# Internet Applications

**Dr./ Ahmed Mohamed Rabie**

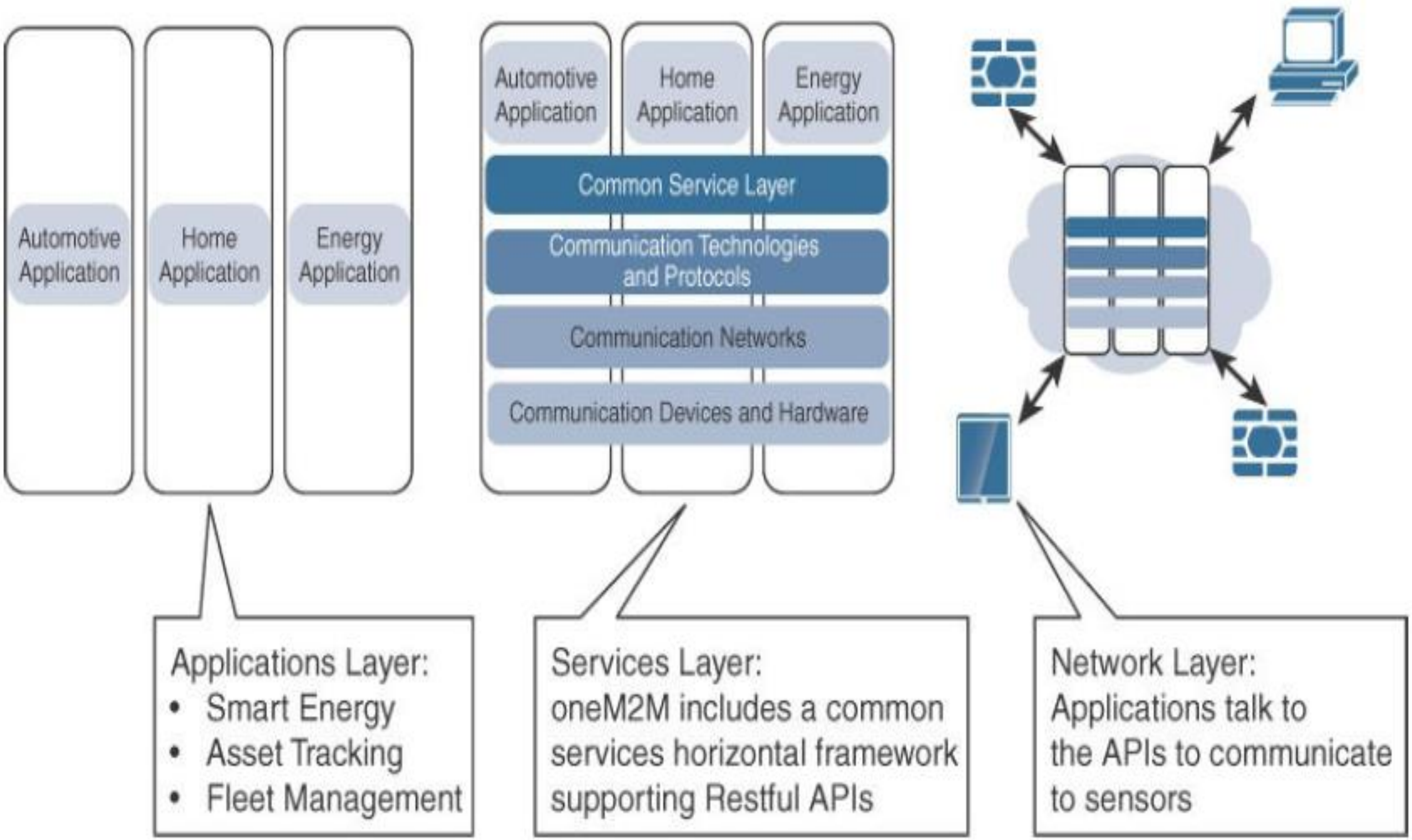
# Chapter 1

# Introduction

# Internet of Things

The foundational concept in all these architectures is supporting data, process, and the functions that endpoint devices perform. Two of the best-known architectures are those supported by oneM2M and the IoT World Forum (IoTWF).

**Machine-to-Machine (M2M)** communications, the European Telecommunications Standards Institute (ETSI) created the M2M Technical. The goal of this committee was to create a common architecture that would help accelerate the adoption of M2M applications and devices. Over time, the scope has expanded to include the Internet of Things.




*The Main Elements of the oneM2M IoT Architecture*

The goal of oneM2M is to create a common services layer, which can be readily embedded in field devices to allow communication with application servers. OneM2M's framework focuses on IoT services, applications, and platforms. These include smart metering applications, smart grid, smart city automation, e-health, and connected vehicles.

One of the greatest challenges in designing an IoT architecture is dealing with the heterogeneity of devices, software, and access methods. By developing a horizontal platform architecture, oneM2M is developing standards that allow interoperability at all levels of the IoT stack.

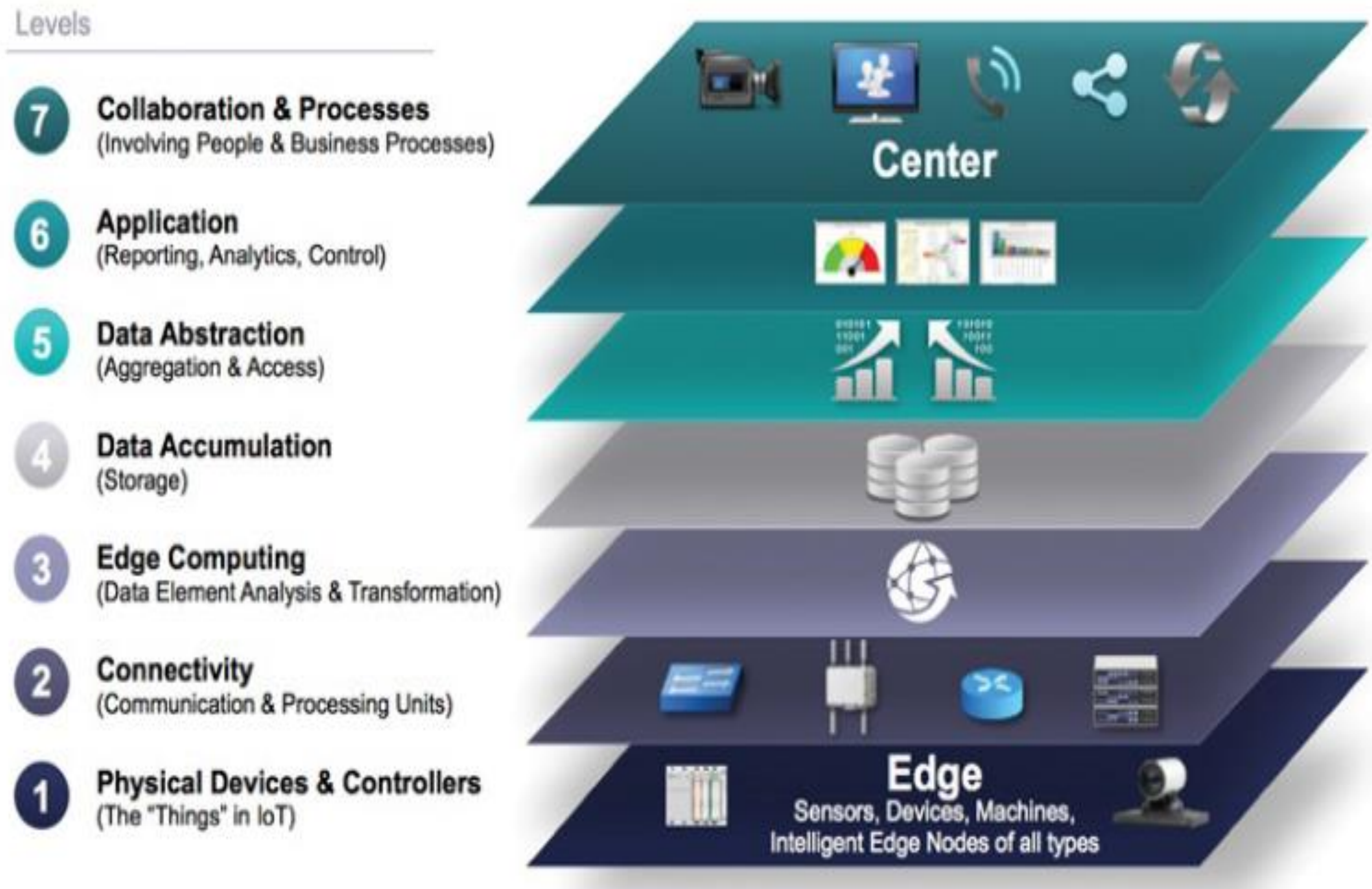
The **oneM2M** architecture divides IoT functions into three major domains: the application layer, the services layer, and the network layer. While this architecture may seem simple and somewhat generic at first glance, it is very rich and promotes interoperability through IT-friendly APIs and supports a wide range of IoT technologies.

**Applications layer:** The oneM2M architecture gives major attention to connectivity between devices and their applications. This domain includes the application-layer protocols and attempts to standardize northbound API definitions for interaction with business intelligence (BI) systems. Applications tend to be industry-specific and have their own sets of data models, and thus they are shown as vertical entities.

**Services layer:** This layer is shown as a horizontal framework across the vertical industry applications. At this layer, horizontal modules include the physical network that the IoT applications run on, the underlying management protocols, and the hardware. One of the stated goals of oneM2M is to “develop technical specifications which address the need for a common M2M Service Layer that can be readily embedded within various hardware and software nodes, and rely upon connecting the myriad of devices in the field area network to M2M application servers, which typically reside in a cloud or data center.

**Network layer:** This is the communication domain for the IoT devices and endpoints. It includes the devices themselves and the communications network that links them. Embodiments of this communications infrastructure include wireless mesh technologies, such as IEEE 802.15.4, and wireless point-to-multipoint systems, such as IEEE 801.11ah.

**The IoT World Forum (IoTWF) Standardized ArchitectureIn:** the IoTWF architectural committee (led by Cisco, IBM, Rockwell Automation, and others) published a seven-layer IoT architectural reference model. While various IoT reference models exist, the one put forth by the IoT World Forum offers a clean, simplified perspective on IoT and includes edge computing, data storage, and access. Each of the seven layers is broken down into specific functions, and security encompasses the entire model.




*IoT Reference Model Published by the IoT World Forum*

The IoT Reference Model defines a set of levels with control flowing from the center (this could be either a cloud service or a dedicated data center), to the edge, which includes sensors, devices, machines, and other types of intelligent end nodes. In general, data travels up the stack, originating from the edge, and goes northbound to the center.

Using this reference model, we are able to achieve the following:

- Decompose the IoT problem into smaller parts.
- Identify different technologies at each layer and how they relate to one another.
- Define a system in which different parts can be provided by different vendors.
- Have a process of defining interfaces that leads to interoperability.
- Define a tiered security model that is enforced at the transition points between levels.

**Layer 1: Physical Devices and Controllers Layer:** The first layer of the IoT Reference Model is the physical devices and controllers layer. This layer is home to the "things" in the Internet of Things, including the various endpoint devices and sensors that send and receive information. The size of these "things" can range from almost microscopic sensors to giant machines in a factory. Their primary function is generating data and being capable of being queried and/or controlled over a network.

**Layer 2: Connectivity Layer:** In the second layer of the IoT Reference Model, the focus is on connectivity. The most important function of this IoT layer is the reliable and timely transmission of data. More specifically, this includes transmissions between Layer 1 devices and the network and between the network and information processing that occurs at Layer 3 (the edge computing layer).

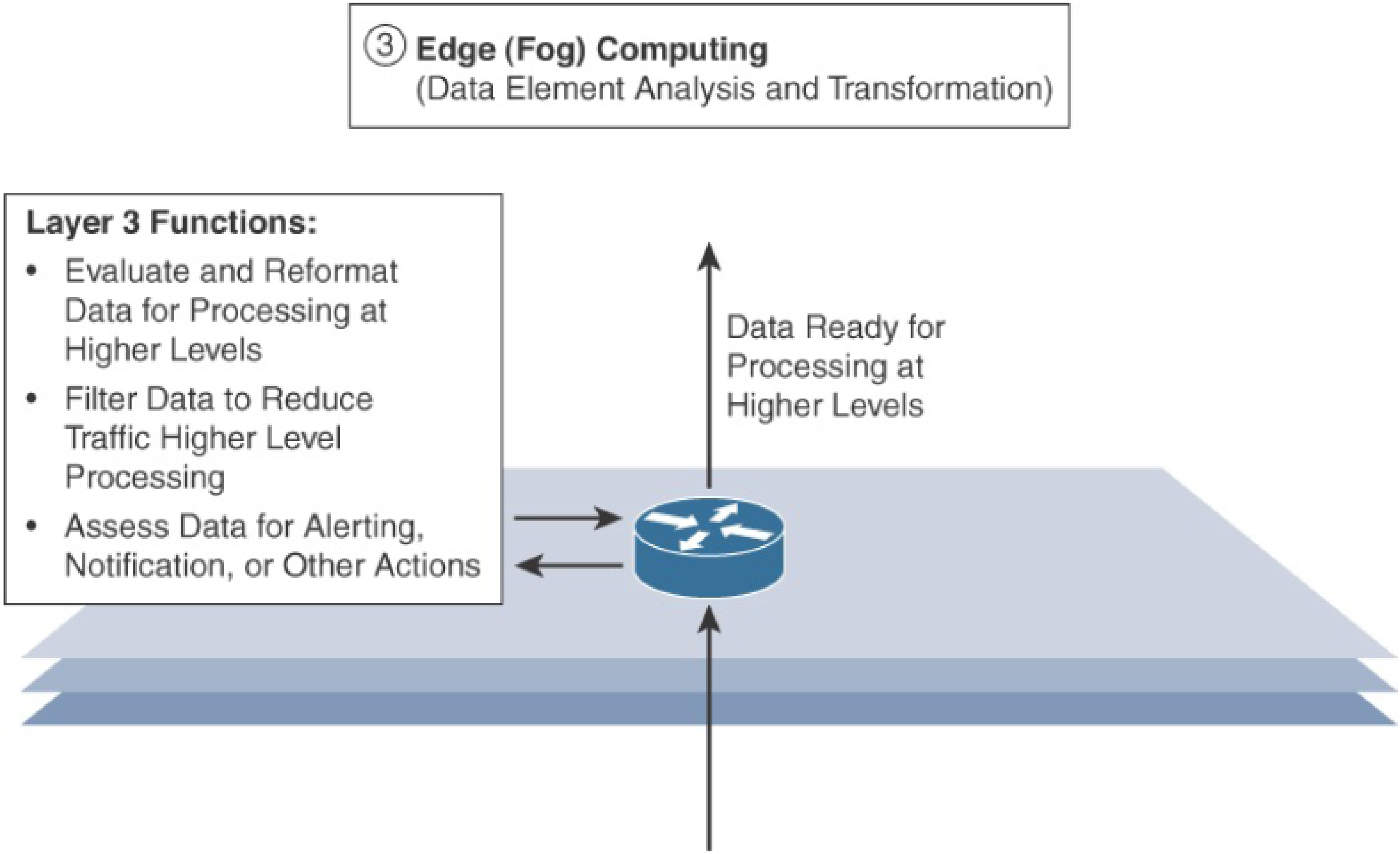
② **Connectivity**
(Communication and Processing Units)

**Layer 2 Functions:**

- Communications Between Layer 1 Devices
- Reliable Delivery of Information Across the Network
- Switching and Routing
- Translation Between Protocols
- Network Level Security

*IoT Reference Model Connectivity Layer Functions*

**Layer 3: Edge Computing Layer:** Edge computing is the role of Layer 3. Edge computing is often referred to as the "fog" layer. At this layer, the emphasis is on data reduction and converting network data flows into information that is ready for storage and processing by higher layers. One of the basic principles of this reference model is that information processing is initiated as early and as close to the edge of the network as possible.




*IoT Reference Model Layer 3 Functions*

Another important function that occurs at Layer 3 is the evaluation of data to see if it can be filtered or aggregated before being sent to a higher layer. This also allows for data to be reformatted or decoded, making additional processing by other systems easier. Thus, a critical function is assessing the data to see if predefined thresholds are crossed and any action or alerts need to be sent.

**Upper Layers: Layers 4–7:** The upper layers deal with handling and processing the IoT data generated by the bottom layer. For the sake of completeness, Layers 4–7 of the IoT Reference Model.

| IoT Reference Model Layer | Functions |
|---|---|
| Layer 4: Data accumulation layer | Captures data and stores it so it is usable by applications when necessary. Converts event-based data to query-based processing. |
| Layer 5: Data abstraction layer | Reconciles multiple data formats and ensures consistent semantics from various sources. Confirms that the data set is complete and consolidates data into one place or multiple data stores using virtualization. |
| Layer 6: Applications layer | Interprets data using software applications. Applications may monitor, control, and provide reports based on the analysis of the data. |
| Layer 7: Collaboration and processes layer | Consumes and shares the application information. Collaborating on and communicating IoT information often requires multiple steps, and it is what makes IoT useful. This layer can change business processes and delivers the benefits of IoT. |

**Table** *Summary of Layers 4–7 of the IoTWF Reference Model*