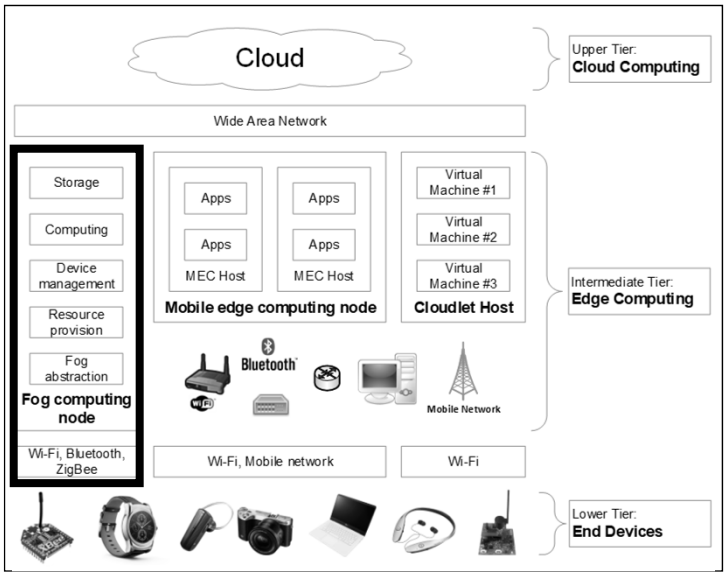
Cloud Technology

Fog Computing

IoT & Mobile Cloud Technology



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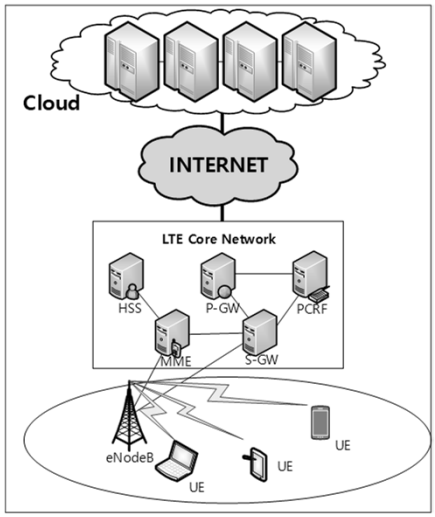
❖ Fog Computing



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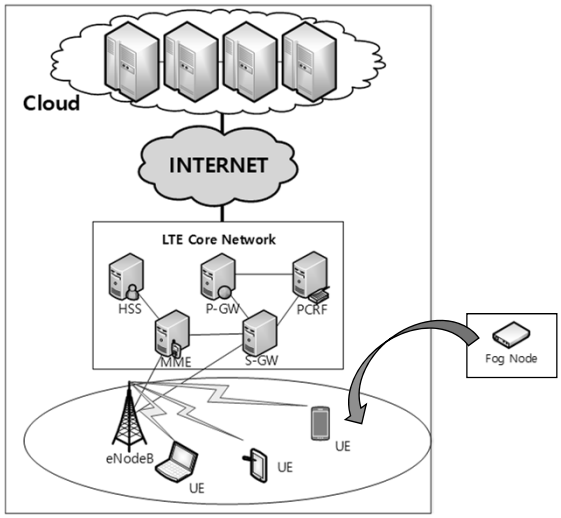
❖ Fog Computing



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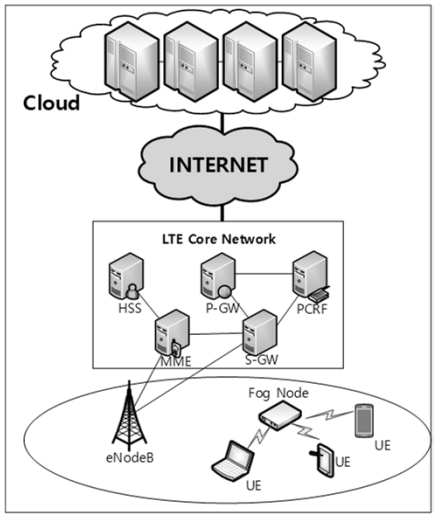
❖ Fog Computing



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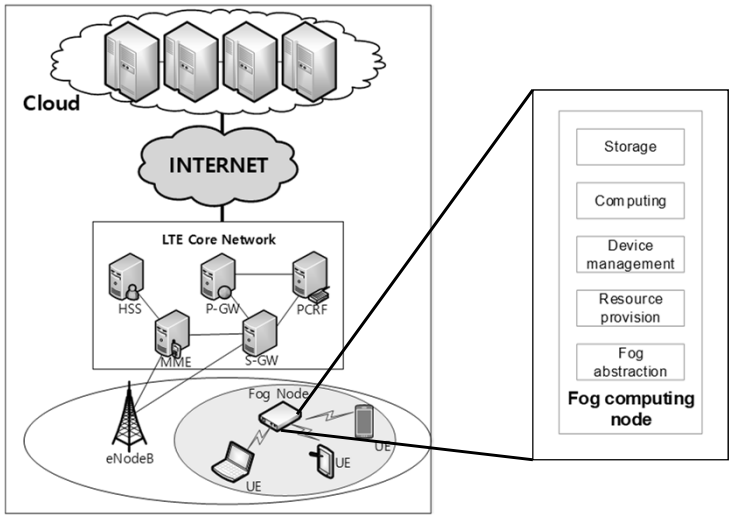

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❖ Fog Computing Definition

- Fog Computing or Fog Networking
- Uses one or more collaborative end-user Clients or near-user Edge devices
- Fog support services
  - Substantial amount of storage
    - Instead of storing in a cloud data center
  - Communications
    - Instead of routing over the Internet backbone

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❖ Fog Computing Definition

- Fog Computing or Fog Networking
- Uses one or more collaborative end-user Clients or near-user Edge devices
- Fog support services
  - Control, configuration, measurement and management
    - Instead of being controlled by Internet gateways or LTE S-GWs or the P-GW

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❖ Fog Computing Characteristic

- Decentralized Computing infrastructure is based on FCNs (Fog Computing Nodes)
- FCNs can be placed anywhere between the end devices and cloud
- FCNs are heterogeneous in nature, and can include various functional elements
  - Routers, switches, AP (Access Point), IoT gateways, set-top box, etc.

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❖ Fog Computing Characteristic

- FCN heterogeneity enables support for different protocols as well as IP and non-IP based access to Cloud services
- Uniform Fog abstraction layer has functions to support resource allocation, monitoring, security, device management, storage, and compute services for various types of end devices

Cloud Technology

MEC (Mobile Edge Computing)

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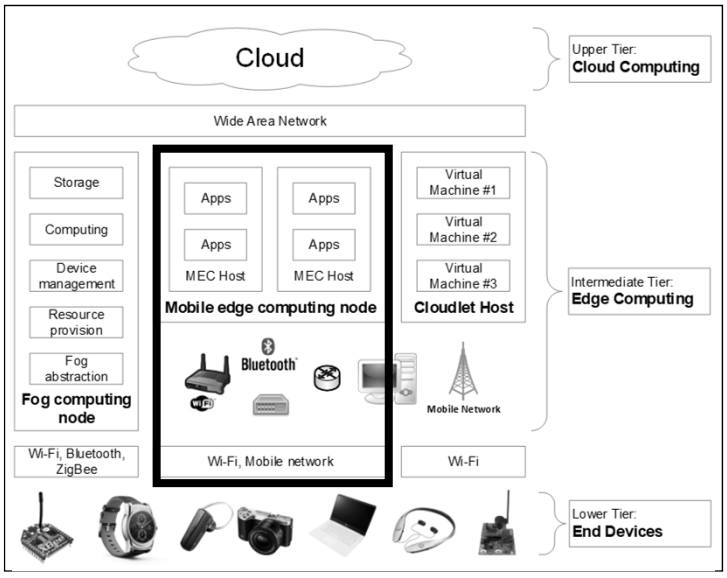

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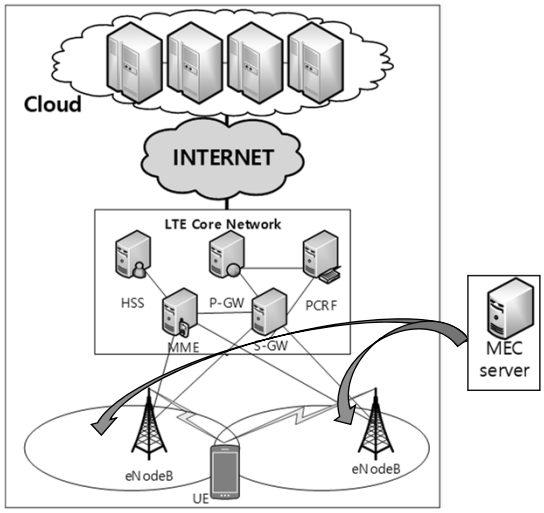
❖ MEC (Mobile Edge Computing)



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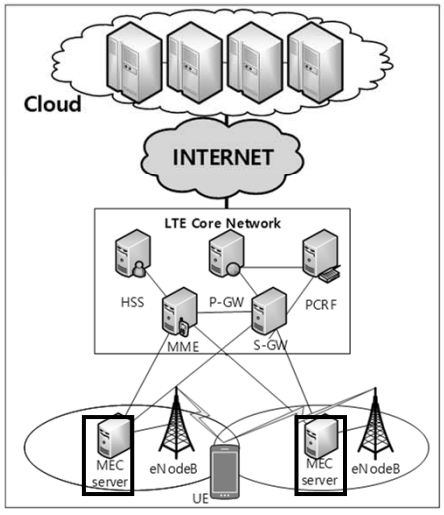

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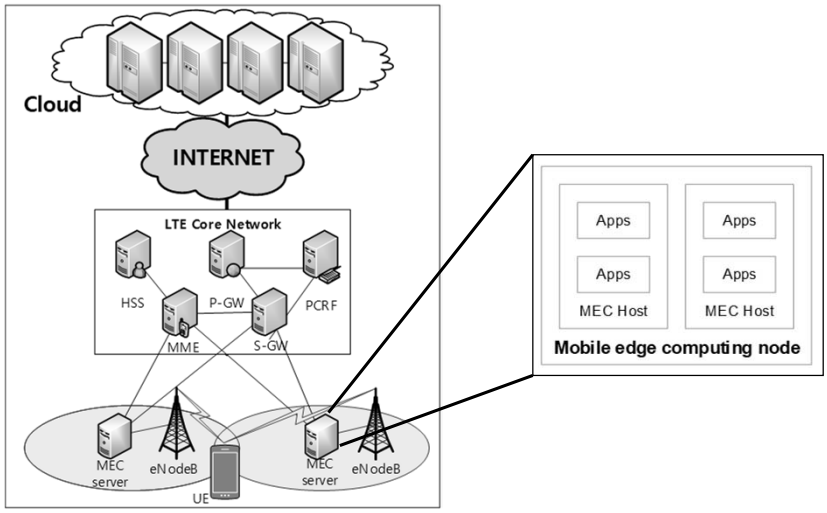
❖ MEC (Mobile Edge Computing)



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❖ MEC (Mobile Edge Computing) Definition

- MECs enable cloud computing and IT services at the edge of the mobile cellular network
- Why use MECs?
  - Faster cloud services to mobile UEs
  - Reduces network congestion
  - More reliable application support

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❖ MEC Characteristics

- MECs enable cellular operators to open their RAN (Radio Access Network) to authorized third-parties (e.g., application developers, content providers, etc.)
- MEC servers offer real-time information
  - Network information (e.g., network load and capacity)
  - Information on the end devices connected to the servers (e.g., location information, etc.)

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❖ MEC Characteristics

- MEC nodes (or servers) are usually co-located with a RNC (Radio Network Controller) or macro BS (Base Station)
  - eNB BS in LTE and LTE-A 4G networks
  - gNB BS in 5G networks
- Servers may run multiple MEC Hosts
- MEC Hosts can perform computation and storage through virtualized interfaces

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❖ MEC Controller

- MEO (Mobile Edge Orchestrator)
  - Manages MEC hosts
  - Controls information flow for services offered by each MEC host
  - Controls resources and network topology
  - Manages the Mobile Edge applications

Cloud Technology

Cloudlet

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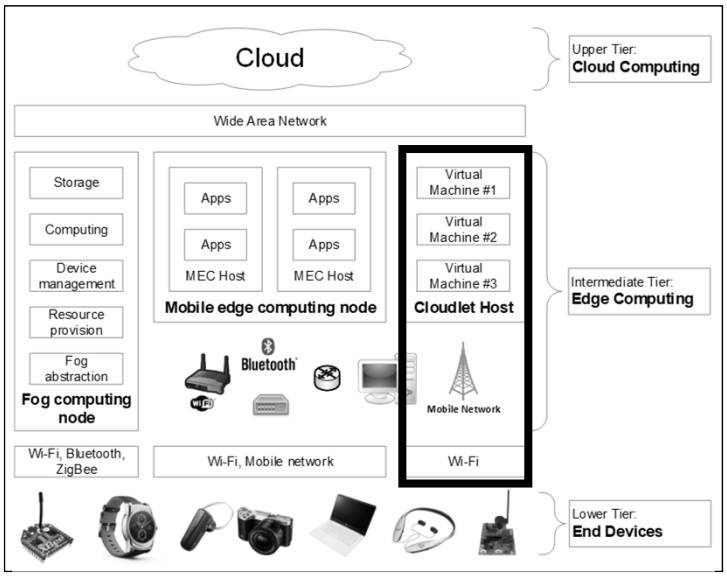

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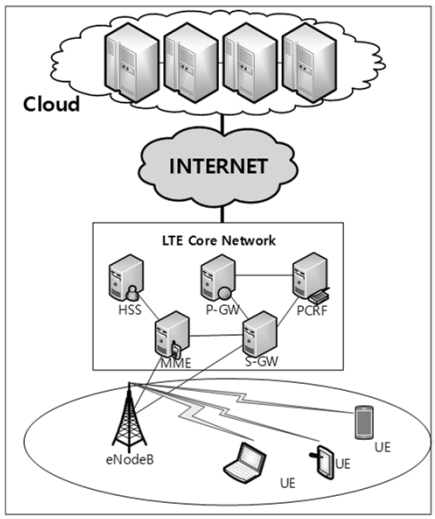
❖ Cloudlet



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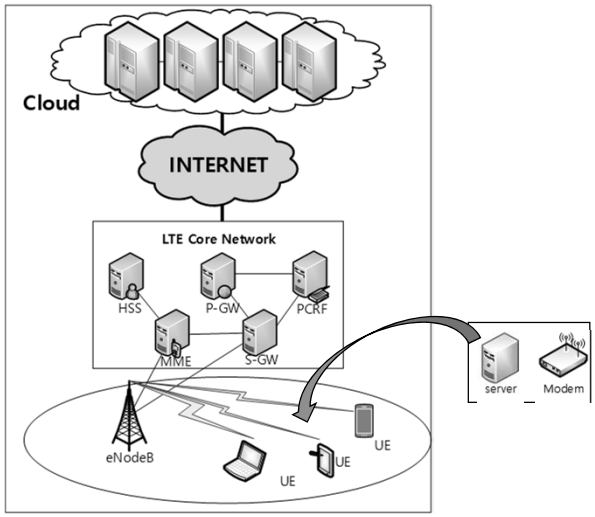
❖ Cloudlet



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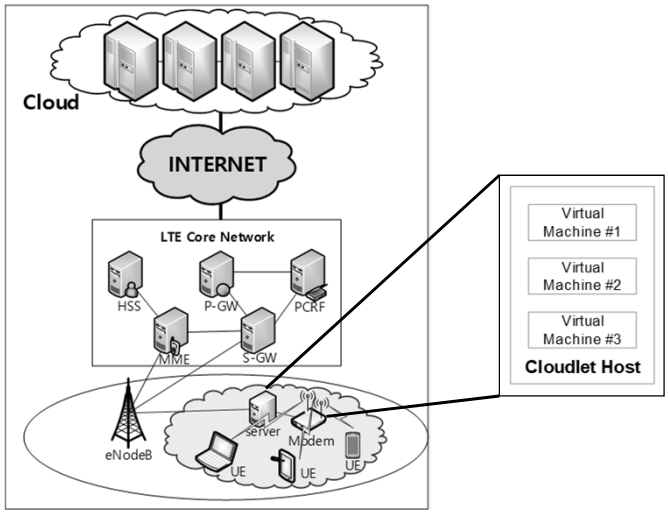
❖ Cloudlet



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❖ Cloudlet Definition

- Mobility-enhanced small-scale cloud data center
- Located at the edge of the Internet nearby the mobile devices
- Supporting resource-intensive and interactive mobile applications
- Provides powerful computing resources to mobile devices with low latency

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❖ Cloudlet Definition

- Used between UE ↔ Cloudlet ↔ Cloud
- Cloudlet is a data center in a box that brings the cloud closer to the UE
- Cloudlets use a VM (Virtual Machine) to provision resources for UEs in real-time over Wi-Fi networks
  - Direct one-hop Cloud access ➔ Low latency

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❖ Cloudlet Architecture: 3 Layers

- Cloudlet layer
  - Group of co-located nodes
  - Managed by a Cloudlet Agent
- Node layer
  - Multiple Execution Environment(s) running on top of the OS (Operating System)
  - Managed by a Node Agent
- Component layer
  - Includes a set of services that interface to the (higher layer) execution environment

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❖ Compare of Fog Computing, MEC, Cloudlet

	Fog Computing	Mobile Edge Comp.	Cloudlet Computing
Node Device	Routers, Switches, Access points, Gateways	Servers running in base stations	Data center in a box
Node location	Varying between end devices & cloud	Radio network controller/ Macro base station	Local/outdoor installation
Software Architecture	Fog abstraction layer	Mobile orchestrator	Cloudlet agent
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 Comm.	Supported	Partial	Partial

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❖ Compare of Fog Computing, MEC, Cloudlet

Physical proximity	High	Fog computing, Cloudlet computing
	Low	Mobile edge computing
Power consumed	High	Mobile edge computing
	Low	Fog computing, Cloudlet computing
Computation time	High	Fog computing
	Low	Mobile edge computing, Cloudlet computing
Context awareness	High	Mobile edge computing
	Low	Fog computing, Cloudlet computing
Logical proximity	Ensured	Cloudlet computing
	Maybe	Fog computing, Mobile edge computing
Non-IP support	Yes	Fog computing
	No	Mobile edge computing, Cloudlet computing

Cloud Technology

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