

THE INTERNET OF THINGS REFERENCE MODEL

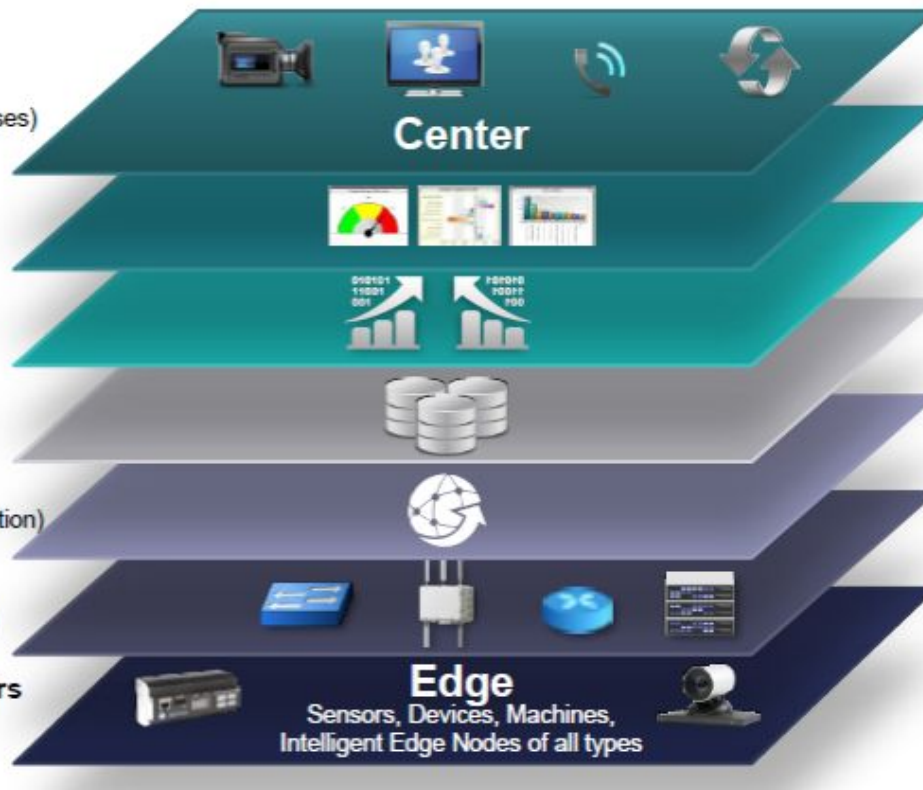
UNIT- III
PART - 1

Reference Model

Internet of Things Reference Model

Levels

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



Level :1 Physical Devices and Controllers

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Physical Devices & Device Controllers (The “Things” in IoT)

IoT “devices” are capable of:

- Analog to digital conversion, as required
- Generating data
- Being queried / controlled over-the-net



Edge

Sensors, Devices, Machines,
Intelligent Edge Nodes of all types

Level 2: Connectivity

Internet of Things Reference Model

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Connectivity (Communication & Processing Units)

Level 2 functionality focuses
on East-West communications

Connectivity includes:

- Communicating with and between the Level 1 devices
- Reliable delivery across the network(s)
- Implementation of various protocols
- Switching and routing
- Translation between protocols
- Security at the network level
- (Self Learning) Networking Analytics



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- Communications and connectivity are concentrated in one level—Level 2. The most important function of Level 2 is reliable, timely information transmission. This includes transmissions:
 - ● Between devices (Level 1) and the network
 - ● Across networks (east-west)
 - ● Between the network (Level 2) and low-level information processing occurring at Level 3

Level 3: Edge (Fog) Computing

Internet of Things Reference Model

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Edge (Fog) Computing (Data Element Analysis & Transformation)

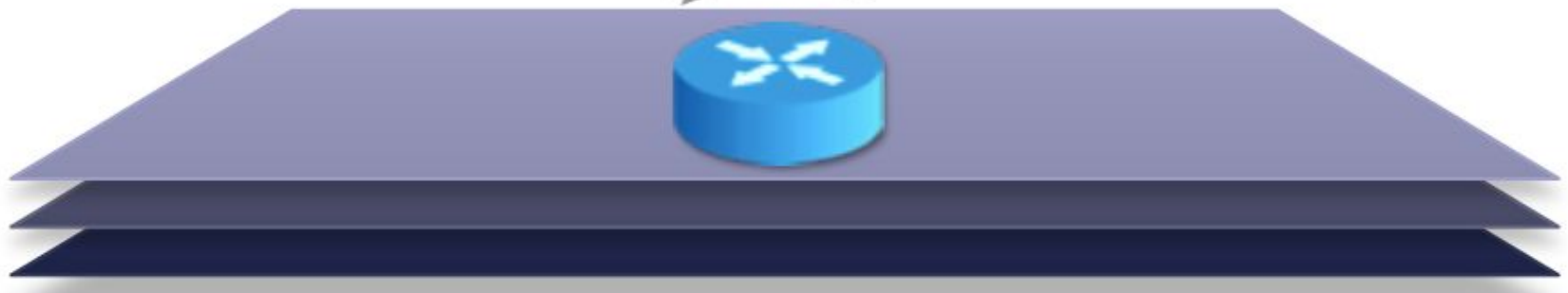
Level 3 functionality
focuses on North-South
communications

Include;

- Data filtering, cleanup, aggregation
- Packet content inspection
- Combination of network and data level analytics
- Thresholding
- Event generation

Data packets

Information
understandable
to the higher levels



- ● Evaluation: Evaluating data for criteria as to whether it should be processed at a higher level
- ● Formatting: Reformatting data for consistent higher-level processing
- ● Expanding/decoding: Handling cryptic data with additional context (such as the origin)
- ● Distillation/reduction: Reducing and/or summarizing data to minimize the impact of data and traffic on the network and higher-level processing systems
- ● Assessment: Determining whether data represents a threshold or alert; this could include redirecting data to additional destinations

Level 4: Data Accumulation

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Data Accumulation (Storage)

- Event filtering/sampling
- Event comparison
- Event joining for CEP
- Event based rule evaluation
- Event aggregation
- Northbound/southbound alerting
- Event persistence in storage

Query Based Data
Consumption



Event Based
Data Generation



Making network data
usable by applications

1. Converts data-in-motion to data-at-rest
2. Converts format from network packets to database relational tables
3. Achieves transition from 'Event based' to 'Query based' computing
4. Dramatically reduces data through filtering and selective storing



or



Data in motion-data in rest

- ● If data is of interest to higher levels: If so, Level 4 processing is the first level that is configured to serve the specific needs of a higher level.
- ● If data must be persisted: Should data be kept on disk in a non-volatile state or accumulated in memory for short-term use?
- ● The type of storage needed: Does persistency require a file system, big data system, or relational database?
- ● If data is organized properly: Is the data appropriately organized for the required storage system?
- ● If data must be recombined or recomputed: Data might be combined, recomputed, or aggregated with previously stored information, some of which may have come from non-IoT sources.

Level 5: Data Abstraction

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Data Abstraction (Aggregation & Access)

Abstracting the data
interface for applications

Information Integration

1. Creates schemas and views of data in the manner that applications want
2. Combines data from multiple sources, simplifying the application
3. Filtering, selecting, projecting, and reformatting the data to serve the client applications
4. Reconciles differences in data shape, format, semantics, access protocol, and security



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- ● Reconciling multiple data formats from different sources
 - ● Assuring consistent semantics of data across sources
 - ● Confirming that data is complete to the higher-level application
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Level 6: Application

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Application
(Reporting, Analytics, Control)



Control
Applications



Vertical and
Mobile
Applications



Business
Intelligence
and Analytics

Level 7: Collaboration and Processes

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Collaboration & Processes

(Involving people and business processes)



Center

Security in the IoT

Levels

