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Architecture and Recommended Best Practices for Optimizing Energy Efficiency and Power Consumption in IoT Devices and Networks

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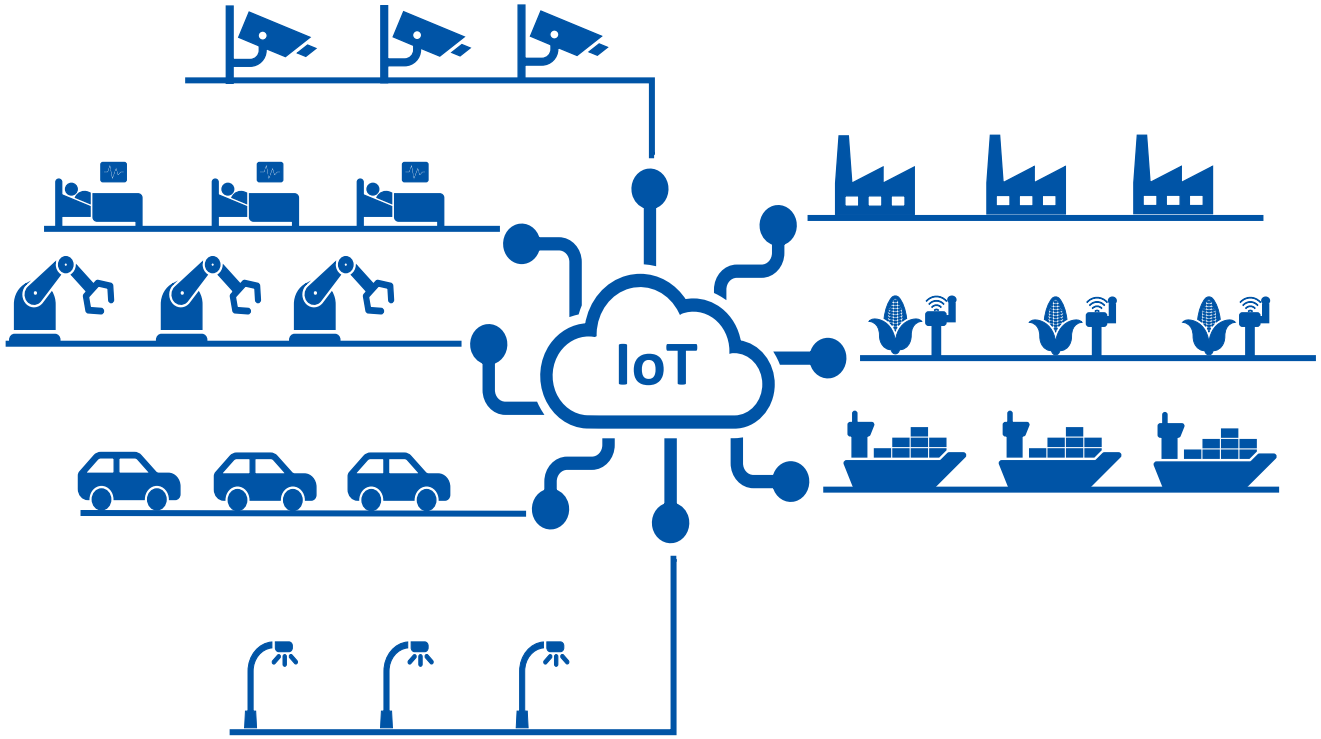
interdigital

The Importance of IoT

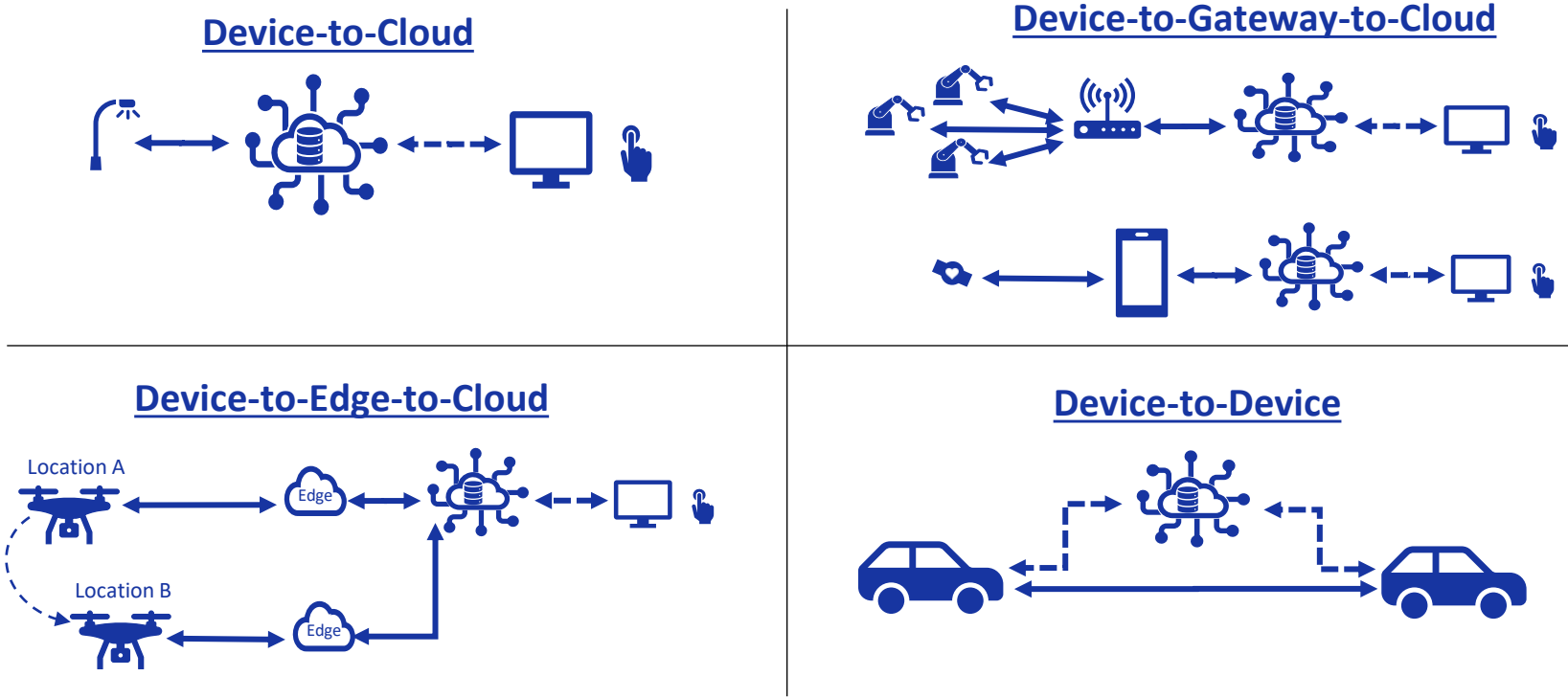


IoT is a very important and well positioned technology to help reduce environmental impact and inefficiencies for many use cases.

E.g., smart farming, smart energy production, smart supply chain management, etc.

However, what's often overlooked is **IoT technologies have their own carbon footprint** which can undermine their benefits if not deployed responsibly.

Energy Efficiency is an IoT System-Wide Concern

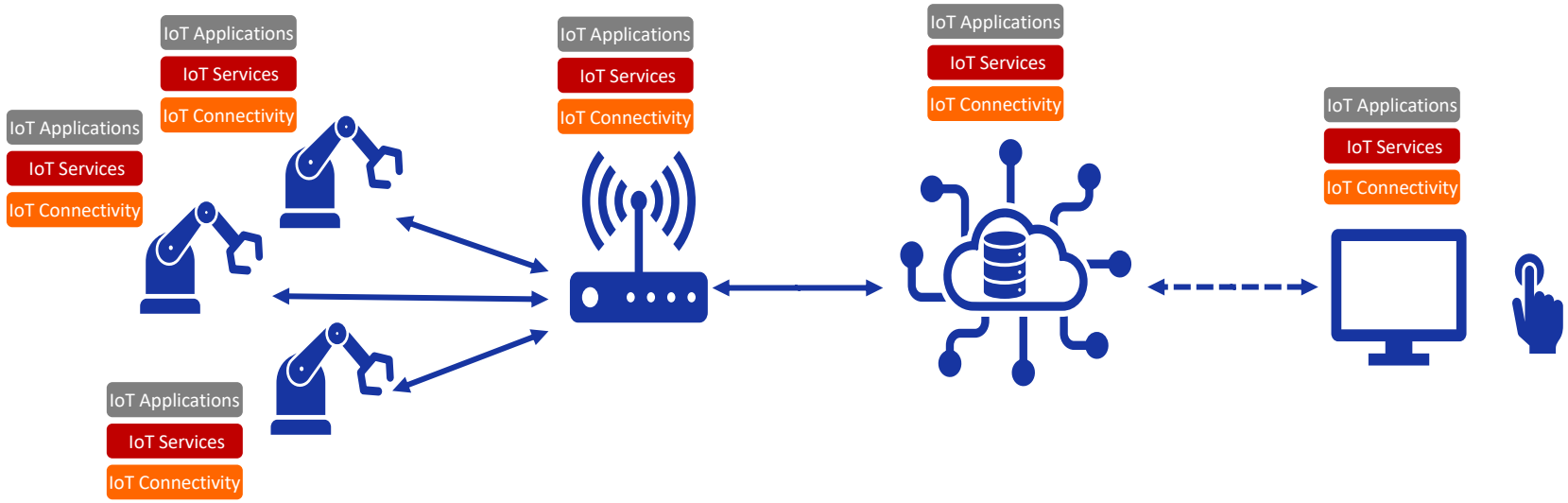


To minimize the power consumption and carbon footprint of an IoT deployment, **the entire end-to-end IoT system must be considered… Not just one part of the system.**

This can include:

- devices
- gateways
- servers
- applications
- networks

IoT Technology Stack Level View

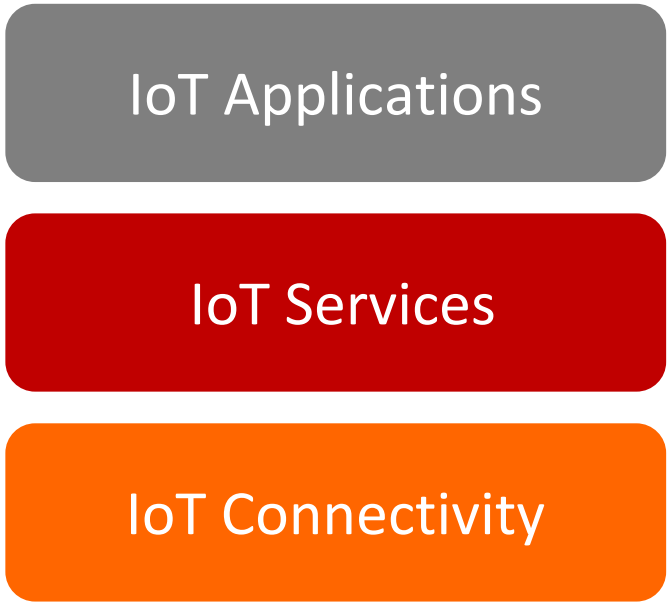


To optimize the energy efficiency of an end-to-end IoT system **the IoT technology stack on each component in the system must be optimized.**

This technology stack includes:

- IoT applications
- IoT services
- IoT connectivity

IoT Technology Stack



To optimize power consumption of the IoT technology stack, **careful selection and responsible deployment/use of IoT technologies is required.**

This is not always trivial since IoT use cases and deployments have diverse technology requirements and **IoT technologies are not one size fits all.**

Industry standards, guidelines and best practices play an important role

IoT Connectivity

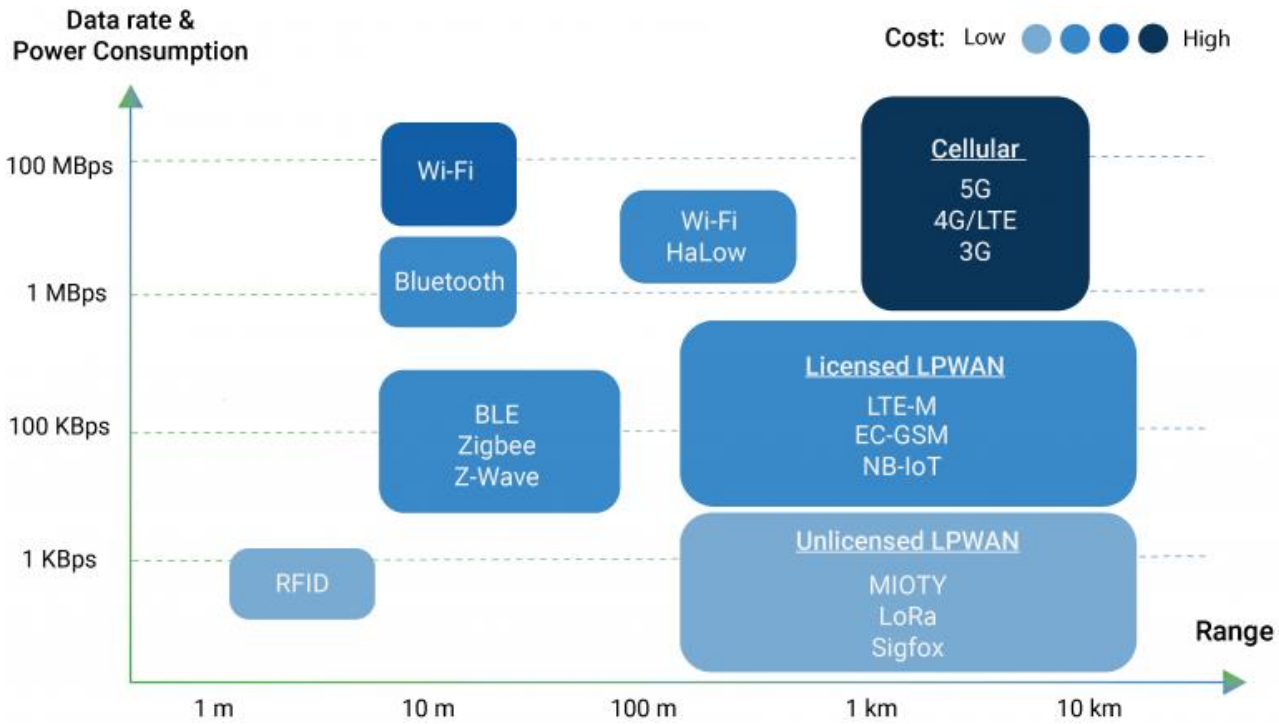
To date, there has been a great deal of focus and attention from industry and the research community to define and standardize power efficient IoT connectivity technologies.

This will, of course, continue as new enabling technologies such as wireless energy harvesting enable even further power optimized connectivity options.

IoT Applications

IoT Services

IoT Connectivity

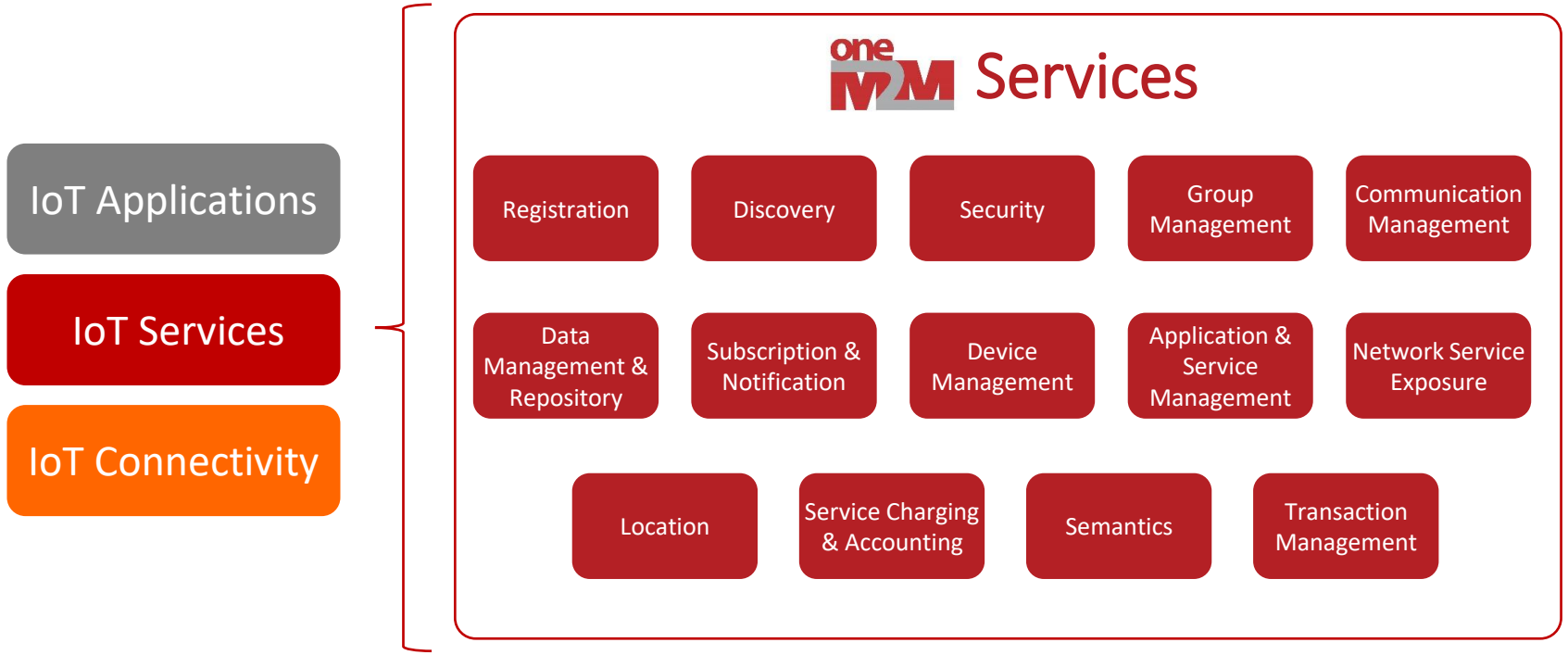


Source: behrtech

IoT Services

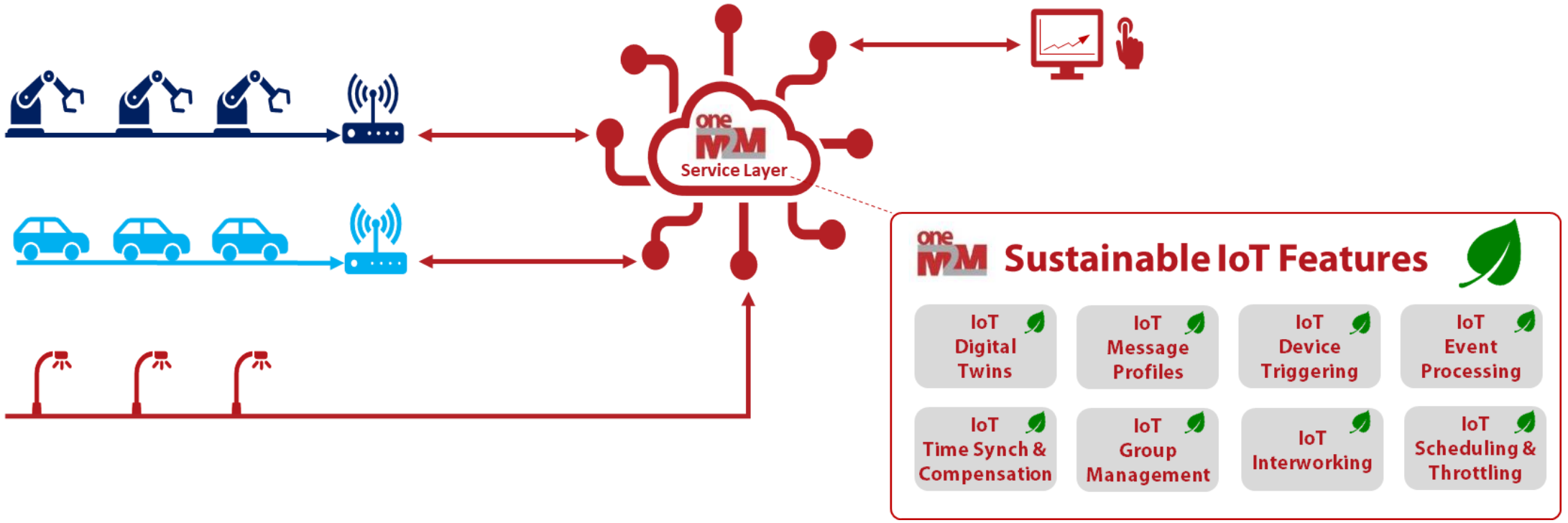
Although IoT services may not get as much attention as IoT connectivity, IoT services are arguably just as important in maximizing the energy efficiency of an IoT deployment.

oneM2M defines a standardized set of IoT services.



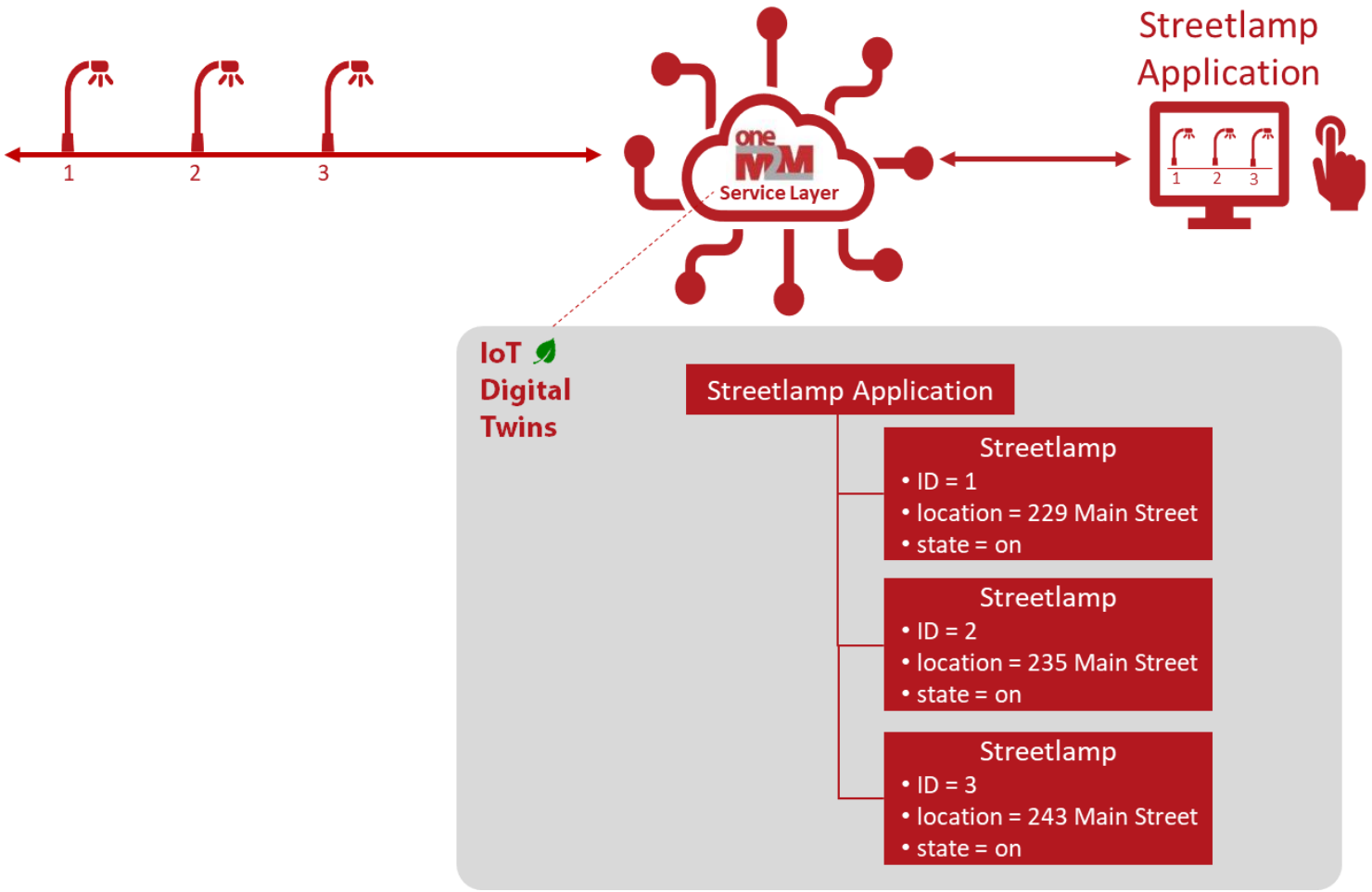
oneM2M Sustainable IoT Features

The oneM2M standard provides several key features enabling more sustainable IoT deployments



These features can help reduce the energy consumption and carbon footprint of IoT deployments

IoT Digital Twins

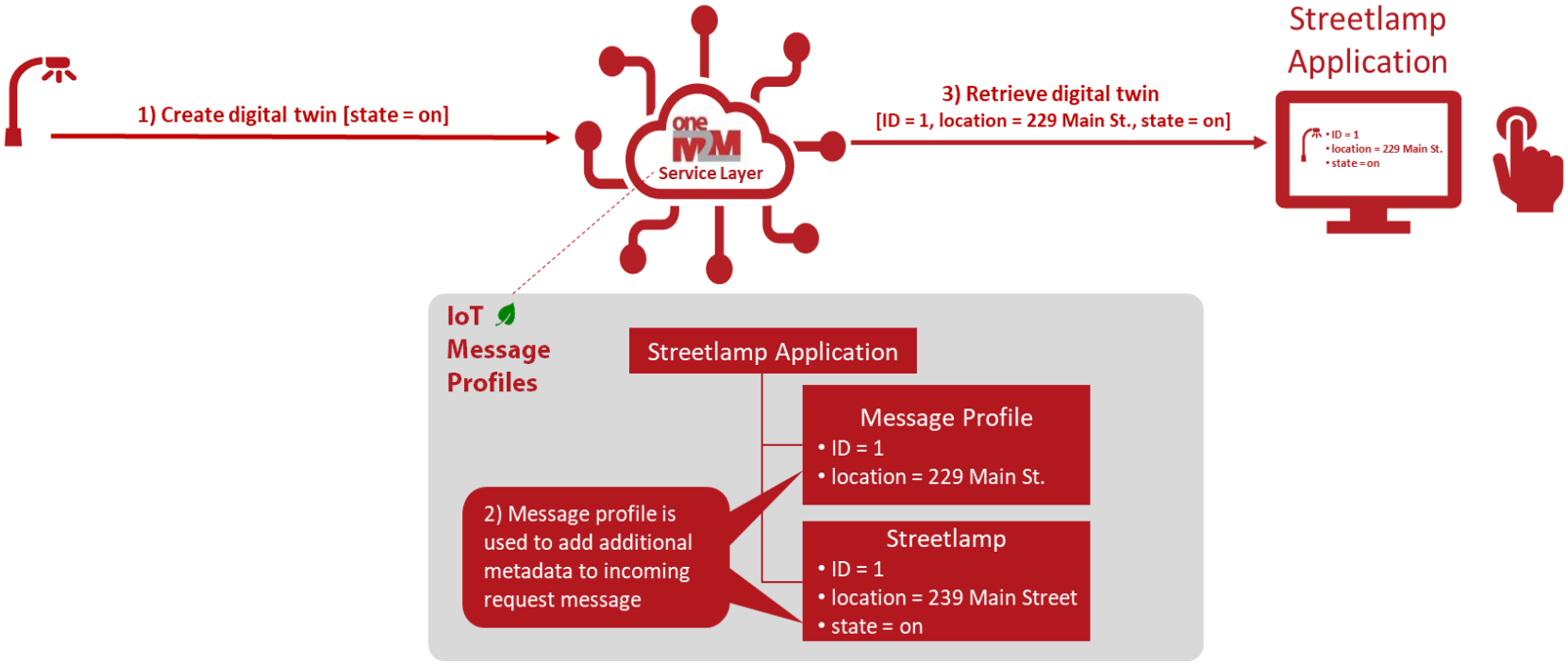


Use of IoT digital twin technology provides a huge power consumption benefit for IoT devices:

- Allows IoT devices to disconnect, power down and sleep for longer durations of time,
- Allows network applications to access device data while IoT devices are sleeping,
- Reduces load on devices - devices only need to interact with their digital twins and not all the applications interested in their data.

oneM2M defines a standardized and extensible framework for IoT digital twins. It provides developers with flexible options for representing their devices and applications as digital counterparts in the oneM2M service layer.

IoT Message Profiles



The number of bytes included within each message a device sends or receives has a major impact on its battery life and the amount of congestion and overhead introduced into the network.

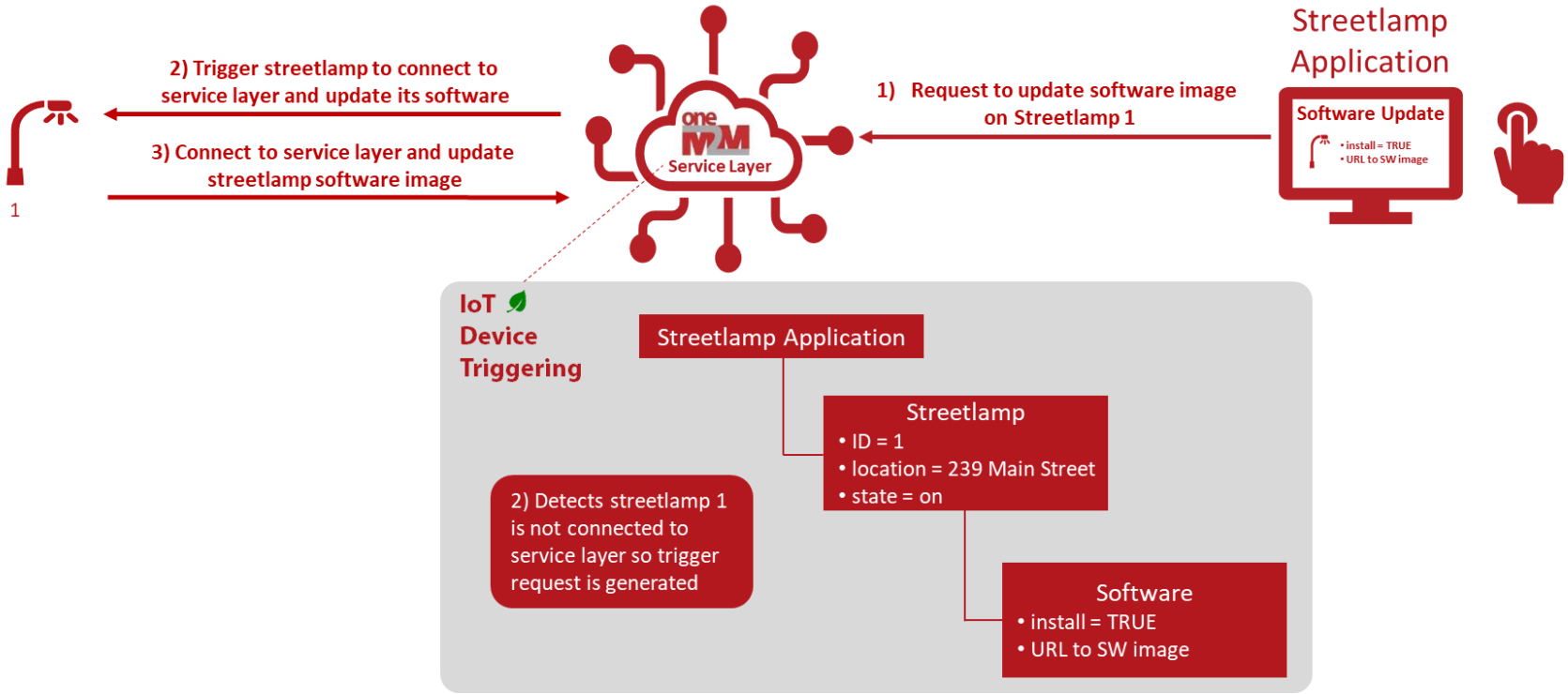
In many IoT use cases, there is a certain amount of static and repetitive data present in sensor readings (e.g., device description or location).

oneM2M defines message profiles to help streamline message sizes.

Devices send only the bare minimum amount of data that is dynamically changing.

oneM2M then enriches messages with static information using message profiles.

IoT Device Triggering

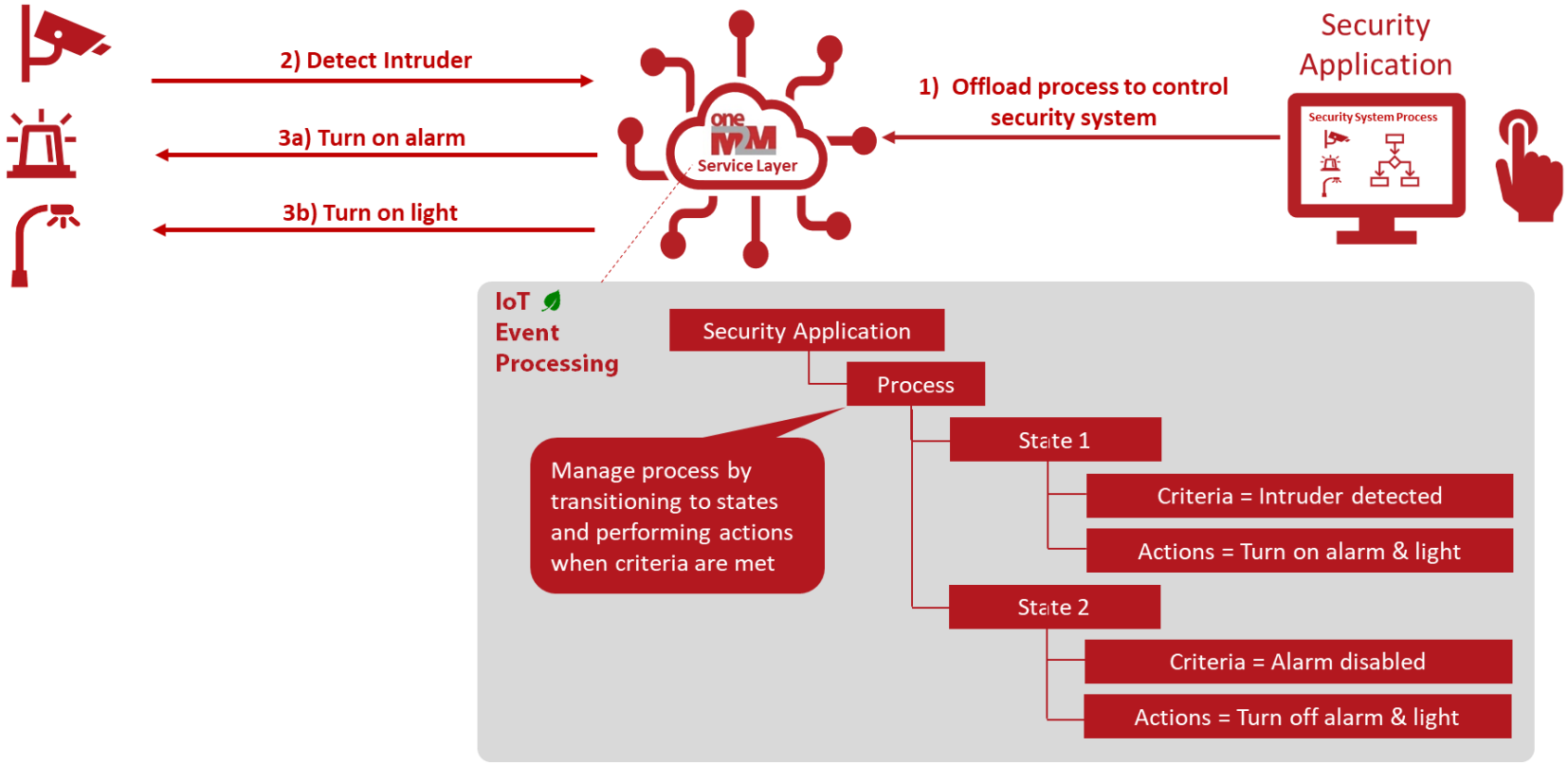


oneM2M device triggering enables an IoT device to "sleep" for long periods of time when not in use, and intelligently "wake up" when applications need to interact with the device.

oneM2M triggers devices in an on-demand fashion via the control plane of underlying communication networks (e.g., 3GPP).

When a device receives the trigger, it fully powers-up, re-connects to the oneM2M service layer and receives application messages.

IoT Event Processing

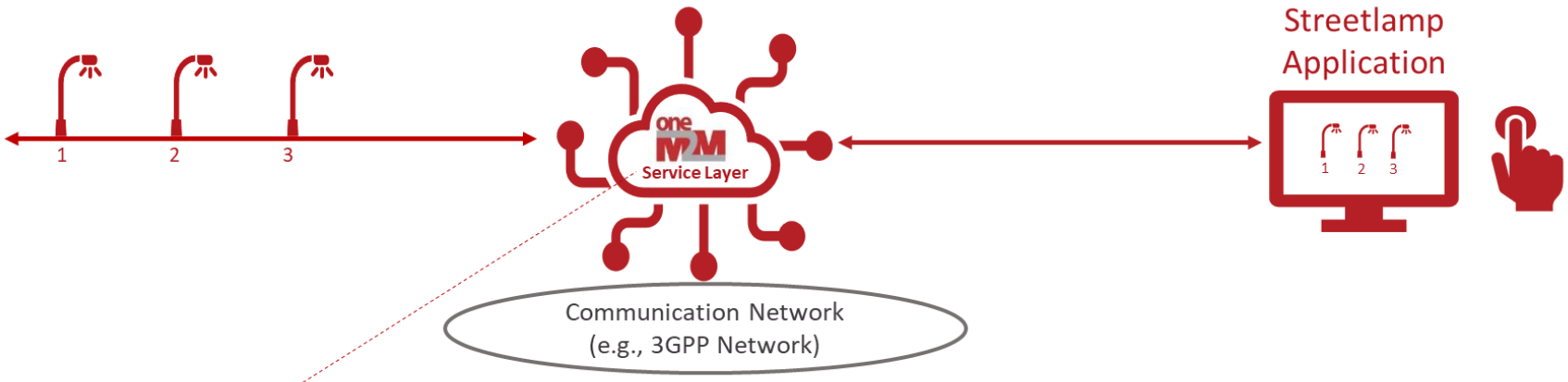


oneM2M supports offloading event detection and processing from devices and applications to the oneM2M service layer.

E.g., checking if sensor readings have crossed a certain threshold and performing actions such as switching an actuator on/off.

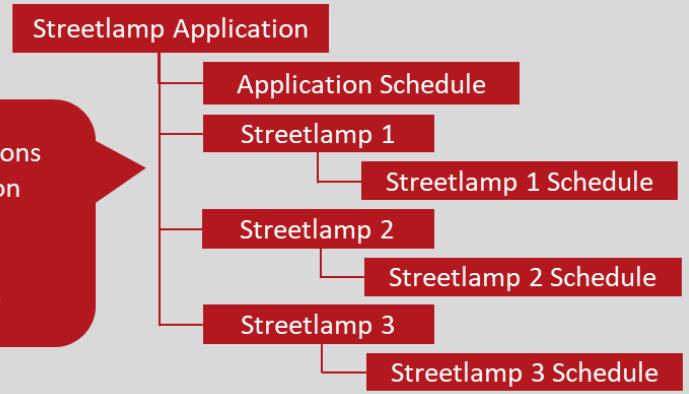
This offloading to the oneM2M service layer greatly reduces the amount of messaging and data exchanged in the system.

IoT Scheduling and Throttling



IoT
Scheduling & Throttling

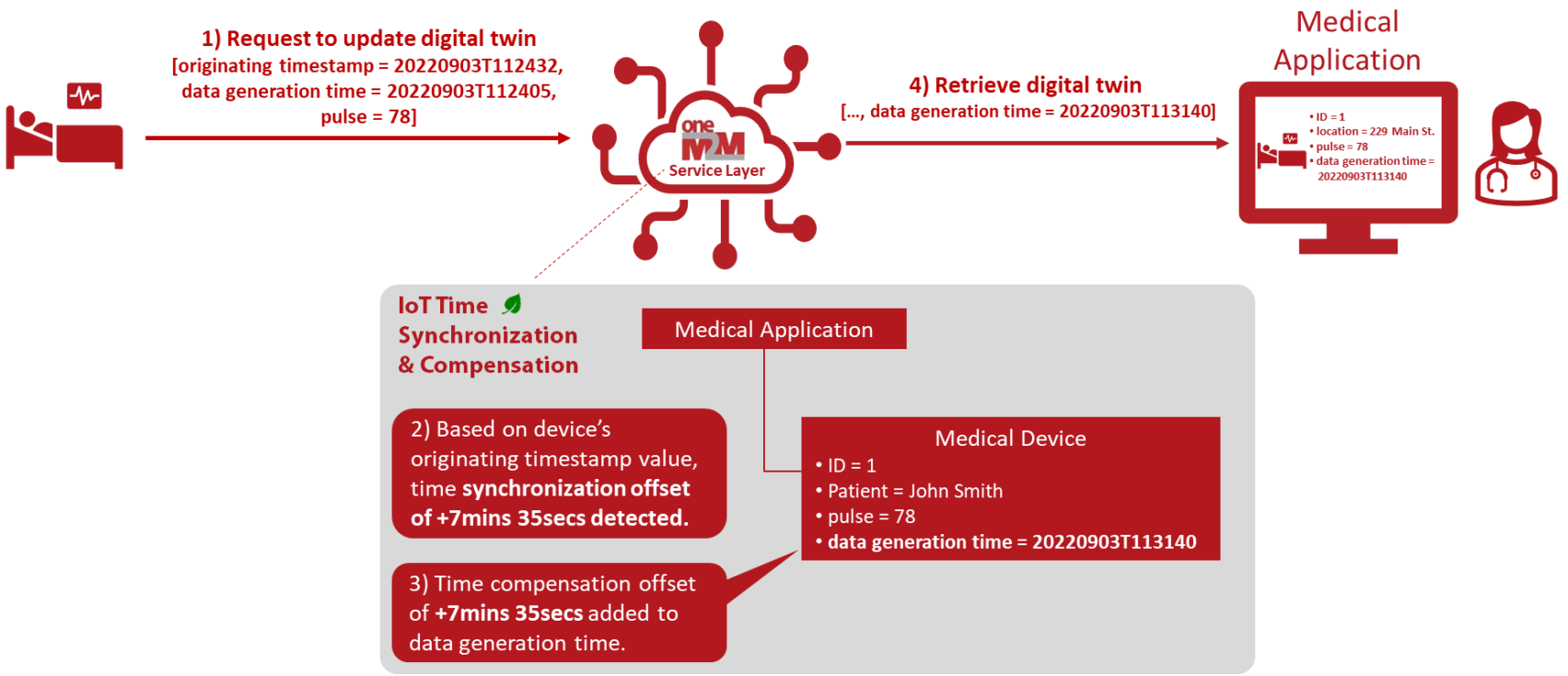
- Schedule message exchanges between devices and applications
- Interwork with communication networks to detect congestion
- Adjust schedules to alleviate network congestion
- Throttle messages to alleviate network congestion
- Batch messages to increase efficiency of message exchanges



By managing peak demands on communication networks, network operators can optimize the amount of network equipment (e.g., switches, routers, servers, cell towers and base stations) required to meet their customer demands. This can significantly reduce the energy consumption and carbon footprints of their networks.

oneM2M supports several scheduling and throttling features to help network operators minimize the peak demand on their communication networks.

IoT Time Synchronization & Compensation

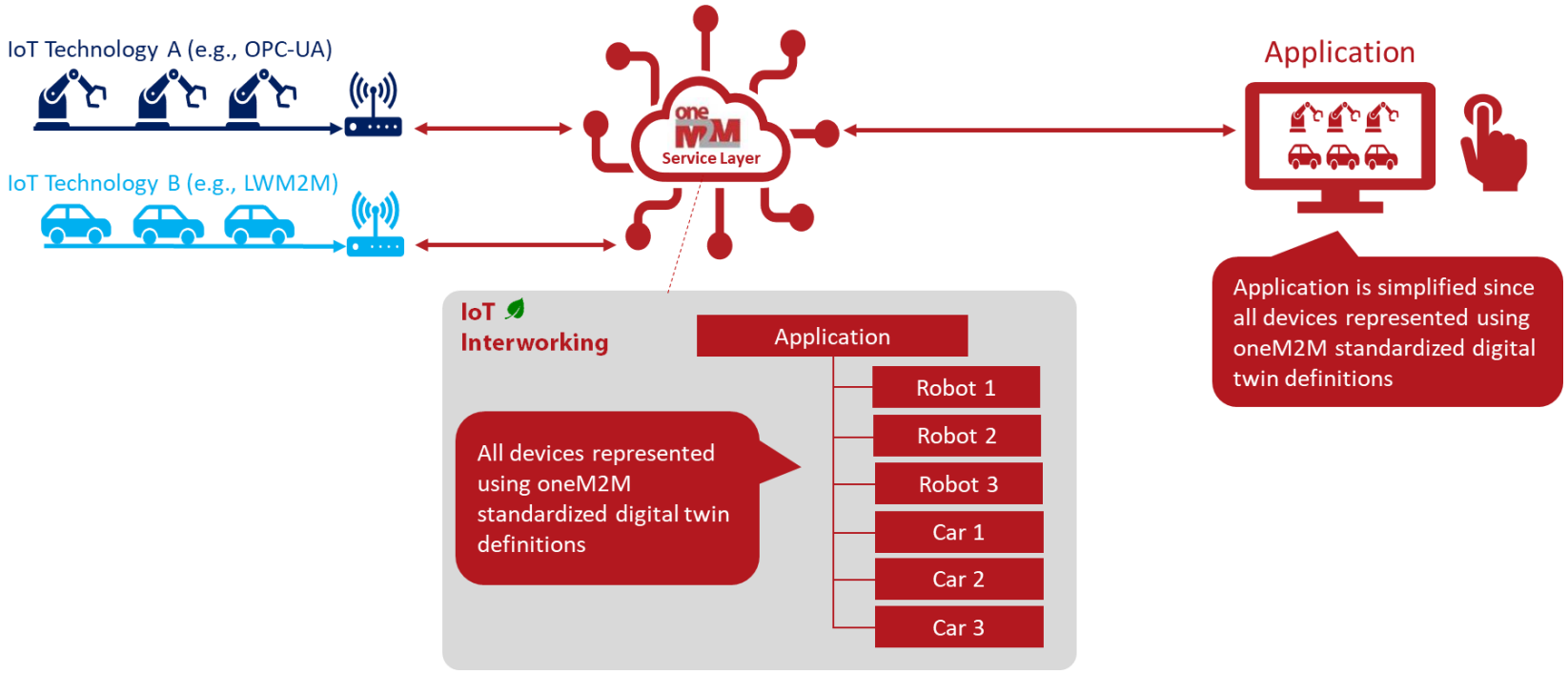


Many resource constrained devices lack the capability to keep their local time synchronized with other devices in the network using traditional technologies such as GPS and Network Time Protocol (NTP).

oneM2M supports low-overhead time synchronization capabilities for IoT devices.

E.g., when messages containing timestamp information are received from devices, the oneM2M service layer can adjust the timestamps to compensate for any detected time offsets.

IoT Interworking



Interworking different IoT platforms together with one another can be challenging, especially newer and older platforms.

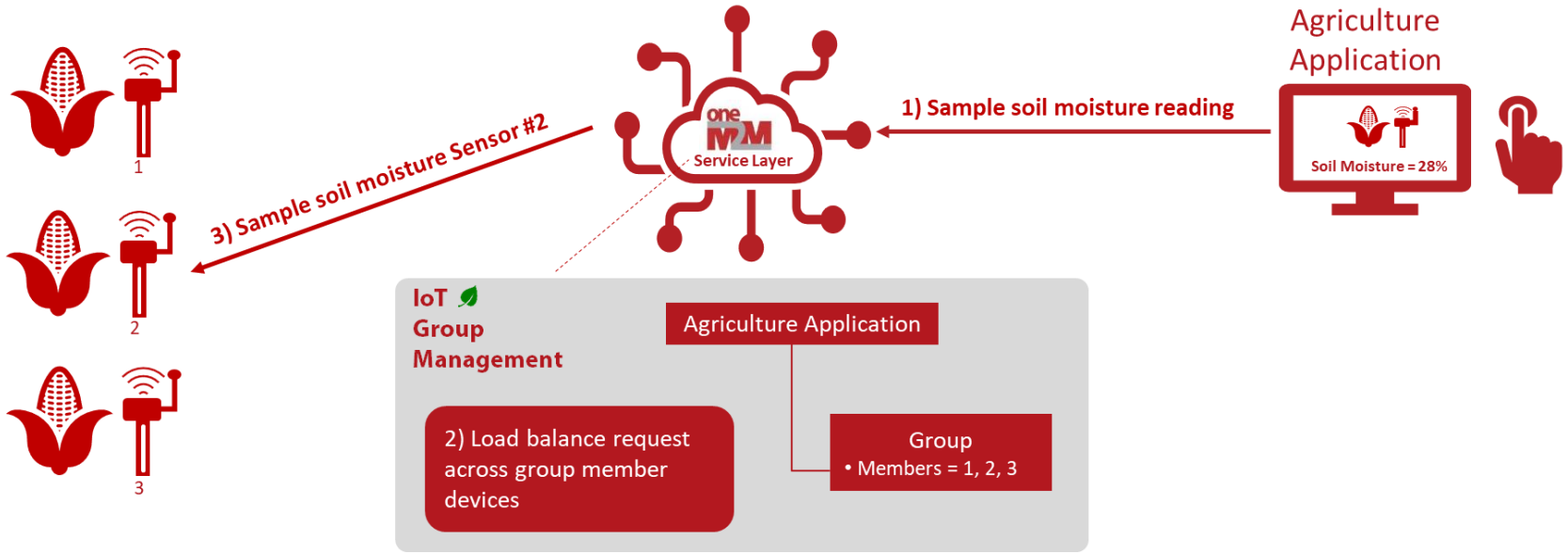
This typically requires developing complex and costly custom over-the-top application code to glue these platforms together.

This can lead to frustration and frequent swapping out and replacing of older platforms with new ones.

This is problematic from a sustainability perspective since frequent refreshing of older platforms with newer ones generates a significant amount of e-waste.

oneM2M can help extend the life of IoT deployments by standardizing and simplifying how IoT platforms are interworked with one another.

IoT Group Management



Deploying IoT devices in groups can extend overall lifetime of an IoT deployment and reduce its carbon footprint.

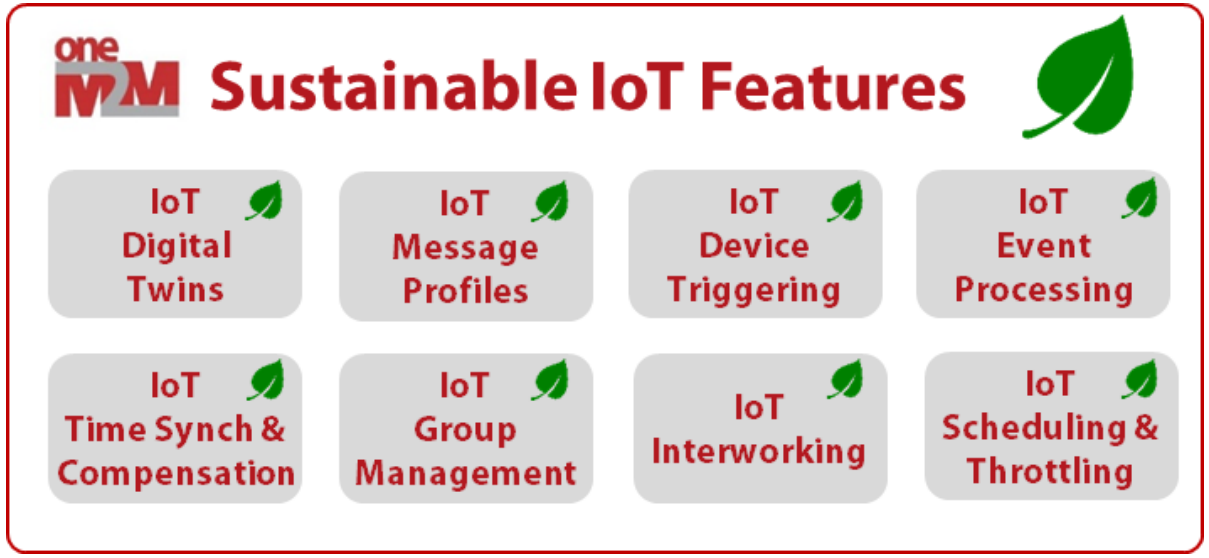
oneM2M supports load balancing requests across a group of functionally equivalent devices.

This can extend the battery lifetime of individual devices as well as extend the overall IoT system deployment lifetime.

Takeaways

- → IoT deployments have their own carbon footprint which can undermine their sustainability benefits.
- → In addition to IoT connectivity technologies, IoT services are a critical technology to enable more sustainable IoT deployments
- → oneM2M standardizes a set of IoT services which can help reduce the power consumption and carbon footprints of IoT deployments.

Link to oneM2M Sustainability White Paper



http://www.oneM2M.org

Thank You!

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