POLITECNICO DI MILANO

Computing Infrastructures

Overview of Computing Infrastructures

The topics of the course: what are we going to see today?

HW Infrastructures:

System-level: Computing Infrastructures and Data Center Architectures, Rack/Structure;

Node-level: Server (computation, HW accelerators), Storage (Type, technology), Networking (architecture and technology);

Building-level: Cooling systems, power supply, failure recovery

SW Infrastructures:

Virtualization: Process/System VM, Virtualization Mechanisms (Hypervisor, Para/Full virtualization)

Computing Architectures: Cloud Computing (types, characteristics), Edge/Fog Computing, X-as-a service

Methods:

Reliability and availability of datacenters (definition, fundamental laws, RBDs)

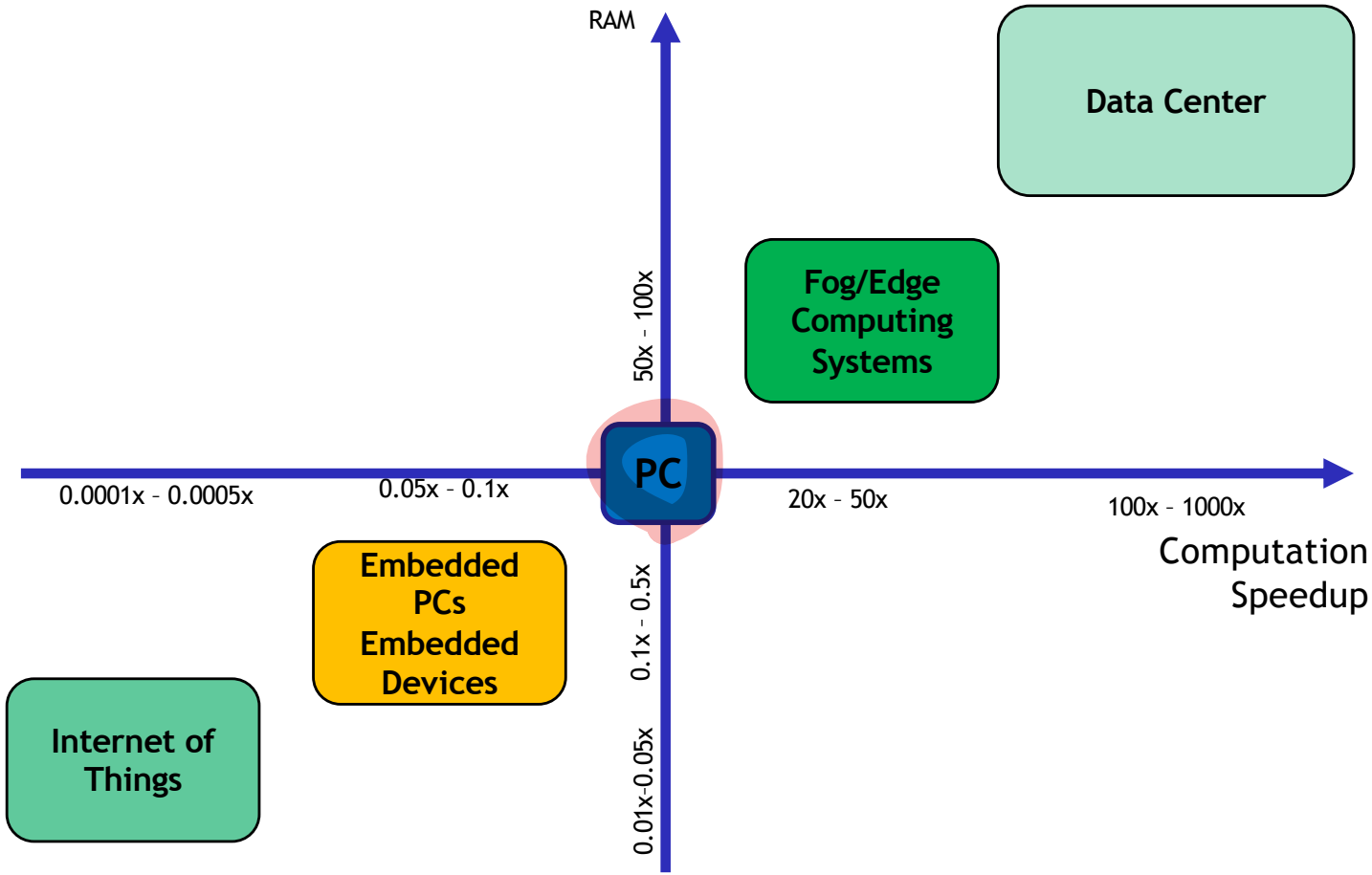
Disk performance (Type, Performance, RAID)

Scalability and performance of datacenters (definitions, fundamental laws, queuing network theory)

What is a computing infrastructure?

Technological infrastructure that provides hardware and software for computation to other systems and services

Examples of Computing Infrastructures



Computing Continuum

The Computing Continuum

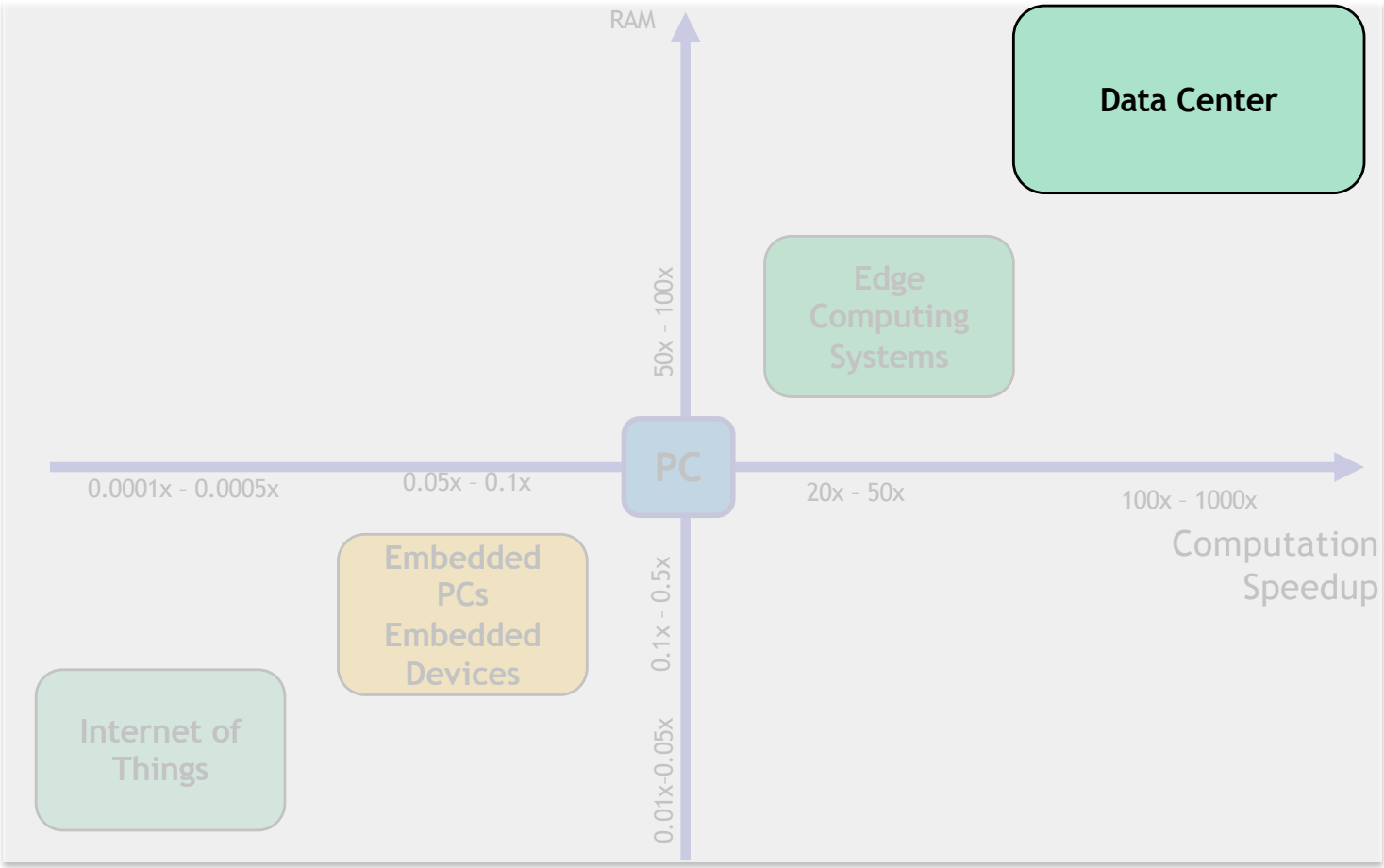
IoT/Edge — Fog — HPC/Cloud/Instrument

Size	Nano	Micro	Milli	Server	Fog	Campus	Facility
Example	Adafruit Trinket	Particle.io Boron	Array of Things	Linux Box	Co-located Blades	1000-node cluster	Datacenter
Memory	0.5K	256K	8GB	32GB	256G	32TB	16PB
Network	BLE	WiFi/LTE	WiFi/LTE	1 GigE	10GigE	40GigE	N*100GigE
Cost	$5	$30	$600	$3K	$50K	$2M	$1000M

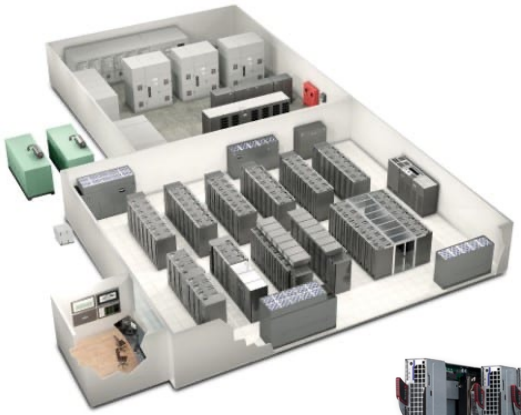
Count = 10^9
Size = 10^1

Count = 10^1
Size = 10^9

Examples of Computing Infrastructures



Data Centers: a technological perspective

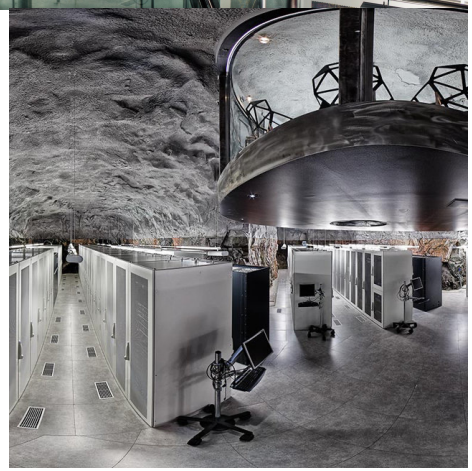


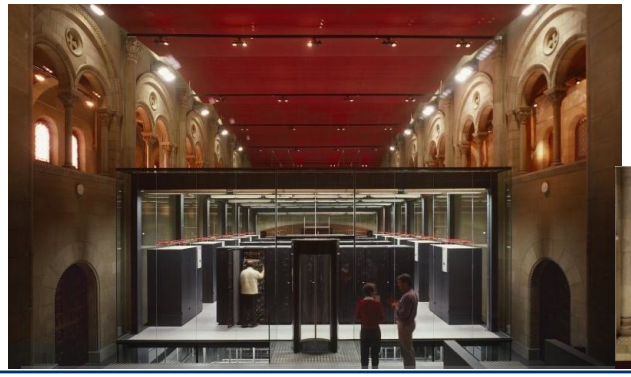
Server for Processing

Server for Storage

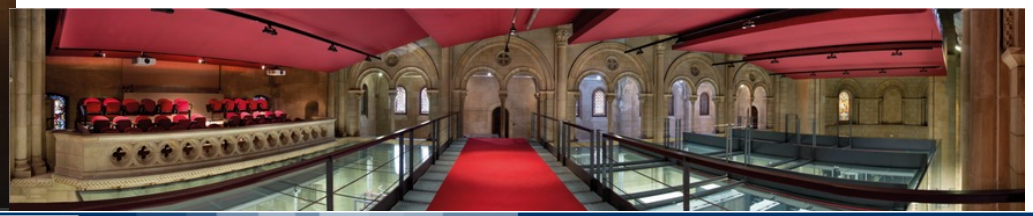
Server for Communication

The Pionen White Mountains is a Swedish data center. This center is located in Stockholm.





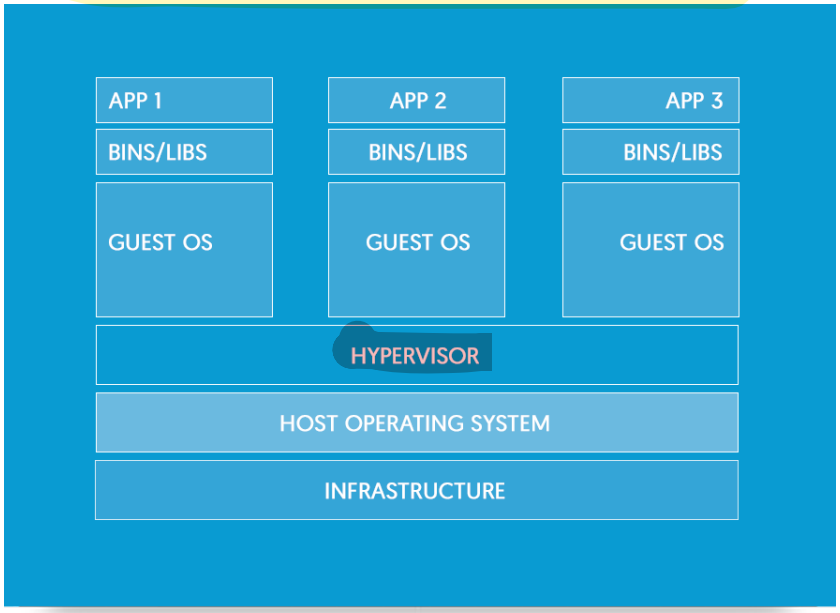
Barcellona Supercomputing Center



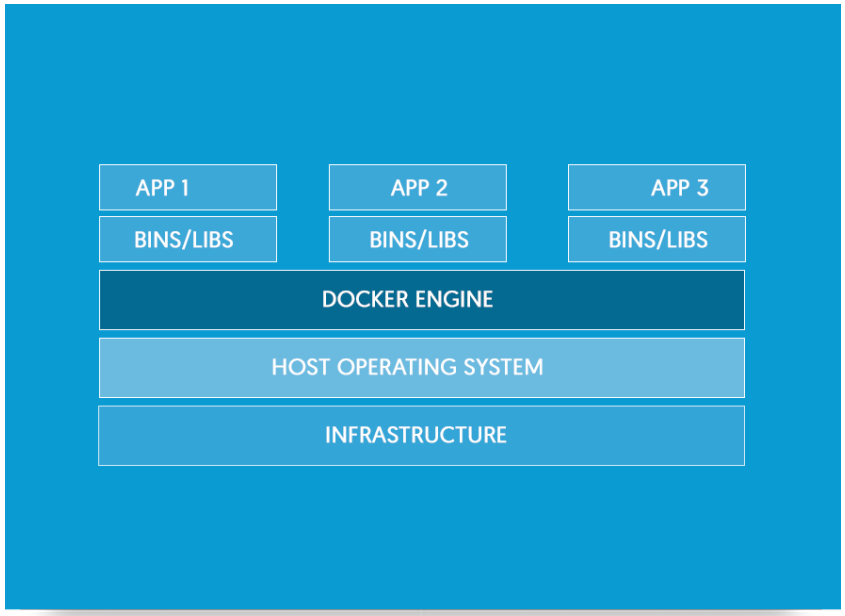
… Not always nice places

Virtual Machines and Containers

VMMs
Provide the full stack (OS, LIB, APP).
Applications depend on guest OS.



Containers
Applications are packaged with all their dependencies into a standardized unit for software development/deployment.

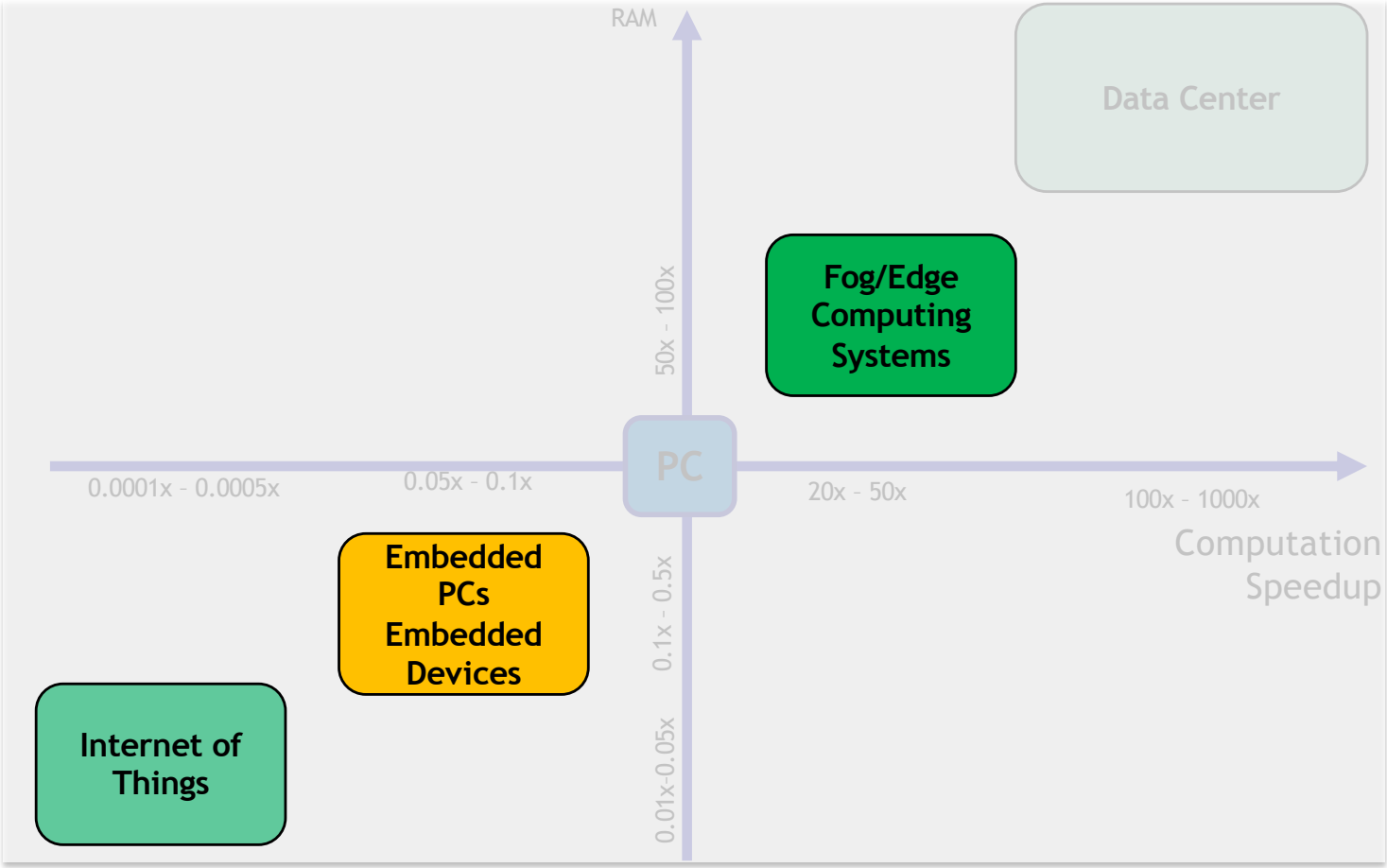


Data Centers: advantages and disadvantages

- ✓ Lower IT costs
- ✓ High performance
- ✓ Instant software updates
- ✓ "Unlimited" storage capacity
- ✓ Increased data reliability
- ✓ Universal data access
- ✓ Device Independence

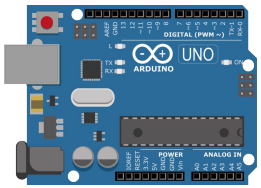
- ➢ Require a constant Internet connection
- ➢ Do not work well with low-speed connections
- ➢ Hardware Features might be limited
- ➢ Privacy and security issues
- ➢ High Power Consumption
- ➢ Latency in making decision

Edge Computing, PC Embedded and IoT

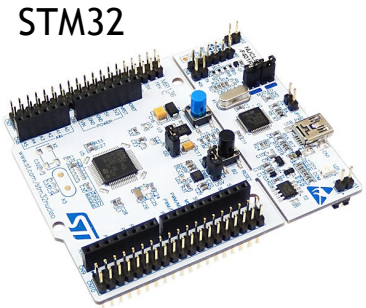


Internet-of-Things

Arduino



STM32



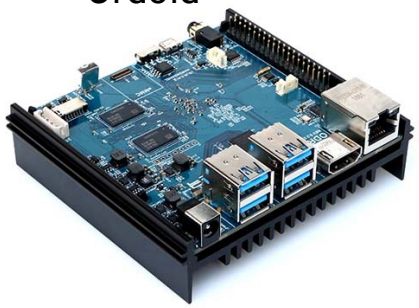
	STM32 L1 Series	STM32F4 Series
Domain	Ultra Low-Power	High-Performance
Flash Memory (kB)	32 to 512	64 to 2048
RAM Memory (kB)	4 to 80	32 to 320
CPU	ARM® Cortex®-M3	ARM® Cortex®-M4
Frequency (MHz)	32	84 to 180
Supply Voltage (V)	1.65 to 3.6	1.71 to 3.6
Supply Current (μA)	0.28 (0.28) to 230	1.1 (140) to 282

- ✓ Highly Pervasive
- ✓ Wireless connection
- ✓ Battery Powered
- ✓ Low costs
- ✓ Sensing and actuating

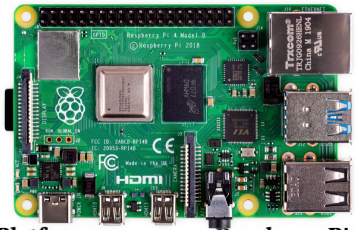
- ➢ Low computing ability
- ➢ Constraints on energy
- ➢ Constraints on memory (RAM/FLASH)
- ➢ Difficulties in programming

Embedded PCs

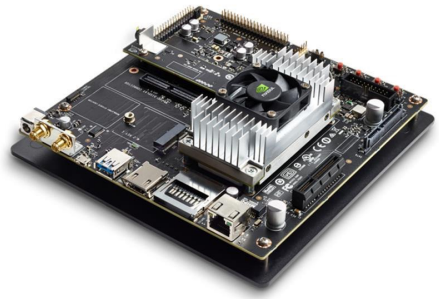
Ordoid



Raspberry



Platform	Raspberry Pi 3B
CPU	ARM11 @ 1.2 GHz
RAM	1024 MB



Jetson TX2

Google Coral

- ✓ Pervasive computing
- ✓ High performance unit
- ✓ Availability of development boards
- ✓ Programmed as PC
- ✓ Large community

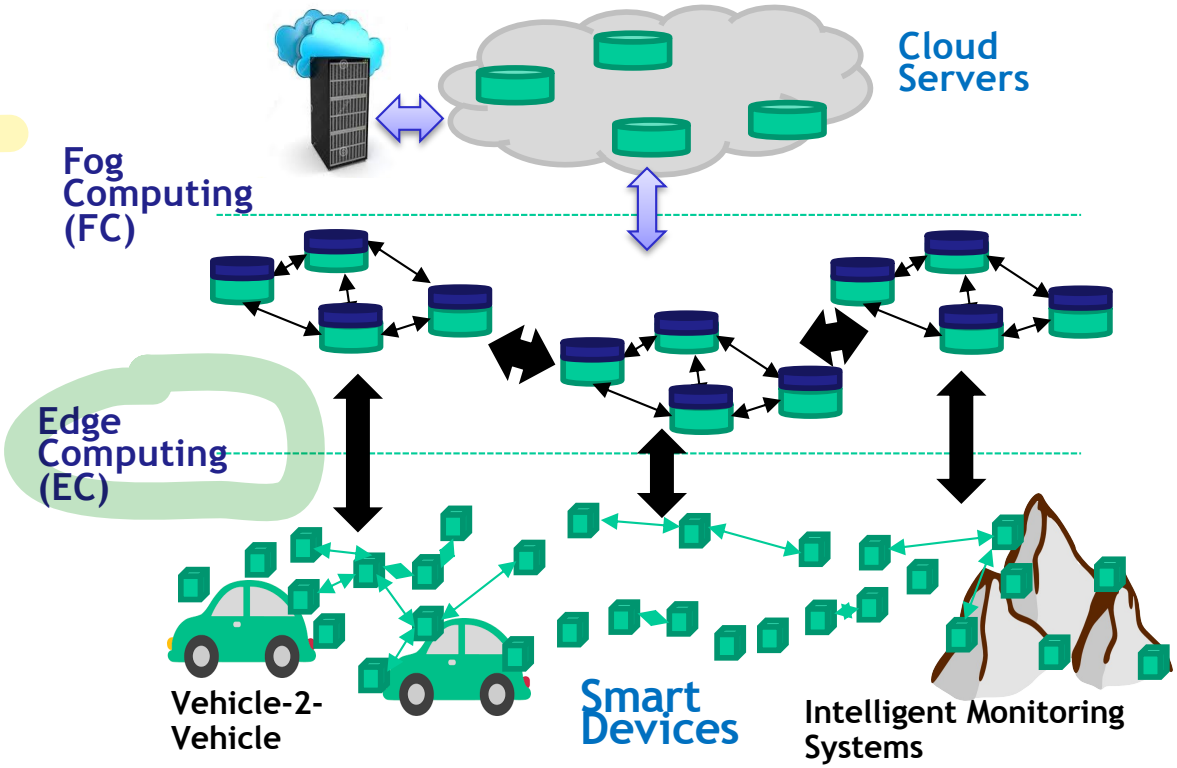
- ➢ Pretty high power consumption
- ➢ (Some) HW design has to be done

Edge/Fog Computing Systems

The key *difference between fog computing* and edge computing is associated with the location **where the data is processed**

- In **edge computing**, the data is processed closest to the sensors
  - *component producing the data*
- In **fog computing**, the computing is moved to processors linked to a local area network (IoT gateway).

Edge computing places the intelligence in the connected devices themselves, whereas, fog computing puts it in the local area network



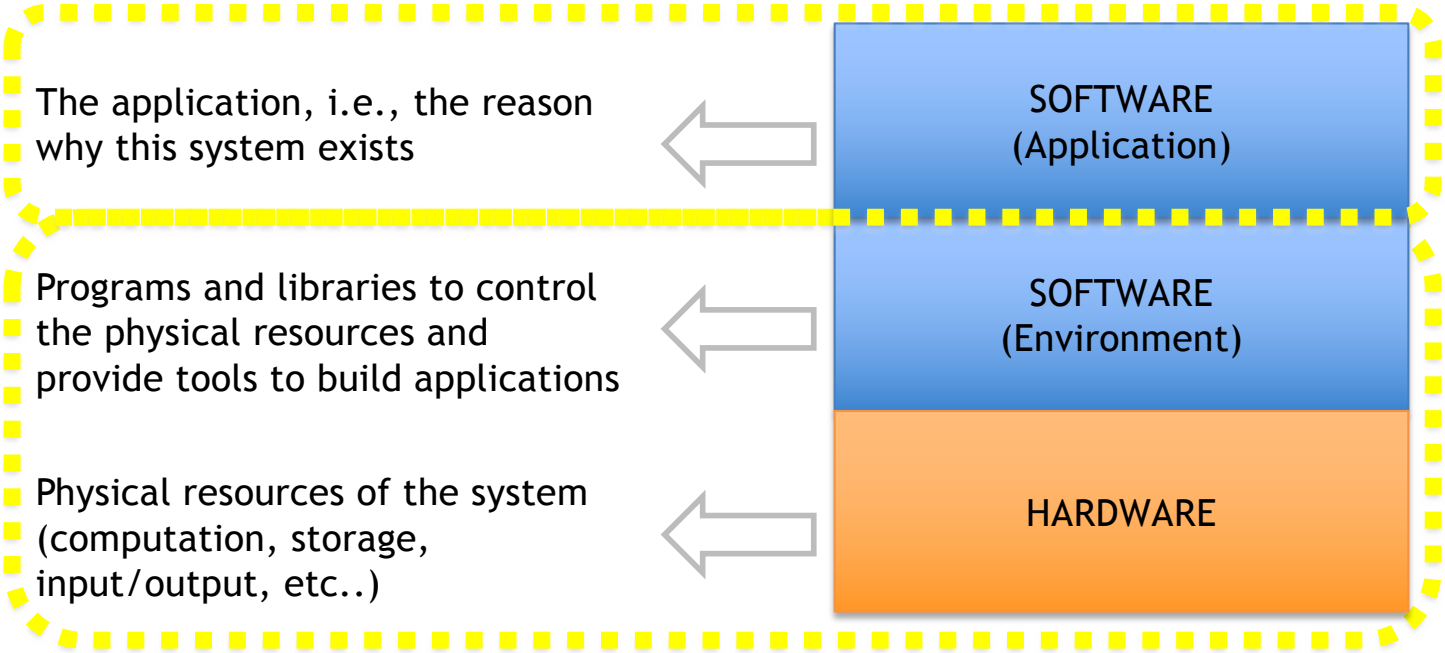
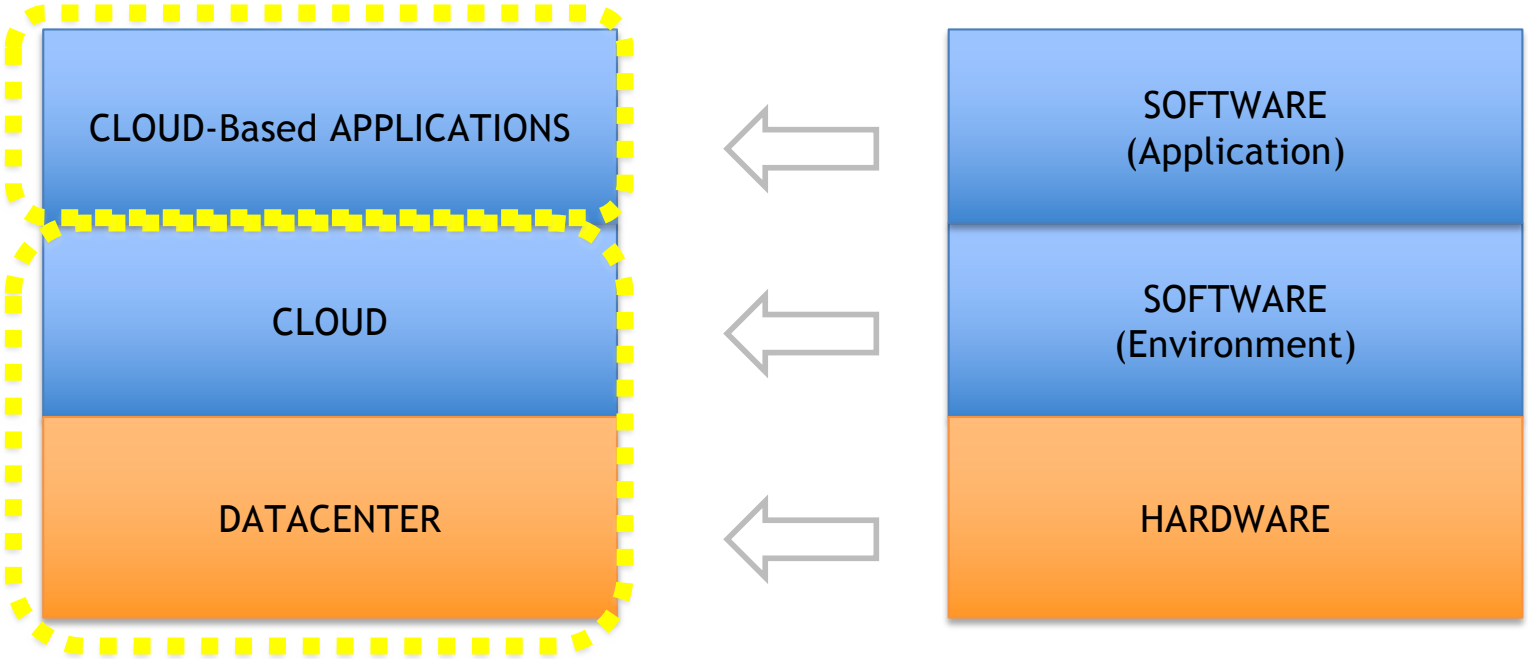
Fog/Edge Examples

IoT Gateways	SYS-E50-9AP-WIFI	SYS-E100-9S-E	SYS-E300-8D	SYS-5018D-FN8T
Processor/Cache				
CPU	**Intel® Atom® processor E3940** Single socket FCBGA 1296 9.5W, 4C	**7th Generation Intel® Core i5-7300U Processor** Single Socket FCBGA 1356 System-on-Chip CPU TDP support 15W	**Intel® processor D-1518,** 2.2GHz; CPU TDP support 35W FCBGA 1667: 4 Cores, 8 Threads / 6MB	**Intel® Xeon® processor D-1518** 2.2GHz; CPU TDP support 35W FCBGA 1667: 4 Cores, 8 Threads / 6MB
System Memory				
Memory Capacity	Up to 8GB Unbuffered non-ECC SO-DIMM DDR3L-1866MHz, in 1 DIMM socket	Up to 32GB Unbuffered non-ECC SO-DIMM, DDR4-2133MHz, in 2 DIMM slots	4x DDR4 DIMM sockets Supports up to 128GB DDR4 ECC RDIMM Supports up to 64GB DDR4 ECC/non-ECC UDIMM	4x DDR4 DIMM sockets Supports up to 128GB DDR4 ECC RDIMM Supports up to 64GB DDR4 ECC/non-ECC UDIMM
Memory Type	DDR3L up to 1866MHz	DDR4 up to 2133MHz	2133/1866/1600MHz ECC DR4 ECC RDIMM and ECC/Non-ECC UDIMM	2133/1866/1600MHz ECC DDR4 ECC RDIMM and ECC/Non-ECC UDIMM
DIMM Sizes	8GB, 4GB, 2GB	16GB, 8GB, 4GB	32GB, 16GB, 8GB, 4GB	32GB, 16GB, 8GB, 4GB
Memory Voltage	1.35 V	1.2 V	1.2 V	1.2 V

- ✓ High computational capacity
- ✓ Distributed computing
- ✓ Privacy and security
- ✓ Reduced Latency in making a decision

- ➢ Require a power connection
- ➢ Require connection with the Cloud

An IT perspective for Computing Infrastructures



An IT perspective for Computing Infrastructures