IoT – Current Trends and Technologies
Course Introduction

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About **HUST**

HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Established in **1956**
- **45.000** students
- **2000** employees, including 1600 faculty members
- **27** schools and research institutes
- **One of the leading** technical universities in Vietnam

IoT Research

- IoT research at the School of Electronics and Telecommunications, HUST
  - WSN, M2M communications, cloud and fog computing, SDN
  - Embedded systems and embedded software for IoT, low-power reconfigurable systems
  - Big data analysis/data science, artificial intelligence
  - IC for IoT: energy harvesting IC for wearable and IoT devices
  - Wireless communications: 5G and IoT
  - IoT applications
    - Environment
    - Bio-medical systems
    - Argriculture

Contents

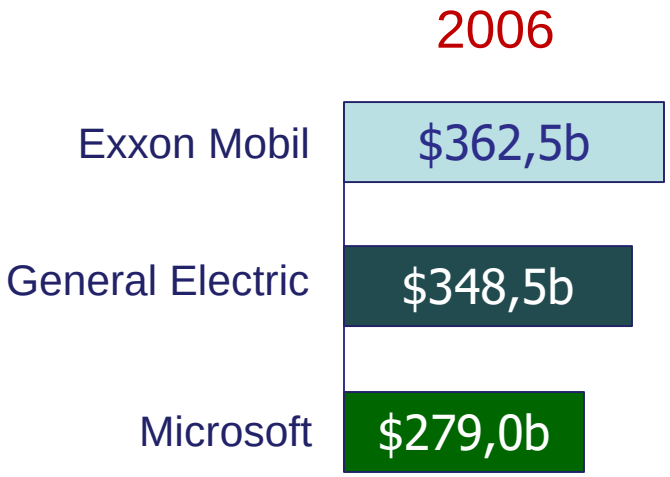
- Backgrounds
  - Why IoT?
  - What are the driving forces?
- Concepts of IoT
- Course introduction and structure

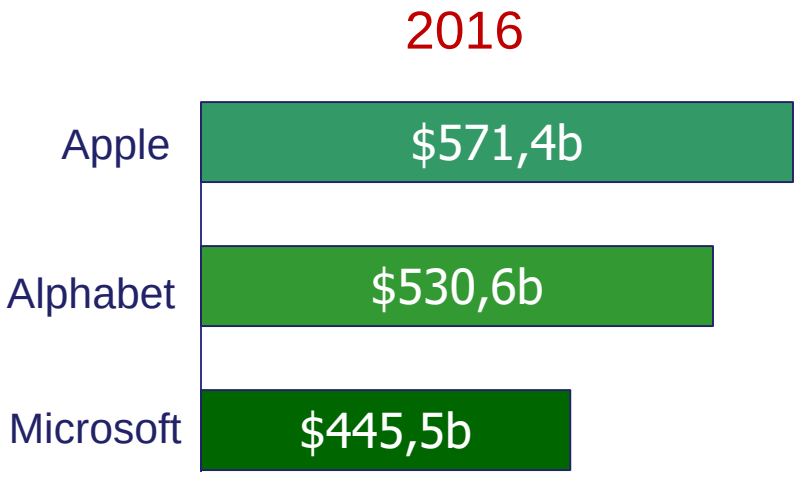
Contents

- Backgrounds
- Concepts

Driving Forces for IoT and Big Data

- "Farewell oil, hello tech!" (World Economic Forum, 2016)
  - 3 most valuable companies





ExxonMobil

Microsoft

Alphabet

Microsoft

Driving Forces for IoT and Big Data (*cont*…)

The Economist | Topics | Print edition | More | Subscribe

Regulating the internet giants

The world's most valuable resource is no longer oil, but data

The data economy demands a new approach to antitrust rules

(Source: The Economist, May 6th 2017)

The Role of Information and Knowledge

- Information and knowledge are the core of smart systems and services
  - Understand the environment
  - Operations can be adapted or optimized based on the outside environment
  - Decisions are made based on the outside environment

TESLA

UBER

The Role of Information and Knowledge

- Smart systems
  - Tesla self-driving car

The Role of Information and Knowledge

- Smart services
  - Uber – the world's largest taxi company
    - owns no vehicles;
  - Facebook – the most popular media owner
    - creates no content;
  - Airbnb – the largest accommodation provider
    - owns no property

→ Revolution in supply and demand sides of business thanks to new technologies

→ It is often far better to own a platform that brings consumers together than the underlying asset

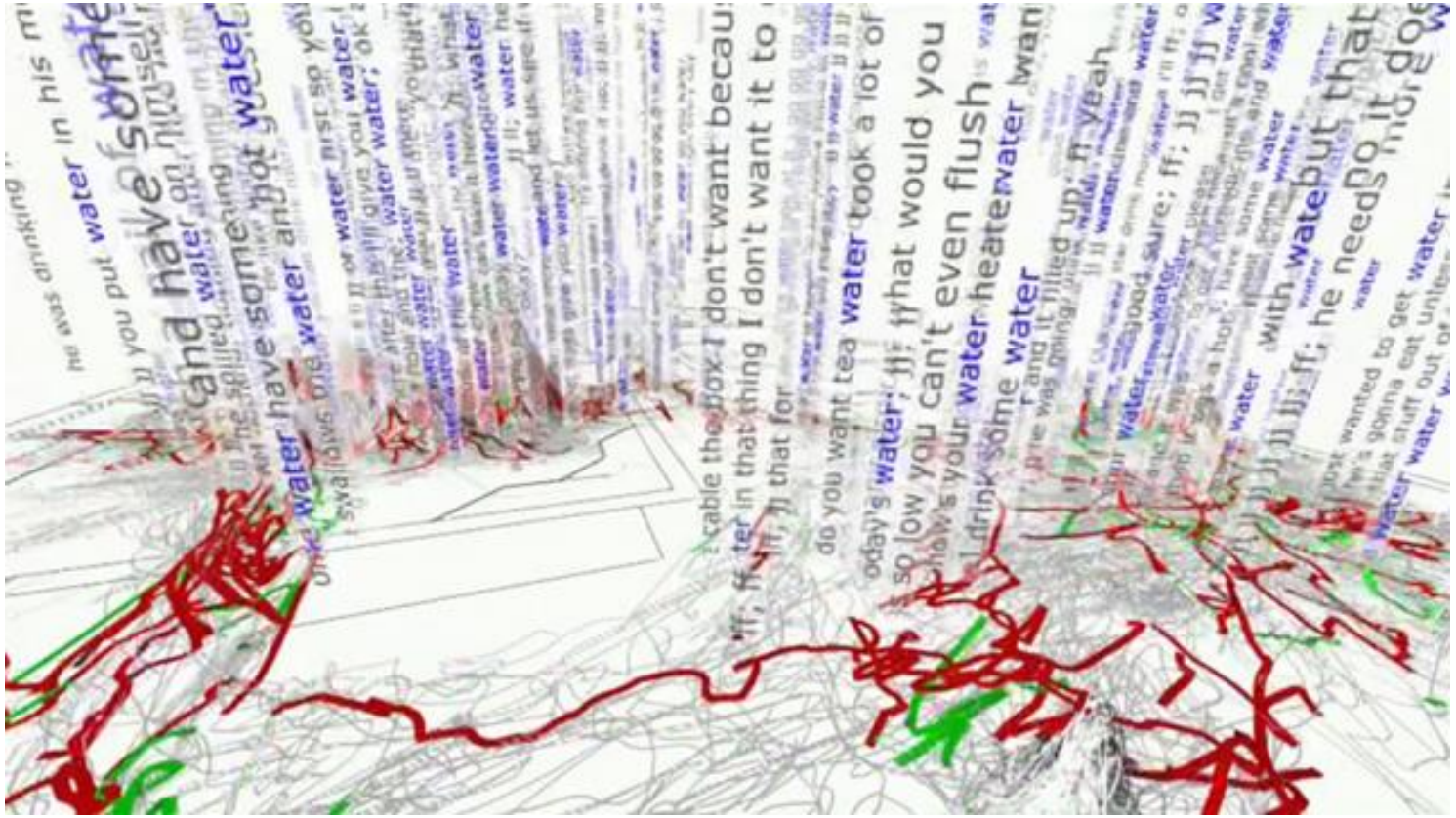
Why Data is Important?

- Data is the basis for information and knowledge

Questions

- How to collect data?
- How to make data valuable?

Where Is Data From?



"The average person today processes more data in a single day than a person in the 1500's did in an entire life time"

(Source: Smolan and Erwitt, The human face of big data, 2013)

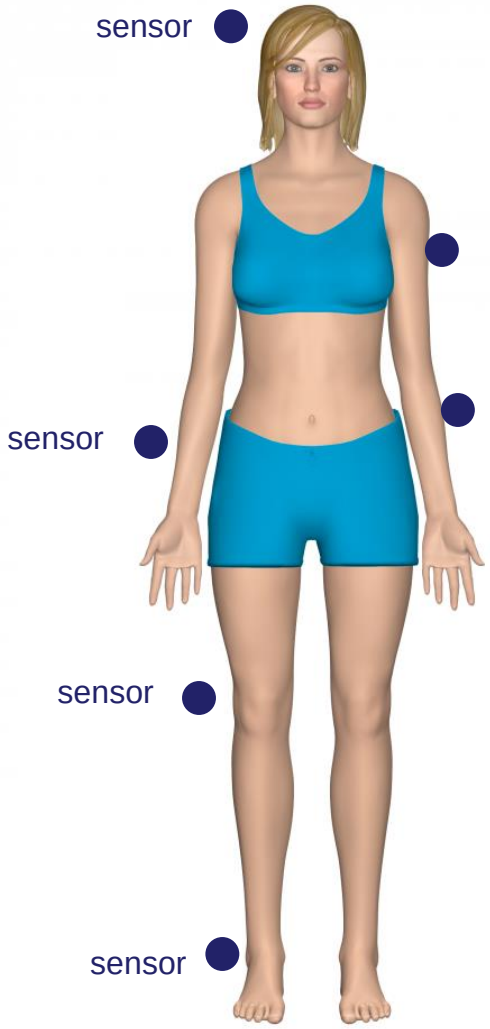
Every 60 seconds

- **98,000+** tweets
- **695,000** status updates
- **11 million** instant messages
- **698,445** Google searches
- **168 million+** emails sent
- **1,820TB** of data created
- **217** new mobile web users

Where Is Data From? (*cont*…)

- Types of unstructured data
  - Docs, media, archives
  - Social media, web
  - Business apps
  - Data storage
  - Machine log data
  - Sensor data
  - Etc.

Sensor and Machine Log Data

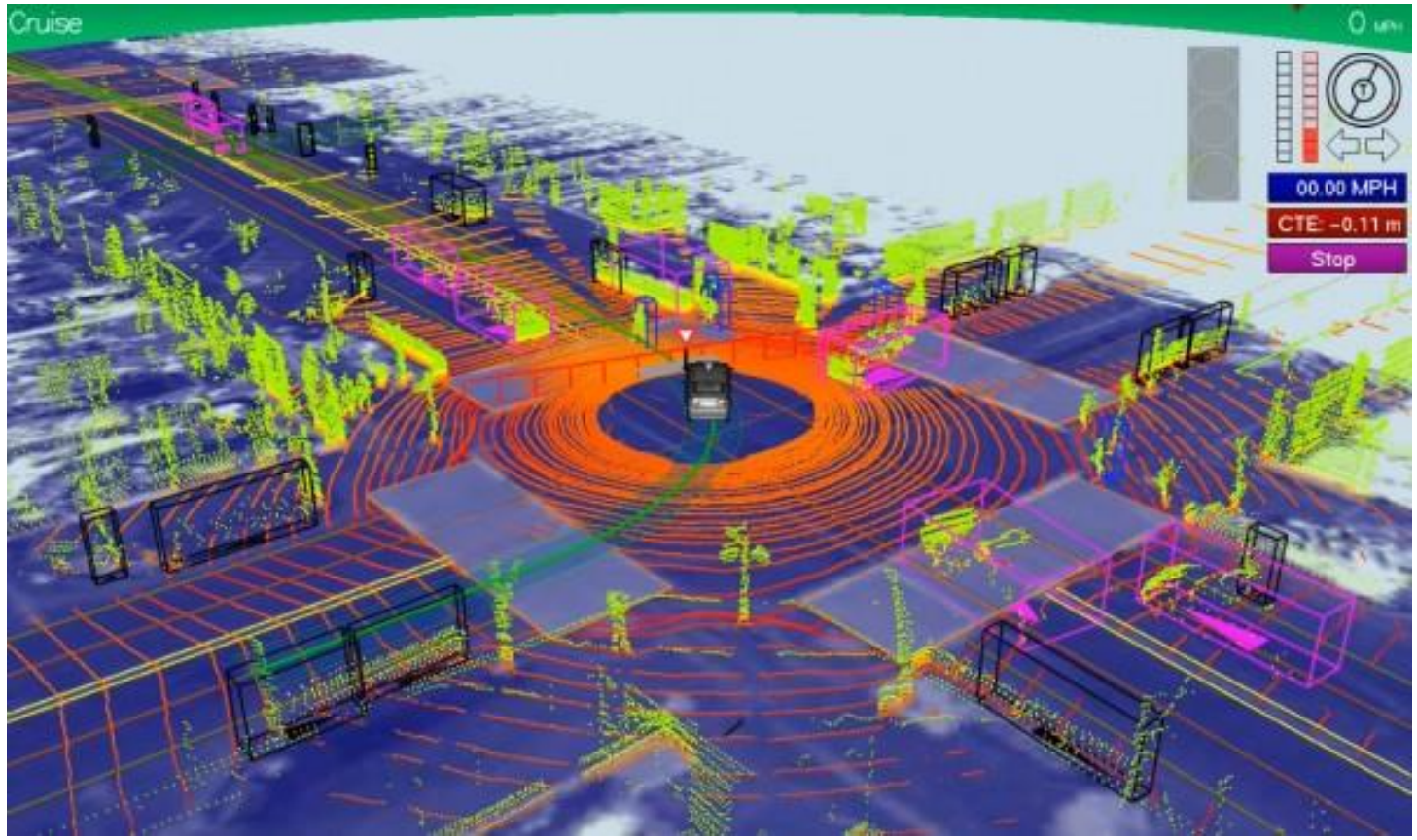


- ECG
- EEG
- Blood pressure
- Toxin
- Toxin
- DNA
- Protein
- Glucose
- Hearing
- Vision
- Movement
- Positioning

During the first day of a baby's life, the amount of data generated by humanity is equivalent to 70 times the information contained in the library of congress

(Source: Smolan and Erwitt, The human face of big data, 2013)

Sensor and Machine Log Data (*cont*...)

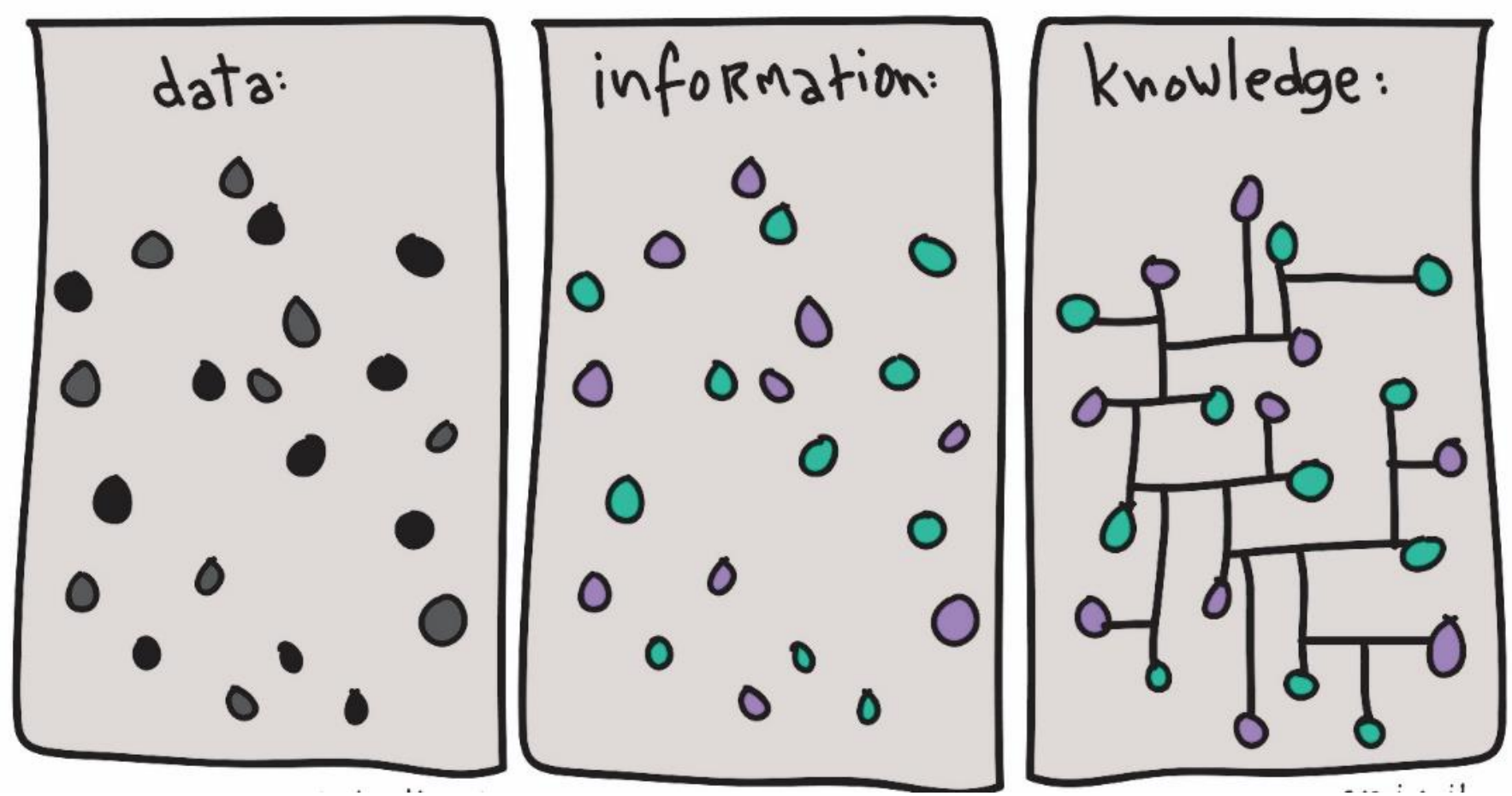


- Image objects
- Speed
- Acceleration
- Tilt
- Position
- Presence
- Engine data
- Temperature
- Fuel consumption

Google self-driving cars gather nearly 1GB of sensor data every second

(Source: Betanews)

How to Make Data Valuable?

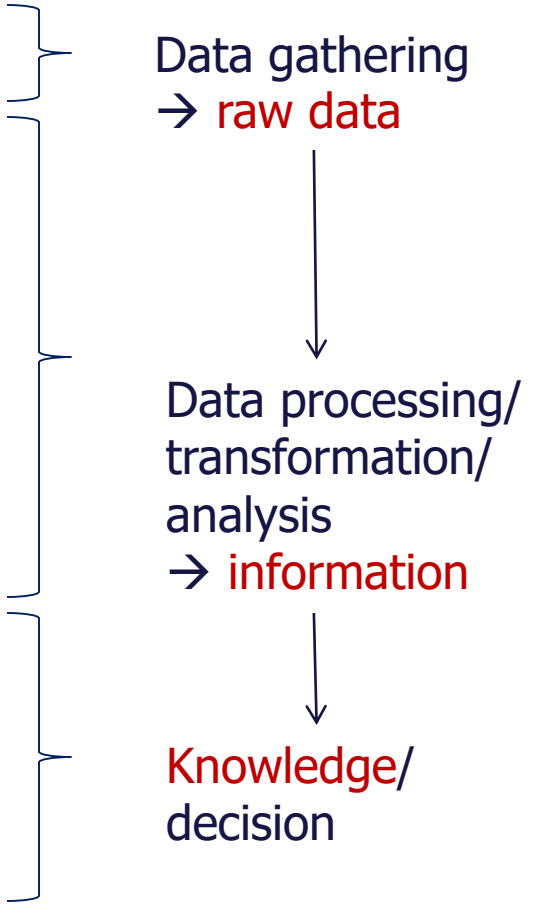


Alignment between business objective and data

(Source: Julien Blin)

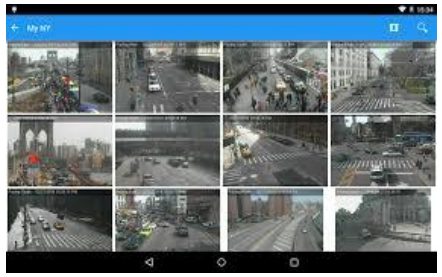
Example

- Automatically detect anomaly traffic
  - Collect realtime traffic video/images
  - Detect anomaly traffic objects/situations from thousand of realtime images
  - Detect anomaly vehicles from hundred of vehicles running on high way
  - Detect plate numbers of anomaly vehicles
  - Associate plate numbers with owners and related data (address, license number etc.)
  - Decide if the vehicles violate traffic law
  - Look up database to see if the owners has other traffic violations
  - Automatically issue fines



Example (*cont*...)

traffic monitoring system



real-time traffic images

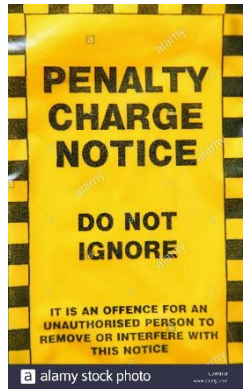
detecting traffic objects

anomality detection

identification of anomaly objects

database

personal identity



decision

New Business Models in the Information Age

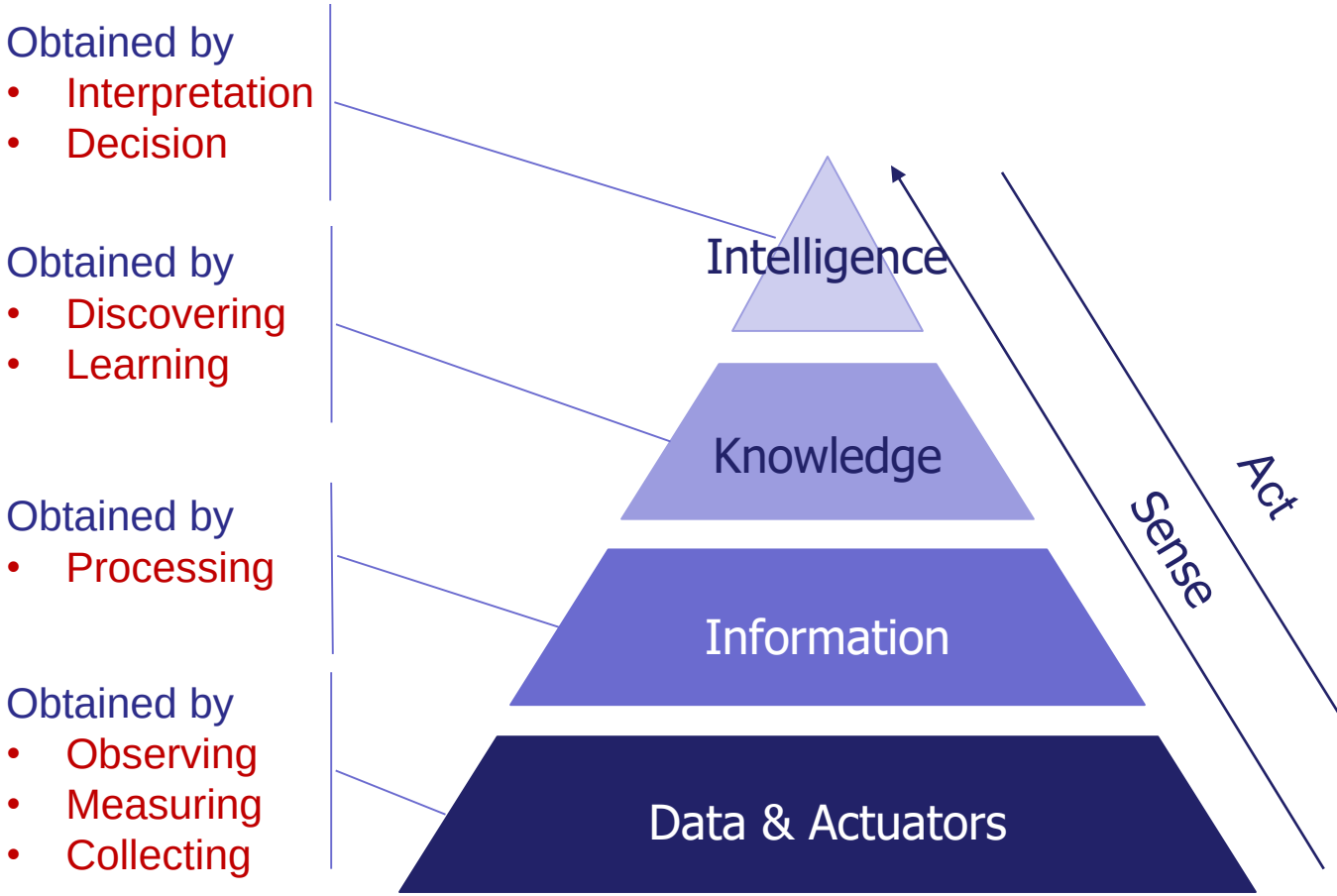
- Information and knowledge are the key role

Information based differentiation	Information based brokering	Information based delivery networks
New service offerings	Raw information	Fostering market places
Improvement of customer satisfaction	Benchmarking	Driving deal making
Providing contextual relevance	Delivering data analysis and insights	Enabling advertisement

Contents

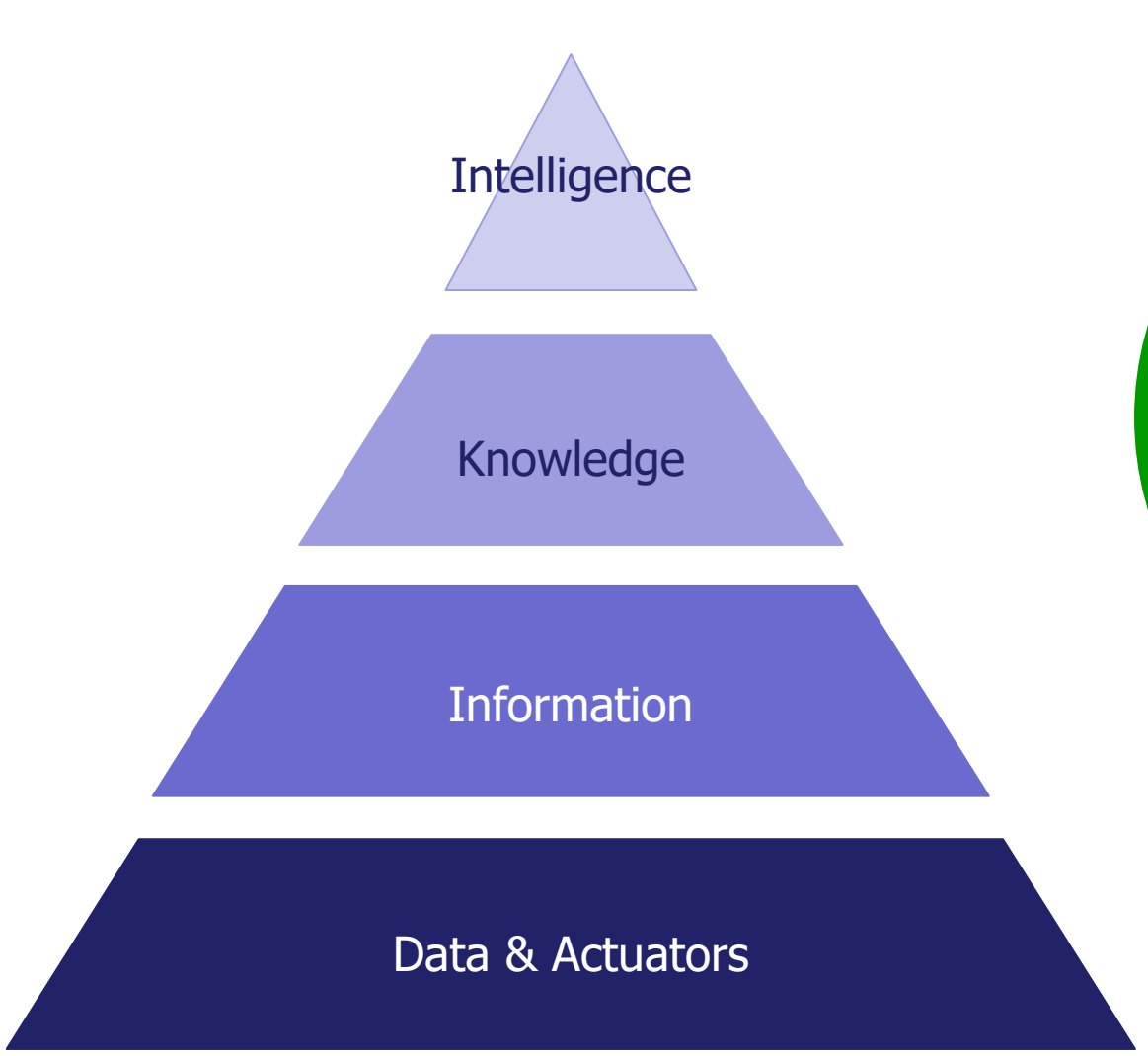
- Backgrounds
- Concepts

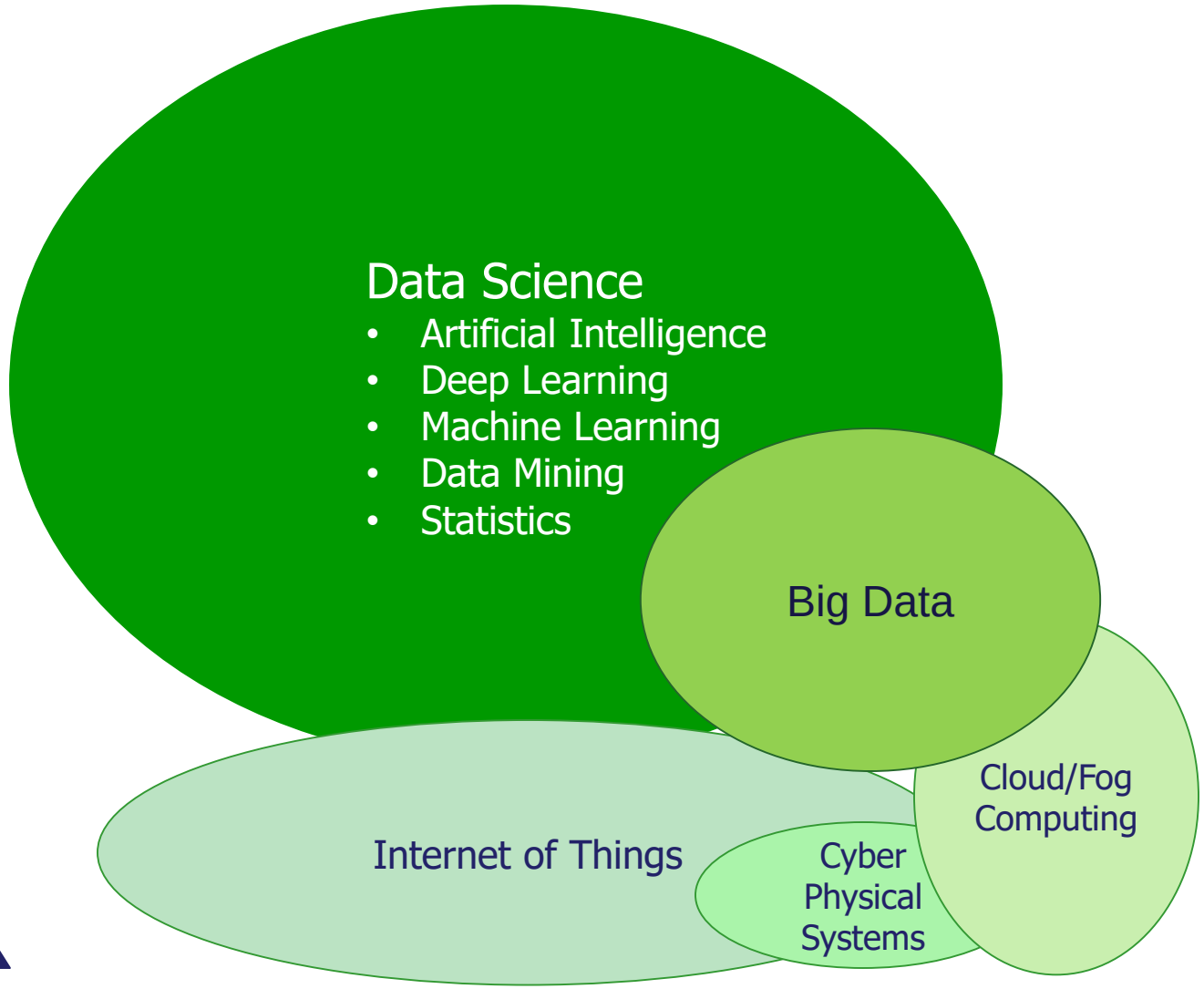
Data, Information, Knowledge, Intelligence



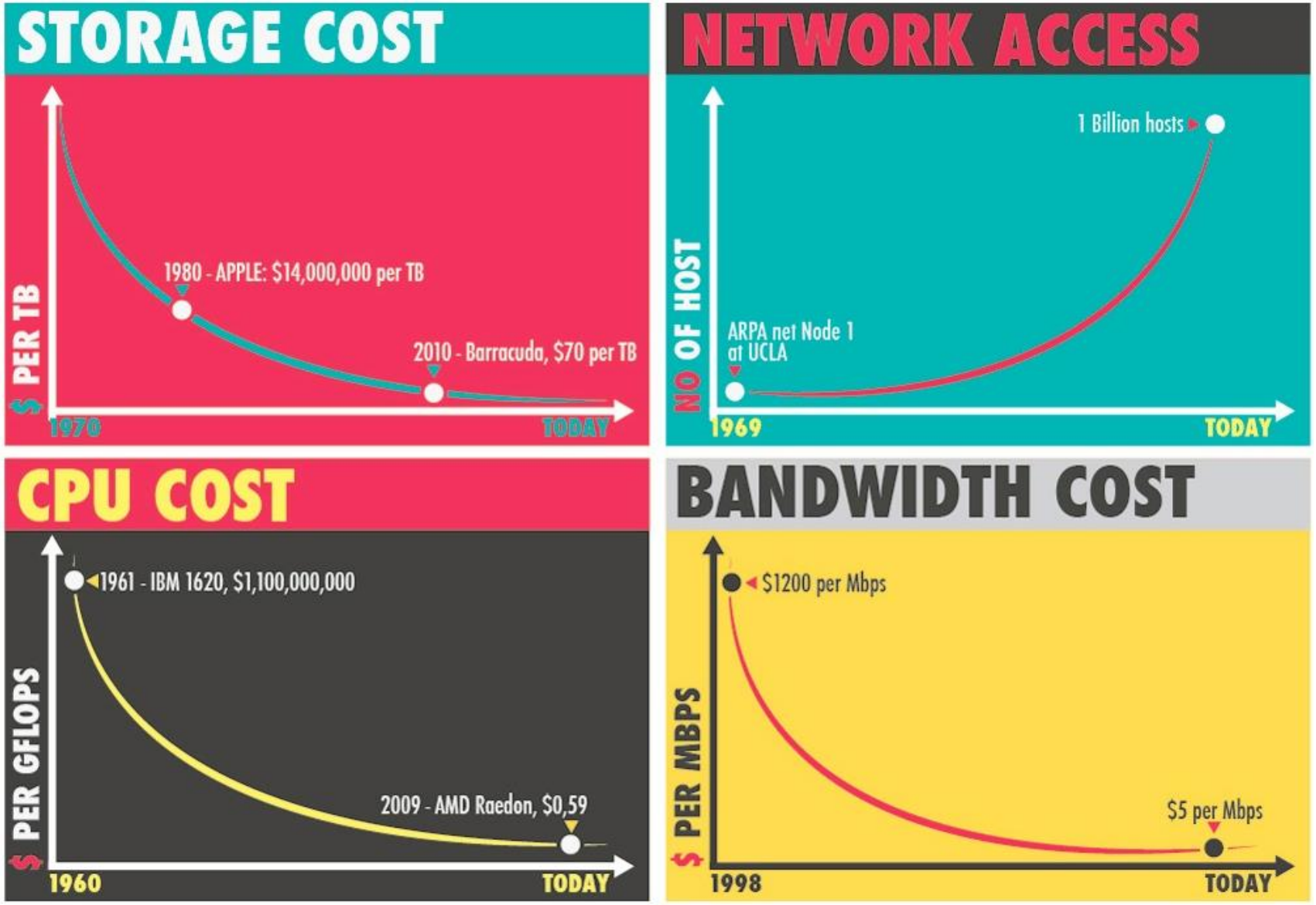
- Interpretation and evaluation
- Data analysis
- Data preprocessing, modelling and transformation
- Data collection and transmission

Enabling Technologies





Why now?

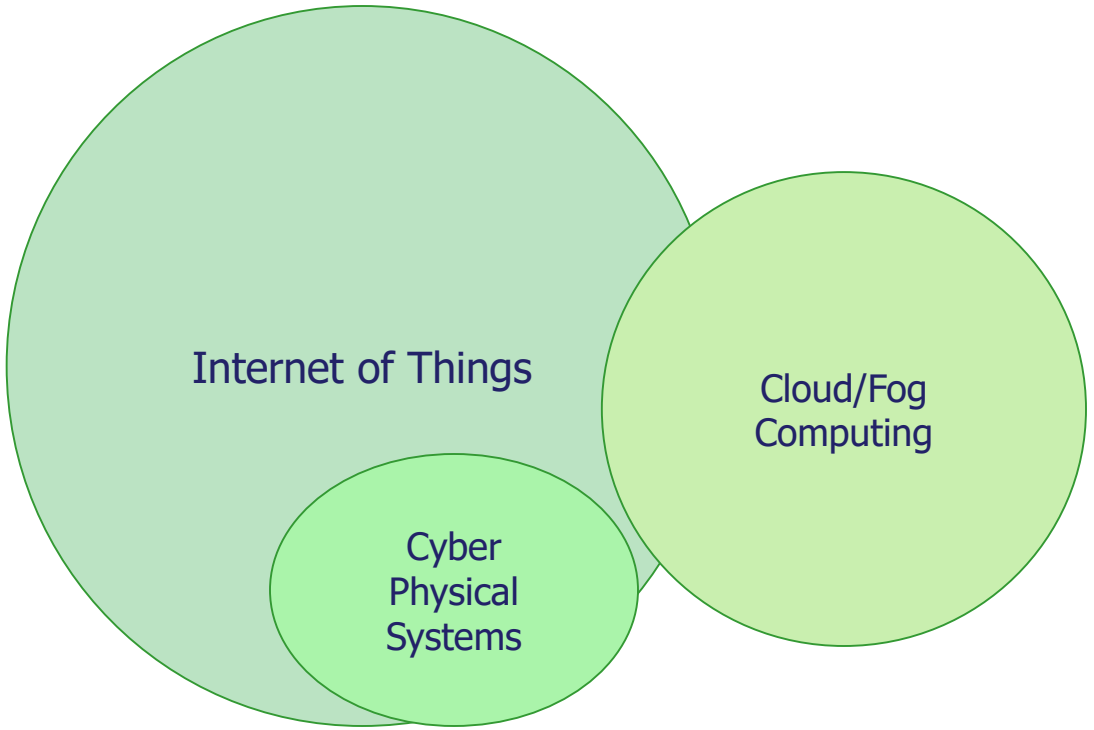


Credit to: Mike Driscoll, CTO Metamarkets: The Three Sexy Skills of Data Scientists (& Data Driven Startups)

Usage

- Healthcare
- Design and manufacturing → Industrie 4.0
- Finance
- Marketing and sales
- Retailing

Data and Information



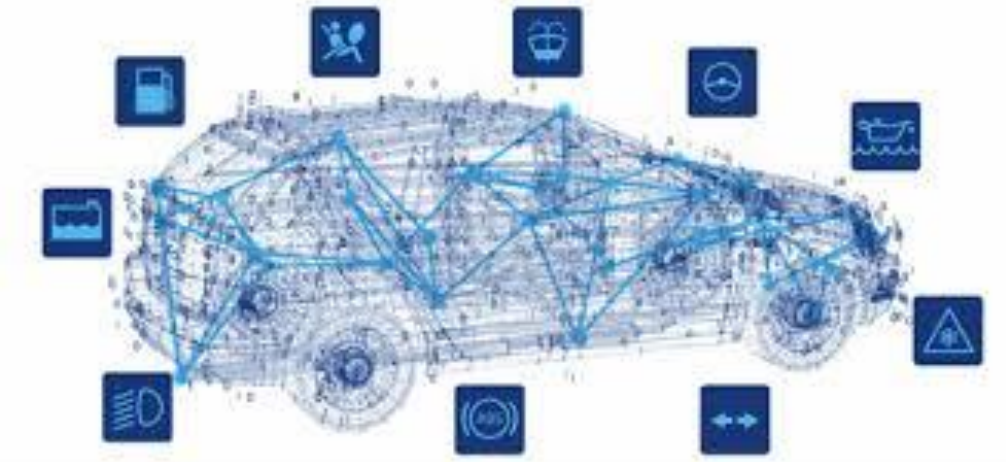
- How to collect data?
- How to transmit, store and preprocess data?

Cyber Physical Systems

- Each physical object has a "digital avatar"
  - Integrations of computation, networking, and physical processes

Physical world

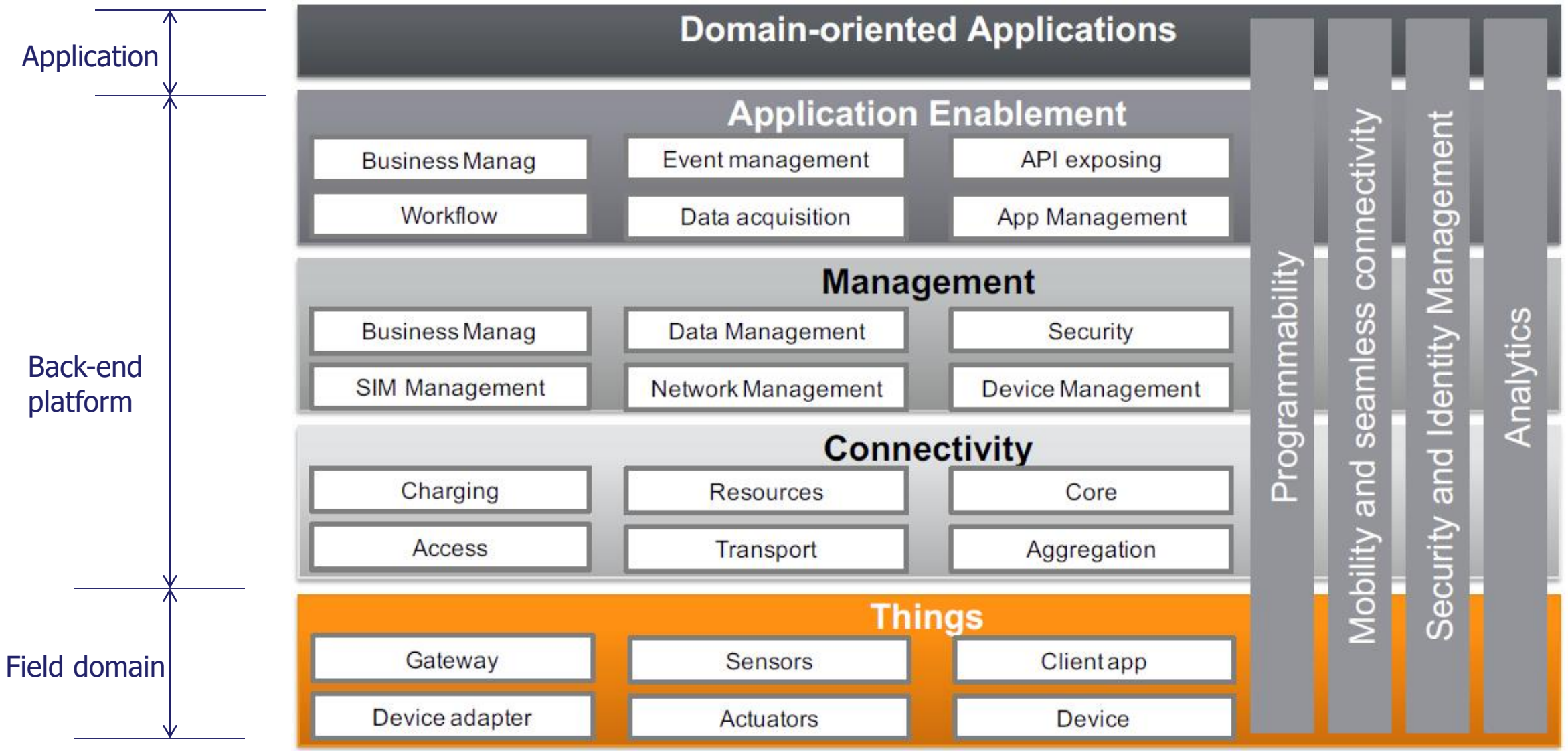
Cyber world



Internet of Things

- Connected CPSs → Internet of Things (IoT)
  - Providing unified connected environments for converging real and virtual world
  - Facilitating new advanced services by interconnecting things based on interoperable information and communication technologies

IoT Reference Model

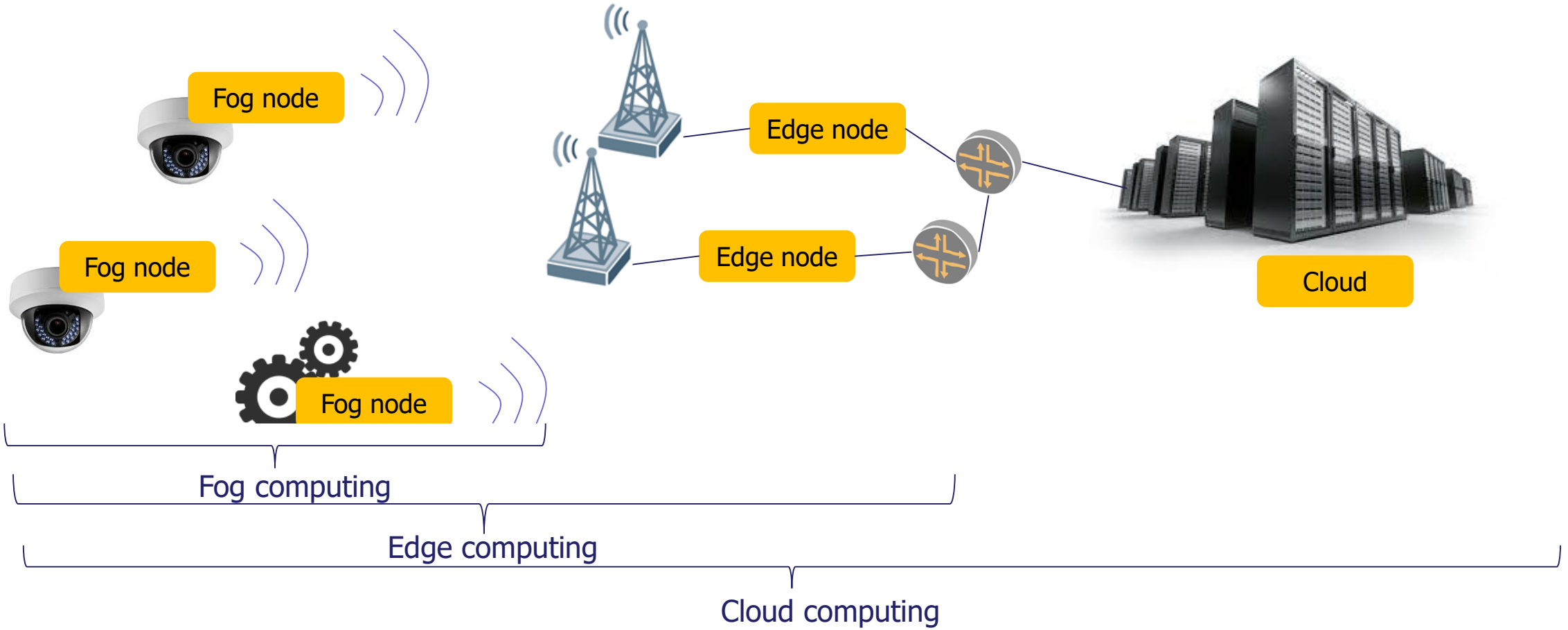


IoT Reference Model (*cont*...)

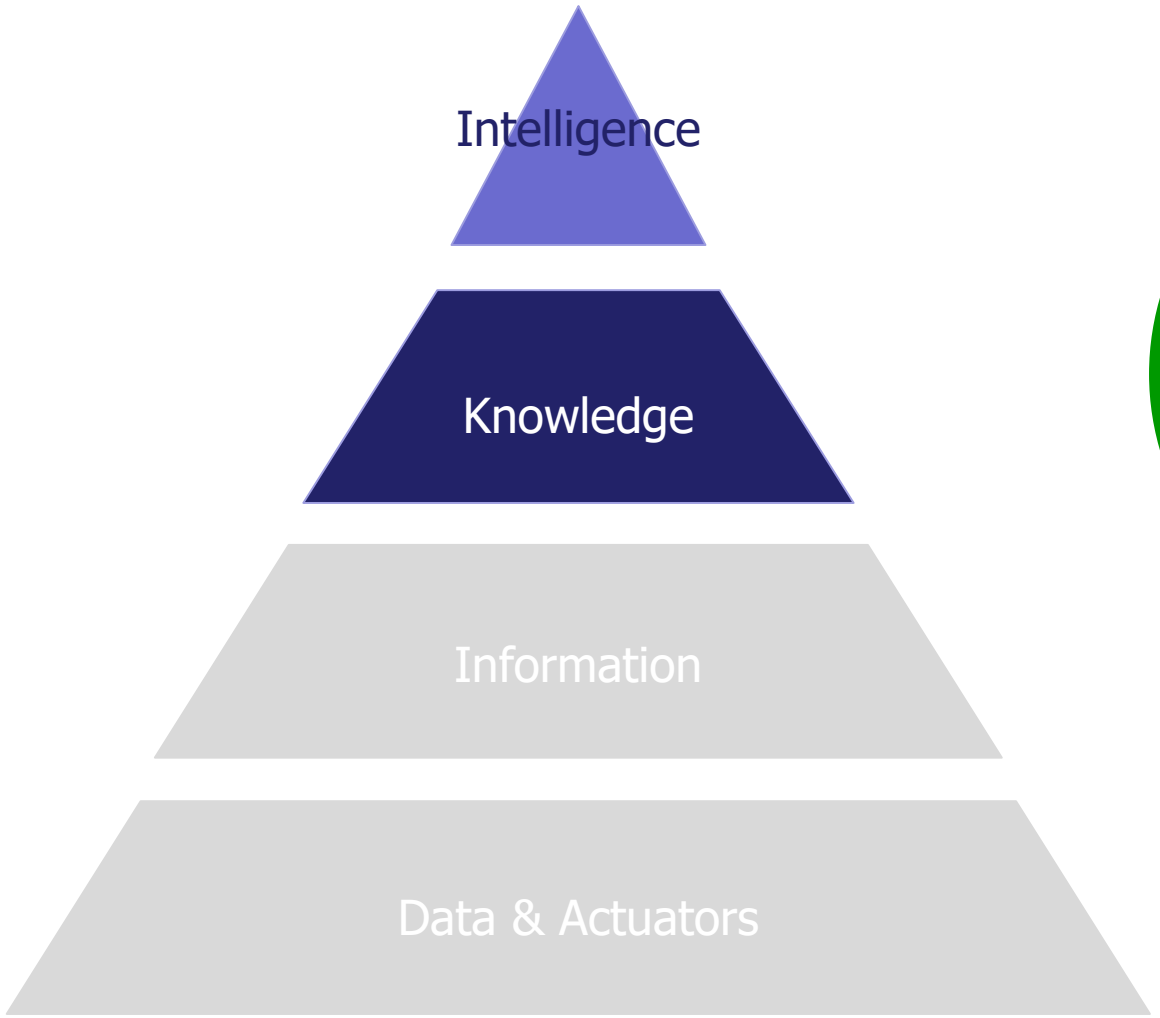
- Field domain
  - covers the integration with domain specific sensors and actuators based on their access technologies and interworking protocols
- Back-end platform
  - aggregating data from gateways, field-domain devices
  - mediating data to applications via open APIs
  - managing connections
  - performing data processing functions and data/device abstraction
- Application
  - providing distinct services to dedicated vertical domains

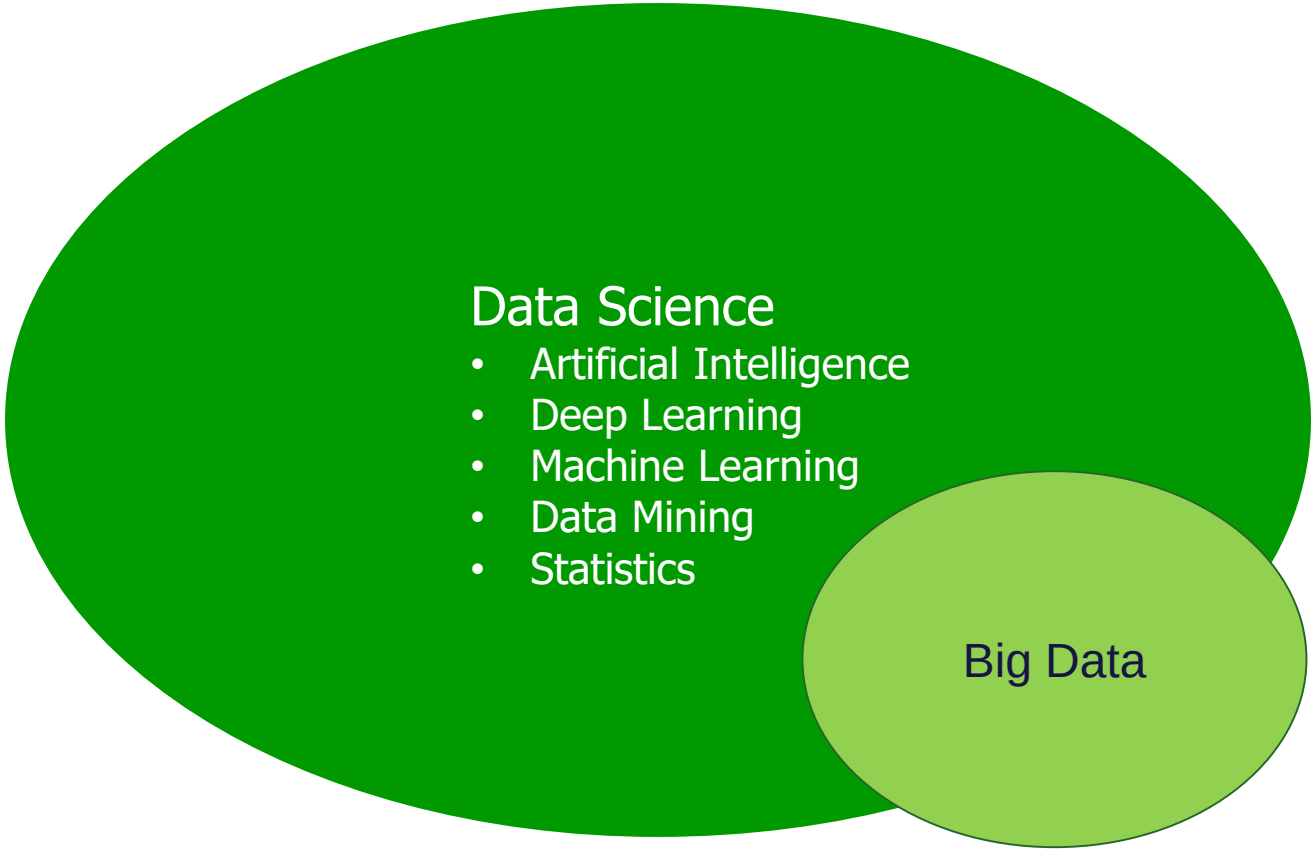
Edge/Fog/Cloud Computing

- Cloud computing and IoT are tightly coupled
  - providing the infrastructure for computing and big data storage and analytics



Information, Knowledge, Intelligence





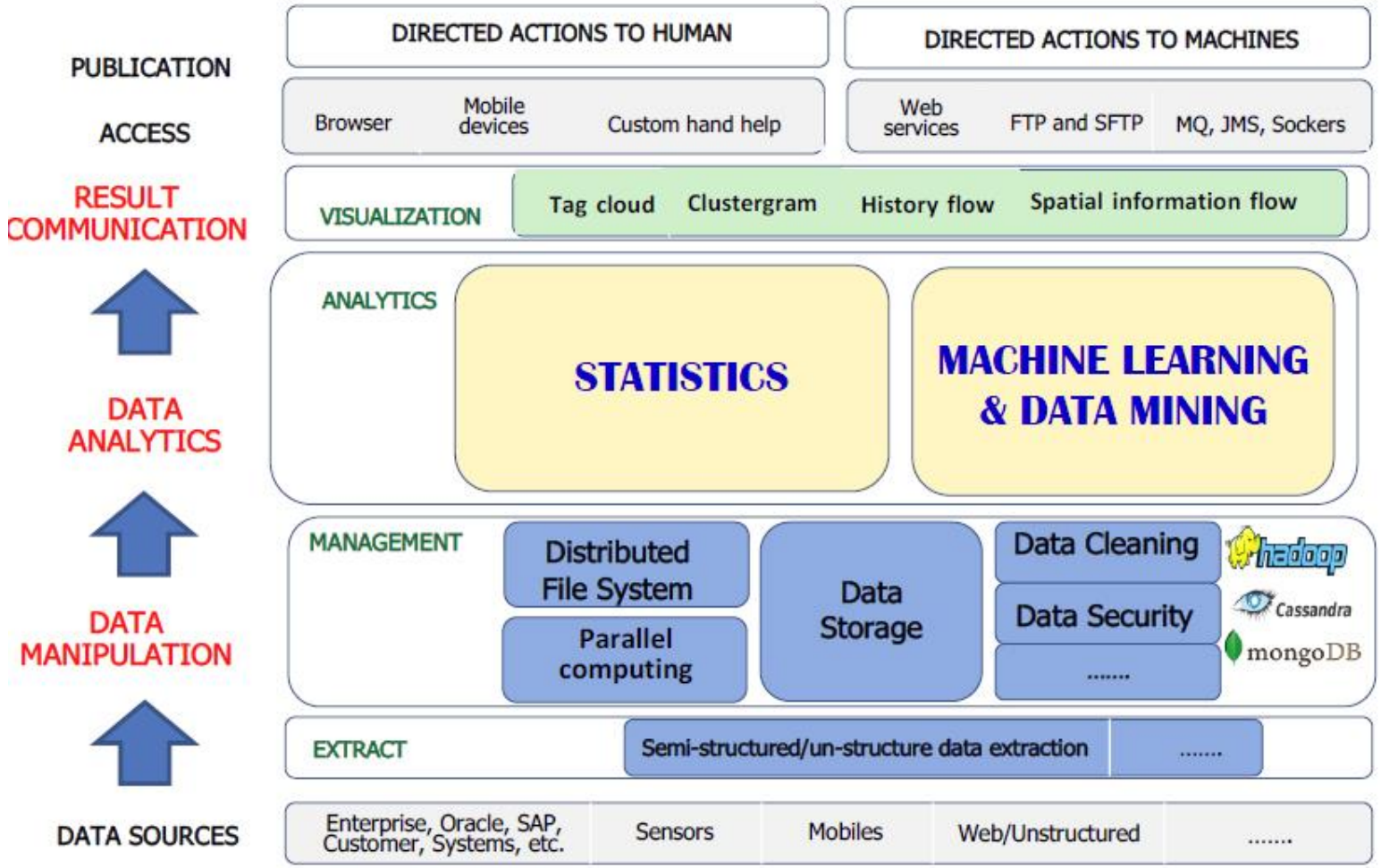
Big Data

- Data sets that are
  - Large
  - Complex
  - Dynamic

→ traditional data processing methods are inadequate to deal with them

Data Science

- Data Science = Mathematics + Computer Science + Application

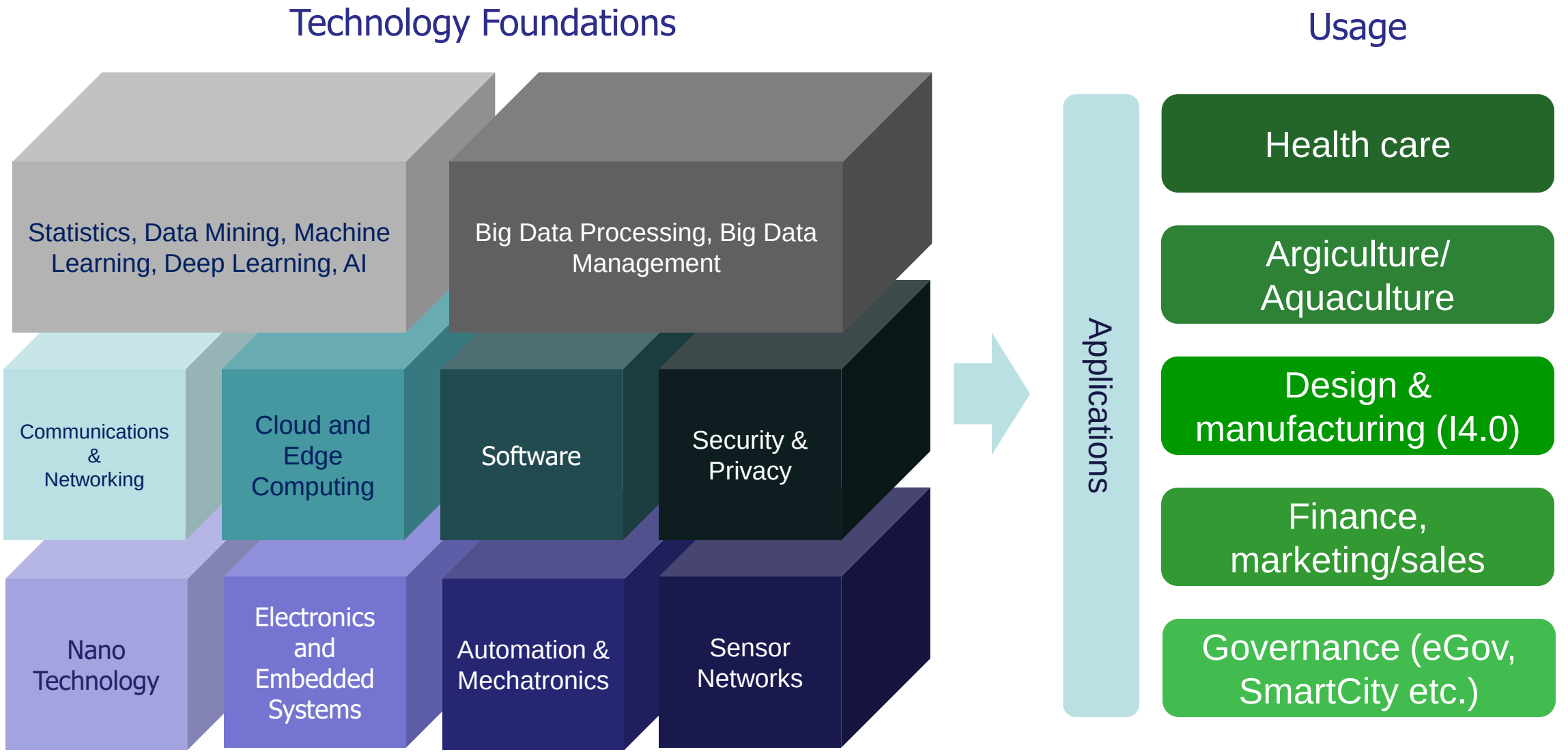


Source: "Overview of Data Science", Ho Tu Bao

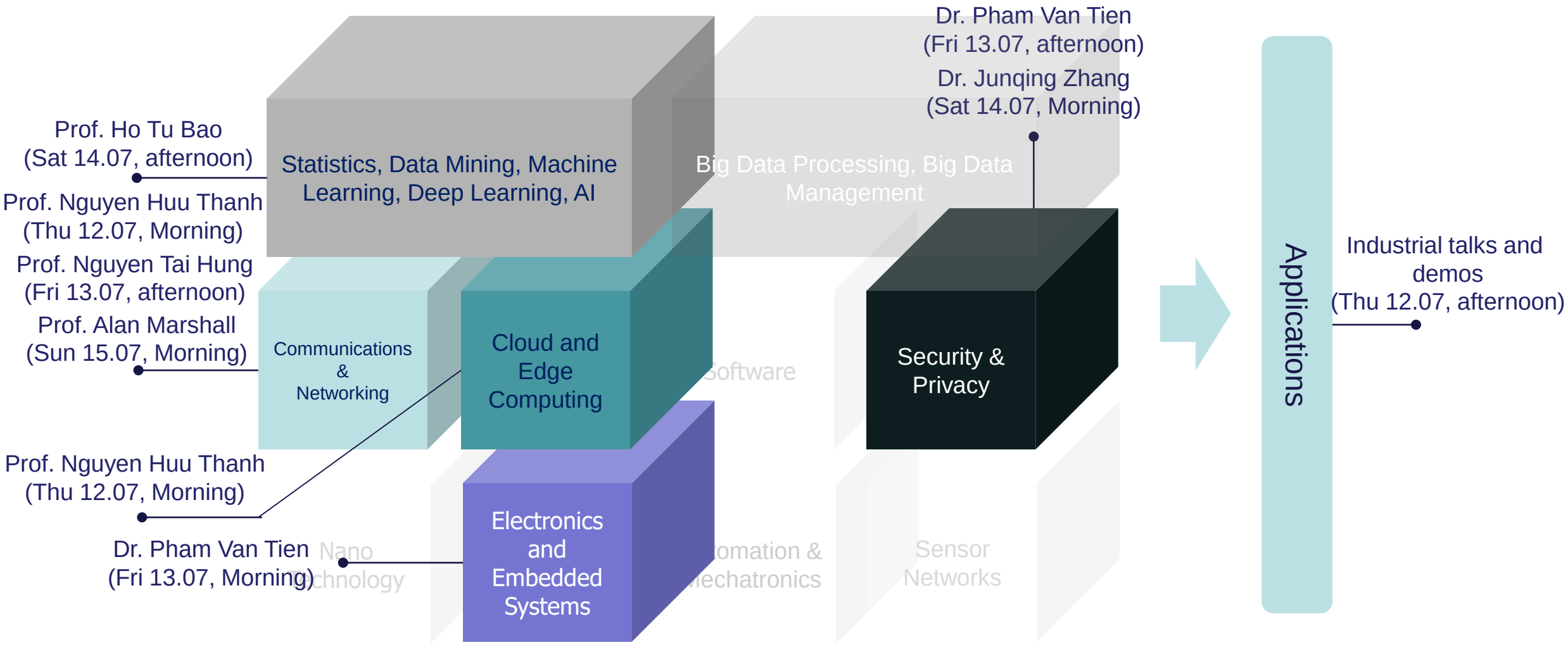
Data Science

- Mathematical background
  - Statistics
  - Data mining
  - Machine learning
  - Deep learning
  - Artificial intelligence
- Computer science
  - Big data processing: distributed/parallel computing
  - Big data management

Technology Foundations and Usages in the Information Age



Course Introduction and Structure



Course Introduction and Structure (*cont*...)

	Thu, 12.07 (morning)	Fri, 13.07 (morning)	Sat, 14.07 (morning)	Sun, 15.07 (morning)
Morning	Lecture on SDN and Cloud Computing Session- Chair: Prof. Nguyen Tai Hung	Lecture on Embedded Systems Chair: Dr. Phung Kieu Ha	Lecture on Security in IoT Chair: Dr. Tran Quang Vinh	Lecture on Detection in WIFI Network Chair: Dr. Phung Kieu Ha/Dr. Han Huy Dung
	8:45-9h00: Opening, Prof. Nguyen Huu Thanh, School of Electronics and Telecommunications, HUST			
	- 09:00 - 10:30: SDN and cloud computing in IoT Lecturer: Prof. Nguyen Huu Thanh, School of Electronics and Telecommunications, HUST	09:00 - 10:30: Embedded systems development in IoT Lecturer: Dr. Nguyen Van Tien, School of Electronics and Telecommunications, HUST	09:00 - 10:30: Security in Physical Layer for IoT Lecturer: Dr. Junqing Zhang, University of Liverpool	09:00 - 10:30: Detection in WIFI network Lecturer: Prof. Alan Marshall - University of Liverpool
	10:30-10:50: TEA BREAK	10:30-10:50: TEA BREAK	10:30-10:50: TEA BREAK	10:30-10:50: TEA BREAK
	10:50 - 11:30: SDN and cloud computing in IoT Lecturer: Prof. Nguyen Huu Thanh, School of Electronics and Telecommunications, HUST	10:50 - 11:30: Embedded systems development in IoT Lecturer: Dr. Pham Van Tien, School of Electronics and Telecommunications, HUST	10:50 - 11:30: Security in Physical Layer for IoT Lecturer: Dr. Junqing Zhang, University of Liverpool	10:50-11:30: Detection in WIFI network Lecturer: Prof. Alan Marshall - University of Liverpool
	11:30-12:00: QA	11:30-12:00: QA	11:30-12:00:QA	11:30-12:00:QA
12:00-14:00	LUNCH	LUNCH	LUNCH	LUNCH
	Thu, 12.07 (afternoon)	Fri, 13.07 (afternoon)	Sat, 14.07 (afternoon)	Sun, 15.07 (afternoon)
Afternoon	Industry session Chair: Dr. Pham Van Tien	Lecture on Block Chain and M2M Communications Chair: Prof. Nguyen Tai Hung	Lecture on Artificial Intelligence Chair: Prof. Nguyen Huu Thanh	Routable Discussion Chair: Prof. Alan Marshall
	14:00 - 14:30: "Smart Controller: Flexible Solution for IoT Applications" Hoang Hung Hai, Smart Devices R&D Center, Viettel	14:00-15:00: Blockchain in IoT Lecturer: Dr. Pham Van Tien, School of Electronics and Telecommunications	14:00-15:15: Artificial Intelligence Lecturer: Prof. Ho Tu Bao, John von Neumann Institute, Vietnam National University Ho Chi Minh City	13:30-15:00: Round table discussion and closing
	14:30 - 15:00: "IoT Deployment Approaches - Business Models for Mobile Operators", Ngo Vu Duc, R&D Center, Mobifone			
	15:00 - 15:30: "Industrial IoT 4.0: VNPT Technology's Viewpoints and Realisation", Pham Hung Manh, VNPT Technology, VNPT Corp.	15:00-15:15: QA		
	15:30-16:00: TEA BREAK & Exhibition sessions	15:15-15-30: TEA BREAK	15:15-15-30: TEA BREAK	
	16:00-16:30 : Industrial Talk	15:30 - 16:30: M2M communications Lecturer: Prof. Nguyen Tai Hung, School of Electronics and Telecommunications, HUST	15:30-16:15: Artificial Intelligence Lecturer: Prof. Ho Tu Bao, Vietnam National University Ho Chi Minh City	
	16:30 - 17:00: Industrial Talk	16:30-17:00: Q&A	16:15-17:00: Q&A	

Thank you!