جامعة المستقبل – كلية العلوم
قسم الانظمة الطبية الذكية
Intelligent Medical Systems Department

Virtualization at the Edge of the Network

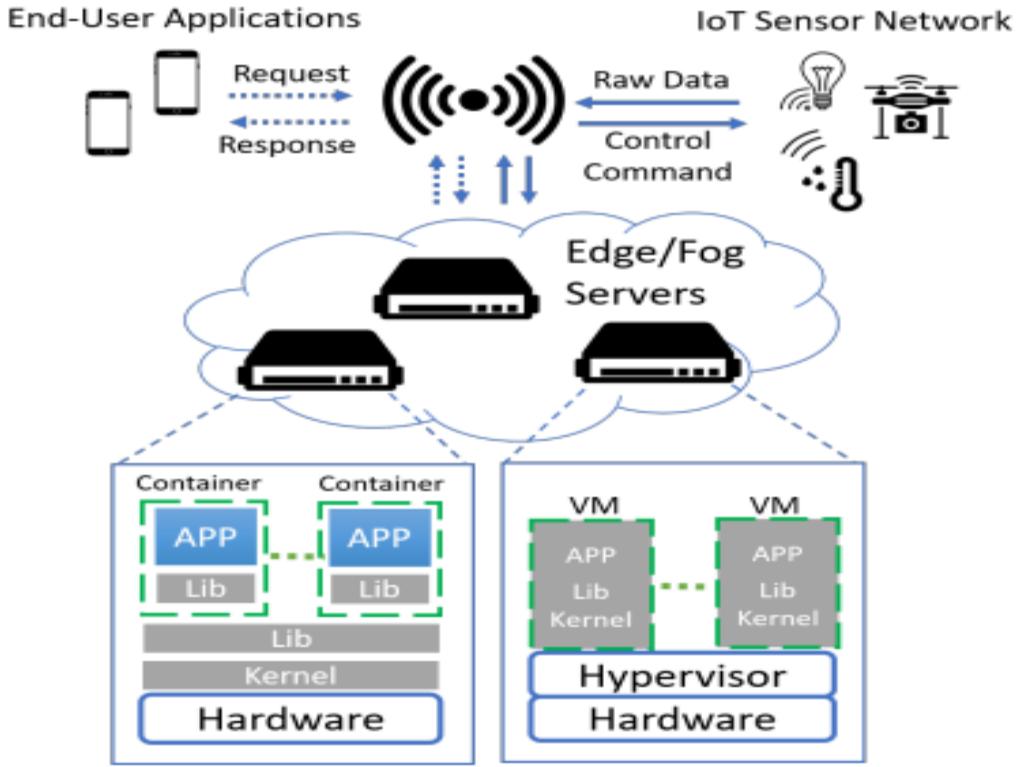
Lecture (7)

Prof. Dr. Mehdi Ebady Manaa

Virtualization at the Edge of the Network:

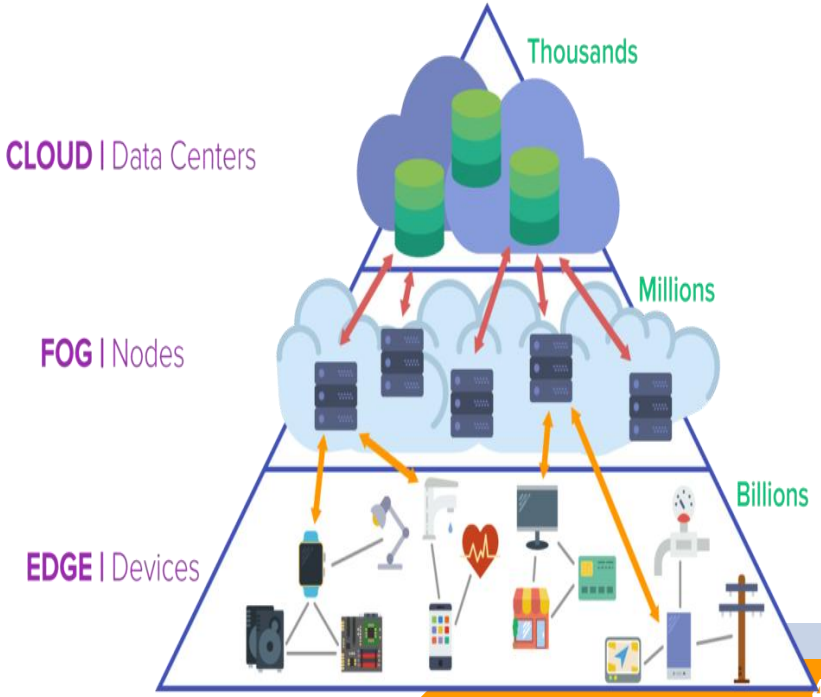
- The virtualization supporting technologies described in previous sections can be used also in the Edge/Fog servers to provide more scalable, reliable, and performing services. A general use-case is depicted in Fig 3. The IoT sensors send the acquire draw data to Edge/Fog servers, instead of sending them to the cloud, and receive commands (solid lines). These servers are directly connected to the IoT network gateway (Edge)or somewhere outside the IoT network (Fog), but geographically close. Virtualization mechanisms are used to ensure the scalability of the network implementing on-demand services by starting a customized VM or a container at the time of the request. The servers elaborate and aggregate the received information, sending results to the cloud if the end-user service is not locally hosted. End-user applications, installed on smartphones or other client devices, send requests to Edge/Fog servers (dotted lines), instead of sending them to the cloud, decreasing the latency and improving the user experience.

Virtualization on Edge/Fog Computing Architecture



What is Fog Computing?

- Fog computing is standard that defines the way edge computing should work, and it enable the operation of compute , storage and networking services between end devices and cloud computing data centers



Characteristics of Fog Computing

- Proximity to end-users, its
- Dense geographical distribution
- Support for mobility.

Fog Computing Services cover:

- Applications that require very low and predictable latency.
- Geographically distributed applications
- Fast mobile applications
- Large-scale distributed control systems

Need of Fog Computing

- IoT applications generate a large amount of data. This data requires analysis to make decisions for implementation and to take various actions.
- Transferring this data to the cloud leads to a number of issues, for example, latency, excessive usage of bandwidth, delay in real-time responses, centralized location of data, etc.
- To overcome these challenges, faced by IoT applications, in the cloud environment, the term fog computing was introduced by Cisco in the year 2012.
- It promises to bring computation near to the end devices leading to minimization of latency and efficient usage of bandwidth.
- With the increase in sensor-based devices, a large amount of data is generated. This data needs storage as well as processing. Storing the data on the cloud is costly and it adds to more processing time. It places resources near to the end devices, decreasing the processing time and saving the cost

Fog Computing Architecture

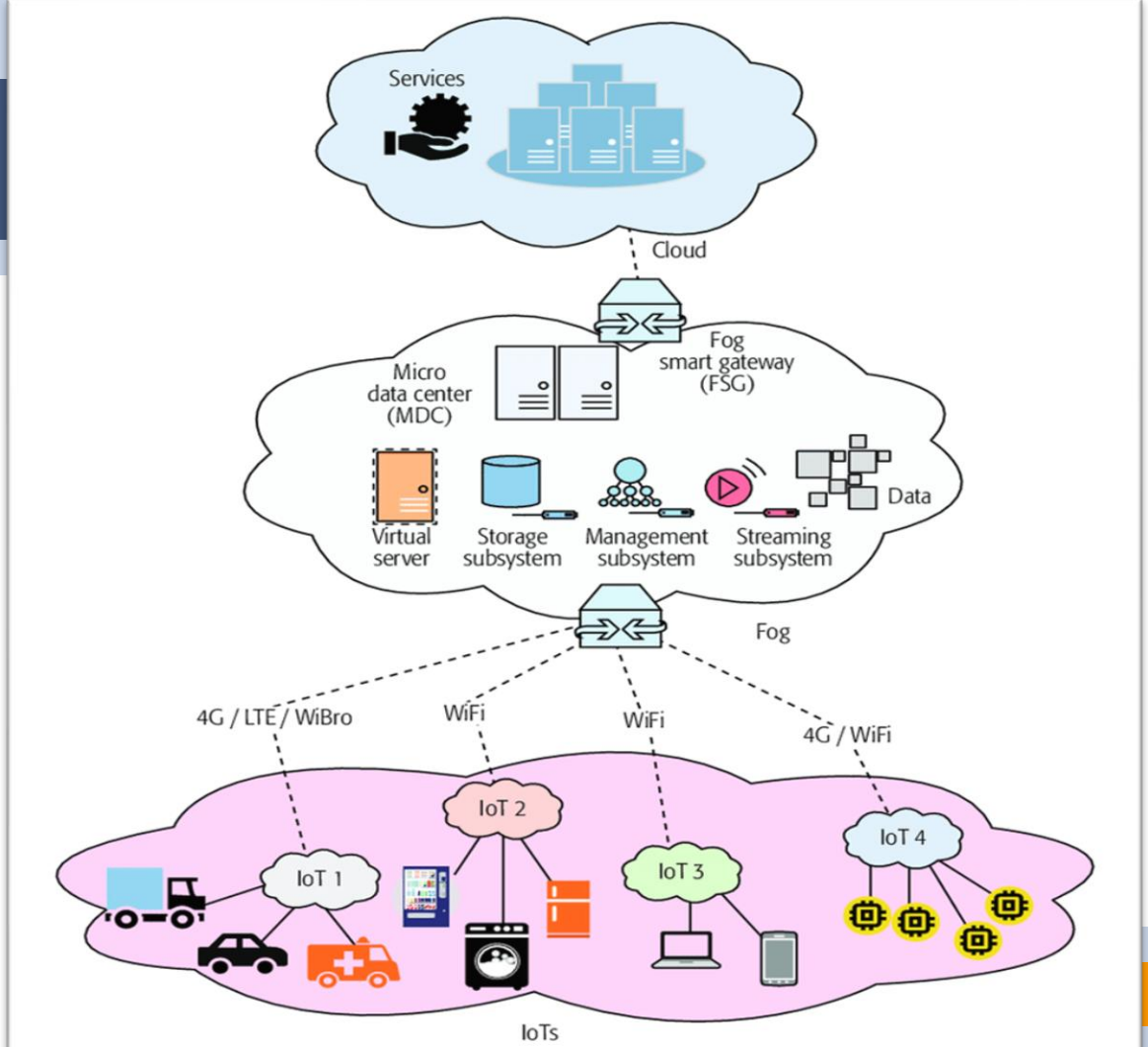


Fig : Overall architecture and positioning of fog

Working

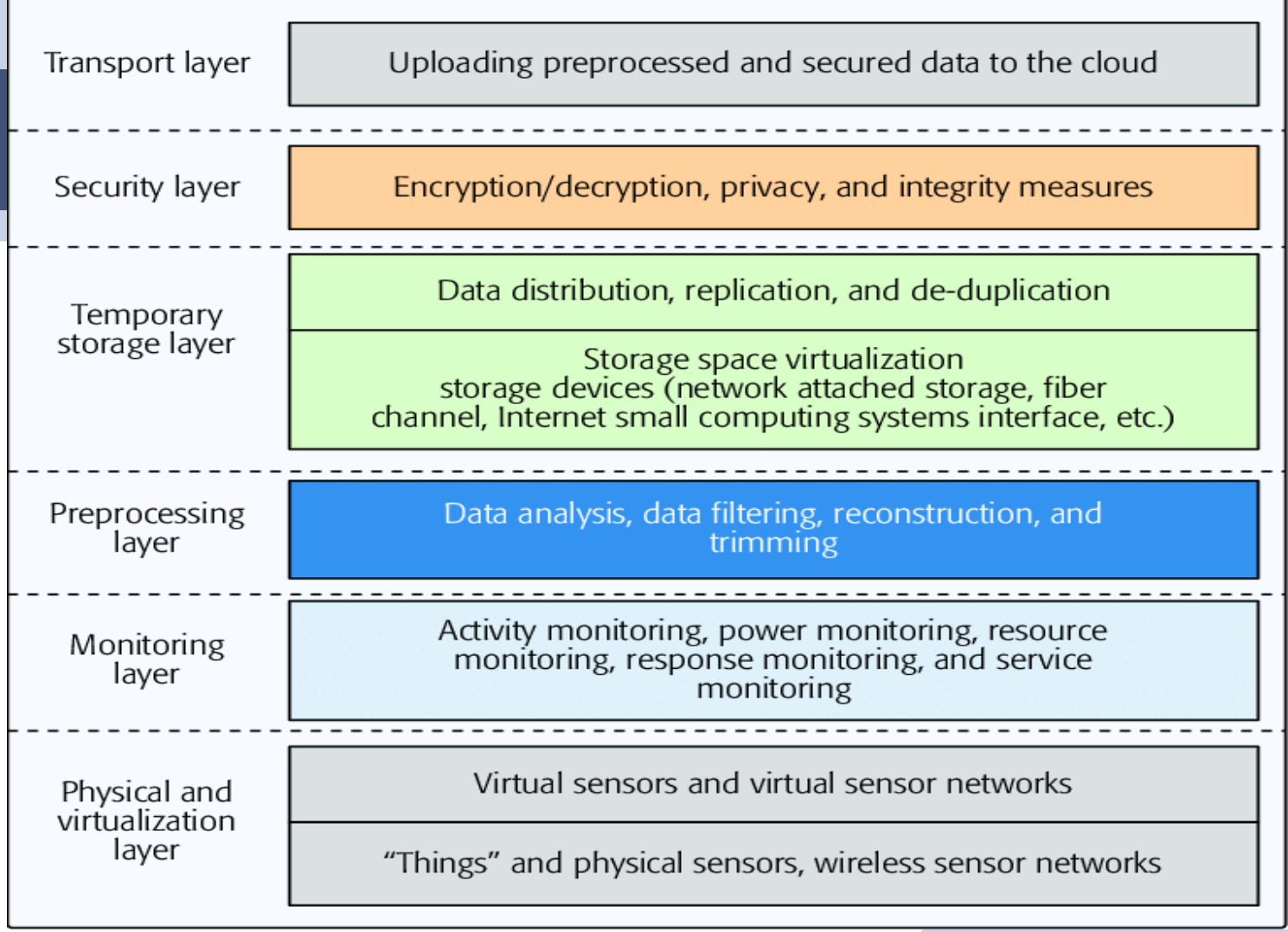


Fig :Layered architecture of fog.

Advantages and Disadvantages of Fog Computing

Advantages

1. Low Latency
2. Better Security
3. Reduced Operation Cost
4. Scalability
5. Flexibility

Disadvantages

1. Authentication
2. Scheduling
3. Power Consumption
4. Fog Servers

Comparison Between Fog, Edge Computing

- Edge Computing
- Deployed as a traditional data center with extended capabilities.
- Uses an edge server similar to a traditional data center server.
- It is completely built as new system or a mini cloud data center.

- Fog Computing
- Deployed at the local premises of mobile users.
- Virtualized device with build-in data storage, computing and communication facility.
- Can be adapted from existing system components

COMPARISON BETWEEN FOG, EDGE COMPUTING

Edge Computing

- Edge uses less resources than the cloud initial overhead to build is high compared to cloud
- Edge server using cloud technologies and virtualization used to control edge components.
- Allows the mobile network operators improve existing services with edge.

Fog Computing

- Energy consumption of fog less than cloud services but overhead is high compared to cloud.
- No central entity controlling the fog cloud
- May not be controlled by network operators, uses an ad-hoc distribution.

Compared Between Cloud , Fog, Edge Computing

COMPARISON OF EDGE COMPUTING IMPLEMENTATIONS

	Fog Computing	Mobile-Edge Computing	Cloudlet Computing
Node devices	Routers, Switches, Access Points, Gateways	Servers running in base stations	Data Center in a box
Node location	Varying between End Devices and Cloud	Radio Network Controller/Macro Base Station	Local/Outdoor installation
Software Architecture	Fog Abstraction Layer based	Mobile Orchestrator based	Cloudlet Agent based
Context awareness	Medium	High	Low
Proximity	One or Multiple Hops	One Hop	One Hop
Access Mechanisms	Bluetooth, Wi-Fi, Mobile Networks	Mobile Networks	Wi-Fi
Internode Communication	Supported	Partial	Partial

Applications

- Edge
- Healthcare
- Traffic Management
- Autonomous Vehicles
- Agricultural Equipment
- Fog
- Connected cars
- Smart grids and smart cities
- Real-time analytics

Application: Use Cases

- **Manufacturing:** An industrial manufacturer deployed edge computing to monitor manufacturing, enabling real-time analytics and machine learning at the edge to find production errors and improve product manufacturing quality.

- **Farming:** Using sensors enables the business to track water use, nutrient density and determine optimal harvest. Data is collected and analyzed to find the effects of environmental factors and therefore produce good yield.

- **Improved healthcare:** The healthcare industry has dramatically expanded the amount of patient data collected from devices, sensors and other medical equipment. That enormous data volume requires edge computing to apply automation and machine learning to access the data

Applications

- **Traffic Management:** Edge computing can enable more effective city traffic management. Examples of this include optimizing bus frequency given fluctuations in demand, managing the opening and closing of extra lanes, and, in future, managing autonomous car flows.

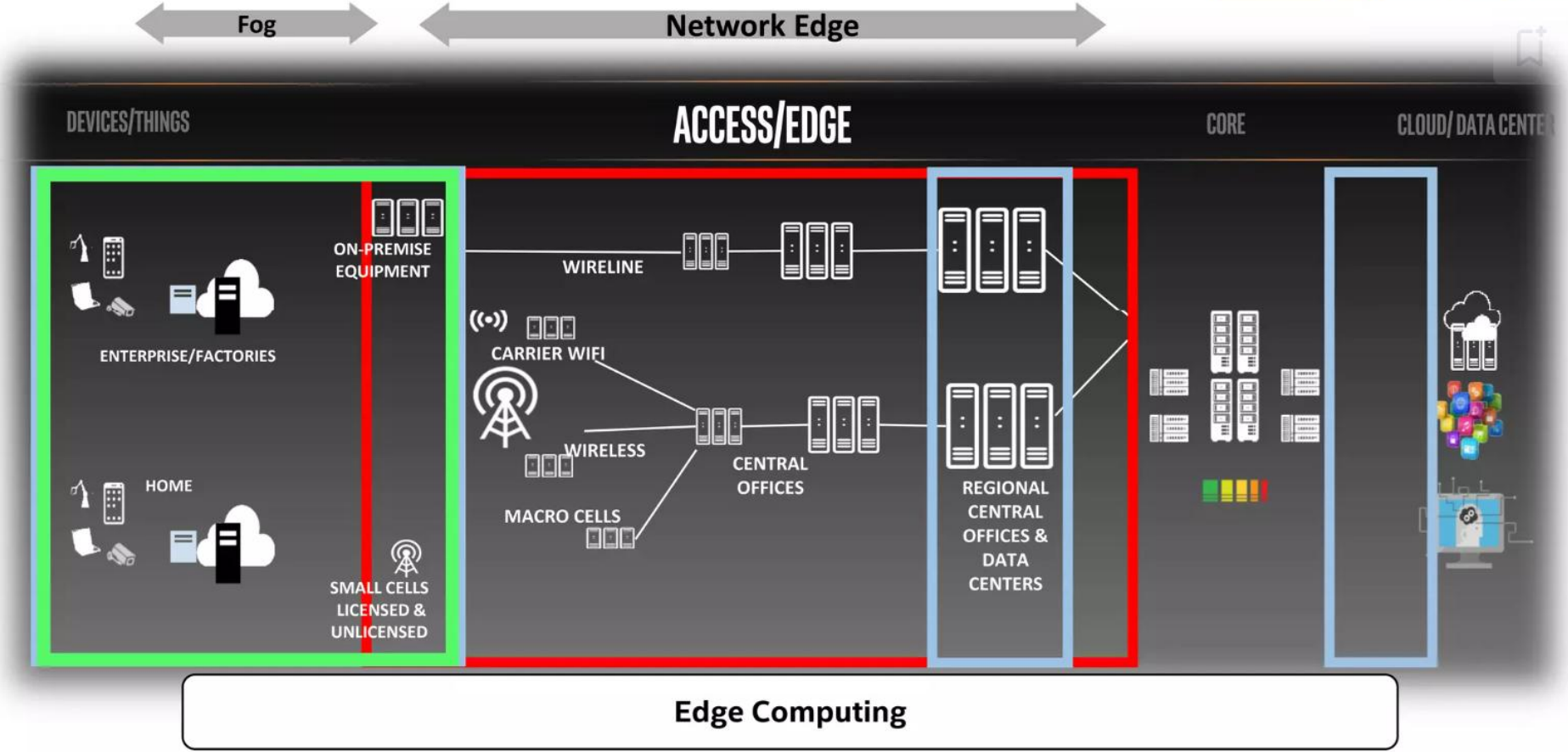
- Smart Homes: Smart homes rely on IoT devices collecting and processing data from around the house. As an example, the time taken for voice-based assistant devices such as Amazon's Alexa to respond would be much faster.

WHERE IS THE EDGE?

CoSP's view of Edge

Enterprises view of Edge

CSP's view of Edge



Edge Computing

Thank You