

**Social and Urban Computing Group**

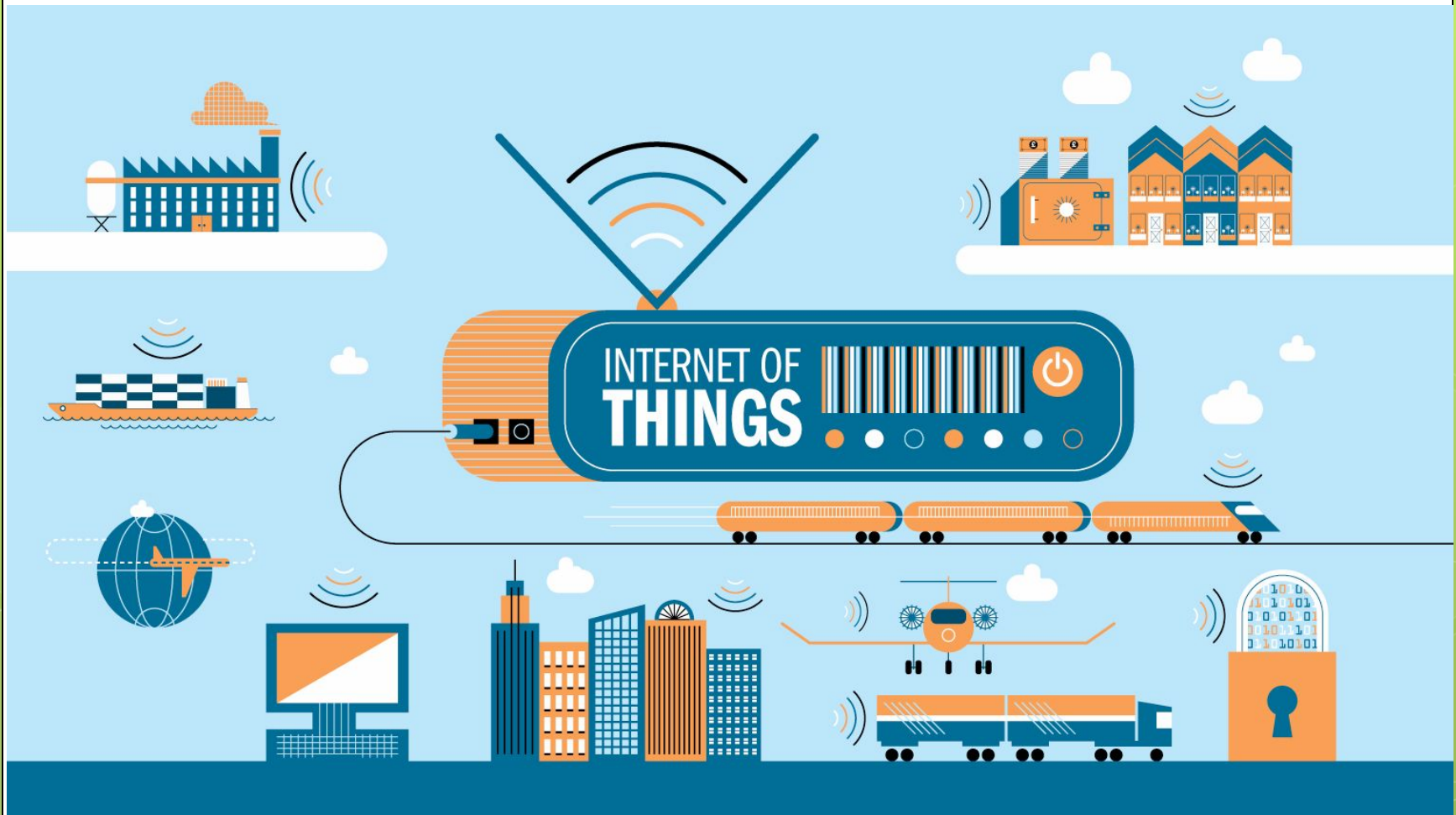
# Internet of Things

*Overview, challenges and solutions*

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- IoT
- Smart Devices
- Trends
- Issues and Challenges
- IoE, Fog Computing, CoT, SDT



*"IoT is the network of physical objects - devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity - enabling these objects to collect and exchange data."*

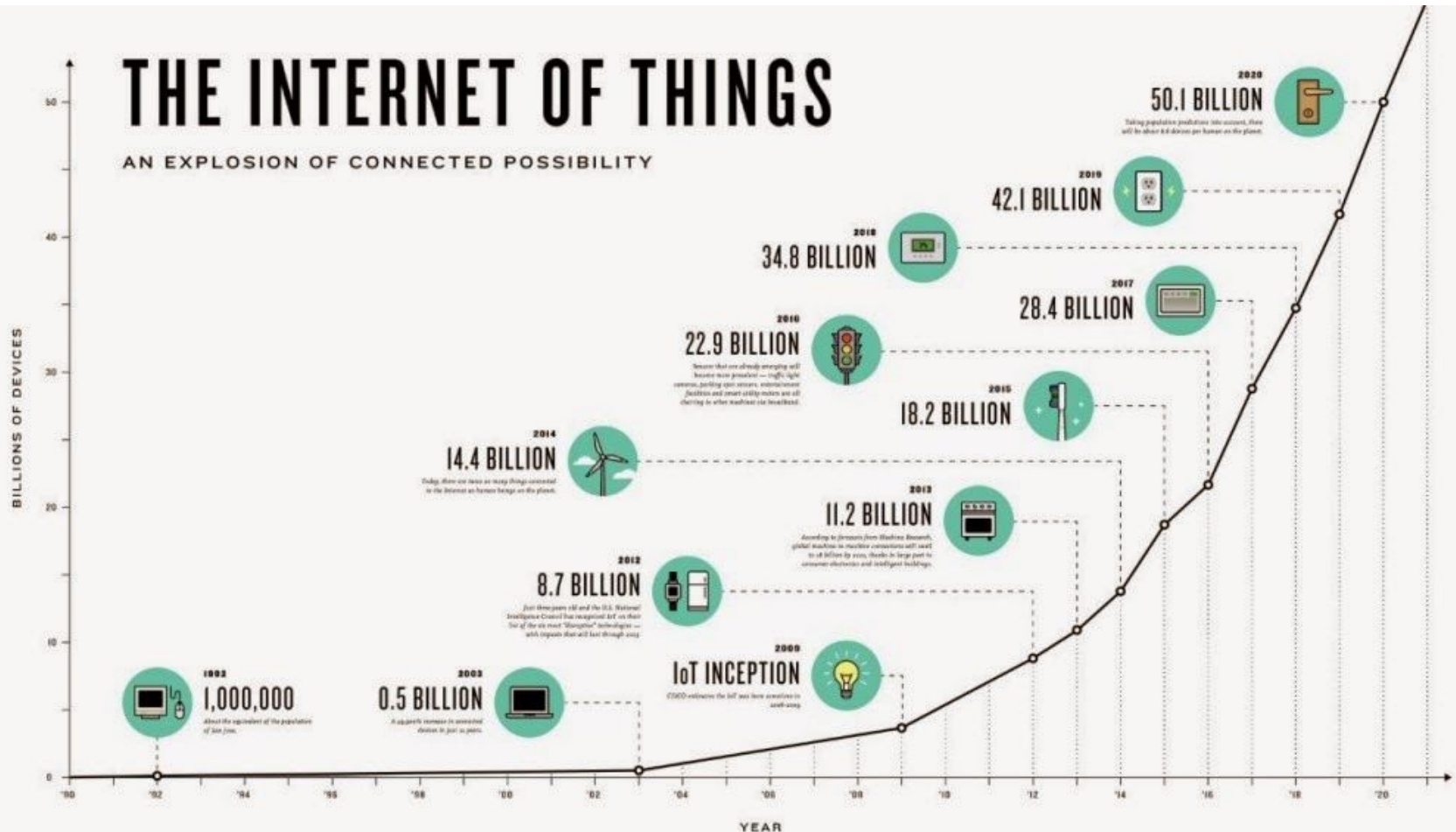
*"Internet of Things Global Standards Initiative". ITU.*

# Smart Devices



## THE INTERNET OF THINGS

AN EXPLOSION OF CONNECTED POSSIBILITY



# 2020

**4**  
BILLION

Connected People



**\$4**  
TRILLION

Revenue Opportunity



**25+**  
MILLION

Apps



**25+**  
BILLION

Embedded and  
Intelligent Systems



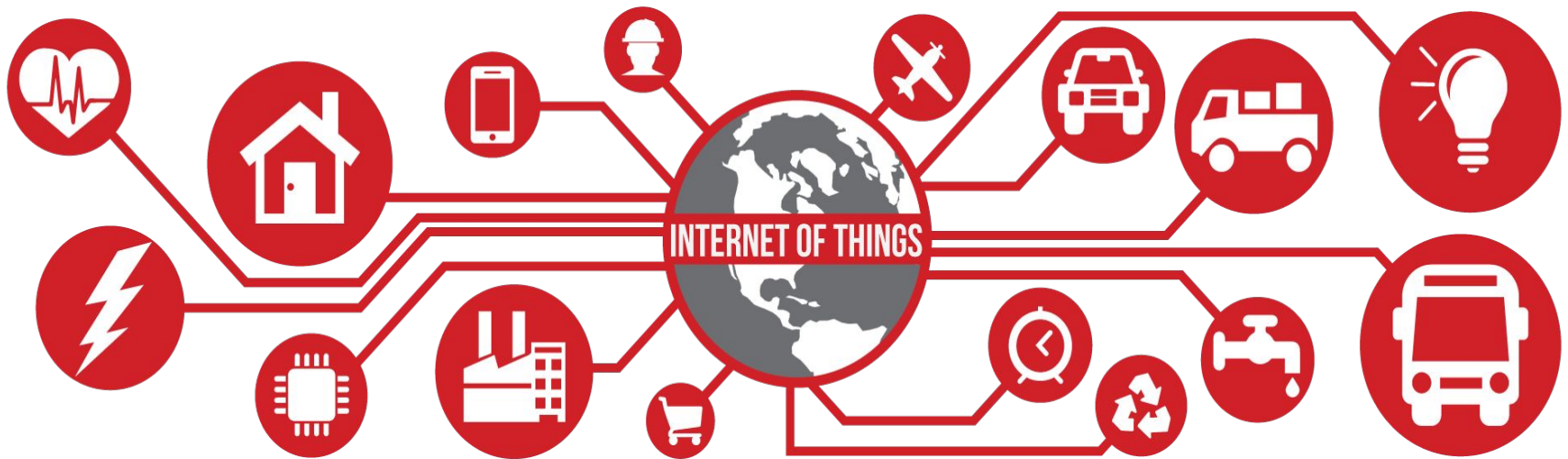
**50**  
TRILLION

GBs of Data




## □ Issues

- Not smart/ Internet enabled devices (e.g. sensors and actuators),
- Not smart objects and things



## □ Challenges

- IoT-zation, turn to smart
- Interconnections, Network
- Identify and categorize things
- Management (things and data)

- Add network interface to existing “things”
- Arduino 
  - Standard interface
  - Highly programmable and configurable
- Intel Galileo
- Samsung Artik
- Nanode, Pinguino, Teense, ...
- Raspberry
- ...



- Heterogeneous nodes-things
  - Communication protocols and mechanisms
  - Unmanned Machine-to-Machine interaction (M2M)
    - CoAP: a light HTTP protocol
    - MQTT: a PubSub system
    - AllJoyn: “discovery” of resources and services
  - Distributed -> No Control
  - Best effort -> No Guarantees

- What is a thing?
- Need of a common knowledge base, semantics, ontologies
  - Sensor and actuator types and metrics
    - OGC Sensor Web Enablement (SWE), Sensor Model Language (SML), (W3C) Semantic Sensor Network (SSN)
  - Semantic Web
    - XML, Resource Description Framework RDL, OWL,
  - Dynamic semantics
- Web of Things

- Wide-scale – billions of things
  - Huge amount of data (Zettabytes  $2^{70}$ - $10^{21}$ )
  
- Solutions
  - Distributed, Autonomic, self-organizing
  - IoT-Cloud convergence: ubiquitous
    - Technological -> Cloud support IoT - SaaS
    - Methodological -> adopt the Cloud-service oriented paradigm to the provisioning of things  
Cloud of things, Things as a Service - IaaS
  - Software defined and virtualized ecosystems
    - SD things, SD cities, SDIoT

## What Is the Internet of Everything (IoE)?



Networked Connection of People, Process, Data, Things

### People

Connecting people in more relevant, valuable ways



### Process

Delivering the right information to the right person (or machine) at the right time



### Data

Leveraging data into more useful information for decision-making



### Things

Physical devices and objects connected to the Internet and each other for intelligent decision-making; often called Internet of Things (IoT)



IoE

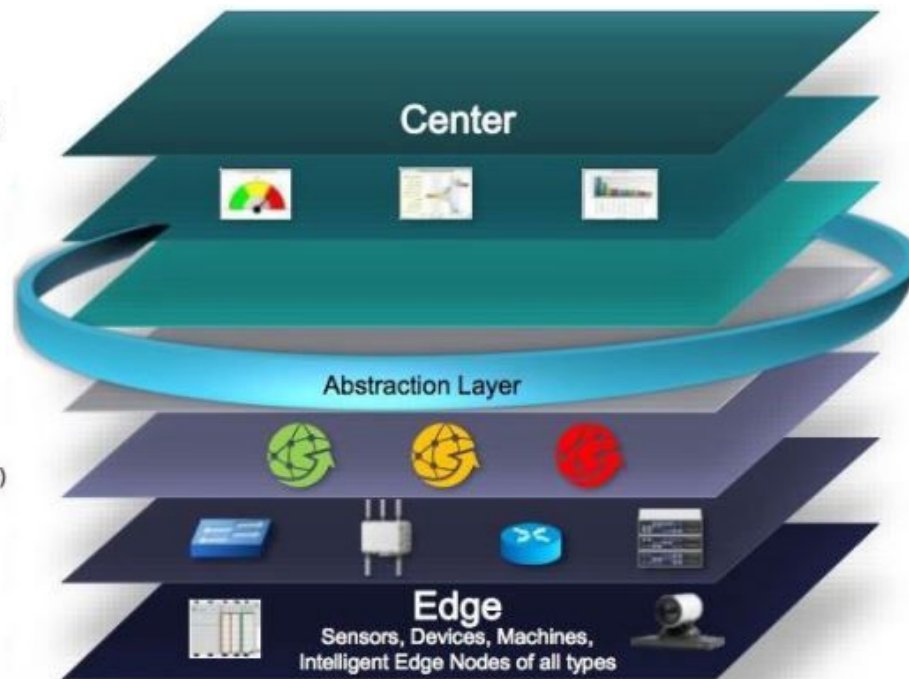
[#FutureOfIT](#)



- Aims at extending Cloud to the edge of an enterprise's network
- Facilitates the end devices-Cloud compute, storage and networking interactions
- Consists of a control plane and a data plane
- Emphasizes proximity to end-users and client objectives, dense geographical distribution and local resource pooling, quality of service (QoS) and edge analytics/stream mining

## Levels

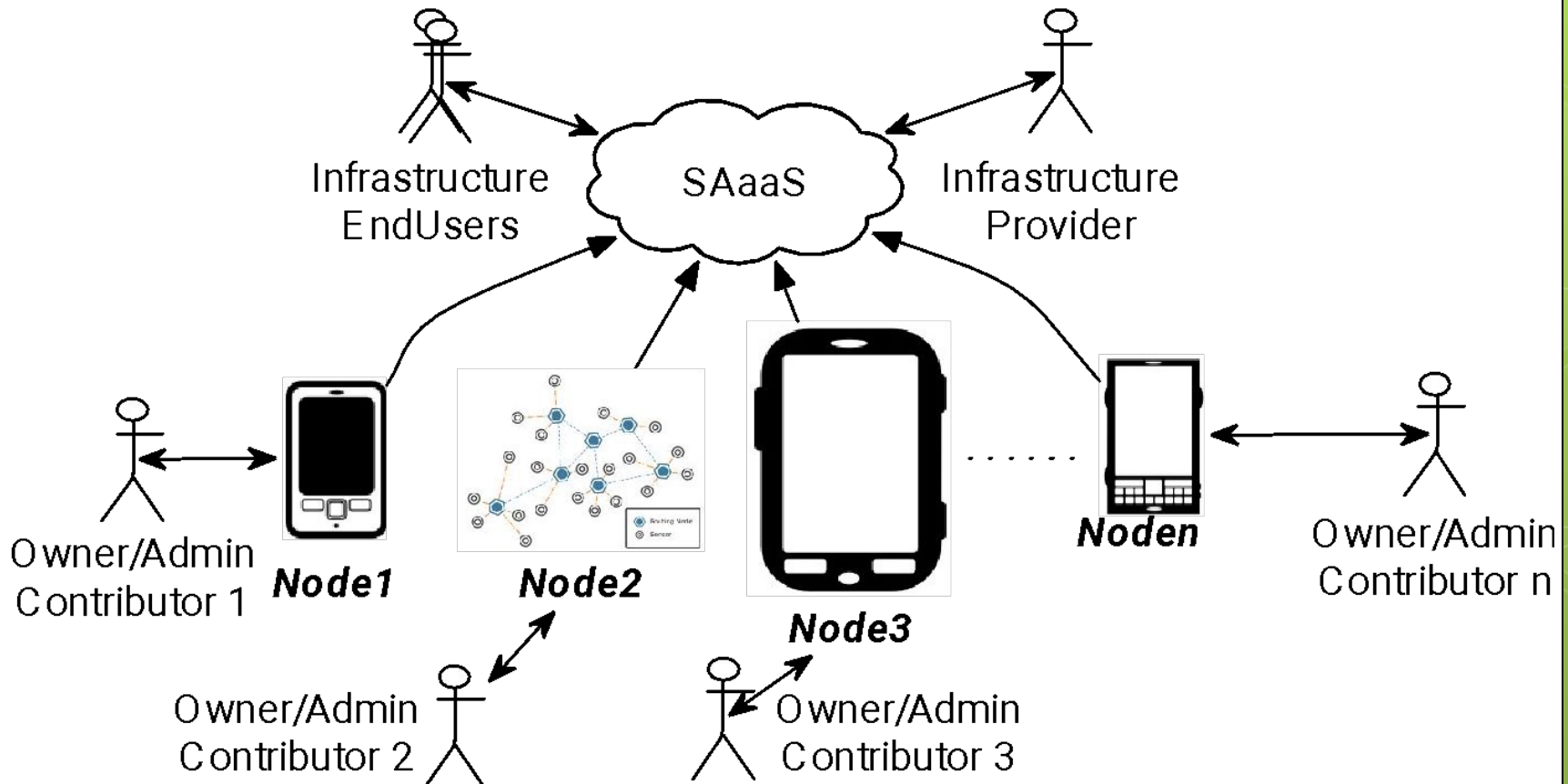
- 7 Collaboration & Processes**  
(Involving People & Business Processes)
- 6 Application**  
(Reporting, Analytics, Control)
- 5 Data Abstraction**  
(Aggregation & Access)
- 4 Data Accumulation**  
(Storage)
- 3 Edge Computing**  
(Data Element Analysis & Transformation)
- 2 Connectivity**  
(Communication & Processing Units)
- 1 Physical Devices & Controllers**  
(The "Things" in IoT)



- IoT, Cloud and Smart Cities
  - SensorCloud
  - SDC
  - MCSaaS
  - ...
  
- Requirements:
  - 2-6 students/project
  - Java and/or Python
  
- International partnership, visit opportunities
  - Politecnico di Milano, Massachusetts Institute of Technology, National Technical University Athens, University of Messina, ...
  - Cisco, Dog Hunter, RosTelecom, ...



- Goal: Implementing a Cloud of sensors
- Device-centric
- Involving actuators



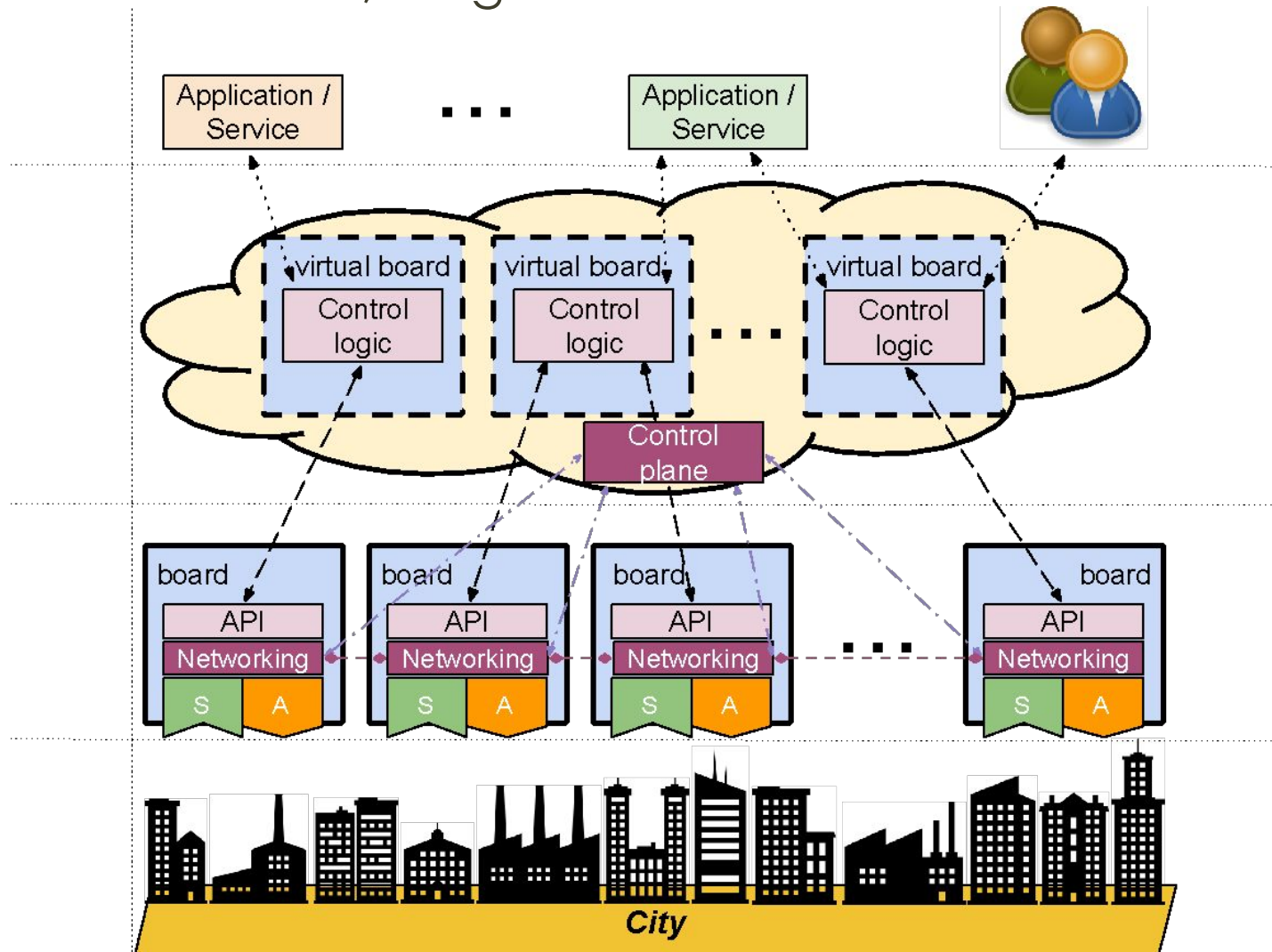


Massachusetts  
Institute of  
Technology



dog hunter

Goal: Smart, Programmable and Customizable Cities

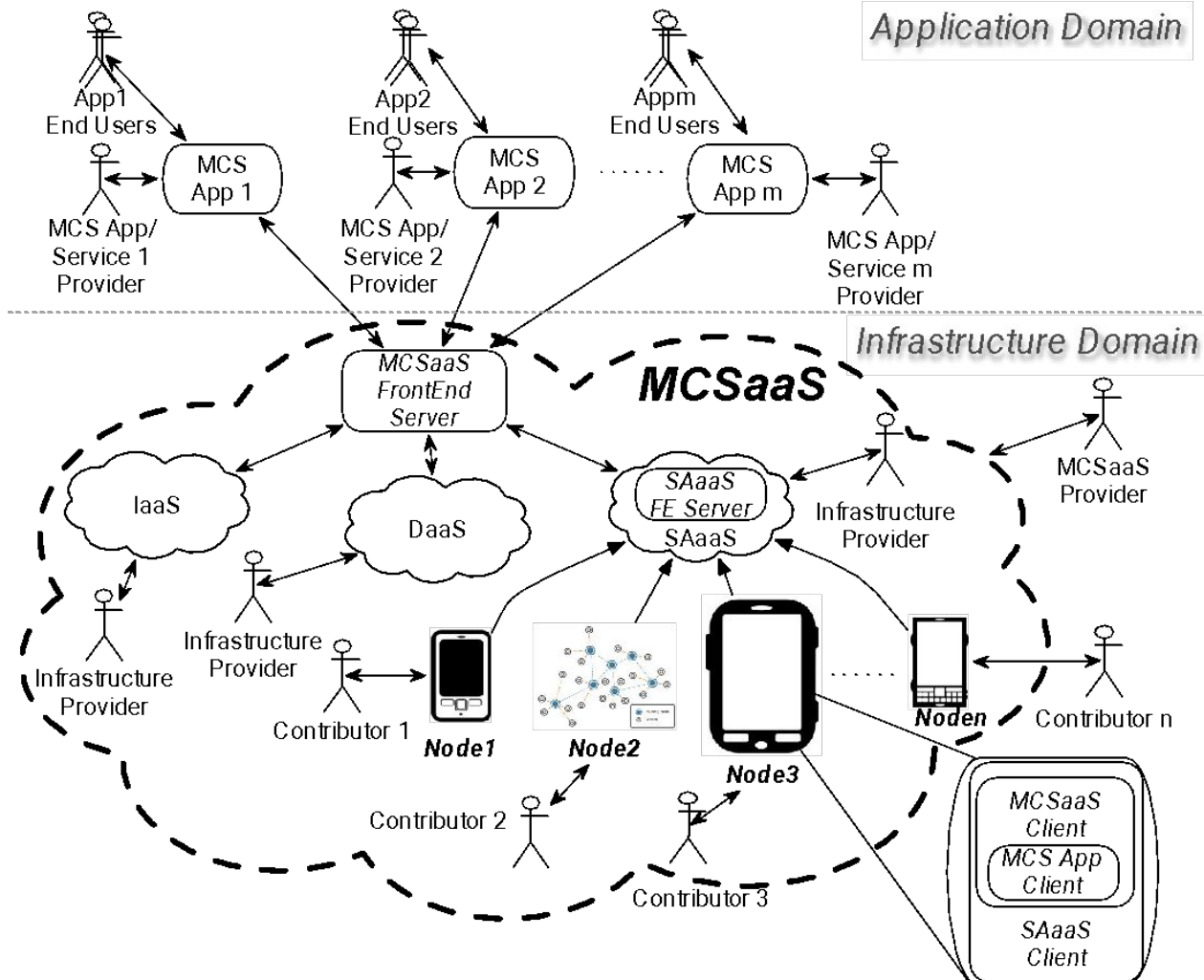






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Technology

## Goal: Unlock MCS capabilities



QUESTIONS?

