IOT
Unit 4- M2M

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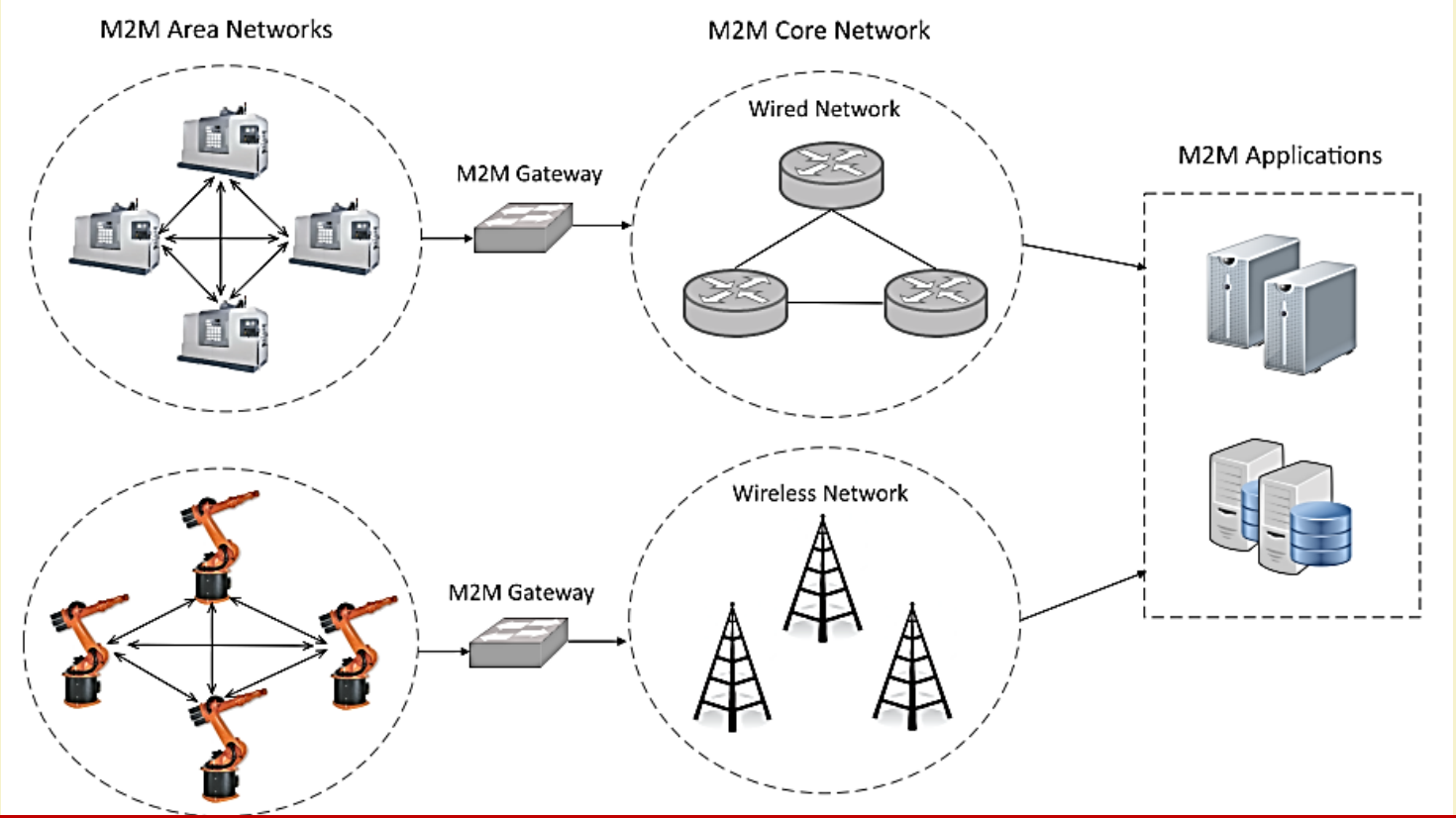
Content

- Machine to Machine (M2M)
- Differences and similarities between M2M and IoT
- Software Defined Networks (SDN)
- Network Function Virtualization
- Difference between SDN and NFV for IoT.

Machine-to-Machine (M2M)

Machine-to-Machine (M2M) refers to networking of machines (or devices) for the purpose of remote monitoring and control and data exchange without any human intervention.



How Machine-to-Machine (M2M) works?

- The main purpose of machine-to-machine technology is to **tap into sensor data and transmit it to a network.** Unlike SCADA or other remote monitoring tools, M2M systems often use **public networks and access methods** -- for example, cellular or Ethernet -- to make it more cost-effective.
- The main components of an M2M system include **sensors**, **RFID**, a **Wi-Fi** or **cellular communications link,** and autonomic computing software programmed to help a network device interpret data and make decisions. These M2M applications **translate the data, which can trigger preprogrammed, automated actions.**
- One of the most well-known types of machine-to-machine communication is **telemetry**, which has been used since the early part of the last century to transmit operational data. Pioneers in telemetrics first used telephone lines, and later, **radio waves**, to transmit performance measurements gathered from monitoring instruments in remote locations.
- The Internet and improved standards for wireless technology have expanded the role of telemetry from pure science, engineering and manufacturing to everyday use in products such as **heating units, electric meters and internet-connected devices, such as appliances**.

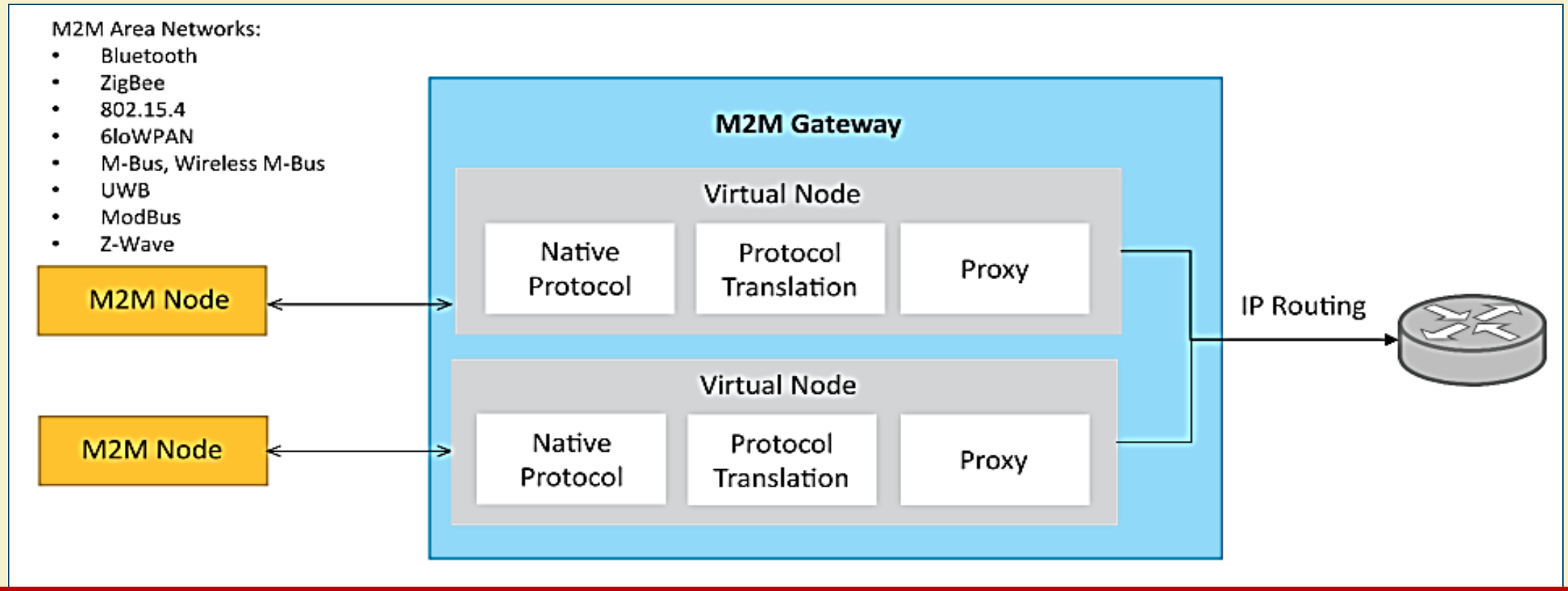
- Beyond being able to remotely monitor equipment and systems, the top benefits of M2M include:
  - **reduced costs** by minimizing equipment maintenance and downtime;
  - **boosted revenue** by revealing new business opportunities for servicing products in the field; and
  - **improved customer service** by proactively monitoring and servicing equipment before it fails or only when it is needed.

Machine-to-Machine (M2M)

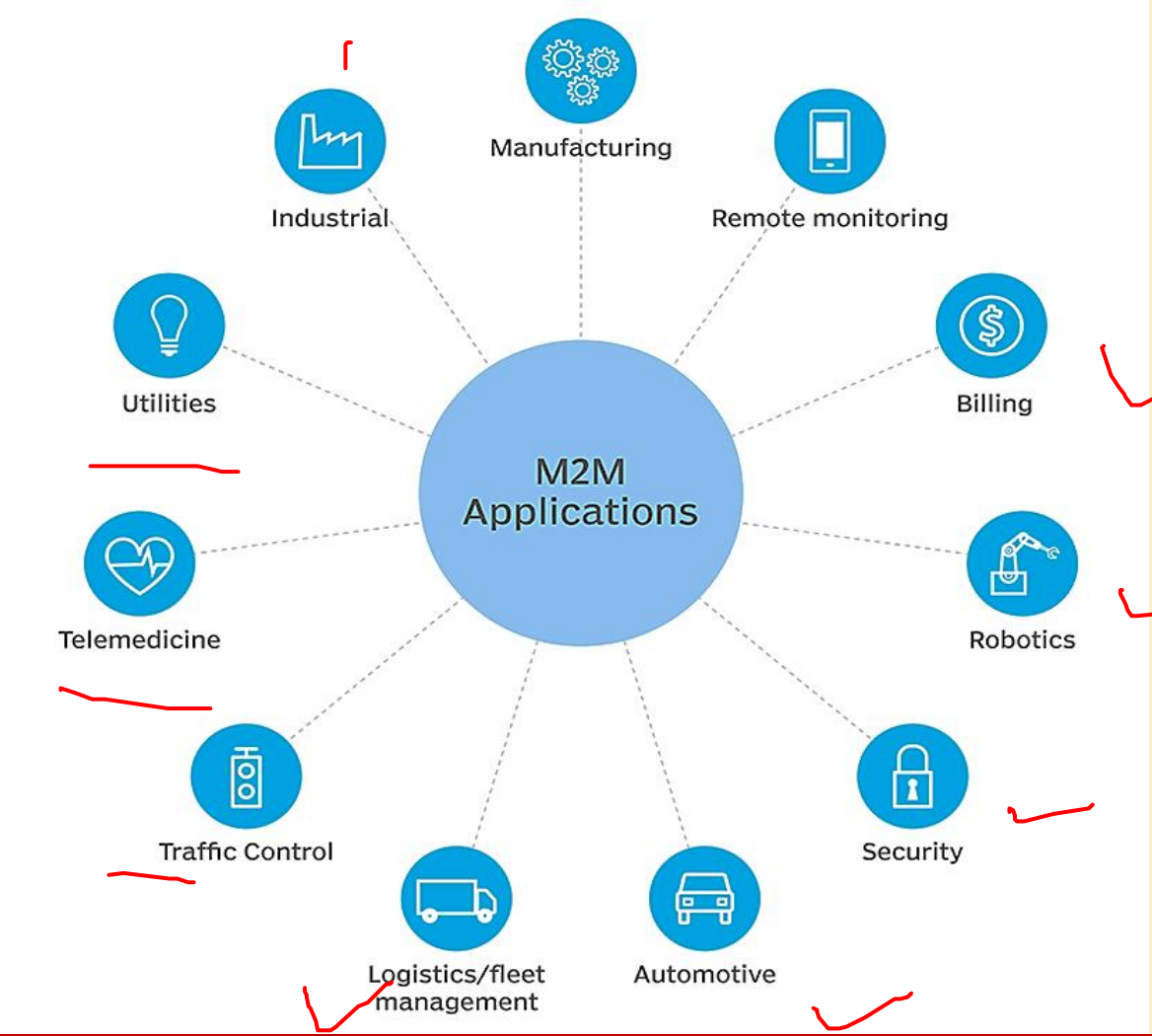
- An M2M area network comprises machines (or M2M nodes) which have embedded hardware modules for sensing, actuation and communication.
- Various communication protocols can be used for M2M local area networks, such as ZigBee, Bluetooth, ModBus, M-Bus, Wireless M-Bus, Power Line Communication (PLC), 6LoWPAN, IEEE 802.15.4, etc.
- The communication network provides connectivity to remote M2M area networks.
- The communication network can use either wired or wireless networks (IP-based).
- While the M2M area networks use either proprietary or non-IP based communication protocols, the communication network uses IP-based networks.

M2M Gateway

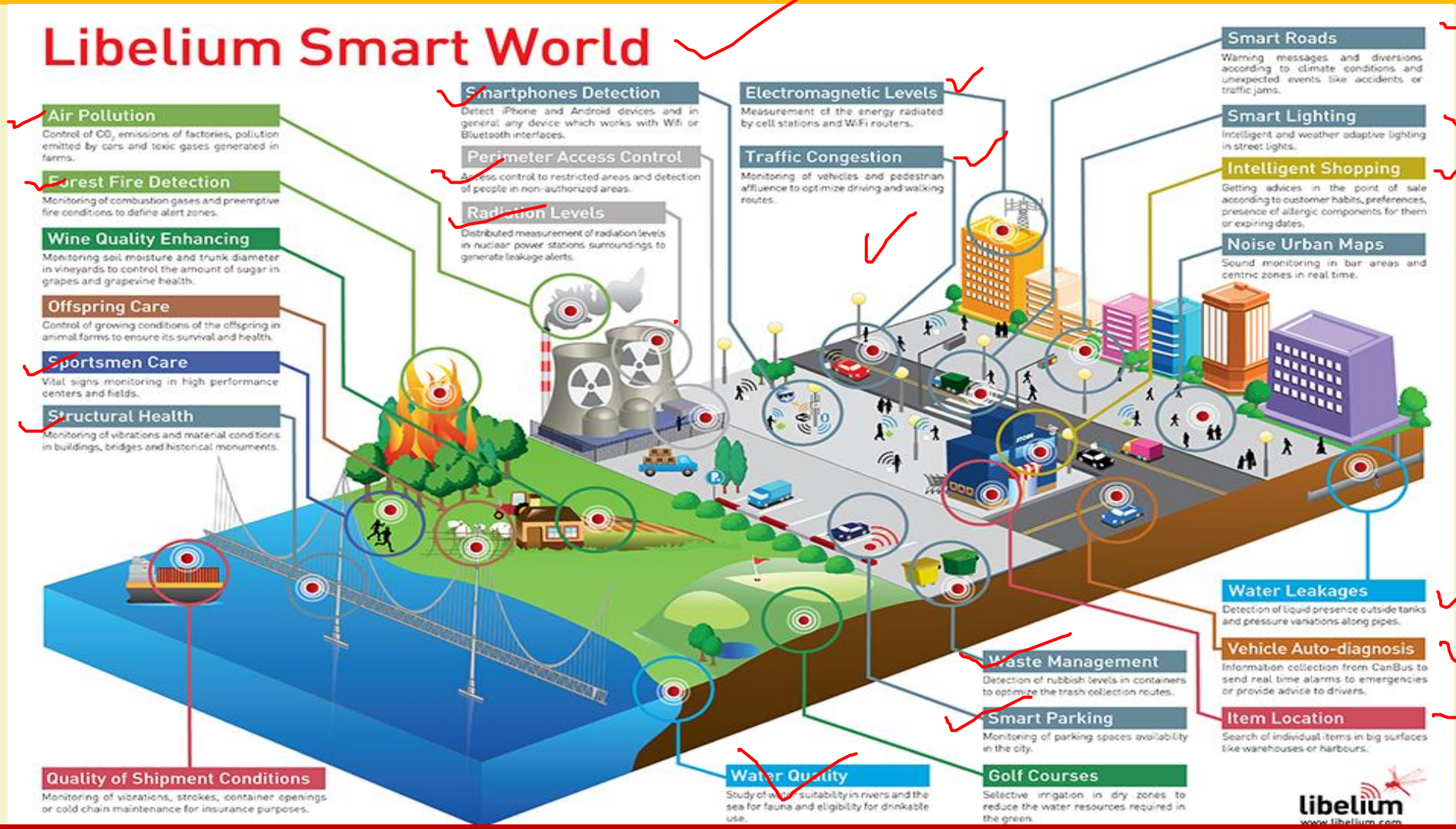
- Since non–IP-based protocols are used within M2M area networks, the M2M nodes within one network cannot communicate with nodes in an external network.
- To enable communication between remote M2M area networks, M2M gateways are used.



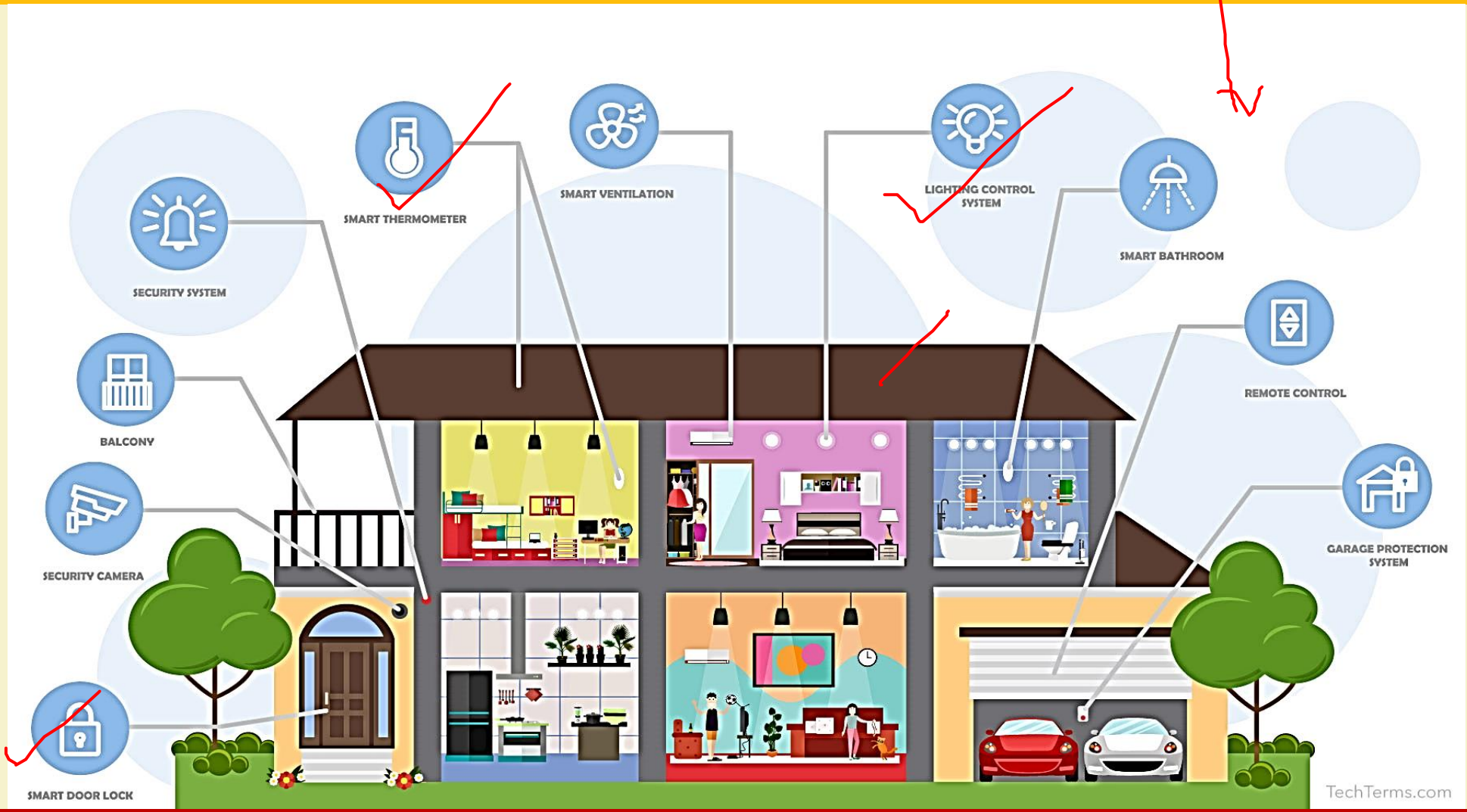
M2M Applications



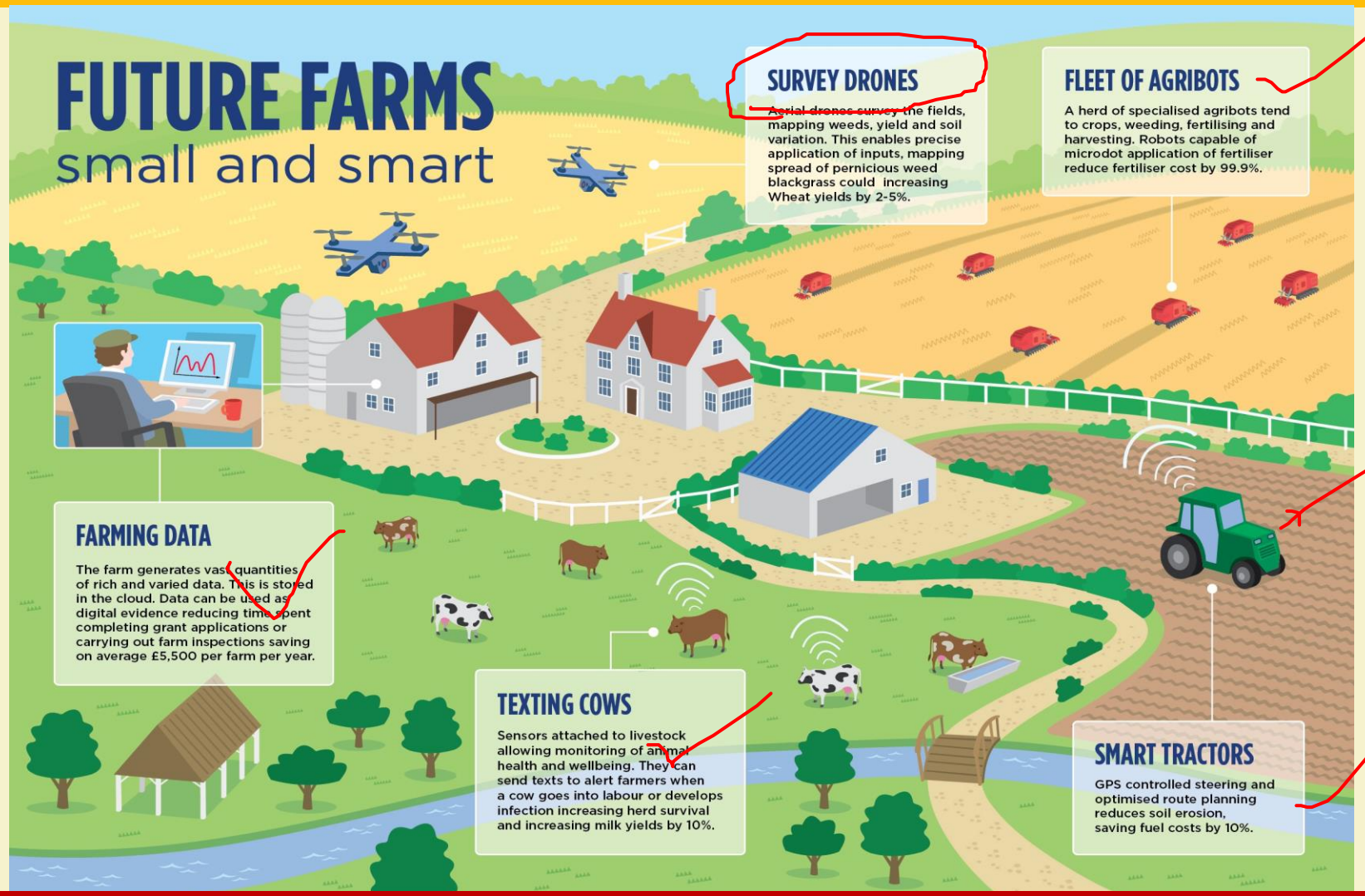
M2M Applications- Smart Cities



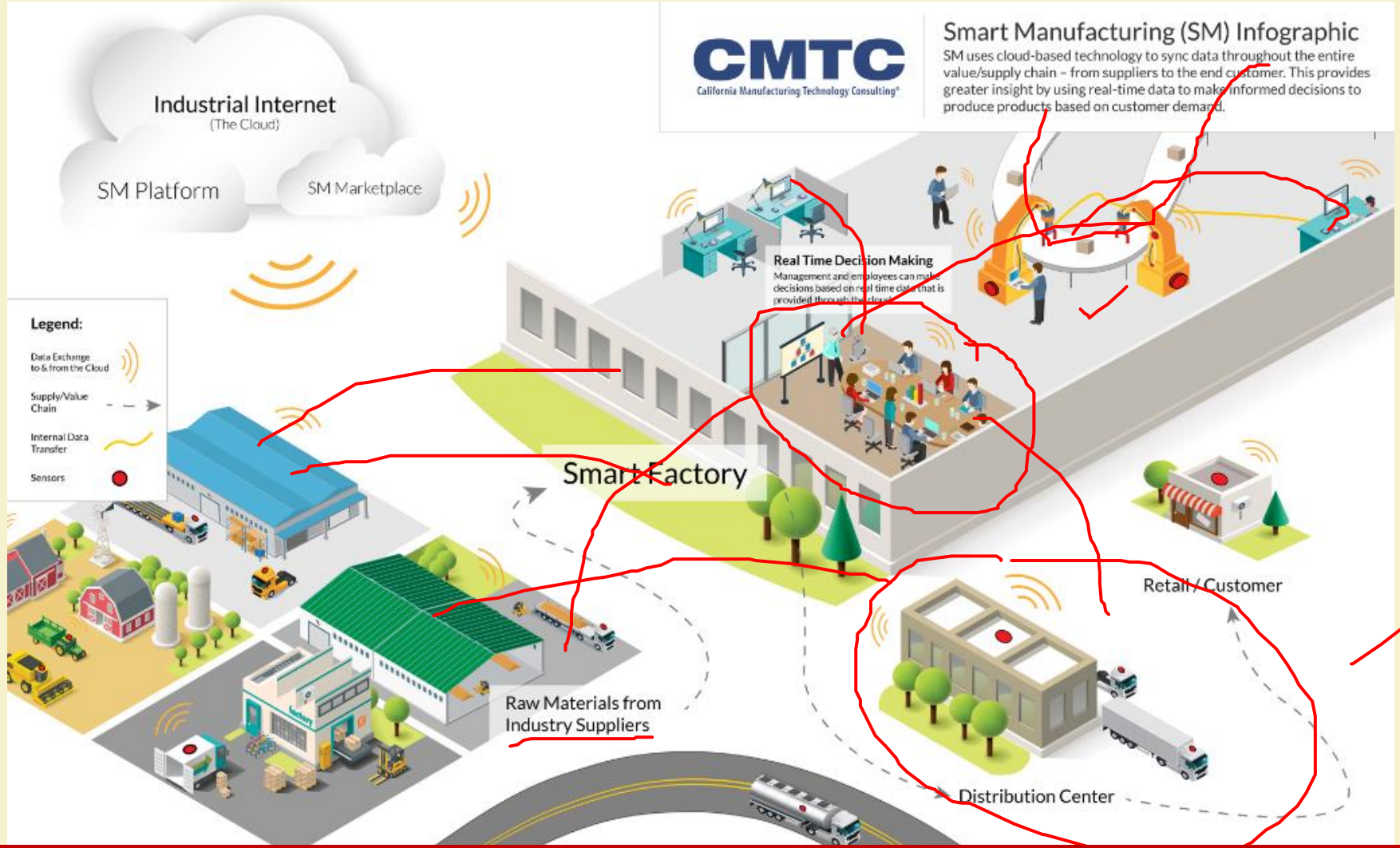
M2M Applications- Smart Home



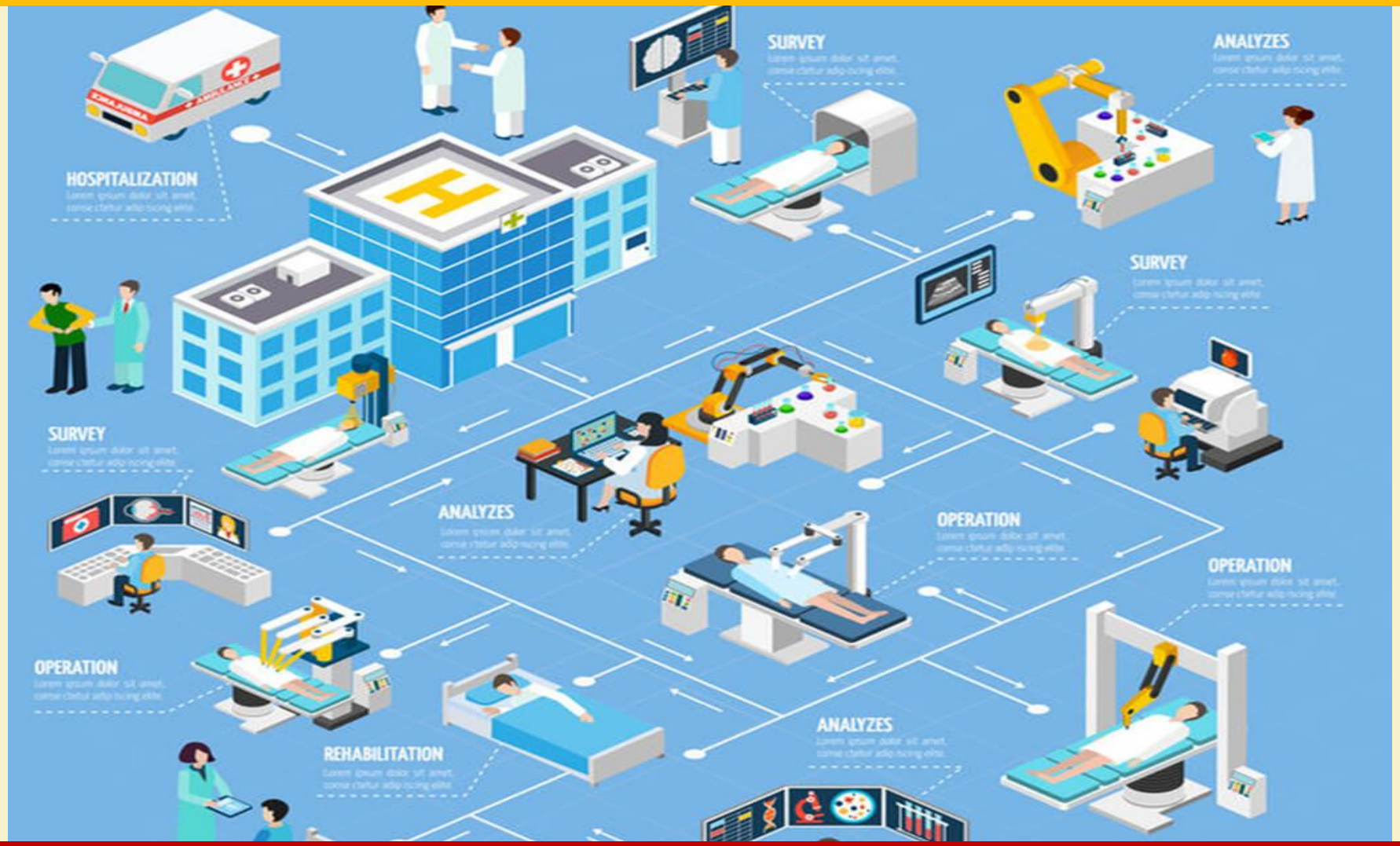
M2M Applications- Smart Agriculture



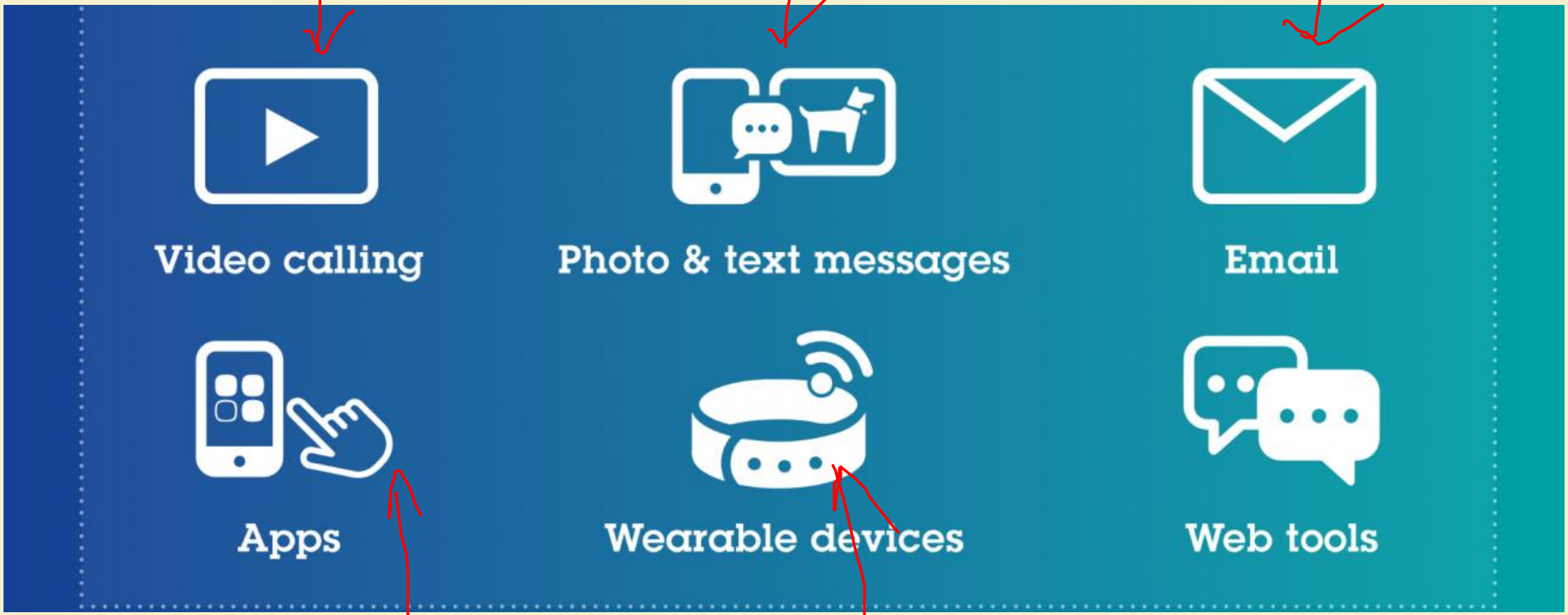
M2M Applications- Smart Manufacturing



M2M Applications- Smart Health Care



M2M Applications- Telemedicine



M2M Features

- **Low power consumption**, in an effort to improve the system's ability to effectively service M2M applications.
- A Network operator that provides **packet-switched service**.
- Monitoring abilities that provide **functionality to detect events**.
- **Time tolerance**, meaning data transfers can be delayed.
- **Time control**, meaning data can only be sent or received at specific predetermined periods.
- **Location specific triggers** that alert or wake up devices when they enter particular areas.
- The ability to continually send and receive small amounts of **data**.

Difference between IoT and M2M

Communication Protocols

- M2M and IoT can differ in how the communication between the machines or devices happens.
- M2M uses either proprietary or non–IP-based communication protocols for communication within the M2M area networks.

Machines in M2M vs Things in IoT

- The "Things" in IoT refers to physical objects that have unique identifiers and can sense and communicate with their external environment (and user applications) or their internal physical states.
- M2M systems, in contrast to IoT, typically have homogeneous machine types within an M2M area network.

Difference between IoT and M2M

Hardware vs Software Emphasis

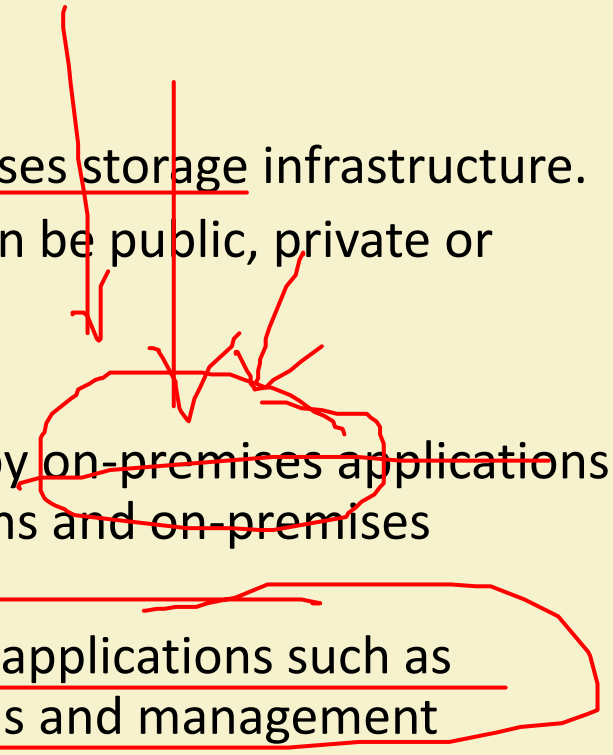
- While the emphasis of M2M is more on hardware with embedded modules, the emphasis of IoT is more on software.

Data Collection & Analysis

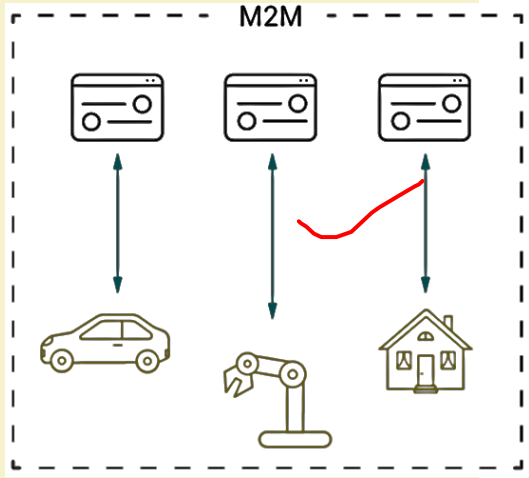
- M2M data is collected in point solutions and often in on-premises storage infrastructure.
- In contrast to M2M, the data in IoT is collected in the cloud (can be public, private or hybrid cloud).

Applications

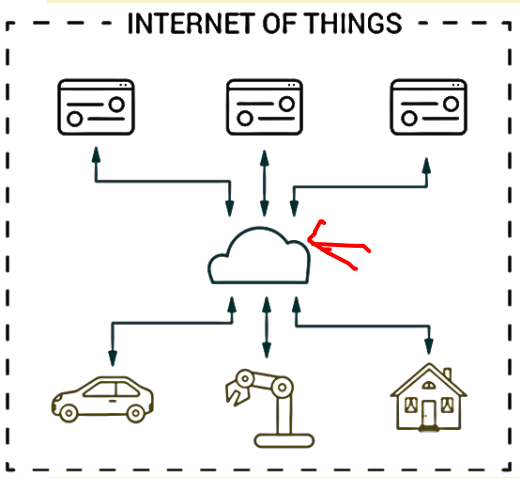
- M2M data is collected in point solutions and can be accessed by on-premises applications such as diagnosis applications, service management applications and on-premises enterprise applications.
- IoT data is collected in the cloud and can be accessed by cloud applications such as analytics applications, enterprise applications, remote diagnosis and management applications, etc.



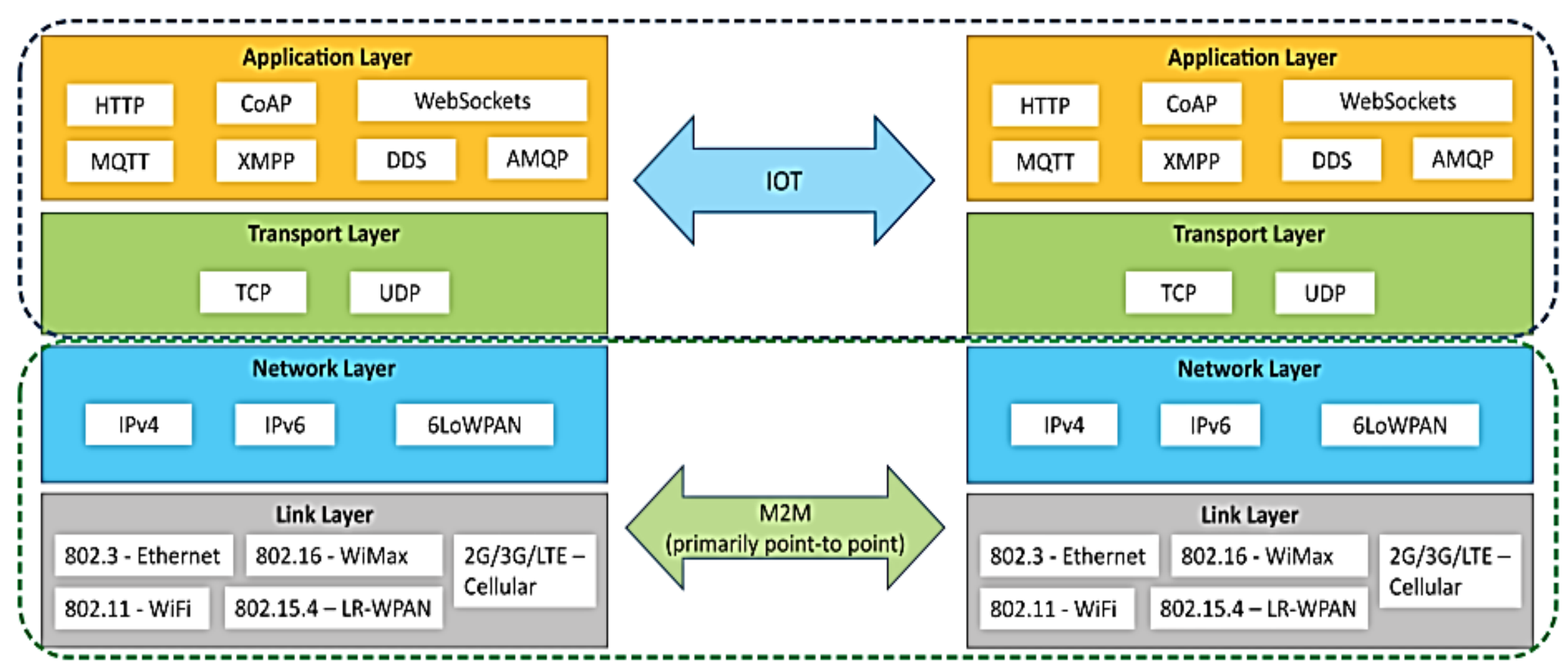
Difference between IoT and M2M



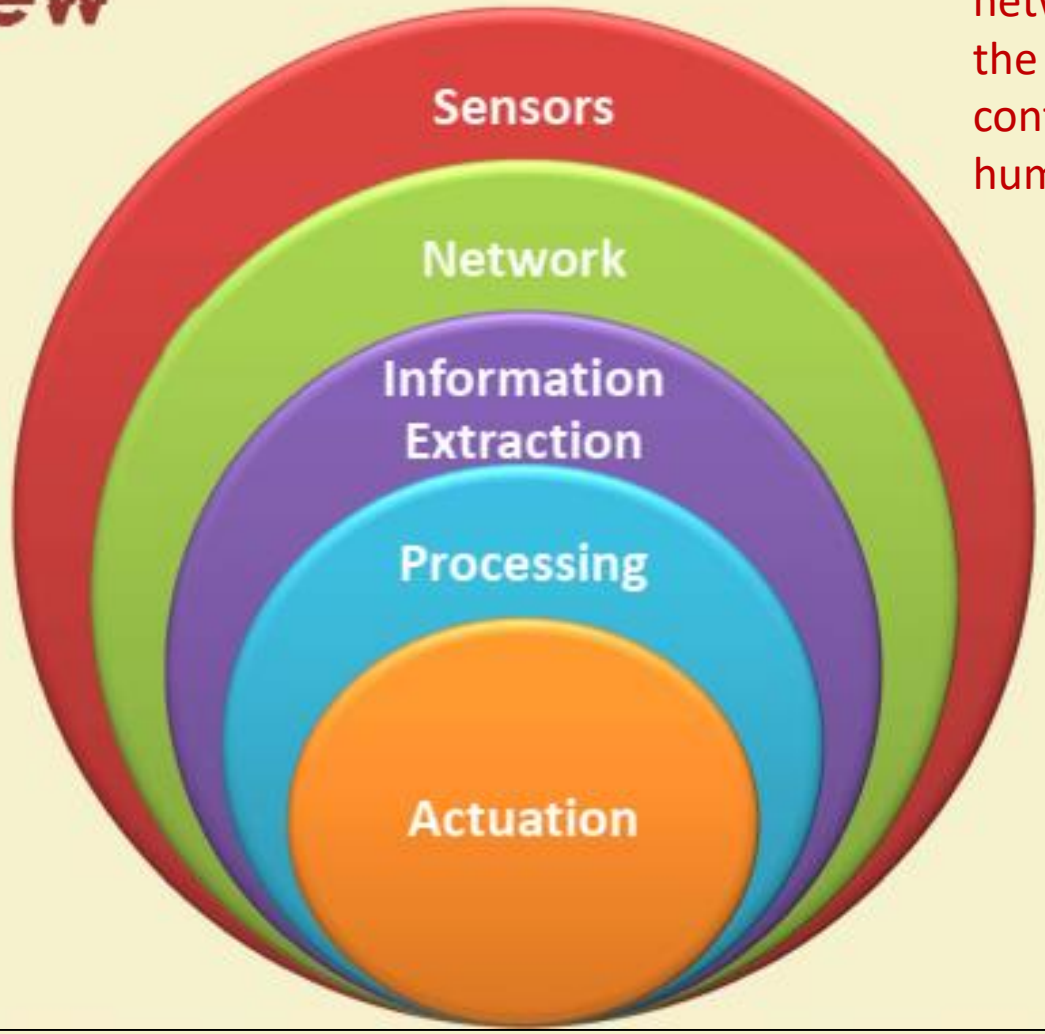
M2M	IoT
Machines	Sensors
Hardware-based	Software-based
Vertical applications	Horizontal applications
Deployed in a closed system	Connects to a larger network
Machines communicating with machines	Machines communicating with machines, humans with machines, machines with humans
Uses non-IP protocol	Uses IP protocols
Can use the cloud, but not required to	Uses the cloud
Machines use point-to-point communication, usually embedded in hardware	Devices use IP networks to communicate
Often one-way communication	Back and forth communication
Main purpose is to monitor and control	Multiple applications; multilevel communications
Operates via triggered responses based on an action	Can, but does not have to, operate on triggered responses
Limited integration options, devices must have complementary communication standards	Unlimited integration options, but requires software that manages communications/protocols
Structured data	Structured and unstructured data



Communication in IoT vs M2M



M2M Overview



Machine-to-Machine (M2M) refers to networking of machines (or devices) for the purpose of remote monitoring and control and data exchange without any human intervention.

M2M Applications

- ✓ Environmental monitoring
- ✓ Civil protection and public safety
- ✓ Supply Chain Management (SCM)
- ✓ Energy & utility distribution industry (smart grid)
- ✓ Intelligent Transport Systems (ITSs)
- ✓ Healthcare
- ✓ Automation of building
- ✓ Military applications
- ✓ Agriculture
- ✓ Home networks

M2M Features

- ✓ Large number of nodes or devices.
- ✓ Low cost.
- ✓ Energy efficient.
- ✓ Small traffic per machine/device.
- ✓ Large quantity of collective data.
- ✓ M2M communication free from human intervention.
- ✓ Human intervention required for operational stability and sustainability.

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.

M2M Node Types

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.

Low-end Sensor Nodes

- ✓ Cheap, and have low capabilities.
- ✓ Static, energy efficient and simple.
- ✓ Deployment has high density in order to increase network lifetime and survivability.
- ✓ Resource constrained, and no IP support.
- ✓ Basic functionalities such as, data aggregation, auto configuration, and power saving.
- ✓ Generally used for environment monitoring applications.

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.

Mid-end Sensor Nodes

- ✓ More expensive than low-end sensor nodes.
- ✓ Nodes may have mobility.
- ✓ Fewer constraints with respect to complexity and energy efficiency.
- ✓ Additional functionalities such as localization, Quality of Service (QoS) support, TCP/IP support, power control or traffic control, and intelligence.
- ✓ Typical application includes home networks, SCM, asset management, and industrial automation.

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.

High-end Sensor Nodes

- ✓ Low density deployment.
- ✓ Able to handle multimedia data (video) with QoS requirements.
- ✓ Mobility is essential.
- ✓ Example: smartphones.
- ✓ Generally applied to ITS and military or bio/medical applications.

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.

M2M Ecosystem

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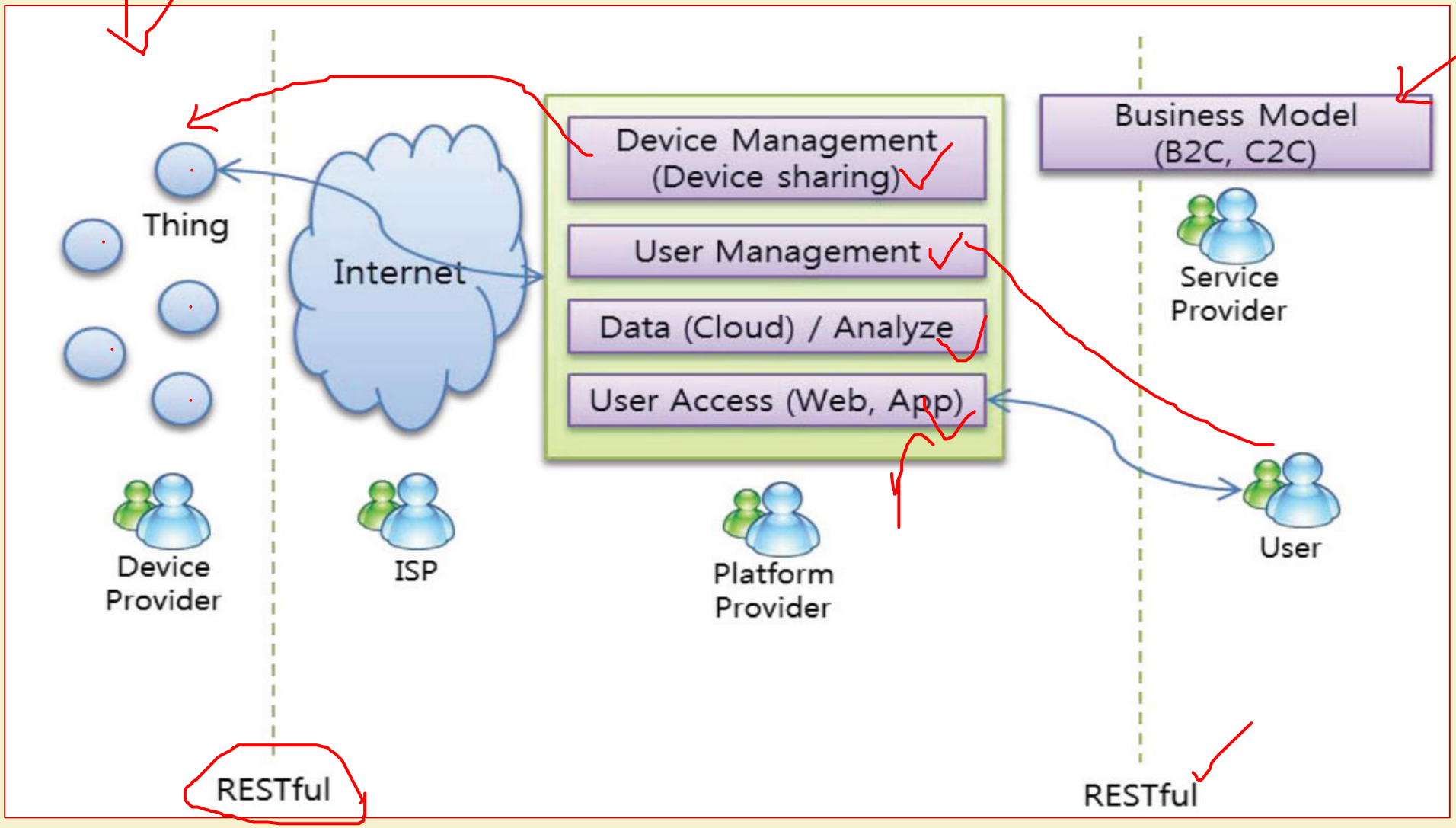
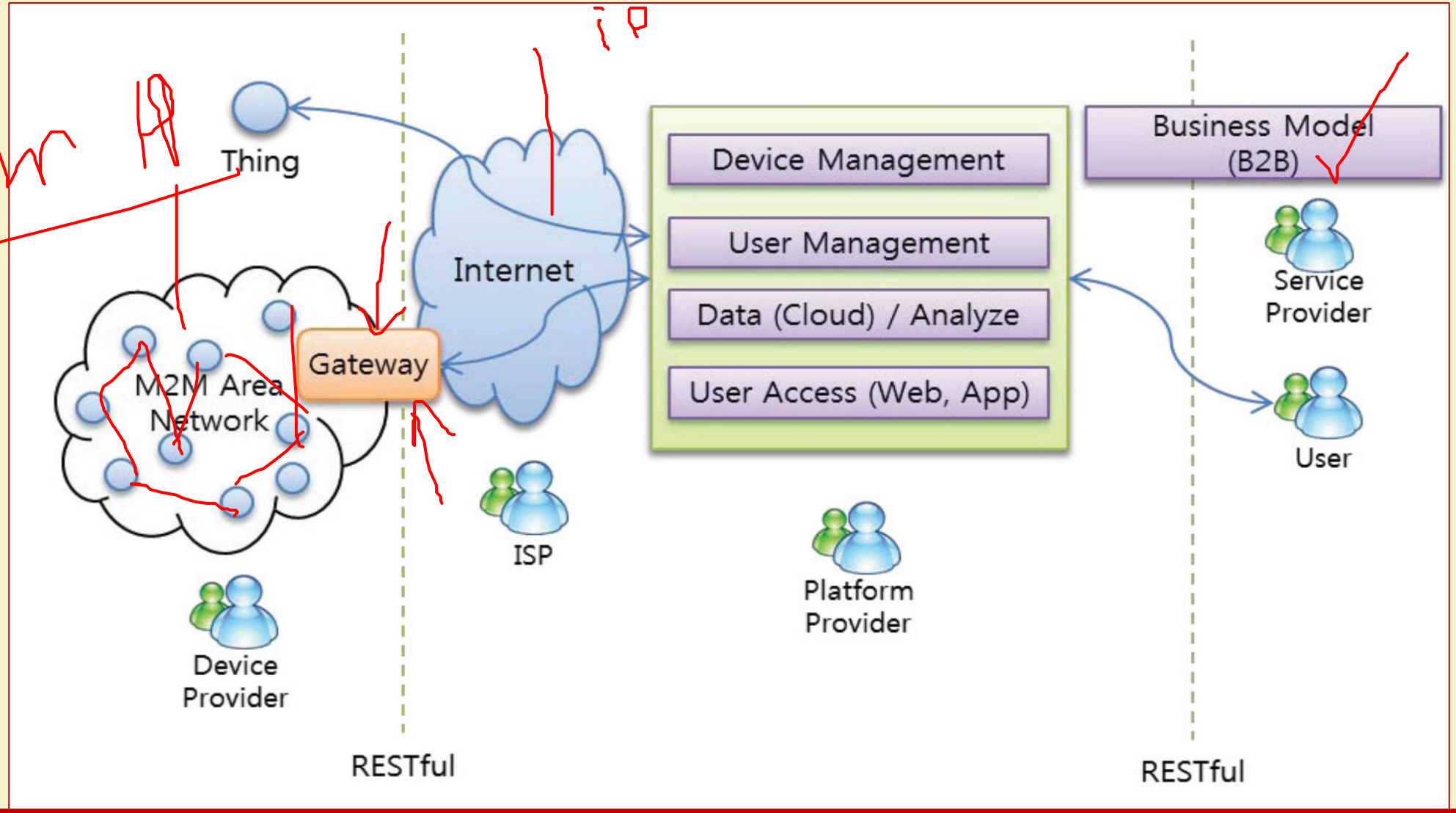
M2M Ecosystem

Stakeholders	Functions
Device Provider	Responsible for devices providing raw data and/or content to the network provider and application provider, according to the service logic.
Internet Service Provider (ISP)	Provides their infrastructures for M2M device communications.
Platform Provider	Provides integration capabilities and open interfaces, as well as data storage, data processing, or device management.
Service Provider	Utilizes capabilities or resources made available by the network provider, device provider, and platform provider, in order to provide M2M applications to customers.
Service User	This is an individual or company that utilizes M2M applications provided by an application provider.

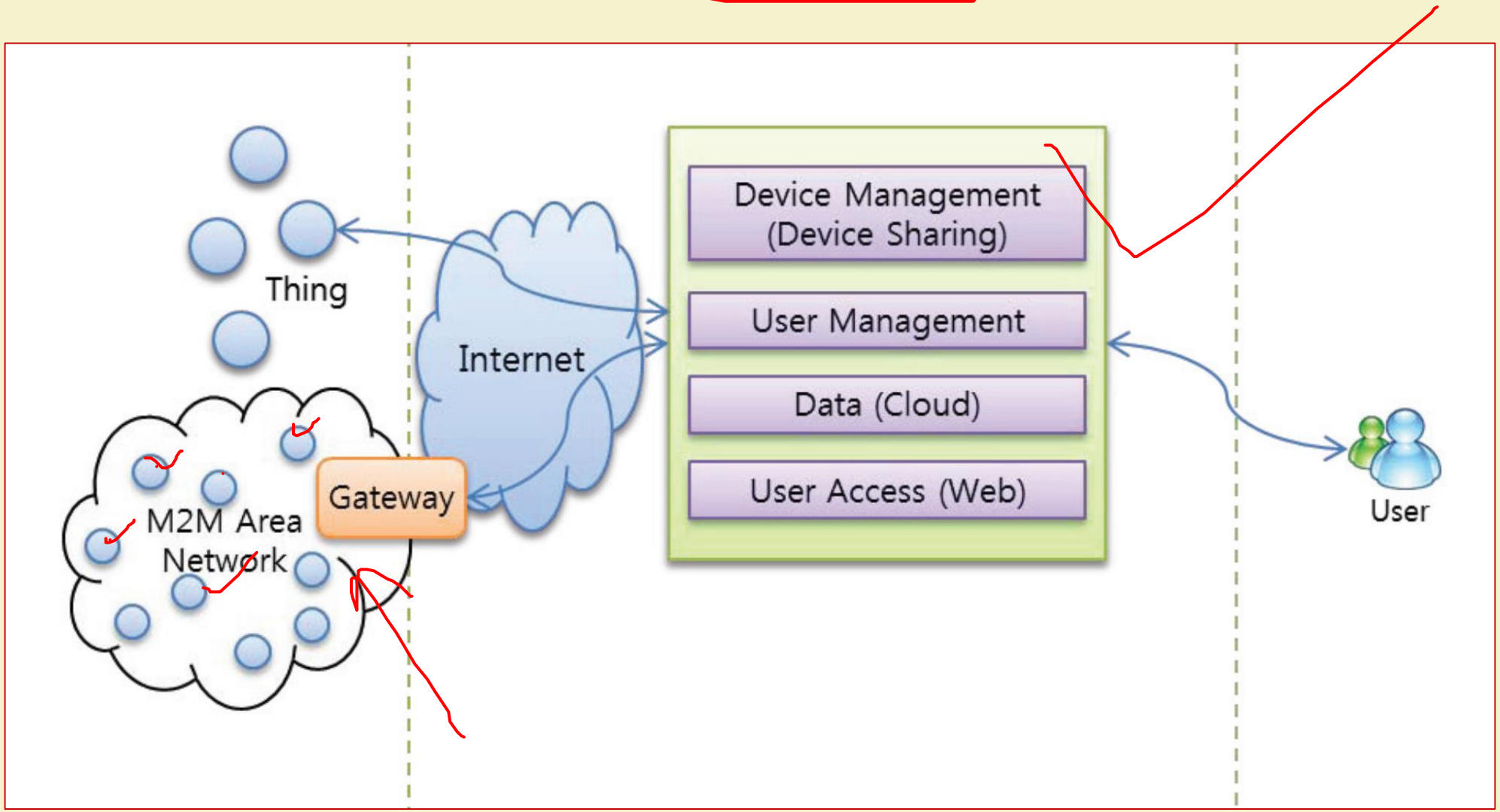
Commercial Platform without M2M Area Network



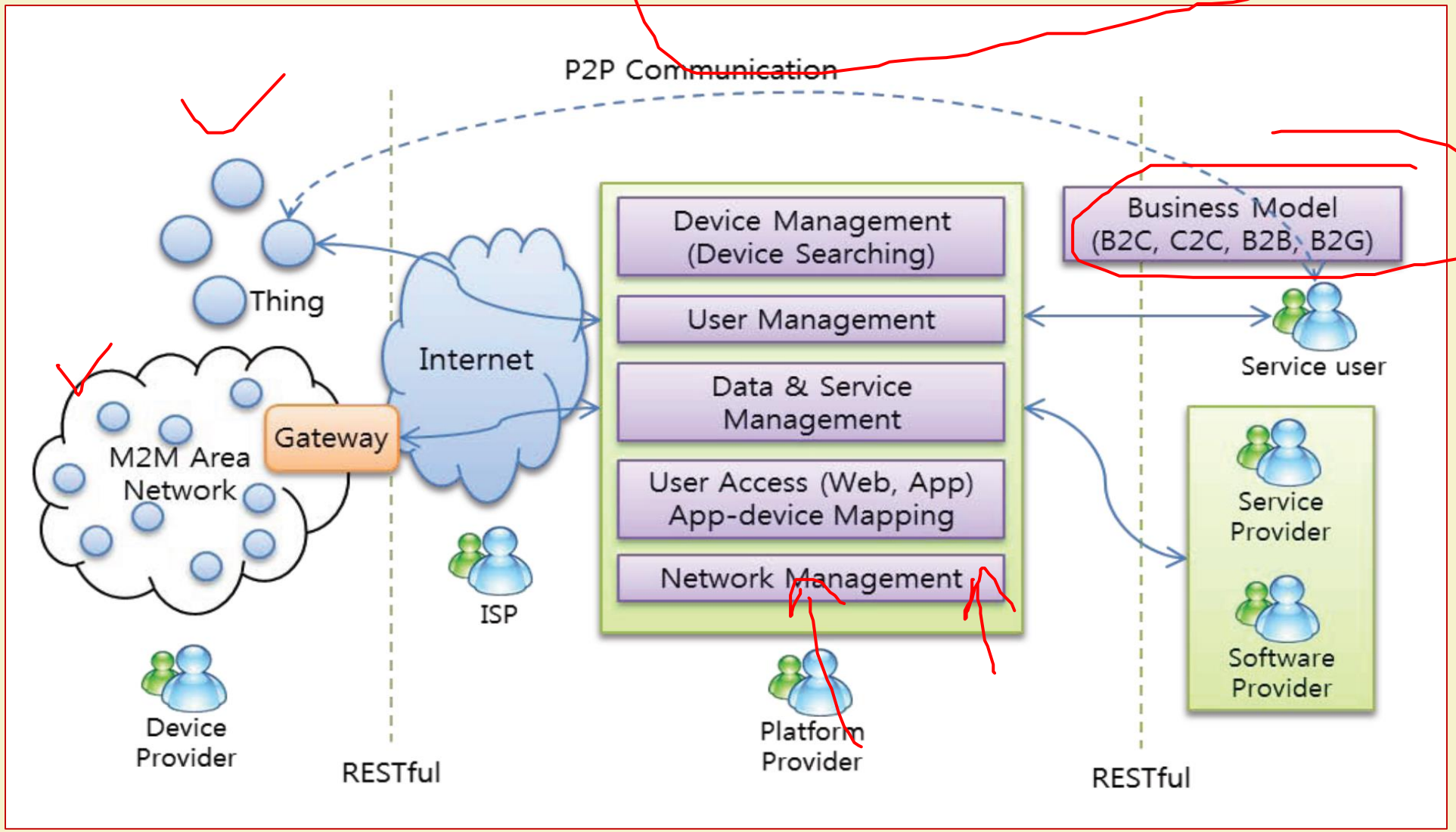
Commercial Platform with M2M Area Network



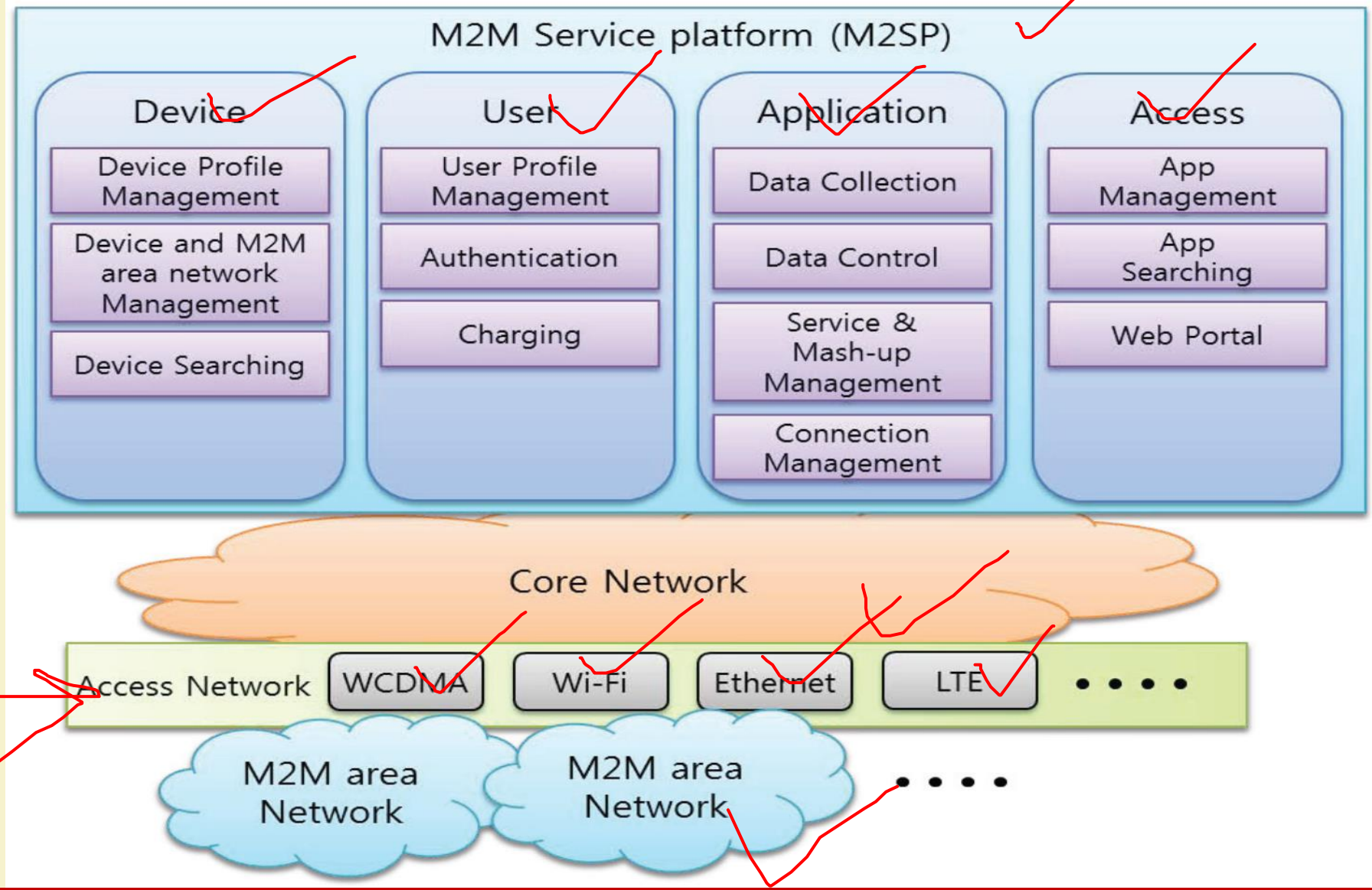
Platform architecture from research area



M2M ideal platform model



M2M Service Platform (M2SP)



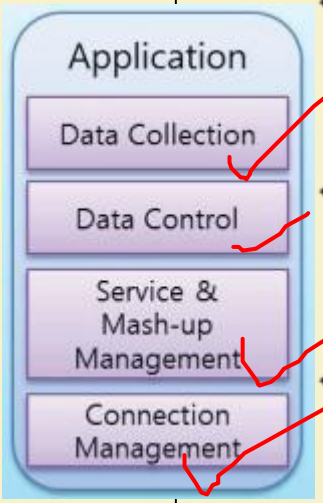
M2M Device Platform

- ✓ Enables access to objects or devices connected to the Internet anywhere and at any time.
- ✓ Registered devices create a database of objects from which managers, users and services can easily access information.
- ✓ Manages device profiles, such as location, device type, address, and description.
- ✓ Provides authentication and authorization key management functionalities.
- ✓ Monitors the status of devices and M2M area networks, and controls them based on their status.

M2M User Platform

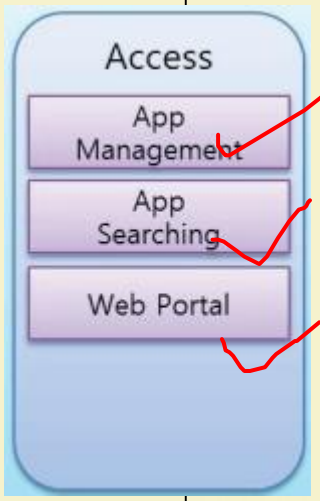
- ✓ Manages M2M service user profiles and provides functionalities such as,
  - User registration
  - Modification
  - Charging
  - Inquiry.
- ✓ Interoperates with the Device-platform, and manages user access restrictions to devices, object networks, or services.
- ✓ Service providers and device managers have administrative privileges on their devices or networks.
- ✓ Administrators can manage the devices through device monitoring and control.

M2M Application Platform



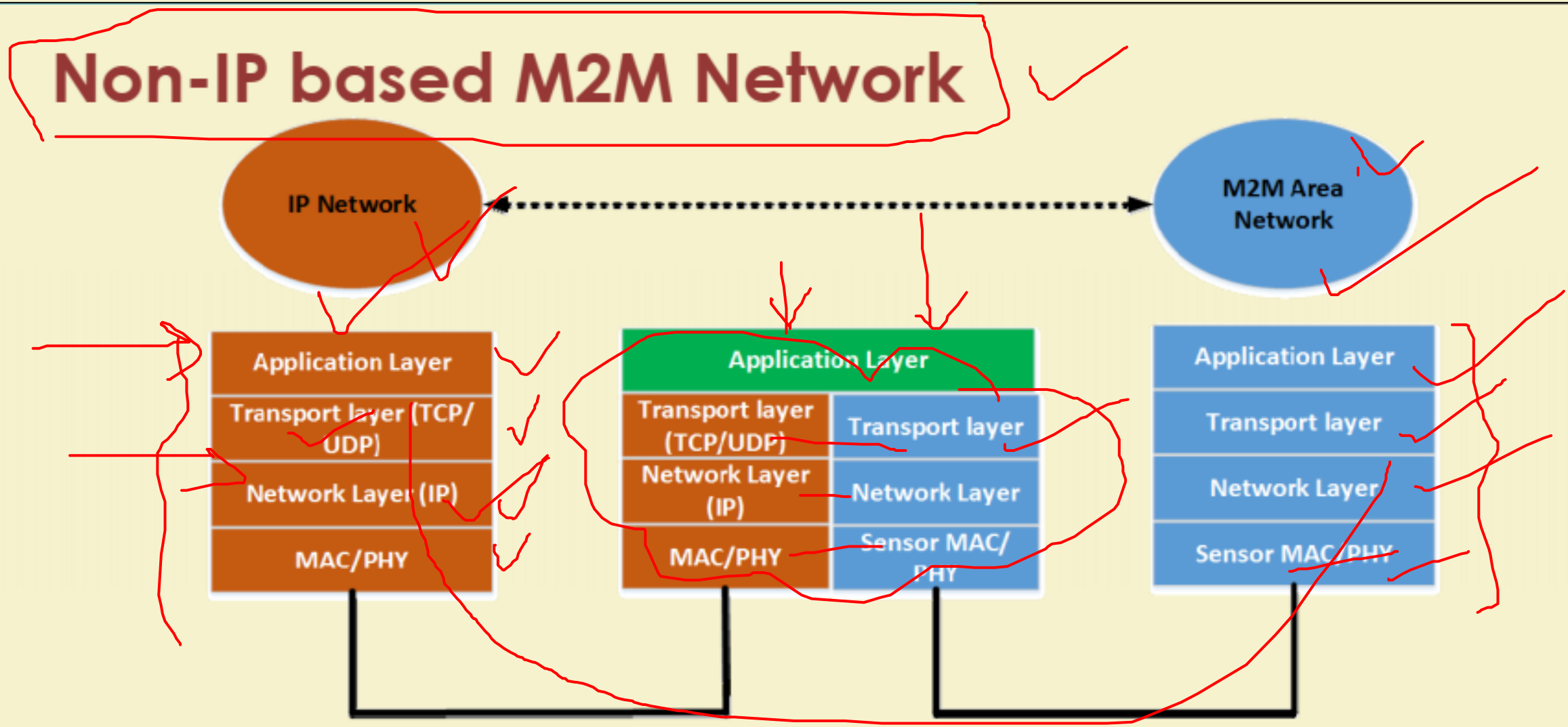
- ✓ Provides integrated services based on device collected data-sets.
- ✓ Heterogeneous data merging from various devices used for creating new services.
- ✓ Collects control processing log data for the management of the devices by working with the Device-platform.
- ✓ Connection management with the appropriate network is provided for seamless services.

M2M Access Platform



- ✓ Provides app or web access environment to users.
- ✓ Apps and links redirect to service providers.
- ✓ Services actually provided through this platform to M2M devices.
- ✓ Provides App management for smart device apps.
- ✓ App management manages app registration by developers and provides a mapping relationship between apps and devices.
- ✓ Mapping function provides an app list for appropriate devices.

IP-interworking architecture and protocol stack for the M2M network



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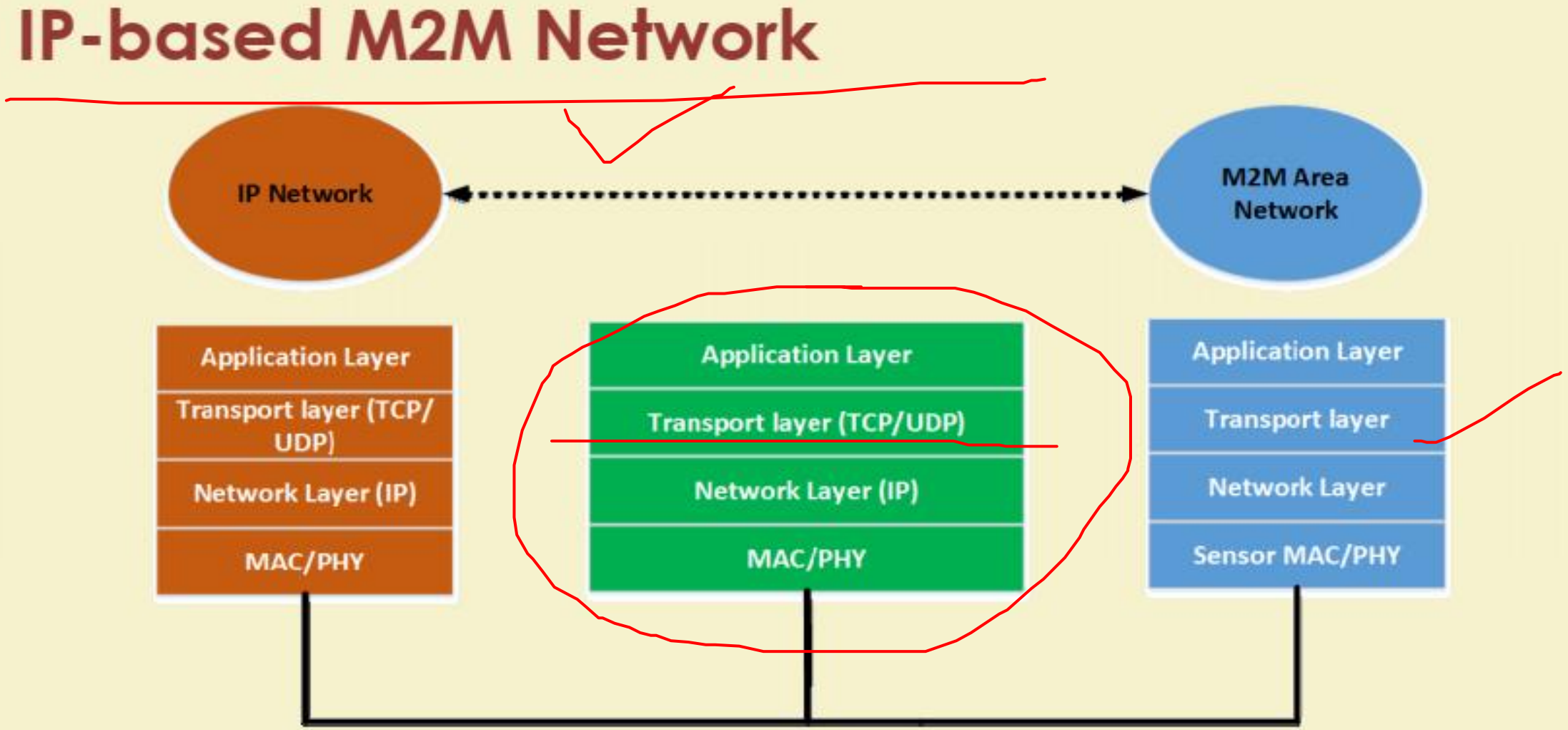

M2M Area Network Management Features

- ✓ Fault tolerant
- ✓ Scalable
- ✓ Low cost, low complexity
- ✓ Energy efficient
- ✓ Dynamic configuration capabilities
- ✓ Minimized management traffic
- ✓ Application dependence:
  - Data-centric application,
  - Emergency application,
  - Real-time application

Source: Kim, Jaewoo, et al. "M2M Service Platforms: Survey, Issues, and Enabling Technologies." *IEEE Communications Surveys and Tutorials* 16.1 (2014): 61-76.