



# ee392b

# Industrial IoT: Applications

# Overview

April 2, 2019

Dimitry Gorinevsky  
[www.stanford.edu/~gorin](http://www.stanford.edu/~gorin)

# Outline

- Why the IIoT?
- Class subject
- IIoT computing
- IIoT applications
- Syllabus

IIoT Class Overview

# WHAT IS INDUSTRIAL IOT?

# IoP and IoT

## **Internet Revolution**

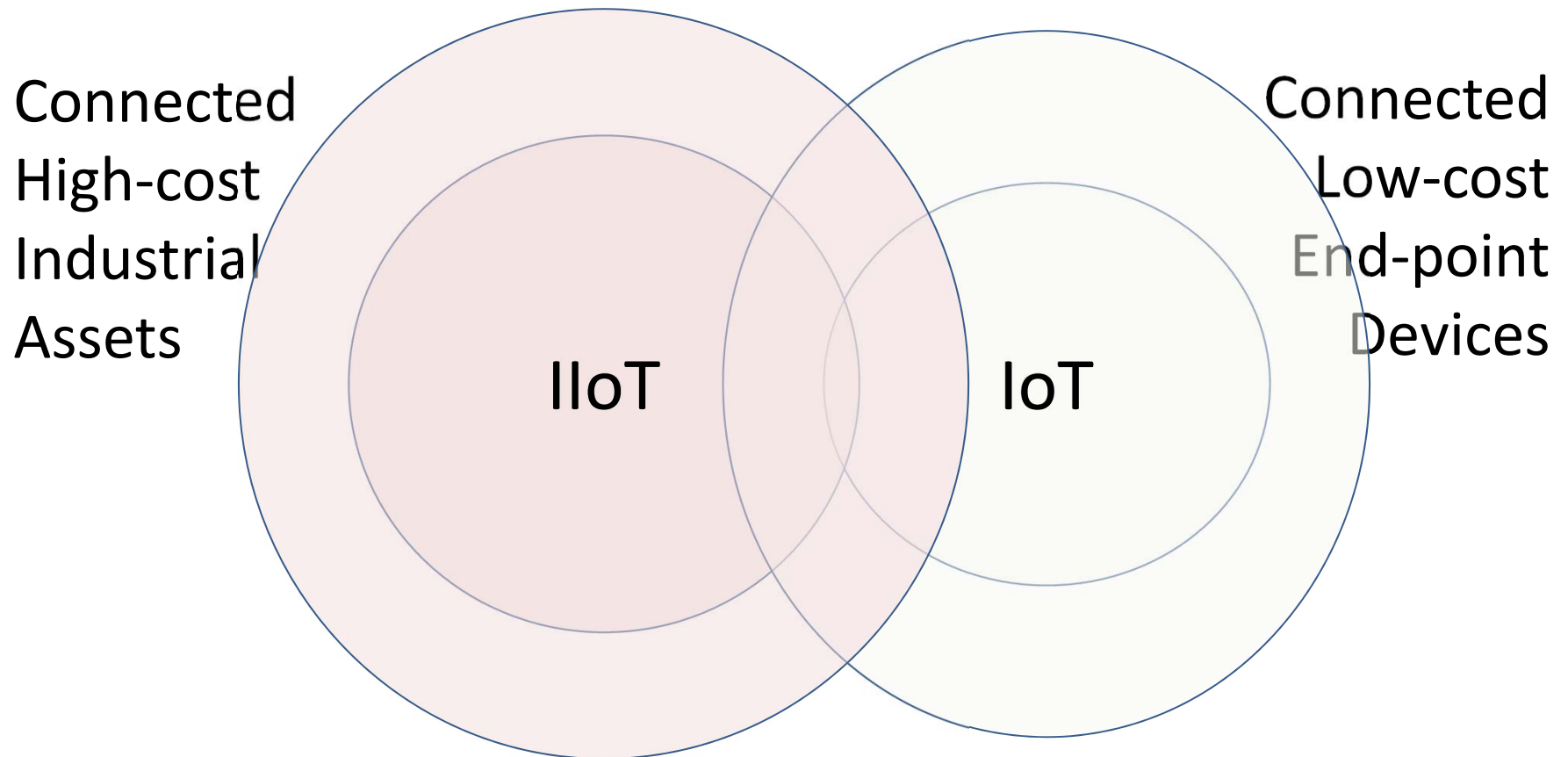
- 10-15% of economy
- Internet of People (IoP)

## **New Digital Revolution**

- 80% of the economy
- Internet of Things (IoT)
- Industrial IoT (IIoT)

# IIoT and IoT

IIoT  $\neq$  IoT



IIoT Class Overview

# **NEW DIGITAL REVOLUTION**

# New Digital Revolution

- Analyses of the IIoT economic impact

|           | Value           | Date | Comment        |
|-----------|-----------------|------|----------------|
| GE        | \$32.3 Trillion | 2012 | Early estimate |
| Accenture | \$14 Trillion   | 2015 | Consulting     |
| McKinsey  | \$11 Trillion   | 2015 | Consulting     |

## Current Forecasts (2018-2019)

- \$1.2T IoT tech spend; 13.2% per year growth
- \$0.5T IoT market; 28.5% per year growth

# Waves of Change

## 1. The First Industrial Revolution

- Mechanized production; water and steam power

## 2. The Second Industrial Revolution

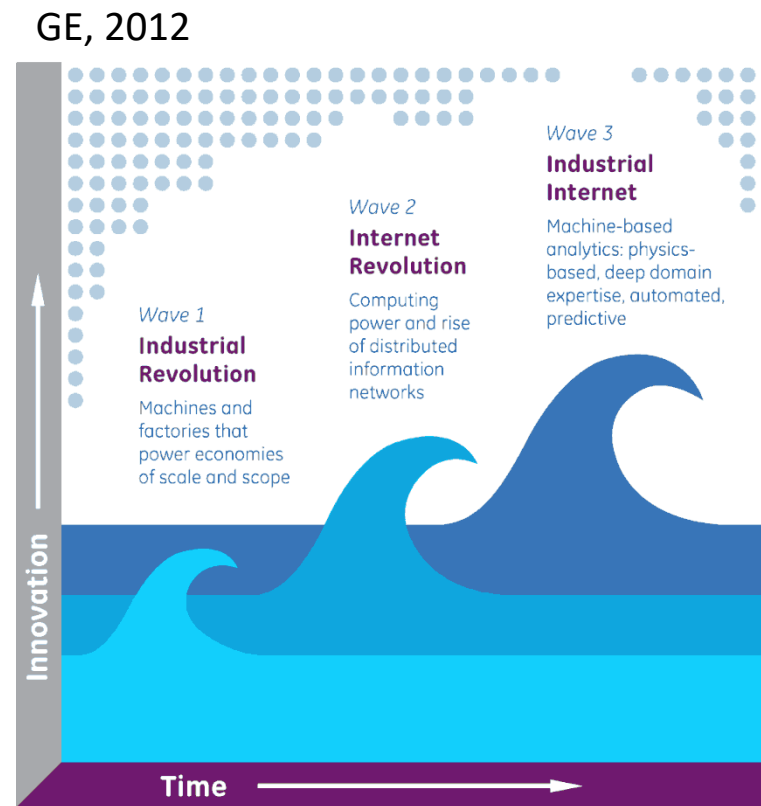
- Mass production; power integration

## 3. Internet Revolution

- Automation; electronics and information technology

## 4. IIoT, the 4<sup>th</sup> Industrial Revolution

- Digital integration



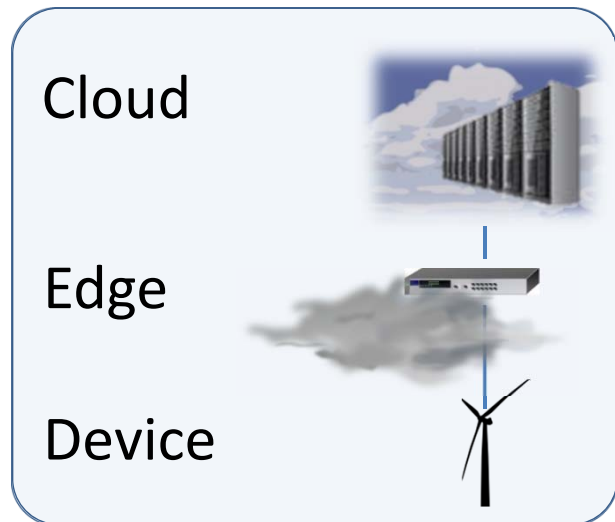


IIoT Class Overview

# **IIOT COMPUTING**

# IT/OT Convergence in the IIoT

## Information Technology



**IT**



**OT**

## Operational Technology

- IT: Enterprise computing. Cloud.

Edge computing. Fog.

- OT: Industrial systems. Secure, closed networks..

# Enterprise Architecture View

Business  
Architecture

Applications  
Architecture

**Added  
Value**

- **Applications**
  - Business processes
  - Data analytics

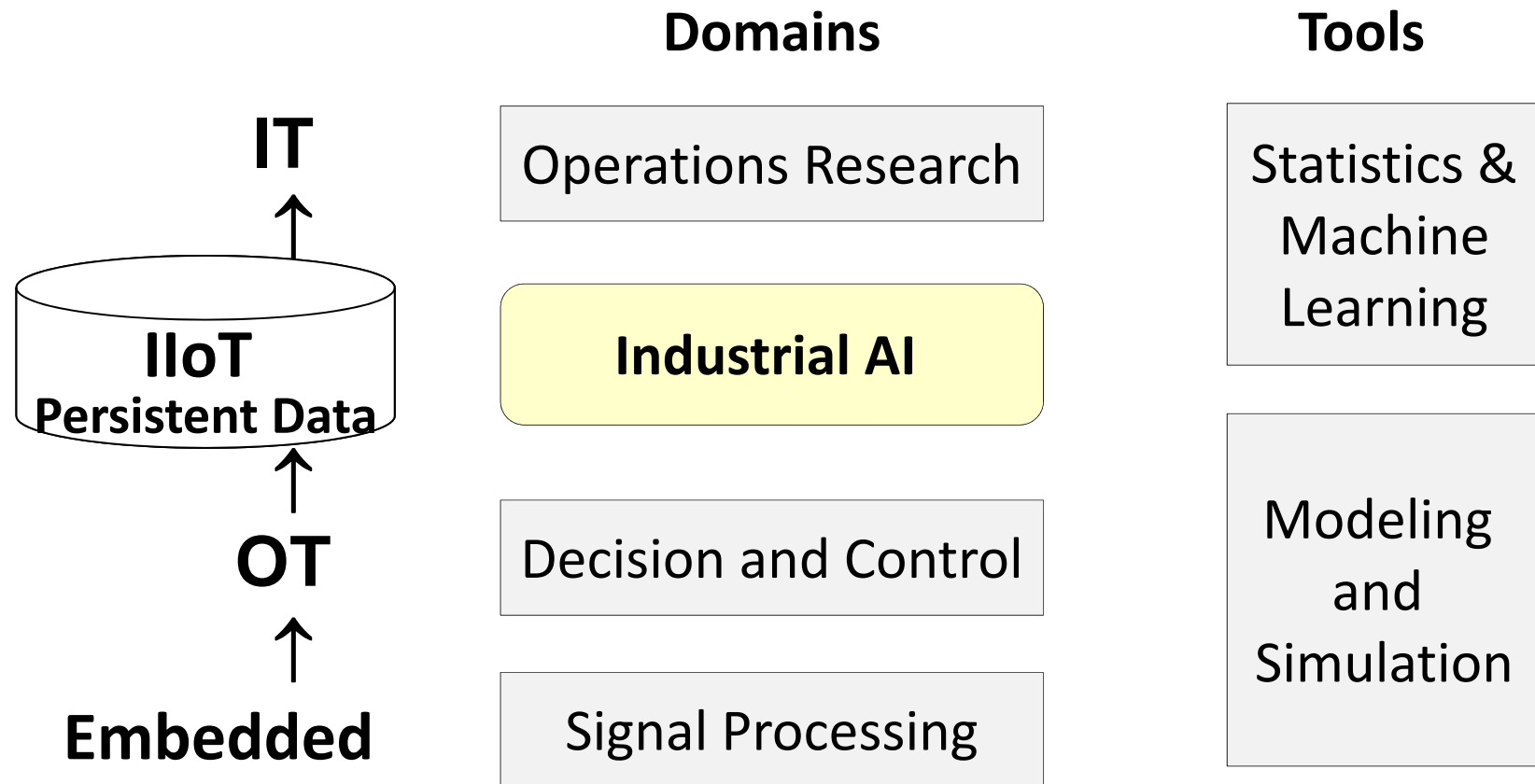
Data  
Architecture

Technology  
Architecture

**Technology  
Investment**

- **Platform**
  - Data management
  - Computing tech
  - Most action, so far

# Analytics Disciplines



# Digital Twin

- Digital Twin is #4 Gartner Top Ten Strategic Technology Trend for 2019, was #4 in 2018
  - Half of all large industrial companies will be using digital twins by 2021
- Industrial AI and Digital Twin
  - Model-based, simulation, verification, and validation
- Example
  - Digital Twin for Maintenance and Logistics

IIoT Class Overview

# **HARDTECH**

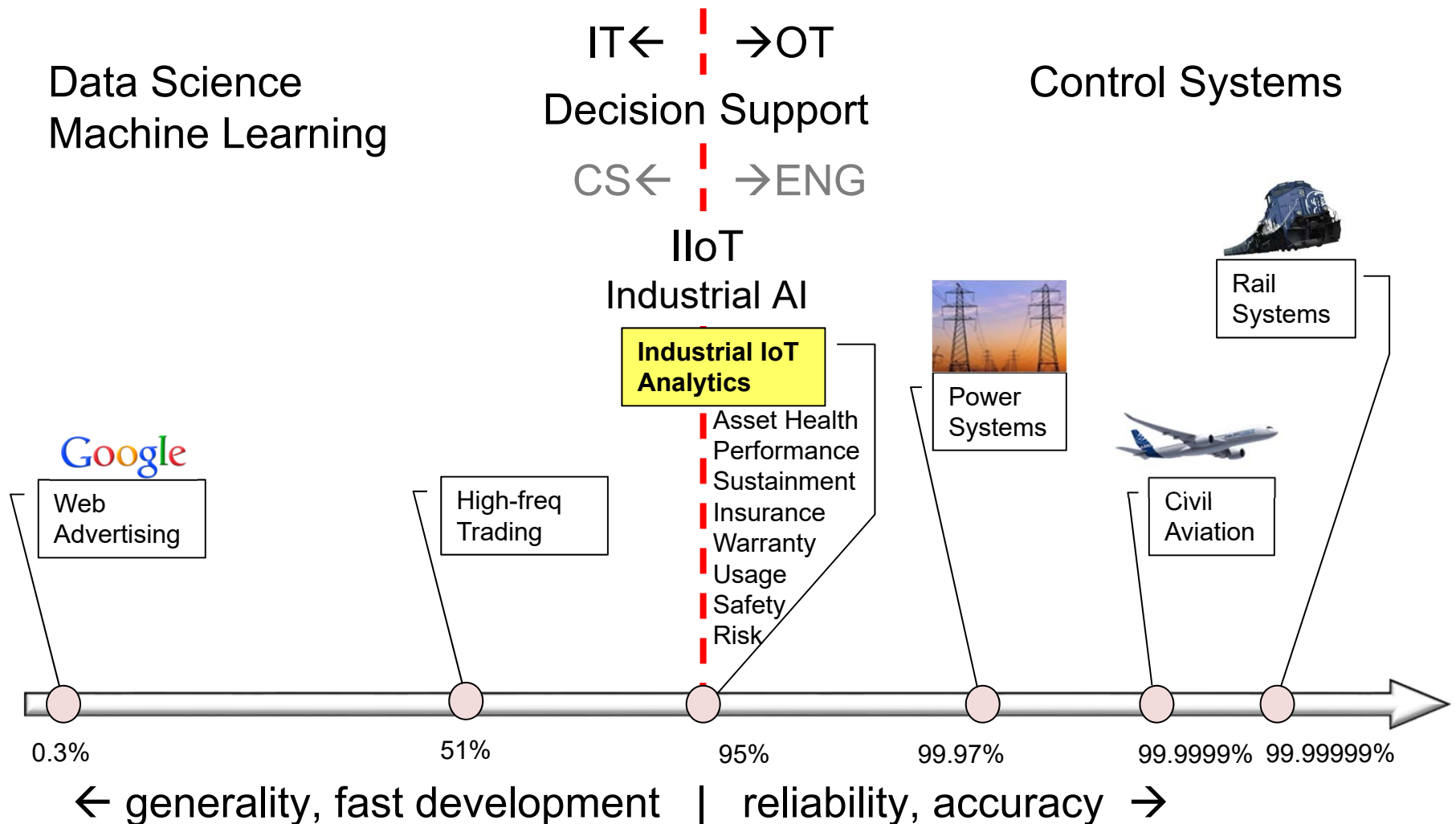
# Aviation Applications

- OT is hard
  - Southwest Airlines, GE engine blow out in 2018
  - Boeing 737 MAX flight control problem in 2019



- Industrial IoT is hard
  - IIoT includes OT

# IIoT and Mission-critical Analytics





IIoT Class Overview

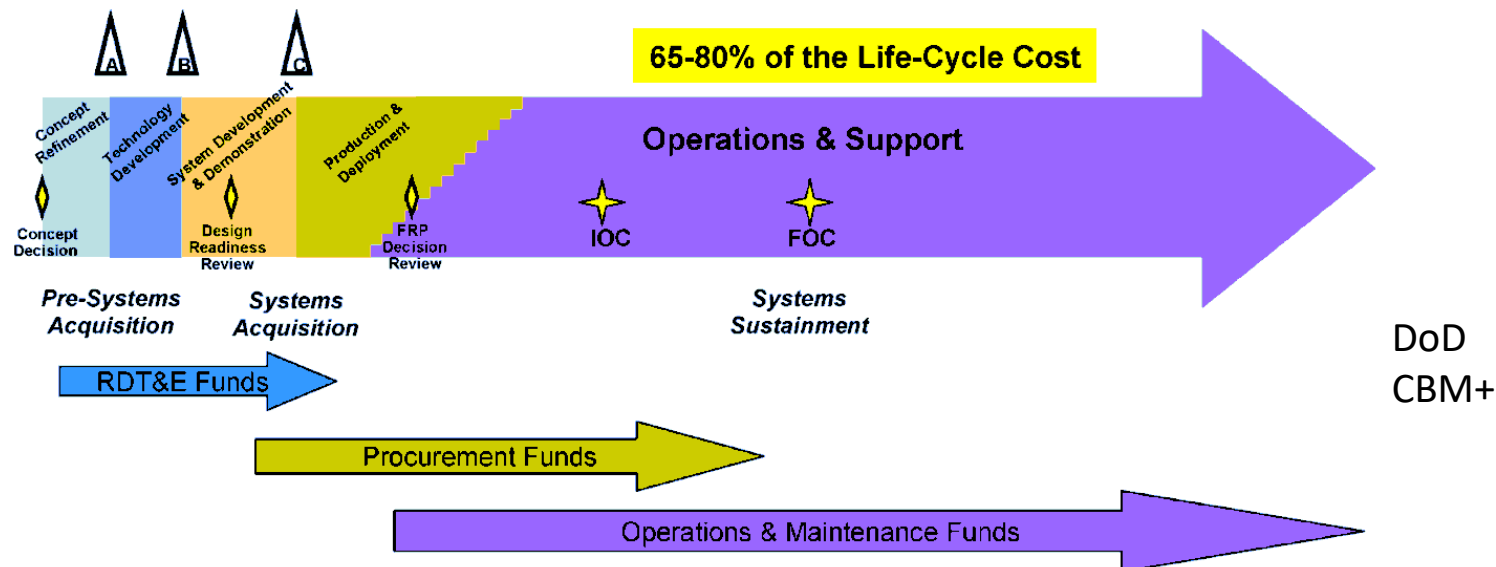
# **IIOT APPLICATION EXAMPLES**

# Where the Action Is?

- Industry 4.0
  - European IIoT initiative focused on manufacturing
- IIoT applications for services and operations
  - 80% of the lifecycle costs

# Operations and Support Apps

- Engineering and manufacturing
  - 10-15% of the lifecycle cost
- IIoT will change the operations
  - 65-80% of the lifecycle cost

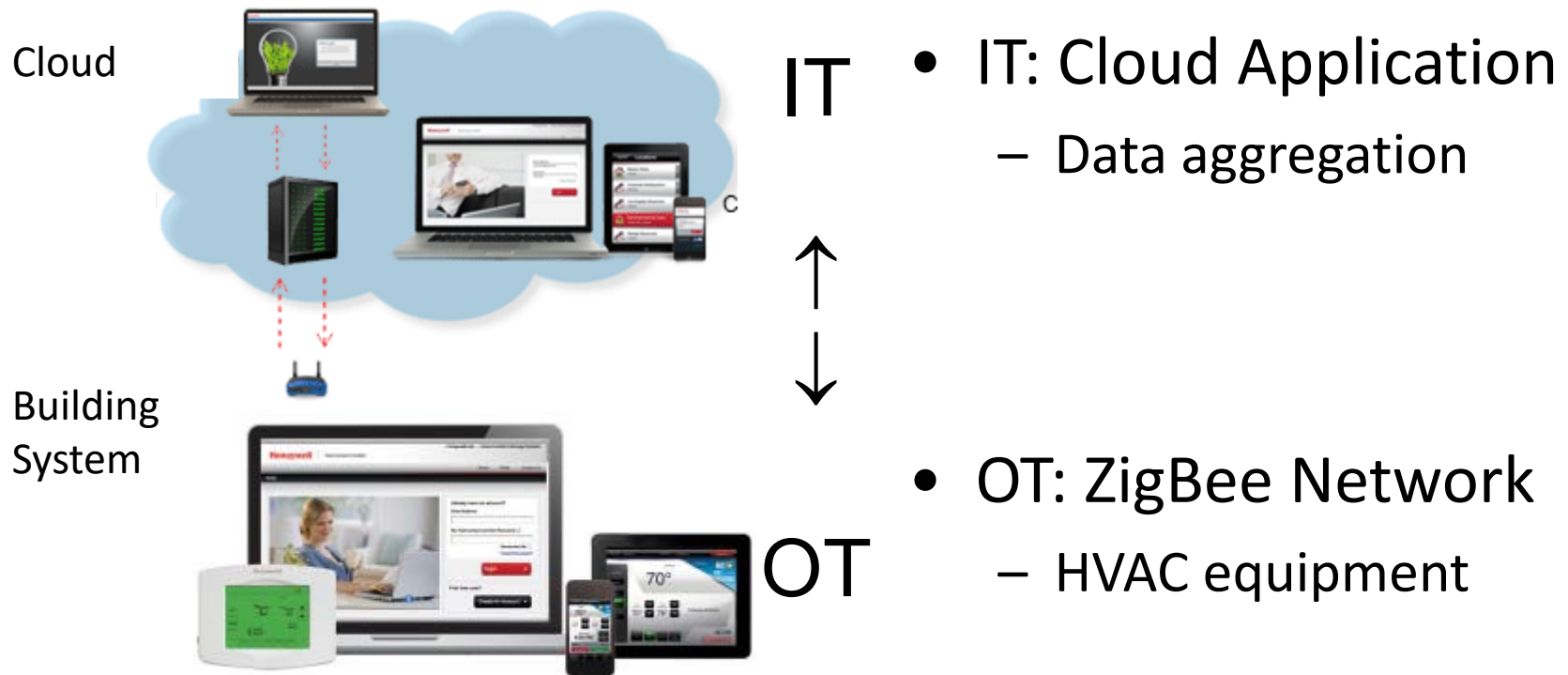


# Vertical Industries

- The future is already here — it's just not very evenly distributed
- Where is it concentrated for IIoT?
  - High-value enterprise application
- Buildings
- Transportation
- Manufacturing processes

# Building Example

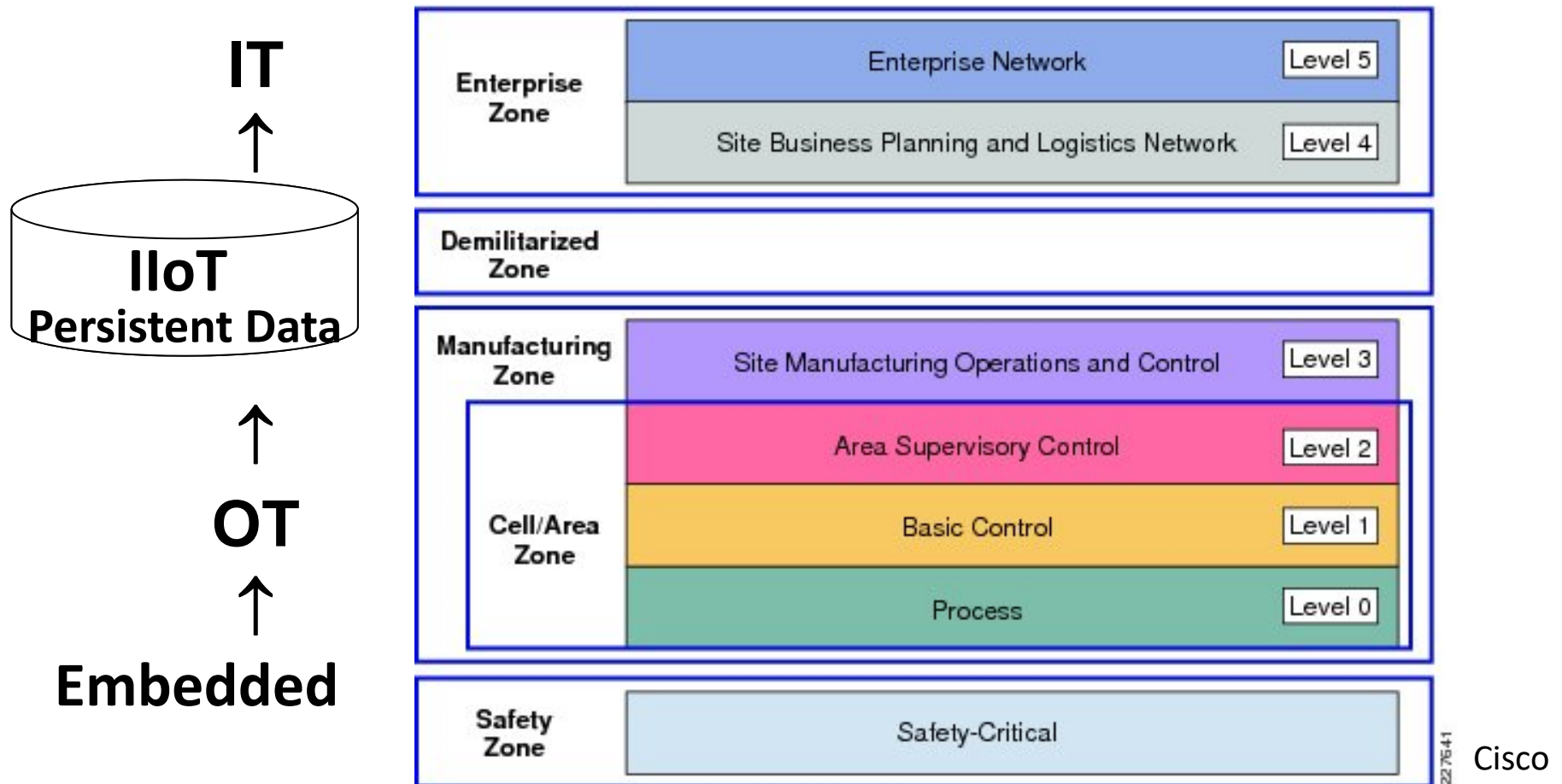
- Predictive monitoring of failures



IIoT Class Overview

# **AUTOMATION LAYERS**

# Levels in ISA-99 Purdue Model



# Ground Vehicle Example

5. Fleet management  
4. Telematics

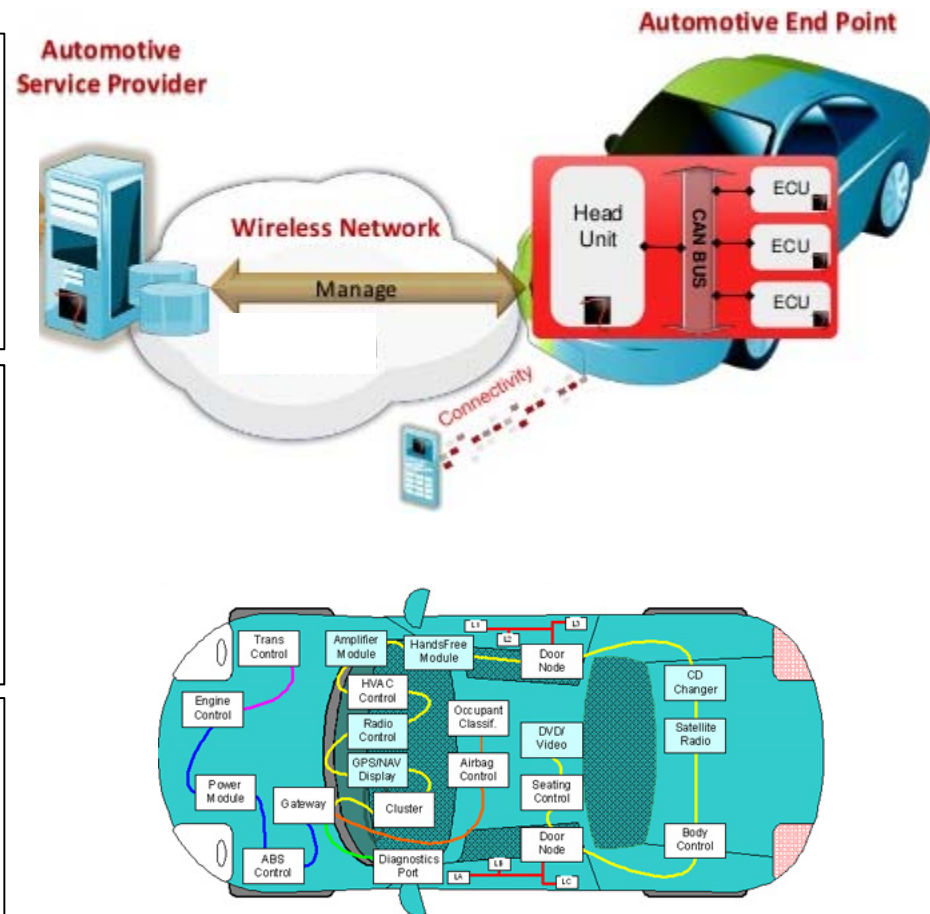
IT

3. Integrated info  
system (head unit)  
2. CAN bus functions

OT

1. ECU  
0. Sensor/Actuator

Embedded





IIoT Class Overview

# **SYLLABUS**

# Planned Lectures

April 2, Introductory Lecture

April 9, State of IIoT Adoption, **McKinsey**

April 16, Data Analytics for IoT, **Google Venture Capital**

April 23, Wireless Networks, **3ten8**

April 30, Large Scale Data Analytics, **Boeing AnalytX**

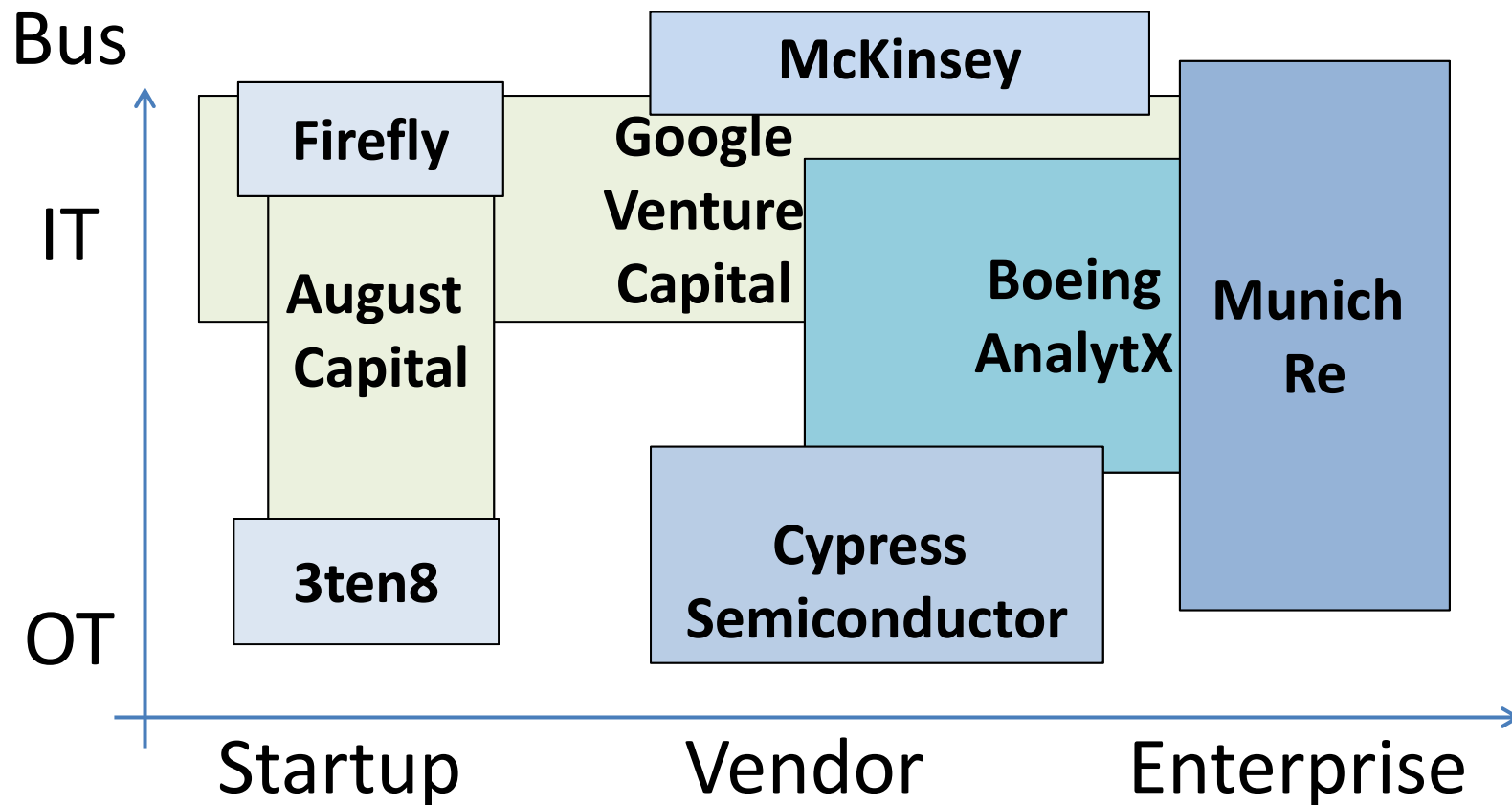
May 7, Car Fleet Application, CEO, **Firefly**

May 14, IoT Connectivity, **Cypress Semiconductor**

May 21, Managing Risks with IIoT, **Munich Re**

June 4, IoT Space Investment, David Hornick, VC, **August Capital**

# IIoT Lecture Map



IIoT Class Overview

# **EVOLVING LANDSCAPE**

# State of the IIoT

- 2016 Seminar on IIoT
  - New Wave, IIoT is the future
  - Upcoming Industry Transformation
- 2017 Seminar on IIoT
  - Platform efforts. Some application projects
  - How do we get on the IIoT train?
- 2018 Seminar on IIoT
  - Venture investor hype cycle is cresting
  - IoT cloud platforms are emerging
  - IIoT keeps rising. Tide, not a hype wave

# IIoT in 2019

- Industrial Internet and Digitization by GE
  - Supernova
- New waves on the tide flow
  - Digital Twin
  - Industrial AI
- Greatest barriers to IoT adoption today (Bain)
  - Security
  - IT/OT integration
  - Unclear ROI