ee392b
Industrial Internet of Things: Applications

March 29, 2016

Dan O'Neill
Dimitry Gorinevsky

Instructors

- Dimitry Gorinevsky, Consulting Professor in EE
  - Analytics for Industrial Internet of Things
  - Information Decision and Control applications in many industries
  - www.stanford.edu/~gorin
- Daniel O'Neill, Consulting Professor in EE
  - Streaming Analytics and Machine Learning
  - Executive and Startup experience
  - www.stanford.edu/~dconeill

Class Logistics

- 1 unit graded CR/NC
  - Attendance
  - No pre-requisites
  - Submitting a one page report/summary in the end
- Weekly on Tuesdays
  - The room and time might still change!
  - Watch the class website announcements
- Introductory lecture - today
- Nine lectures from industry leading companies

Planned Lectures

1. March 29, Introduction, Dimitry Gorinevsky and Dan ONeill, Stanford
2. April 5, The Industrial Awakening: The Internet of Heavier Things, David Mount, Kleiner Perkins
3. April 12, IIoT: Key Use Cases, Adoption Patterns, and Challenges, Edy Liongosari, Accenture
4. April 19, Using Aircraft Fleet Data to Improve Operations, Bertrand Masson, Qantas Airline
5. April 26, Physical Analytics, Hendrik Hamann, IBM
6. May 3, IoT in the Age of the Fourth Industrial Revolution, Roman Shaposhnik, Pivotal
7. May 10, Enterprise Internet of Things, Nino Vidovik, Konica Minolta
8. May 17, Harnessing Startup Innovation to Address Challenges in Energy, Debjit Mukerji, Siemens
9. May 24, IoT Strategy and Markets, Depti Vachani, Intel
10. May 31, From Connected Things to Real Outcomes, Nayaki Nayyar, SAP

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Industrial IoT: Applications
Overview

March 29, 2016

Dimitry Gorinevsky

Industrial Internet of Things: Applications
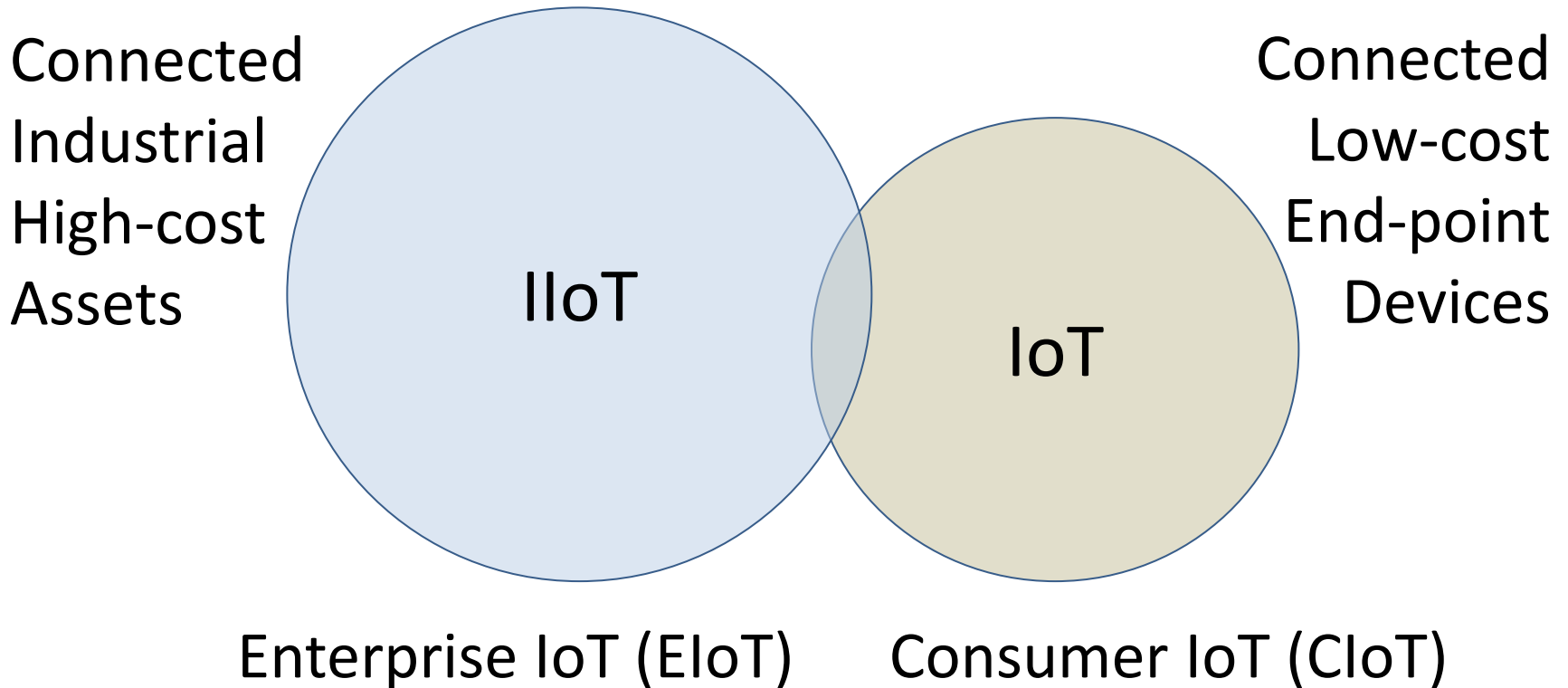Gorinevsky

IIoT Class Overview

WHAT IS IIOT?

Industrial Internet of Things (IIoT)

- Accenture, McKinsey, IBM, GE, and others expect that IIoT will generate $14T of economic activity in the next 10 years
- New industrial revolution
  - Internet revolution: B2C
  - IIoT revolution: the rest of the economy

IIoT and IoT

IIoT ≠ IoT

Connected Industrial High-cost Assets

IIoT

IoT

Connected Low-cost End-point Devices

Enterprise IoT (EIoT)

Consumer IoT (CIoT)

Internet of Everything (IoE)

IoE concept comes from Cisco Systems

- IoE $\approx$ IIoT + IoT

- Connectivity of things, internet plumbing
  - M2M Communication

Consortia and Initiatives

- Industrial Internet Consortium
  - IIoT, GE-version (with IBM, Cisco, AT&T, Intel)
- Open Interconnect Consortium
  - IIoT interoperability
- AllSeen Alliance
  - IoT interoperability
- Industry 4.0
  - Manufacturing: EU, Germany,

Waves of Change

1. The 1st Industrial Revolution
   – Mechanized production; water and steam power
2. The 2st Industrial Revolution
   – Mass production; electric power
3. Internet Revolution
   – Automation; electronics and information technology
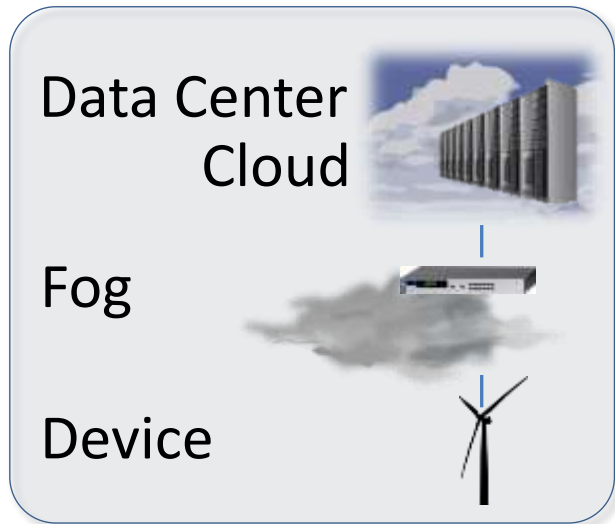4. Industrial Internet (IIoT)
   – Digital integration

GE, 2012
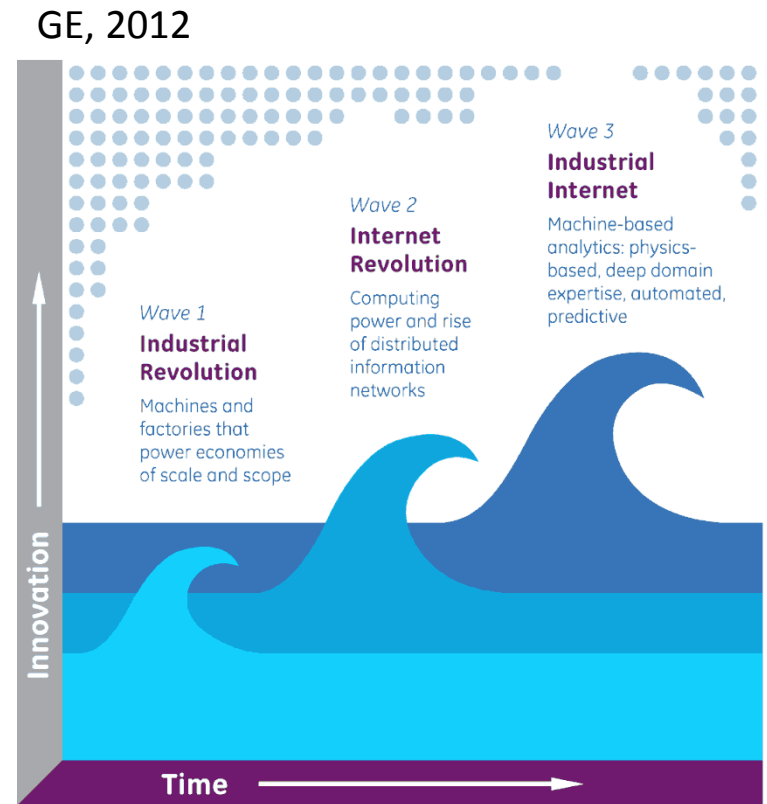
IIoT Class Overview

SO WHAT IS REALLY NEW ABOUT THE IIOT?

IT/OT Convergence in the IIoT

Information **T**echnology
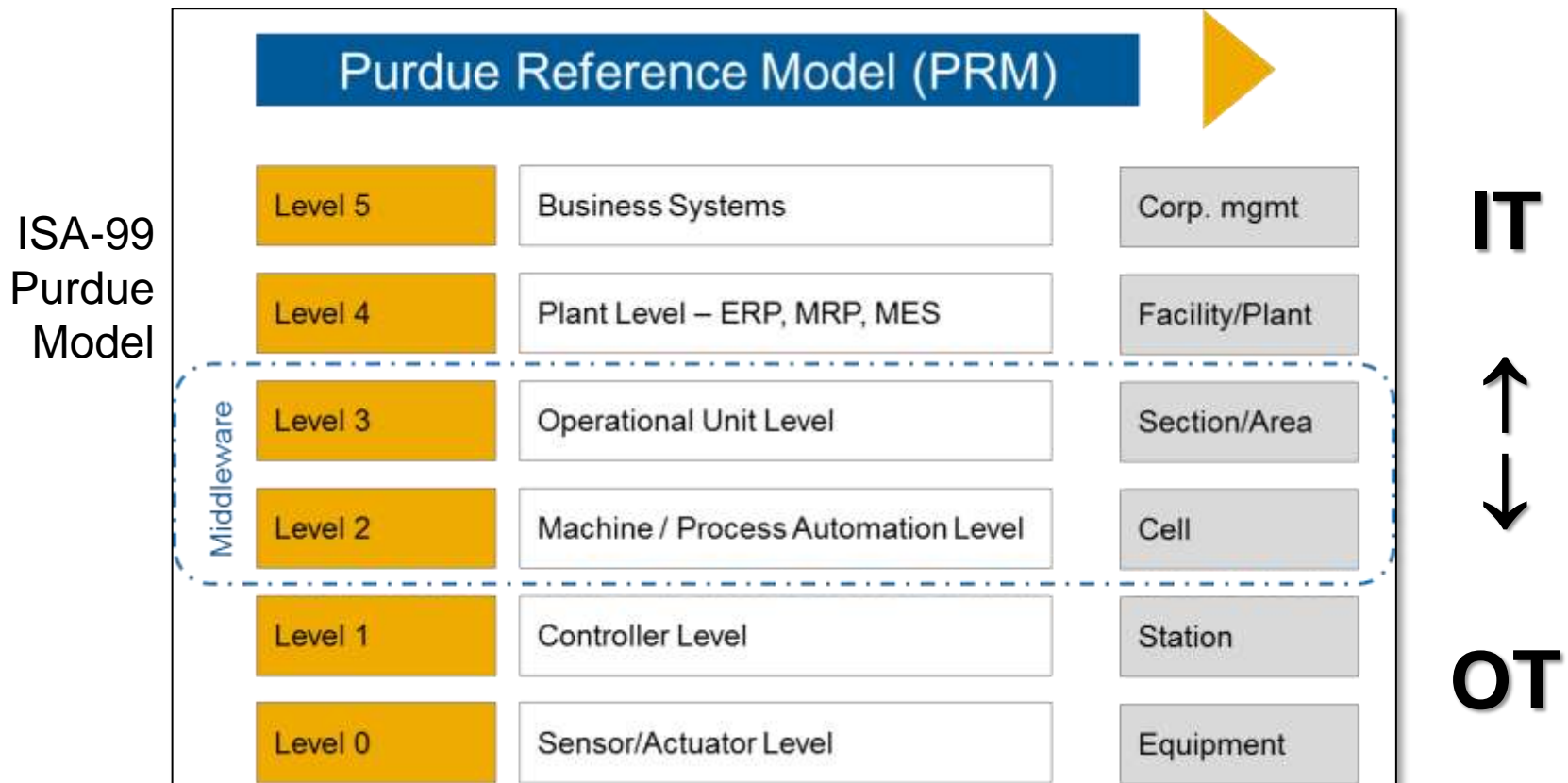

IT

OT

Operational **T**echnology

- IT: Enterprise computing. Data Center. Cloud.
  Fog.

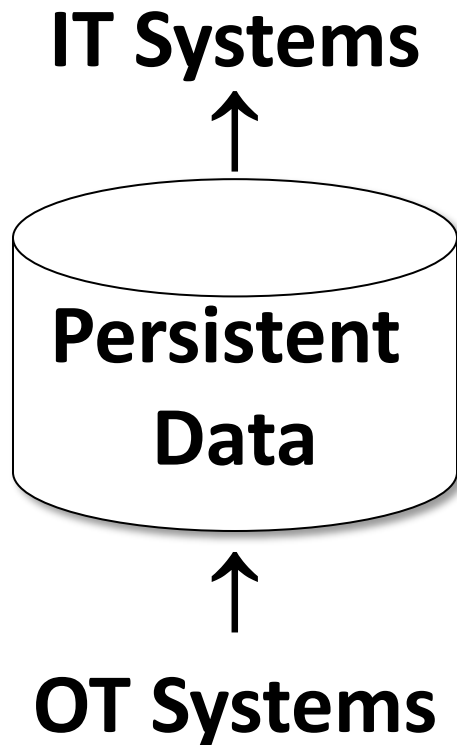- OT: Embedded and industrial systems. Machine to Machine. Secure, closed networks.

Industrial Automation Levels

- Purdue model; IIoT is a higher level of integration

ISA-99
Purdue
Model

Purdue Reference Model (PRM)

Level 5	Business Systems	Corp. mgmt	IT
Level 4	Plant Level – ERP, MRP, MES	Facility/Plant	
Level 3	Operational Unit Level	Section/Area	
Level 2	Machine / Process Automation Level	Cell	
Level 1	Controller Level	Station	
Level 0	Sensor/Actuator Level	Equipment	OT

Middleware

https://blogs.saphana.com/2015/04/13/bridging-chasm-m2m-iot-part-3/

Persistent Data

IT Systems

↑

Persistent Data
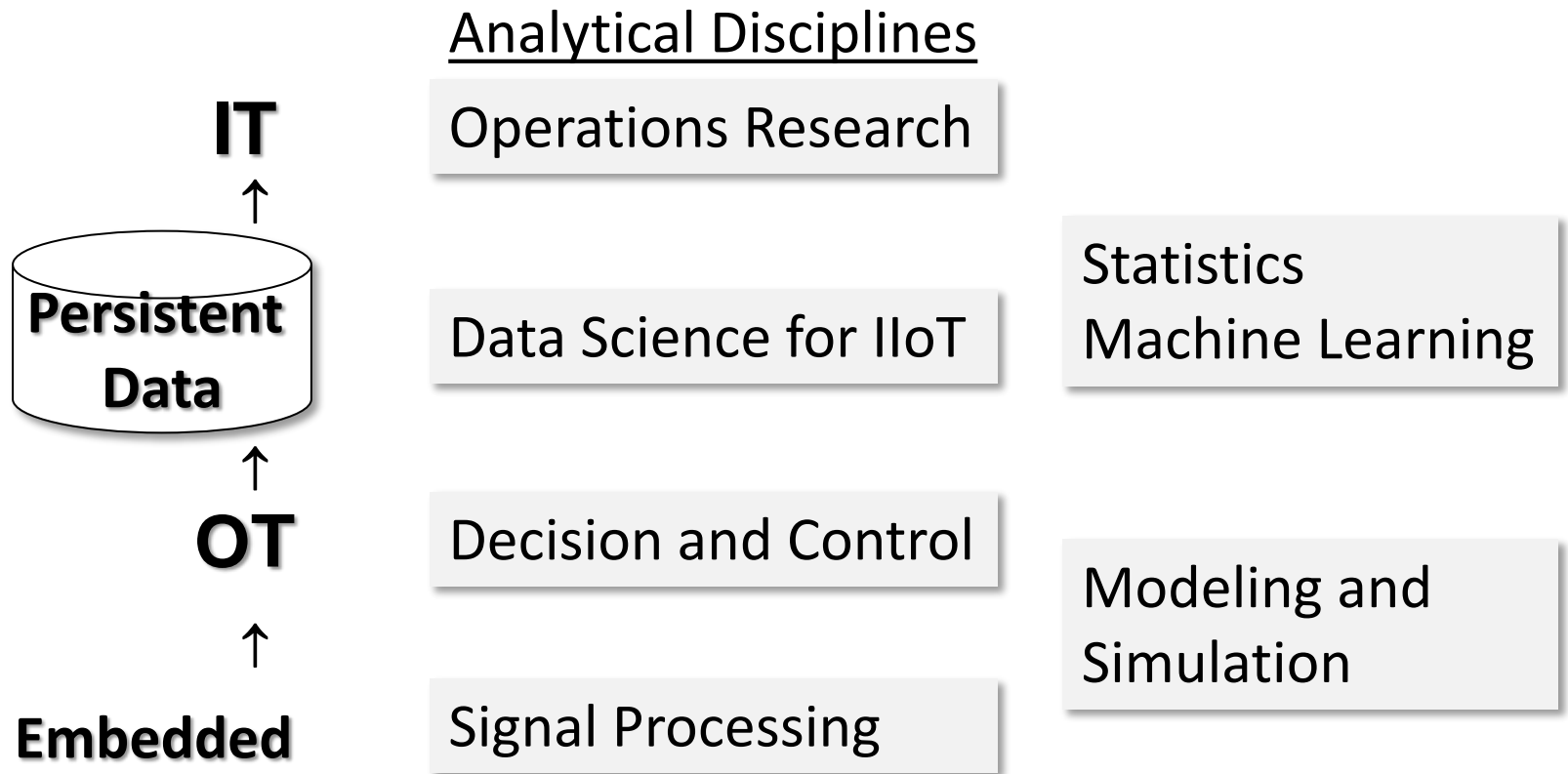
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OT Systems

- IIoT IT systems make use of OT data

- Presently, OT systems consume and use their raw data on-line, but do not accumulate it

- IIoT accumulates OT data as Persistent Data

IIoT Platform and Applications

- Viewpoint of enterprise customer

- IIoT Platform
  - Collect and manage data
  - Platform is an investment, cost
  - Necessary to run applications

- IIoT Applications
  - Process and analyze the data
  - Applications create value
    - Provide savings or generate profit

Analytics Layers

IT

↑

Analytical Disciplines

Operations Research

Persistent Data

↑

Data Science for IIoT

Statistics
Machine Learning

OT

Decision and Control

↑

Modeling and Simulation

Embedded

Signal Processing
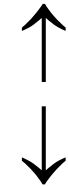
IIoT Class Overview

APPLICATION EXAMPLE

Airline IIoT Example

- Aircraft fleet monitoring

IT

OT

- IT: Airline Data Center
  - Aircraft fleet data
  - Operations safety

- OT: Aircraft on-board network – 1553 Bus
  - Avionics
  - Flight Data Recorder

Airline IIoT Business Value

- Collect OT (avionics) data through each flight

- Accumulate and process fleet operational data

- Asset Management
  - Manage engine maintenance and replacement

- Operations
  - Improve fuel burn
    - Total burn across the fleet

IIoT Analytics

BUSINESS & MANAGEMENT

Business Value Estimates

- Analyses of the IIoT economic impact

|	Value	Date	Comment
GE	$32.3 Trillion	2012	Early estimate
Accenture	$14 Trillion	2015	GE partner
McKinsey	$11 Trillion	2015	Consulting
Cisco	$17 Trillion	2015	IoE
Industrie 4.0	$4 Trillion	2014	Manufacturing
Gartner	$2 Trillion	2015	IoT only

IIoT Wave - New Value

World Economic Forum: IIoT disruption/new value

- Operational efficiency
  - Asset management

- Outcome economy
  - Pay-per-outcome

- Connected ecosystems
  - Blurring industry boundaries

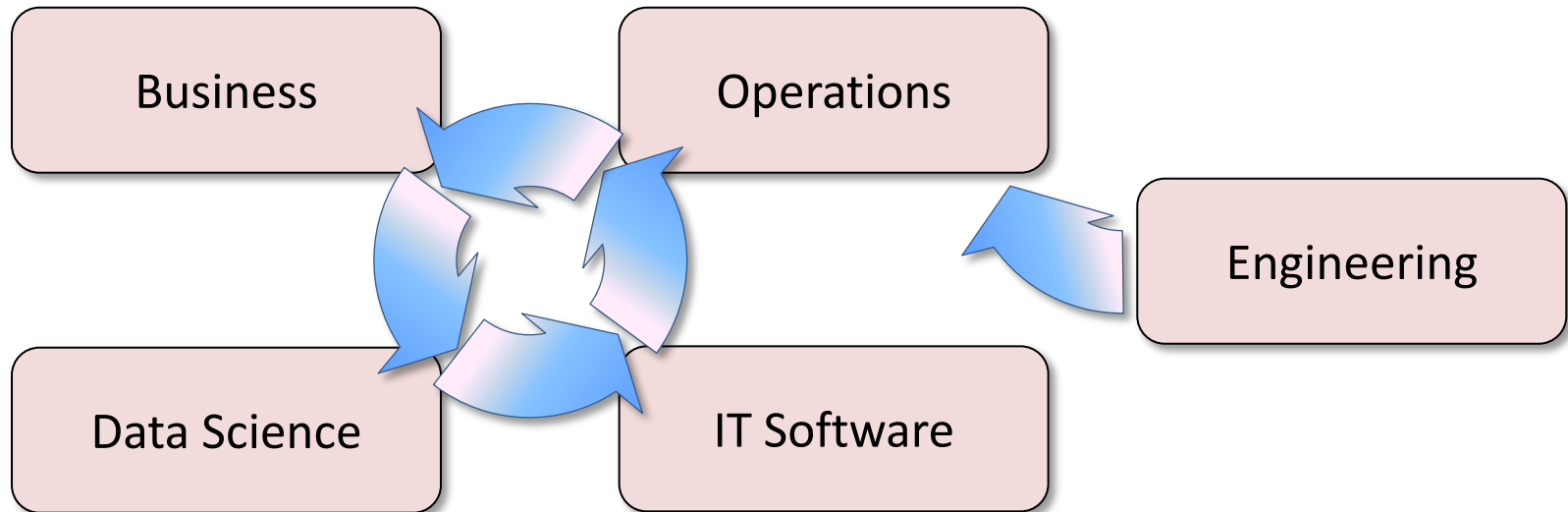- Collaboration between humans and machines
  - Productivity

Operations Impact

- Engineering is focused on system design
  - 5-10% of the lifecycle cost, requires analytic skills
- IIoT will change the operations
  - 65-80% of the lifecycle cost
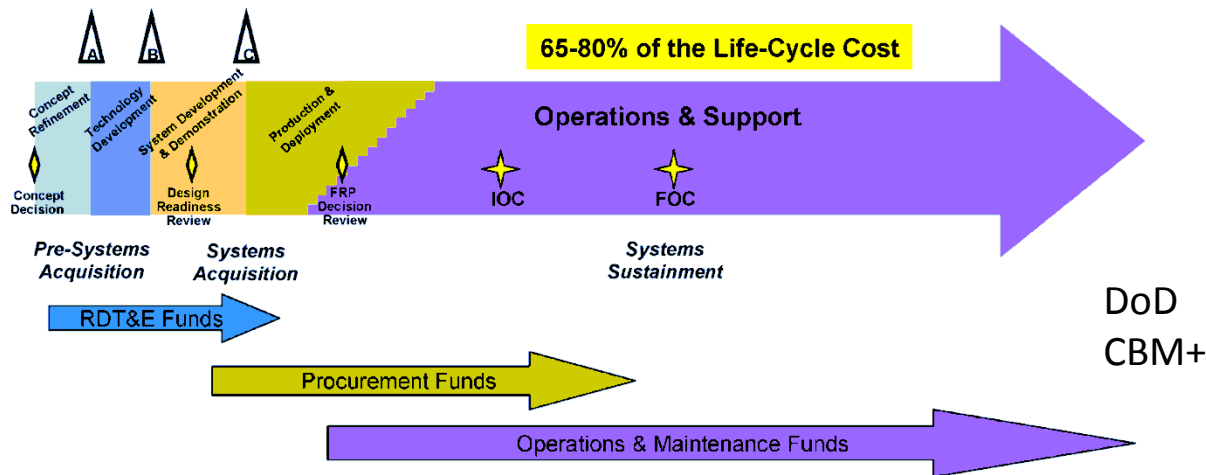
Managing IIoT Development

- Groups developing and deploying the IIoT Analytics

IIoT Analytics

CLASS COVERAGE

Planned Lectures

March 29, Intro, **Stanford**

April 5, **Kleiner Perkins**

April 12, **Accenture**

April 19, **Qantas Airline**

April 26, **IBM**

May 3, **Pivotal**

May 10, **Konica Minolta**

May 17, **Siemens**

May 24, **Intel**

May 31, **SAP**

IIoT Dimensions