SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107
Accredited by NAAC-UGC with 'A' Grade
Approved by AICTE, Recognized by UGC & Affiliated to Anna University, Chennai

Department of Computer science and Technology

Course Name – 19IT503 Internet of Things III Year / V Semester

Unit 1 – IoT INTRODUCTION AND APPLICATIONS

Topic 2- IoT Definition, IoT Framework

IoT Definition

- Internet of Things is a twenty-first century phenomenon in which physical consumer products (meta products) connect to the web and start communicating with each other by means of sensors and actuators.
- The term “Internet of Things” denotes a trend where a large number of devices benefit from communication services that use Internet protocols.
- The M2M . . . term is used to refer to machine-to-machine communication, i.e., automated data exchange between machines.
- The vision of the internet of things is to attach tiny devices to every single object to make it identifiable by its own unique IP address. These devices can then autonomously communicate with one another.

Technical Challenges of IoT

The success of the internet of things relies on overcoming the following technical challenges:

(1) The current manner of using IP addresses must change to a system that provides an IP address to every possible object that may need one in the future.

(2) The power behind the embedded chips on such devices will need to be smaller and more efficient. And,

(3) The software applications must be developed that can communicate with and manage the stream of data from hundreds of interconnected non-computing devices that comprise a ‘smart’ system which can adapt and respond to changes.

Working Definitions

A broadly-deployed aggregate computing/communication application and/or application-consumption system, that is deployed over a local (L-IoT), metropolitan (M-IoT), regional (R-IoT), national (N-IoT), or global (G-IoT) geography, consisting of

(i) dispersed instrumented objects (“things”) with embedded one or two-way communications and some (or, at times, no) computing capabilities,

(ii) where objects are reachable over a variety of wireless or wired local area and/or wide area networks, and,

(iii) whose inbound data and/or outbound commands are pipelined to or issued by a(n application) system with a (high) degree of (human or computer-based) intelligence.

Things – sensors, actuators, tags, objects

Sensors are active devices that measure some variable of the natural or man-made environment (e.g., a building, an assembly line, an industrial assemblage supporting a process).

An actuator is a mechanized device of various sizes (from ultra-small to very large) that accomplishes a specified physical action, for example, controlling a mechanism or system, opening or closing a valve.

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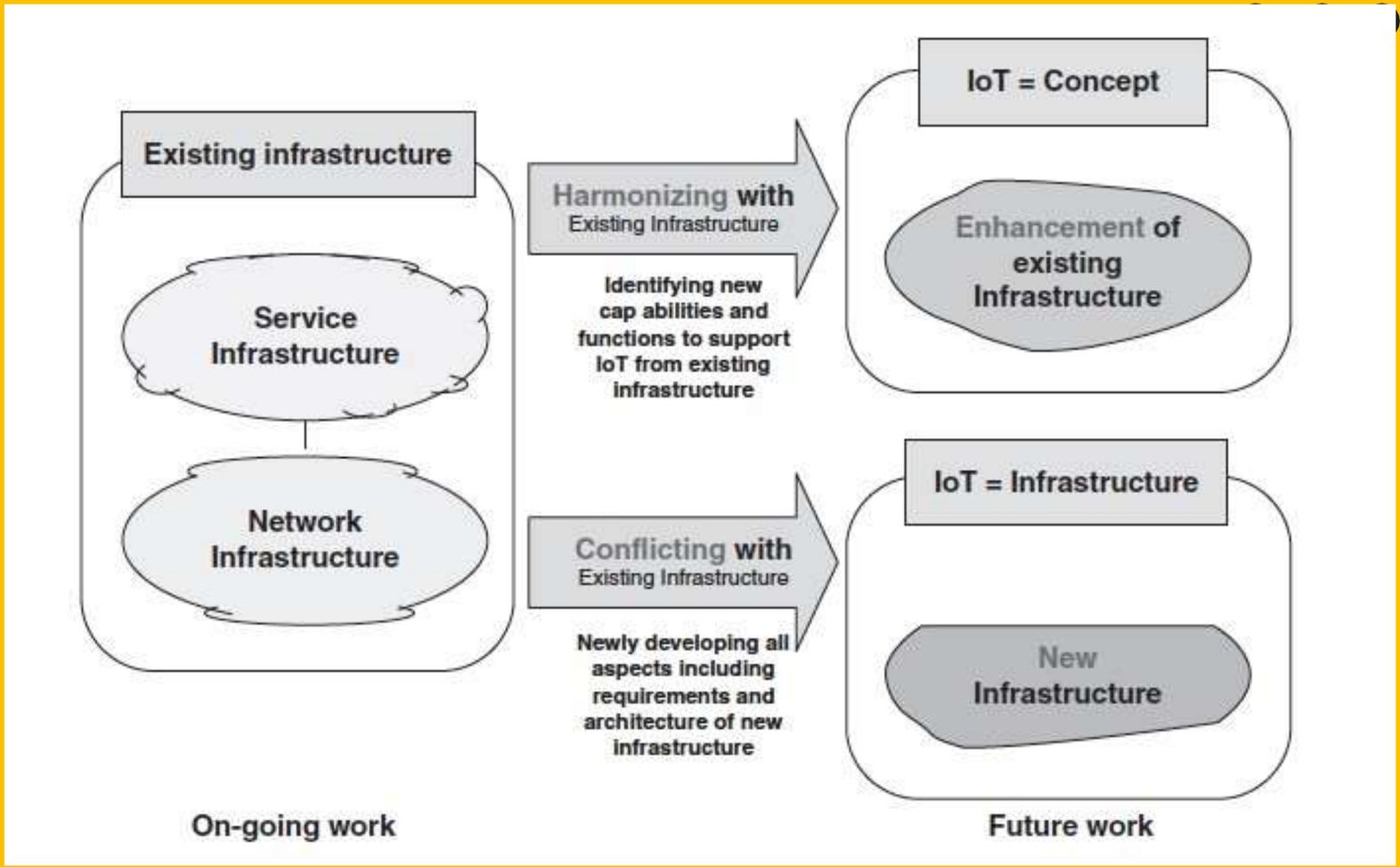
Topic 2- IoT Framework

ITU-T Views

International Telecommunications Union -Telecommunication Standardization Sector

View A: IoT is just a concept: the IoT does not refer to a network infrastructure; the IoT is not a technical term but a concept.

View B: IoT is an infrastructure: The IoT refers to an infrastructure.



ITU-T Views

International Telecommunications Union -Telecommunication Standardization Sector

View A: IoT is just a concept: the IoT does not refer to a network infrastructure; the IoT is not a technical term but a concept.

View B: IoT is an infrastructure: The IoT refers to an infrastructure.

Definition for View A

A technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology

The networked interconnection of objects—from the sophisticated to the mundane—through identifiers such as sensors, RFID tags, and IP addresses

The Internet of things links the objects of the real world with the virtual world, thus enabling anytime, anyplace connectivity for anything and not only for anyone

ITU-T Views

Definition for View B: IoT is an infrastructure

A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. This infrastructure includes existing and evolving Internet and network developments. It will offer specific object identification, sensor and connection capability as the basis for the development of independent federated services and applications.

A global information and communication infrastructure enabling automated chains of actions (not requiring explicit human intervention) facilitating information assembly and knowledge production and contributing to enrichment of human life by interconnecting physical and logical objects based on standard and interoperable communication protocols and through the exploitation of data capture and communication capabilities supported by existing and evolving information and communication technologies.

The Internet of Things consists of networks of sensors attached to objects and communication devices, providing data that can be analyzed and used to initiate automated actions. The data also generate vital intelligence for planning, management, policy, and decision-making. CISCO

IoT Framework

A high level M2M system architecture (HLSA)

- Defined by ETSI TS 102 690 V1.1.1 (European Telecommunications Standards Institute – Technical Specification)

- The HLSA comprises the **device and gateway domain**, **the network domain**, and the **applications domain**

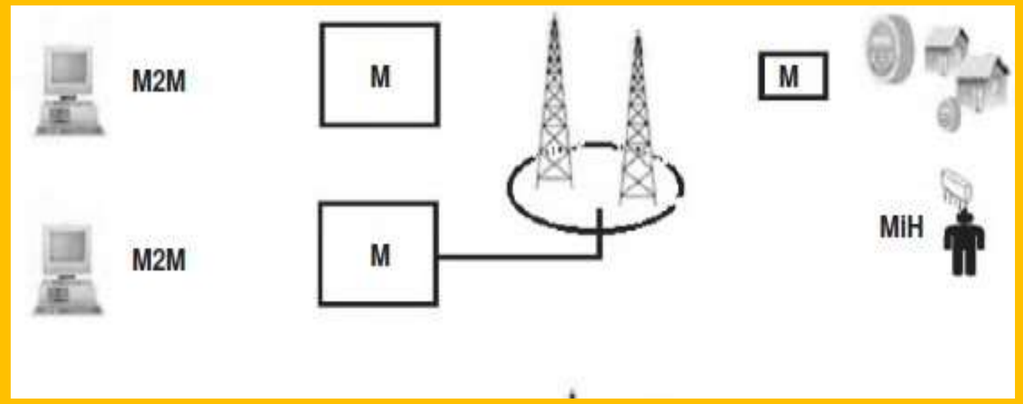
The **device and gateway domain** is composed of the following elements,

1. **M2M device**: A device that runs M2M application(s) using M2M service capabilities.

2. **M2M area network**: It provides connectivity between M2M devices and M2M gateways. Examples of M2M area networks include personal area network (PAN) technologies such as IEEE 802.15.1, Zigbee, Bluetooth, IETF ROLL, ISA100.11a, among others, or local networks such as power line communication (PLC), M-BUS, Wireless M-BUS, and KNX.

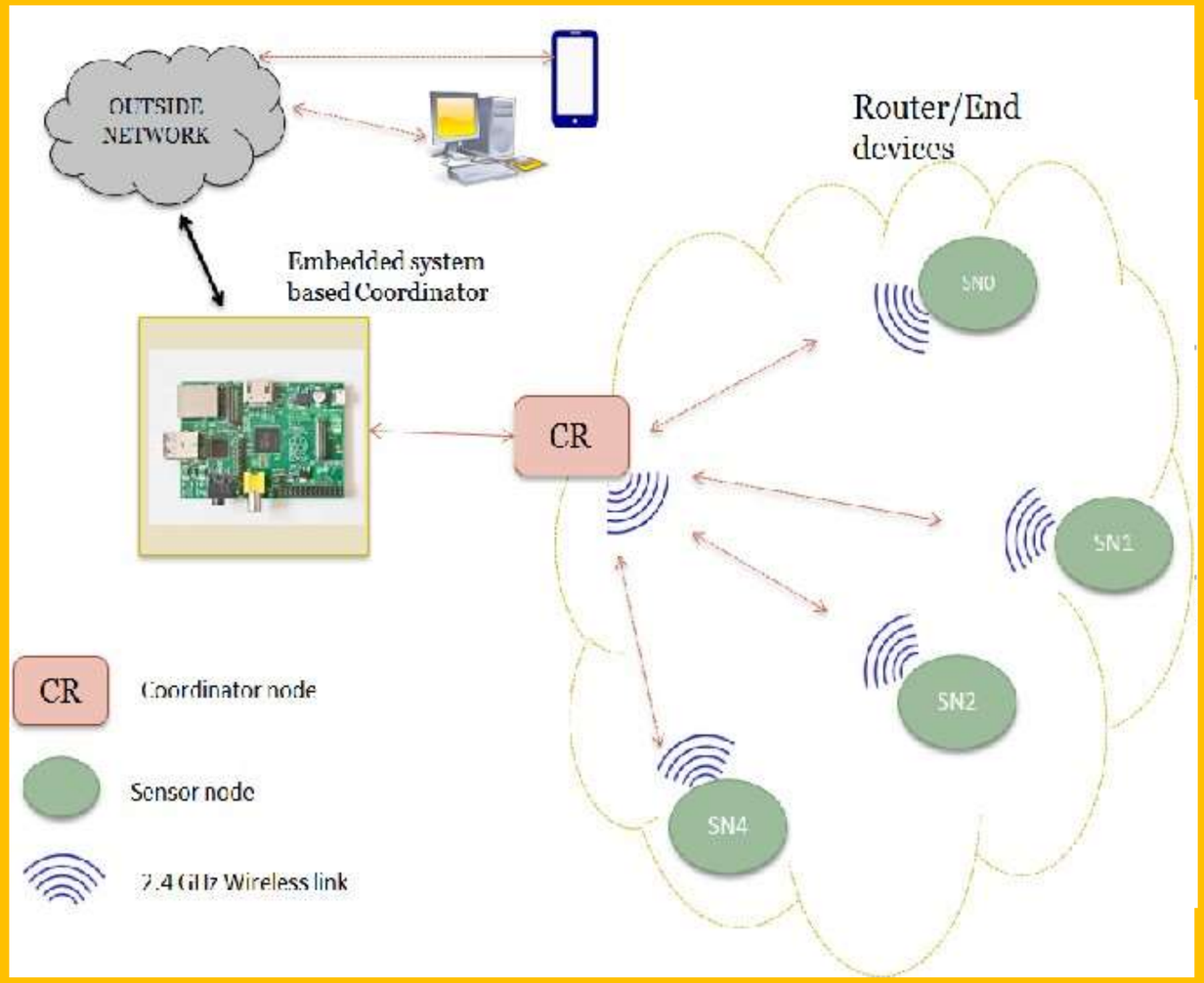
3.M2M gateway: A gateway that runs M2M application(s) using M2M service capabilities. The gateway acts as a proxy between M2M devices and the network domain. The M2M gateway may provide service to other device.

IoT Framework



M2M devices connect to network domain in the following manners

- Direct Connectivity
- Gateway as a Network Proxy - The M2M device connects to the network domain via an M2M gateway. M2M devices connect to the M2M gateway using the M2M area network



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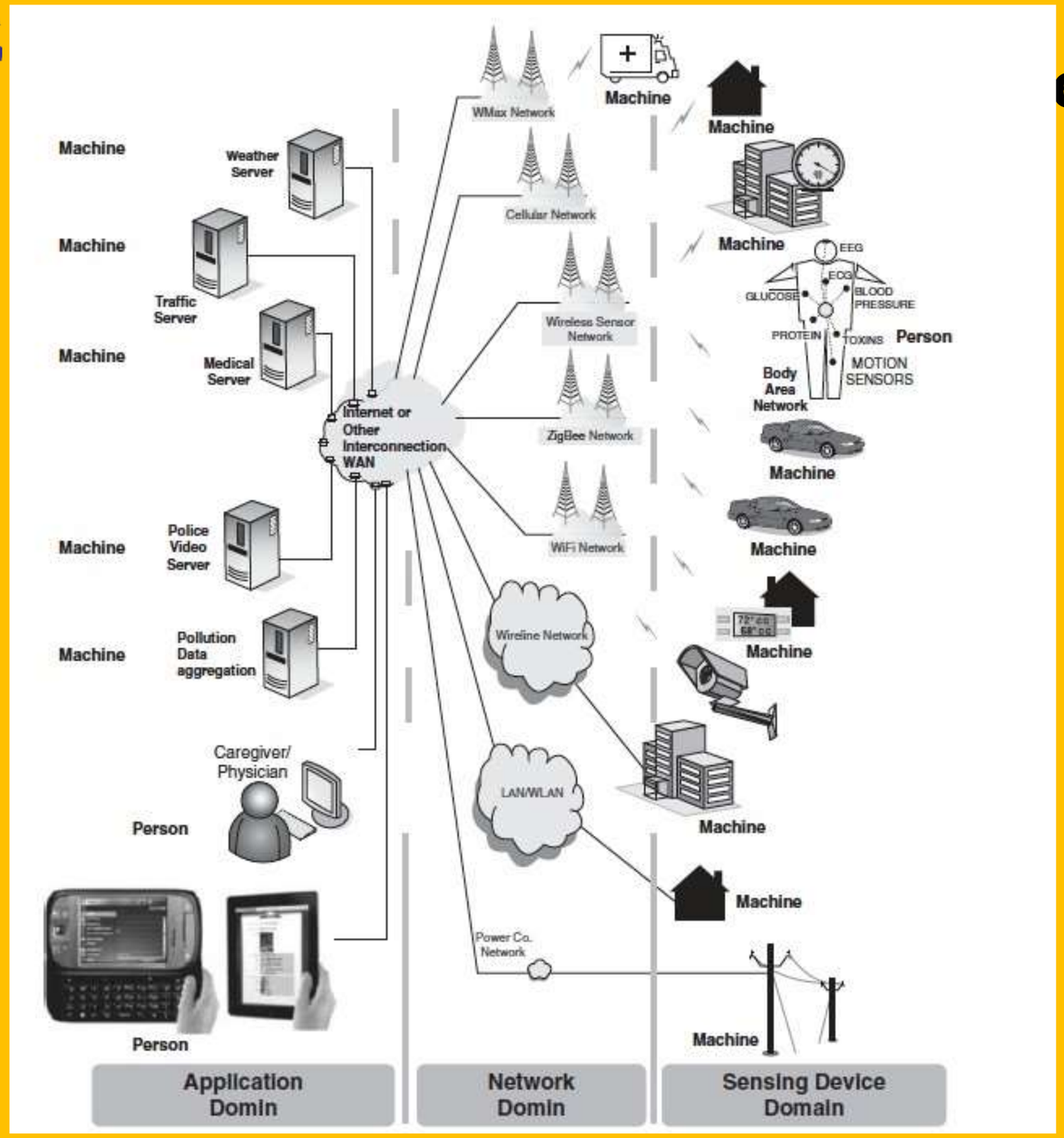
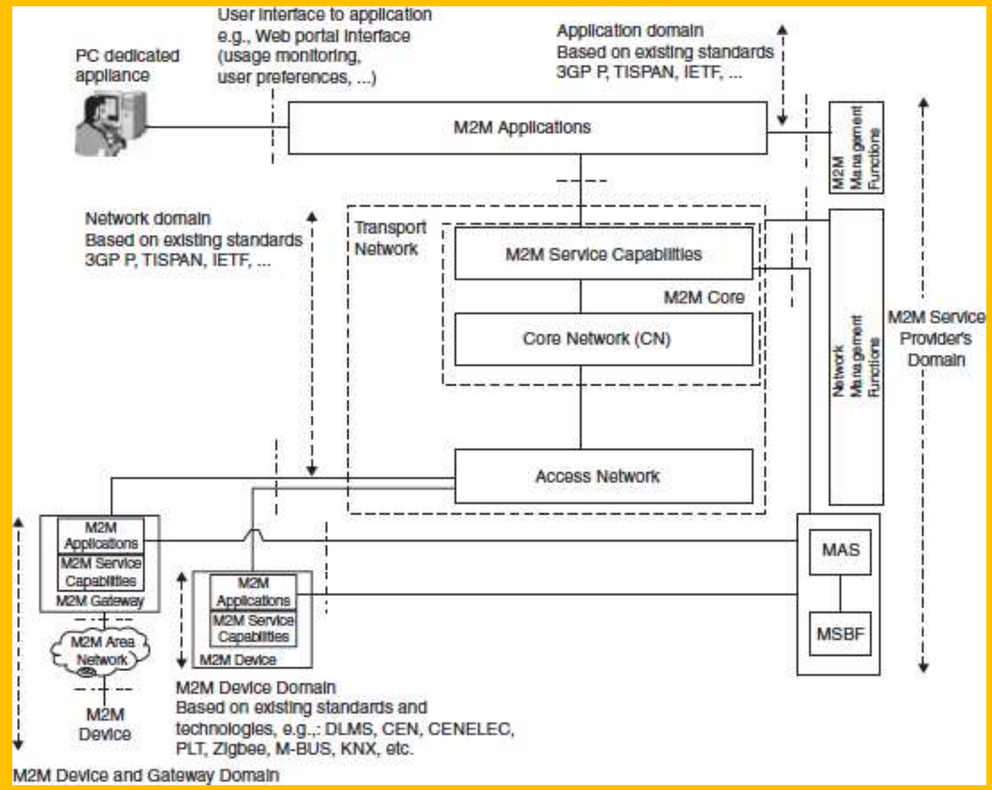

Machine
Weather Server
Machine
Traffic Server
Machine
Medical Server
Machine
Police Video Server
Machine
Pollution Data aggregation
Caregiver/ Physician
Person
Person
Internet or Other Interconnection WAN
WMax Network
Cellular Network
Wireless Sensor Network
ZigBee Network
WiFi Network
Wireline Network
LAN/WLAN
Power Co. Network
Machine
Machine
Machine
EEG
ECG
GLUCOSE
BLOOD PRESSURE
PROTEIN
TOXINS
Person
MOTION SENSORS
Body Area Network
Machine
Machine
Machine
Machine
Machine
Machine
Application Domin
Network Domin
Sensing Device Domain


User interface to application
e.g., Web portal interface
(usage monitoring,
user preferences, ...)
Application domain
Based on existing standards
3GP P, TISPAN, IETF, ...
PC dedicated appliance
M2M Applications
M2M Management Functions
Network domain
Based on existing standards
3GP P, TISPAN, IETF, ...
Transport Network
M2M Service Capabilities
M2M Core
Core Network (CN)
Access Network
Network Management Functions
M2M Service Provider's Domain
M2M Applications
M2M Service Capabilities
M2M Gateway
M2M Area Network
M2M Device
M2M Applications
M2M Service Capabilities
M2M Device
MAS
MSBF
M2M Device Domain
Based on existing standards and
technologies, e.g.,: DLMS, CEN, CENELEC,
PLT, Zigbee, M-BUS, KNX, etc.
M2M Device and Gateway Domain

IoT Framework

The **network domain** is composed of the following elements:

1.Access network: A network that allows the M2M device and gateway domain to communicate with the core network

Access networks include (but are not limited to) digital subscriber line (xDSL), hybrid fiber coax (HFC), satellite, GSM/EDGE radio access network (GERAN), UMTS terrestrial radio access network (UTRAN).

2.Core network: A network that provides the following capabilities (different core networks offer different features sets):

– ***IP connectivity at a minimum, and possibly other connectivity means ,Service and network control functions, Interconnection (with other networks), Roaming, Core networks***

3. M2M service capabilities:

– Provide M2M functions that are to be shared by different applications, Expose functions through a set of open interfaces, Use CoN functionalities, Simplify and optimize application development and deployment through hiding of network specificities

IoT Framework

The **applications domain** is composed of the following elements:

1. **M2M applications:** Applications that run the service logic and use M2M service capabilities accessible via an open interface.

There are **also management functions** within an overall M2M service provider domain, as follows:

1. Network management functions: Consists of all the functions required to manage the access and core networks; these functions include provisioning, supervision, fault management.

2.M2M management functions: Consists of all the functions required to manage M2M service capabilities in the network domain

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III Year / V Semester

Unit 1 – IoT INTRODUCTION AND APPLICATIONS

Topic 1- Overview and Motivations - IPv6 Role

Overview and Motivation

- ARPANET
- Connected Institutions.
- Internet has connected servers of all kinds to users of all kinds seeking access to information and applications of all kinds
- The next evolution is to connect all “things” and objects that have (or will soon have) embedded wireless (or wireline) connectivity to control systems that support data collection, data analysis, decision-making, and (remote) actuation.
- “Things” include, but are not limited to, machinery, home appliances, vehicles, individual persons, pets, cattle, animals, habitats, habitat occupants, as well as enterprises.

Overview and Motivation

It is perceived by proponents as the “next-generation network (NGN) of the Internet

The IoT has two attributes:
(i) being an Internet application and
(ii) dealing with the thing’s information.

The term Internet of Things was coined and first used by Kevin Ashton over a decade ago.

Overview and Motivation

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Unit 1 – IoT INTRODUCTION AND APPLICATIONS

Topic 3- IPv6 Role and Nodal Capabilities

Role of IPv6

- IPv6 with its abundant address spaces,
- globally unique object (thing) identification
- permanent unique identifier, an object ID (OID)
- unique network address (Nadr)
- IPv4 supports 2^32 ~ 10^10 NAdr location can be identified uniquely. 4,294,967,296
- IPv6 offers a much larger 2^128 space
- the number of available unique node addressees is 2^128~ 10^39
- 340,282,366,920,938,463,463,374,607,431,768,211,456

Advances of IPv6

- Scalability and expanded addressing capabilities

- IPv6 has 128-bit addresses versus 32-bit IPv4 addresses. Example IPv4 Address : 192.168.1.1
  Example IPv6 Address : 2001:0db8:3c4d:0015:0000:0000:1a2f:1a2b

- "Plug-and-play": IPv6 includes a "plug-and-play" mechanism facilitates the connection of that equipment to the network.

- Security: IPv6 includes and requires security in its specifications such as payload encryption and authentication of the source of the communication.

- Mobility: IPv6 includes an efficient and robust mobility mechanism namely an enhanced support for mobile IP, specifically, the set of mobile IPv6

Node or Device - have a basic protocol stack that supports as a minimum local connectivity and networking connectivity.

In addition, some higher layer application support protocols

are generally needed. IoT devices may have capability

differences such as

- maximum transmission unit (MTU) differences,
- Simplified versus full-blown web protocol stack (COAP/UDP versus HTTP/TCP),
- single stack versus dual stack,
- sleep schedule,
- security protocols,
- processing and communication bandwidth.

Typical requirements include the following capabilities

Retransmission
- Network recovers from packet loss or informs application
- Recovery is immediate: on the order of RTTs, not seconds

Network independent of MAC/PHY

Scale
- Thousands of nodes
- Multiple link speeds

Multicast
- Throughout network
- Reliable (positive Ack)

Duplicate suppression

Emergency messages
- Routed and/or queued around other traffic
- Other traffic slushed as delivered

Routine traffic delivered in sequence

Separate timers by peer/message

Polling of nodes
- Sequential
- Independent of responses

Paradigm supports peer-to-peer
- Not everything is client/server

Capabilities
- Discover nodes
- Discover node capabilities
- Deliver multisegment records (files)

Exchange of multisegment records

Network and application versioning

Simple publish/subscribe parsers

Security
- Strong encryption
- Mutual authentication
- Protection against record/playback attacks
- Suite B ciphers

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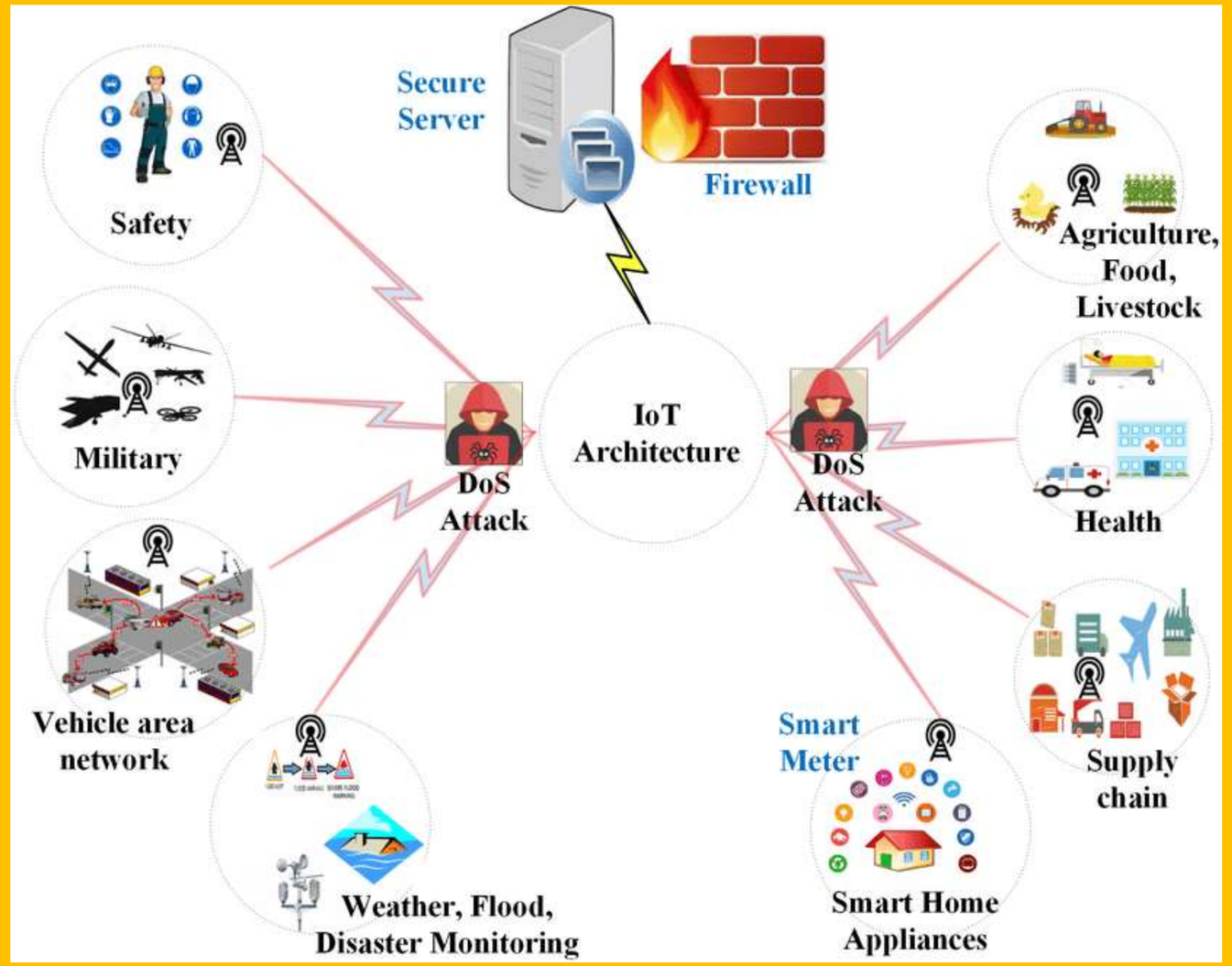
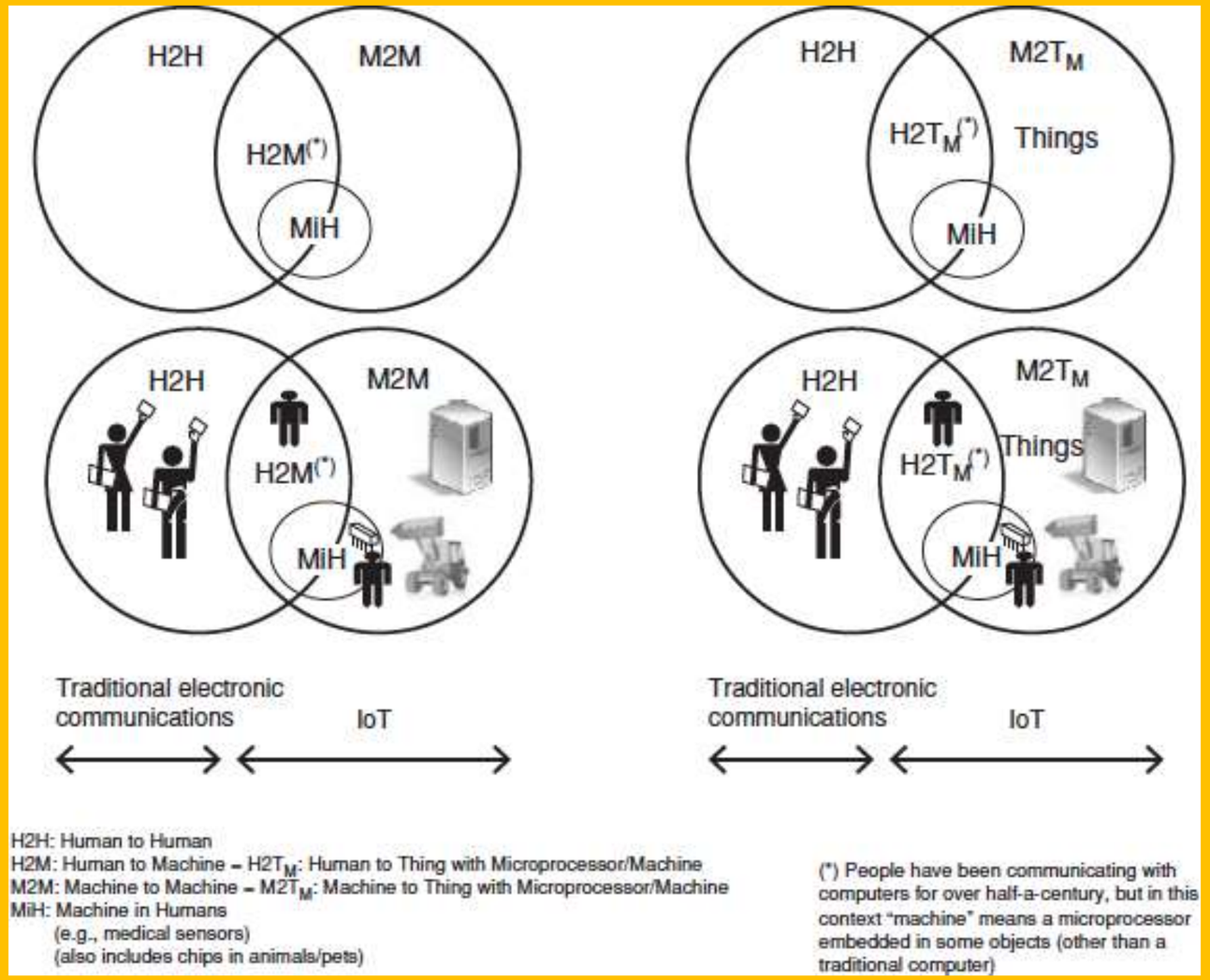
Unit 1 – IoT INTRODUCTION AND APPLICATIONS

Topic 3- overview and motivation

Overview and Motivation



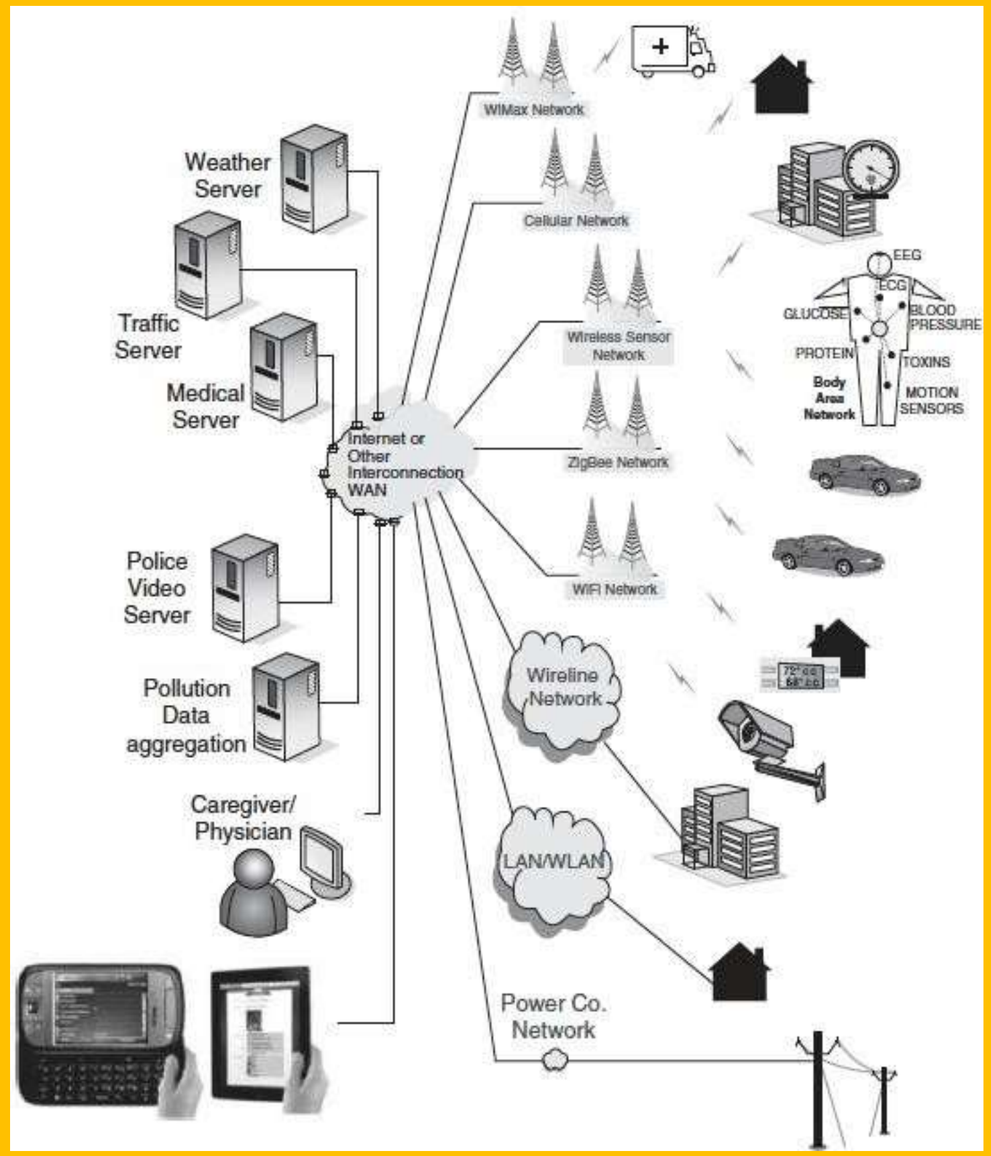
Overview and Motivation



H2H: Human to Human
H2M: Human to Machine – $H2T_M$: Human to Thing with Microprocessor/Machine
M2M: Machine to Machine – $M2T_M$: Machine to Thing with Microprocessor/Machine
MiH: Machine in Humans
(e.g., medical sensors)
(also includes chips in animals/pets)

(*) People have been communicating with computers for over half-a-century, but in this context "machine" means a microprocessor embedded in some objects (other than a traditional computer)

Overview and Motivation



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