

# CONTEXT-AWARENESS

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BLM5134 – Week 2

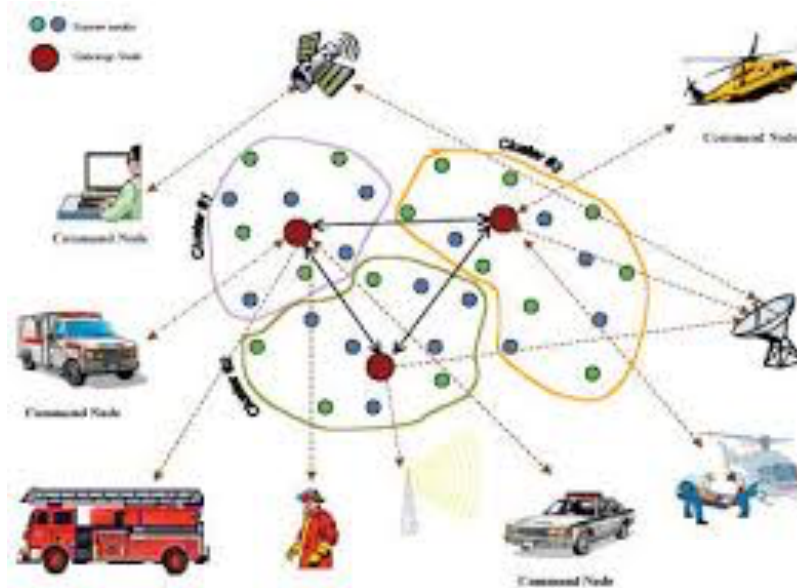
# What is Context-Awareness?

- desktop applications
- web applications
- mobile computing
- pervasive/ubiquitous computing



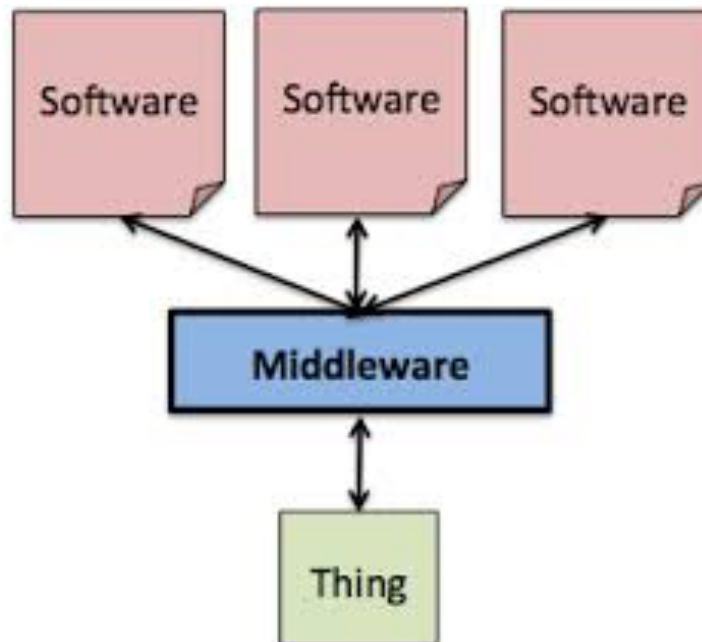
# IoT and Sensor Networks

- Sensors
  - powerful
  - cheaper
  - smaller in size
- IoT
  - billions of sensors are connected
    - to the Internet
- Big Data
- Middleware solutions



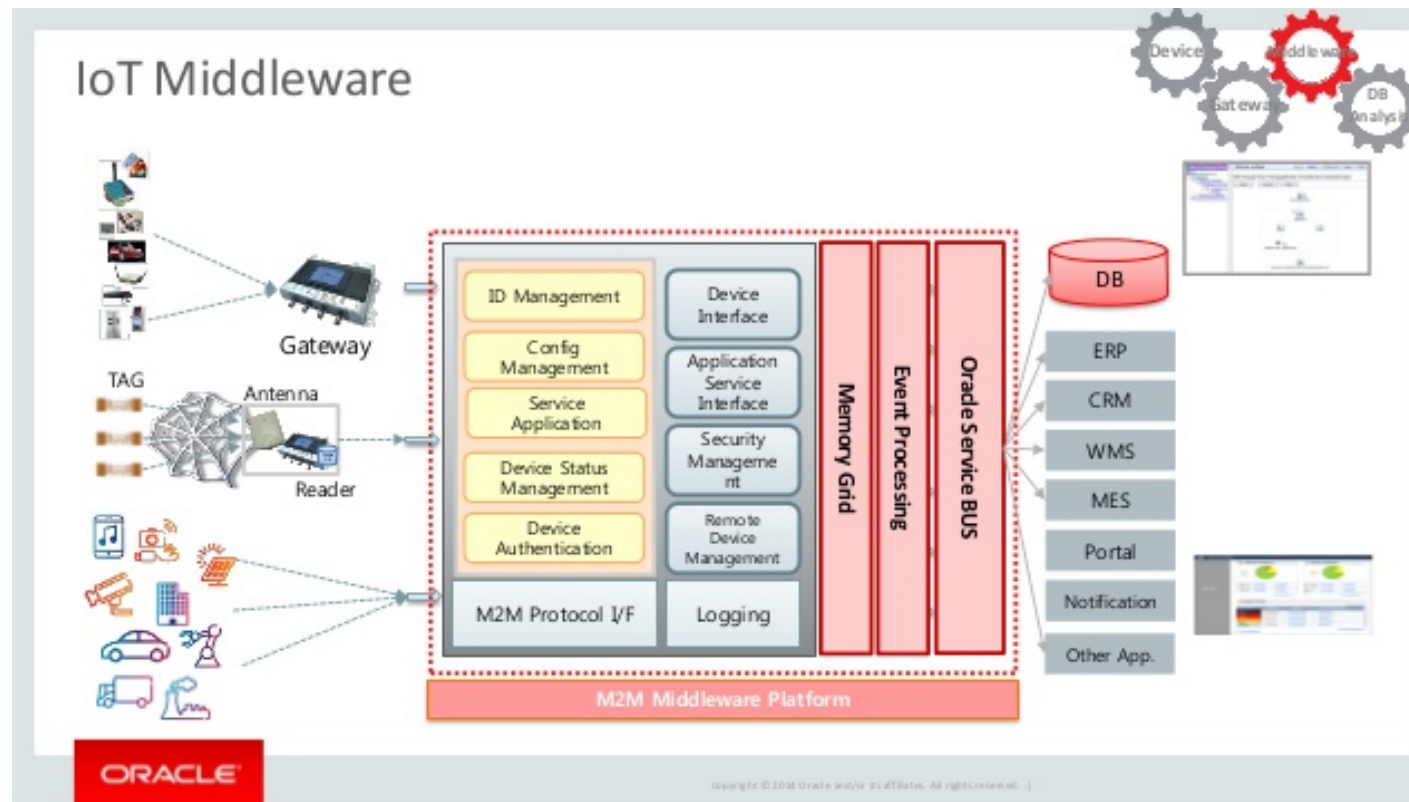
# What is Middleware?

- Middleware is a software layer that stands between the networked operating system and the application and provides well known reusable solutions to frequently encountered problems like heterogeneity, interoperability, security, dependability.*

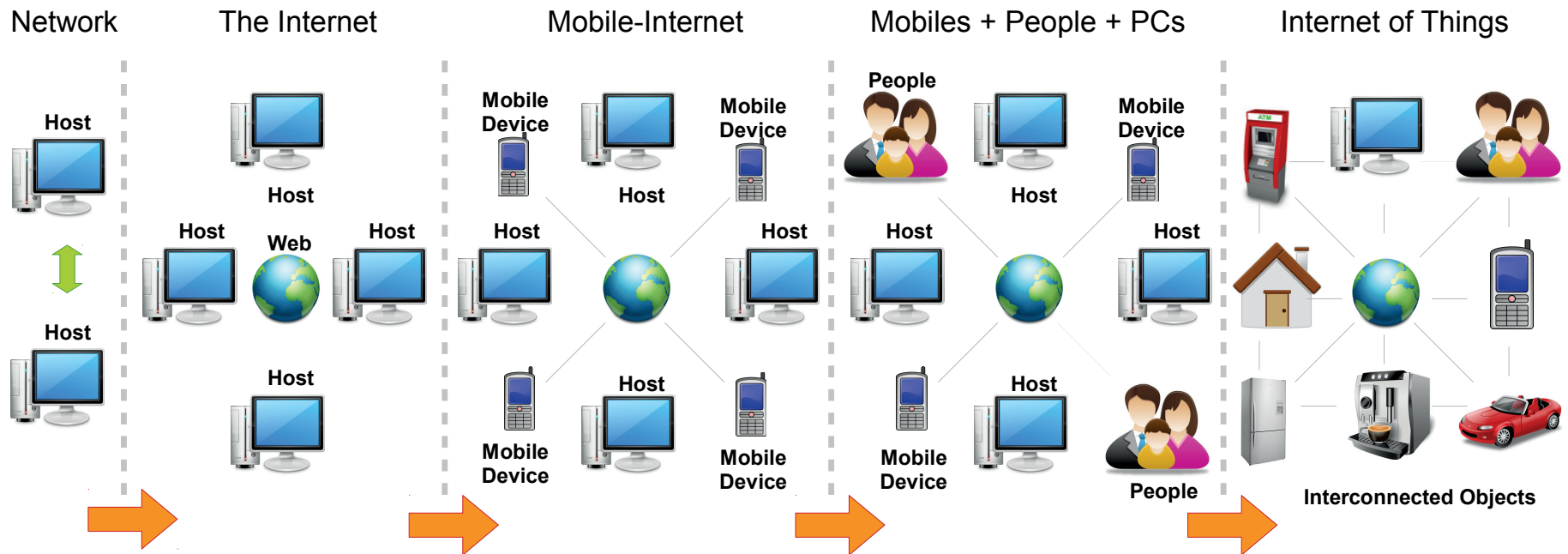


# Middleware Solutions for IoT

- device management
- interoperability
- platform portability
- context-awareness
- security and privacy



# Evolution of Internet



# Definitions of IoT

- *“Things have identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environment, and user contexts.”*



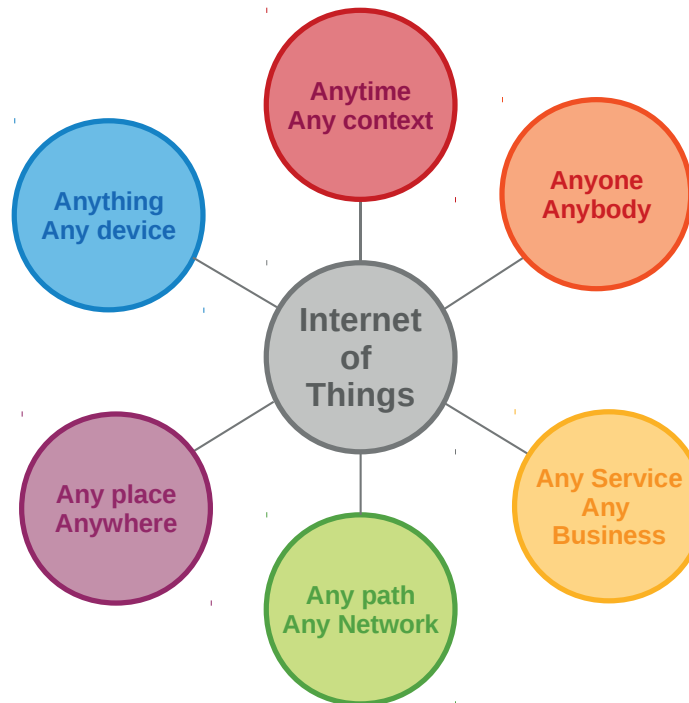
# Definitions of IoT

- *“The semantic origin of the expression is composed by two words and concepts: Internet and Thing, where Internet can be defined as the world-wide network of interconnected computer networks, based on a standard communication protocol, the Internet suite (TCP/IP), while Thing is an object not precisely identifiable Therefore, semantically, Internet of Things means a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols.”*



# Definitions of IoT

- *“The Internet of Things allows people and things2 to be connected Anytime, Anyplace, with Any- thing and Anyone, ideally using Any path/network and Any service.”*



# Types of Internet of Things

## Information Technology

- PCs
- Servers
- Virtualization
- Routers
- Switches

## Personal Technology

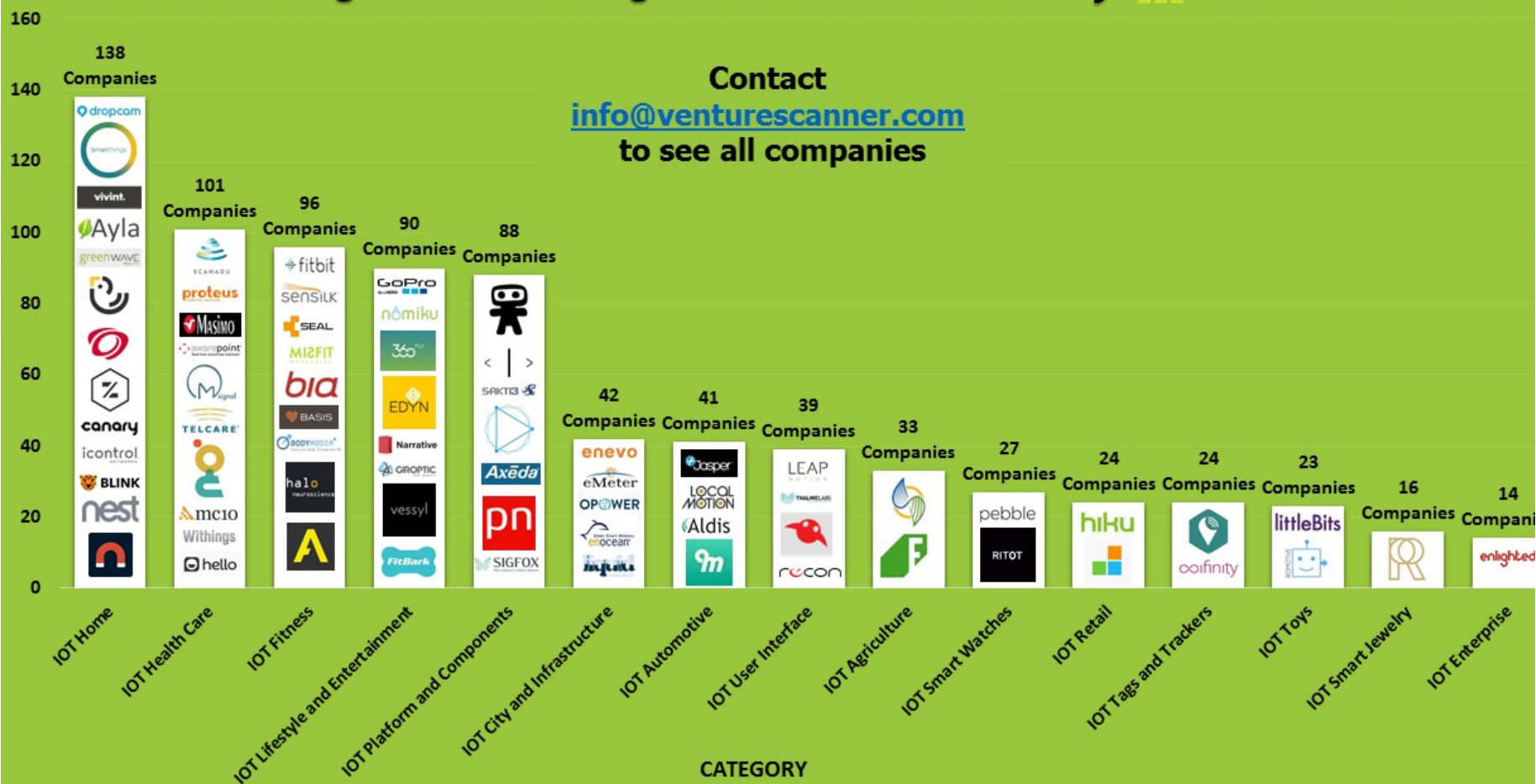
- Tablets
- Smart phones
- Smart watches
- Home energy
- Home entertainment
- Home control
- Medical implants
- Medical wearables

## Operational Technology

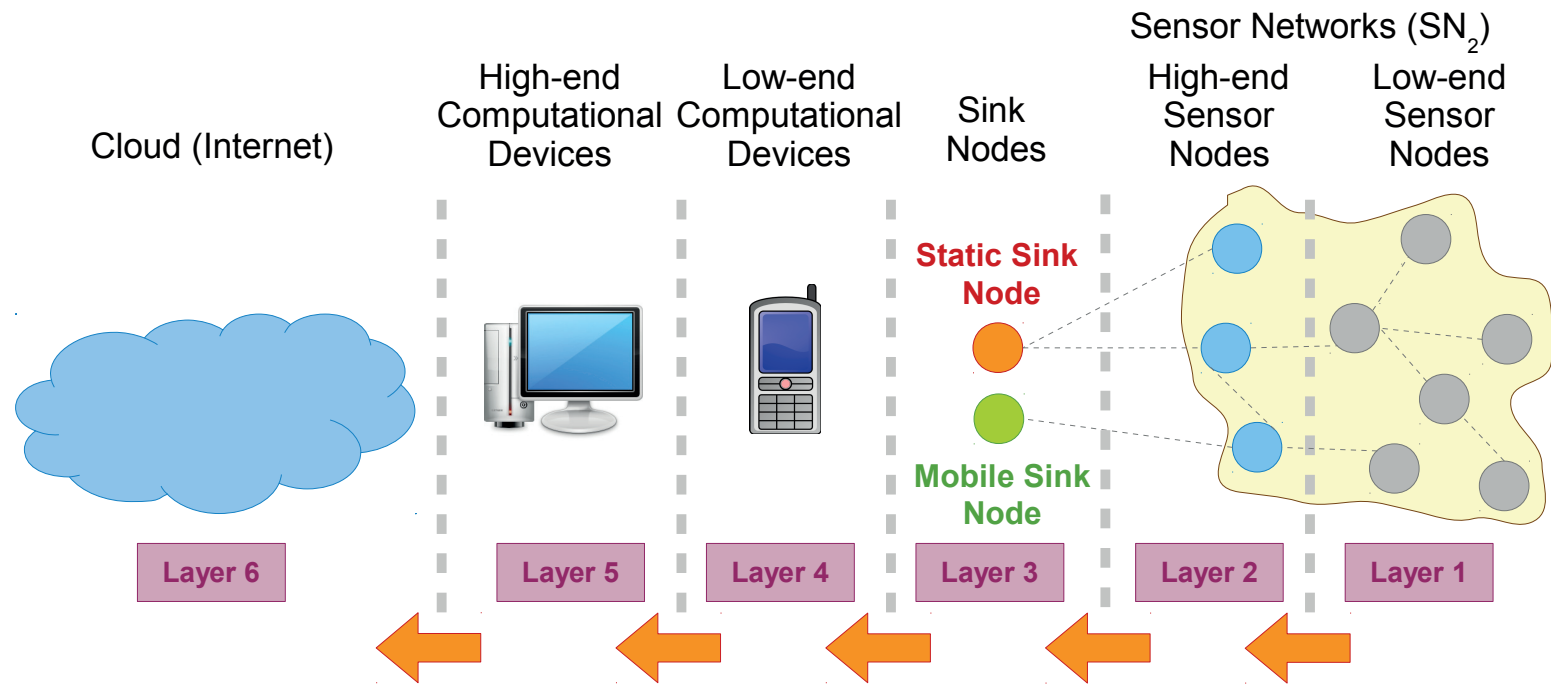
- Industrial Control Systems(ICS)
- Supervisory control and data acquisition
- Medical machines
- Kiosks
- Manufacturing
- Cloud service infrastructure
- Environmental Monitoring

# IoT App Categories

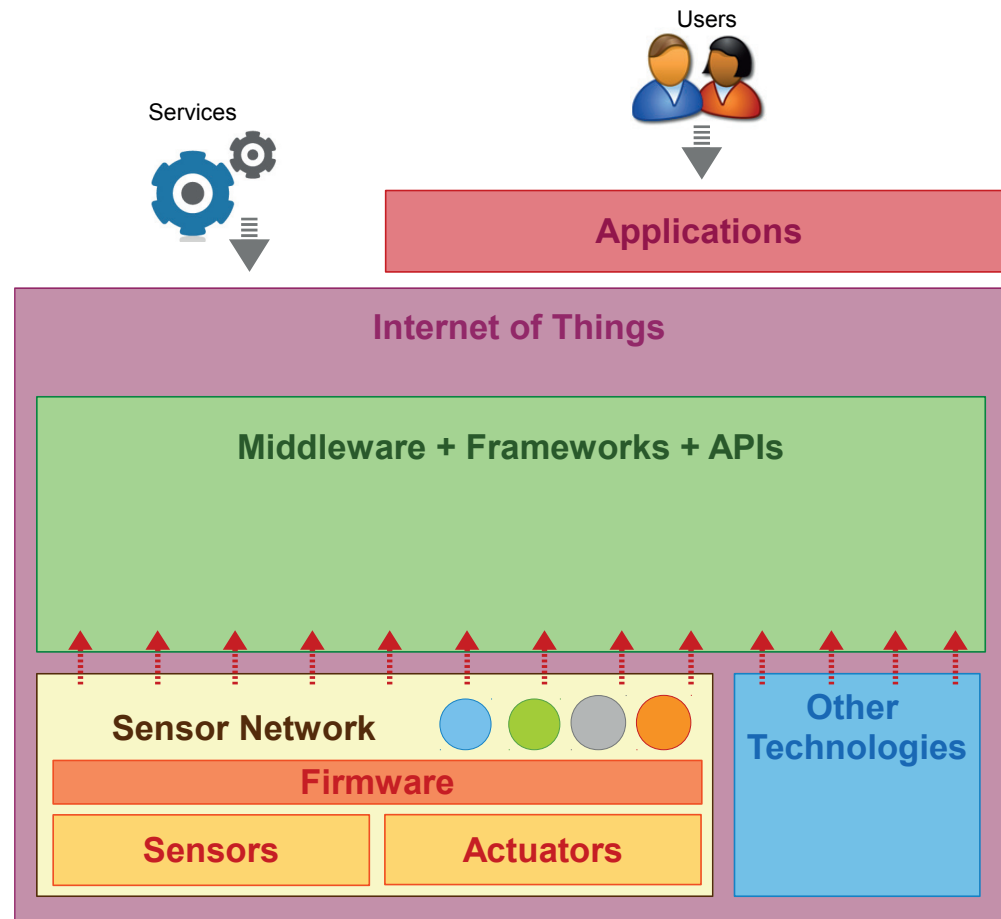
Which IOT Categories Are Seeing the Most Innovation? by  Venture Scanner



# Sensor Networks

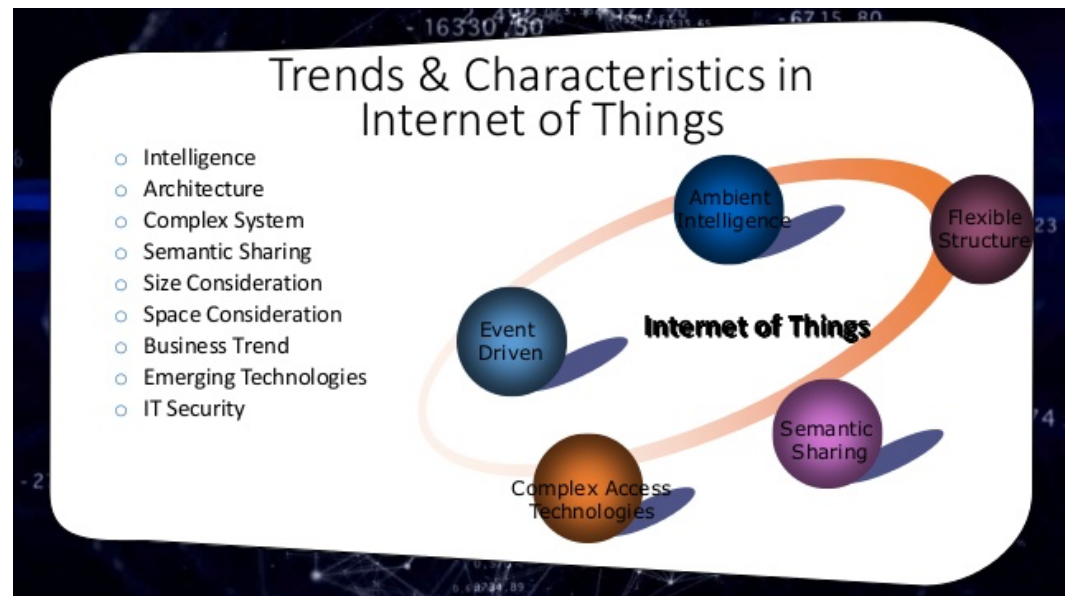


# Relationship between Sensor Networks and IoT



# Major Characteristics for IoT

- *intelligence*
  - fuse sensor data
- *architecture*
  - *Event-driven, time-driven*
- *complex system*
  - Sensors, actuators
- *size considerations*
  - 50-100 billion devices
- *time considerations*
  - Real-time data processing
- *space considerations*
  - location plays a significant role in context-aware computing
- *everything-as-a-service*
  - Sharing would be essential



# What is Context ?

- *“Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves”*
- “

# What is Context ?

- *Circumstance, situation, phase, position, posture, attitude, place, point; terms; regime; footing, standing, status, occasion, surroundings, environment, location, dependence.”*





# Raw Data and Context Information

- Raw (sensor) data: Is unprocessed and retrieved directly from the data source, such as sensors.
- Context information: Is generated by processing raw sensor data. Further, it is checked for consistency and meta data is added.



# Events

- Discrete Events



- Continuous Events



# Context-Awareness

- *“A system is context-aware if it uses context to provide*
- *relevant information and/or services to the user, where relevancy depends on the user’s task.*
- Context awareness frameworks typically should support
  - acquisition
  - representation
  - delivery
  - reaction

# Context Model and Context Attribute

- *A context model identifies a concrete subset of the context that is realistically attainable from sensors, applications and users and able to be exploited in the execution of the task. The context model that is employed by a given context-aware application is usually explicitly specified by the application developer, but may evolve over time.*
- *A context attribute is an element of the context model describing the context. A context attribute has an identifier, a type and a value, and optionally a collection of properties describing specific characteristics*

# Quality of Context

- context data validity
- context data precision
- context data up-to-dateness

# Categories of Context

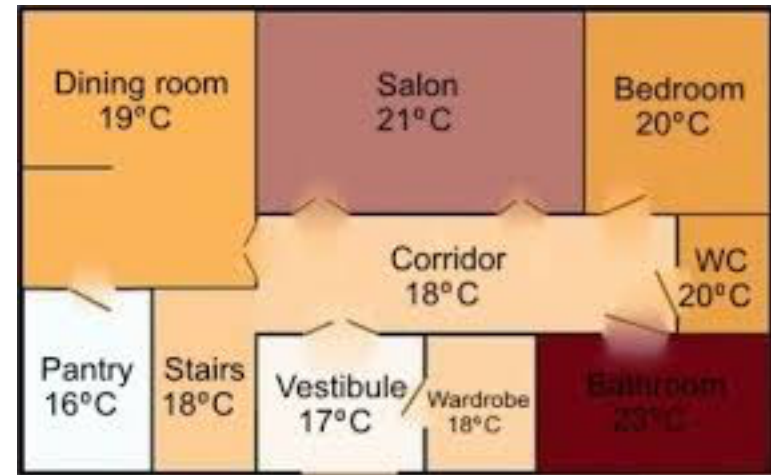
Categories of Context (Operational Perspective)	
Categories of Context (Conceptual Perspective)	
	Primary
	Secondary
Location	Location data from GPS sensor (e.g. longitude and latitude)
Identity	Distance of two sensors computed using GPS values Image of a map retrieved from map service provider
Time	Identify user based on RFID tag
Activity	Retrieve friend list from users Facebook profile Identify a face of a person using facial recognition system
	Calculate the season based on the weather information Predict the time based on the current activity and calender
	Predict the user activity based on the user calender Find the user activity based on mobile phone sensors such as GPS, gyroscope, accelerometer

# A different Approach

- Sensed: Sensor data directly sensed from the sensors, such as temperature measured by a temperature sensor. Values will be changed over time with a high frequency.
- Static: Static information which will not change over time, such as manufacturer of the sensor, capabilities of the sensor, range of the sensor measurements.
- Profiled: Information that changes overtime with a low frequency, such as once per month (e.g. location of sensor, sensor ID).
- Derived: The information computed using primary context such as distance of two sensors calculated using two GPS sensors.

# *Levels of Context Awareness*

- Personalisation
- Passive context-awareness
- Active context-awareness

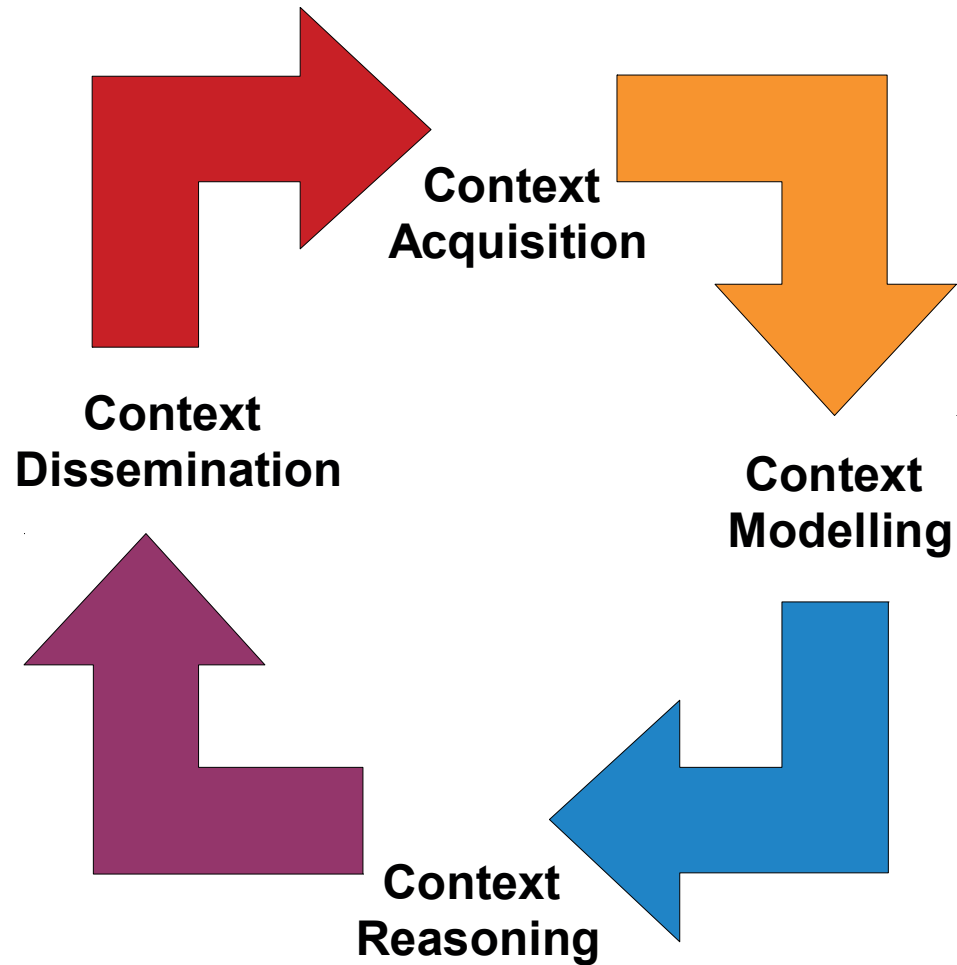




# Characteristics of Context-Awareness

- 1) is sensed through sensors or sensor networks
- 2) is sensed by small and constrained devices
- 3) originates from distributed sources
- 4) is continuously changing
- 5) comes from mobile objects
- 6) has a temporal character
- 7) has a spatial character
- 8) is imperfect and uncertain.

# Context LifeCycle



# Context LifeCycle

- 1) *Information Lifecycle Management (ILM)* [110]: creation and receipt → distribution → use → maintenance → disposition → ...
- 2) *Enterprise Content Management (ECM)* [111]: capture → manage → store → preserve → deliver → ...
- 3) *Hayden's Data Lifecycle* [112]: collection → relevance → classification → handling and storage → transmission and transportation → manipulate, conversion and alteration → release → backup → retention destruction → ...
- 4) *Intelligence Cycle* [113]: collection → processing → analysis → publication → feedback → ...
- 5) *Boyd Control Loop* (also called OODA loop) [114]: observe → orient → decide → act → ...

# Context Lifecycle

- 6) *Chantzara and Anagnostou Lifecycle* [115]: sense (context provider) → process (context broker) → disseminate (context broker) → use (service provider) → ...
- 7) *Ferscha et al. Lifecycle* [116]: sensing → transformation → representation → rule base → actuation → ...
- 8) *MOSQUITO* [117]: context information discovery → context information acquisition → context information reasoning → ...
- 9) *WCXMS Lifecycle* [109]: (context sensing → context transmission → context acquisition → ... ) → context classification → context handling → (context dissemination → context usage → context deletion → context request → ... ) → context maintenance → context disposition → ...
- 10) *Baldauf et al.* [10]: sensors → raw data retrieval → reprocessing → storage → application.

# Context Acquisition

- Based on Responsibility
  - Pull and Push
- Based on Frequency
  - Instant and Interval Events
- Based on Source
  - Sensor Hardware, Middleware, Context Servers
- Based on Sensor Types
  - Physical, Virtual (calendar, contact number directory, twitter statuses, email and chat applications) and Logical (weather information)
- Based on Acquisition Process
  - Sense, Derive, Manually

# Context Modelling

- Key-Value Modelling
- Markup Scheme Modelling (Tagged Encoding)
  - XML, JSON, ContextML, ...
- Graphical Modelling
  - UML, ORM
- Object Based Modelling
- Logic Based Modelling
- Ontology Based Modelling

# Context Reasoning Decision Models

- Context pre-processing
- Sensor data fusion
- Context inference
- *supervised learning, unsupervised learning, rules, fuzzy logic, ontological reasoning and probabilistic reasoning.*

