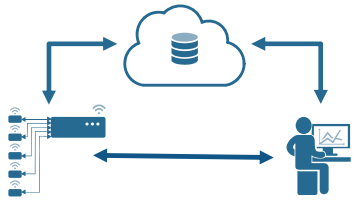
Benefit

- Eliminates error-prone self-reporting and visits to the doctor

http://www.mathworks.com/company/user_stories/isonea-develops-mobile-app-for-wheeze-detection-and-asthma-management.html

Customer Study: iSonea

Cloud and Embedded Analytics

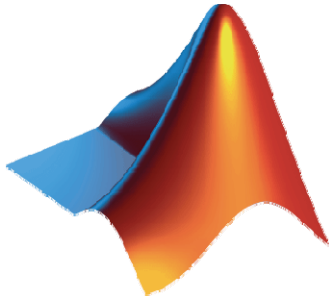


Opportunity

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

Spectral processing and pattern-detection analytics for wheeze detection

Windpipe sound capture and processing to clean up and reduce ambient noise



TECHSOURCE
Dynamic Solutions Precise Results

Quick Break (5 Minutes)

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