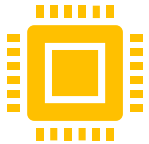
IoT Protocols

Internet of Things

Internet of Things (IoT)

Internet-connected devices such as sensors, appliances, RFID devices, actuators, instruments etc.

Mainly works with IPv6 instead on IPv4

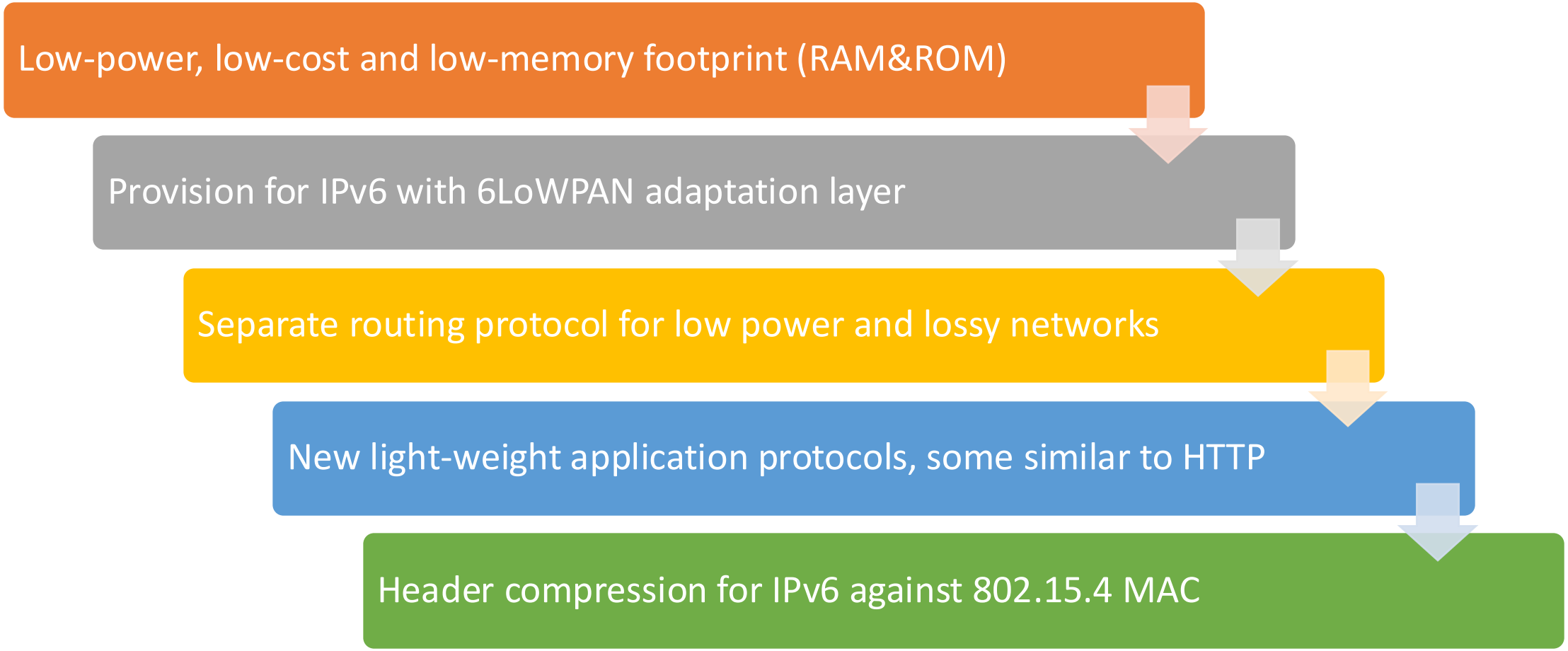


Powered mainly by sensors nodes (motes) which are low-cost, small-size and power-efficient

Every node has an address that can be accessed from (theoretically) anywhere

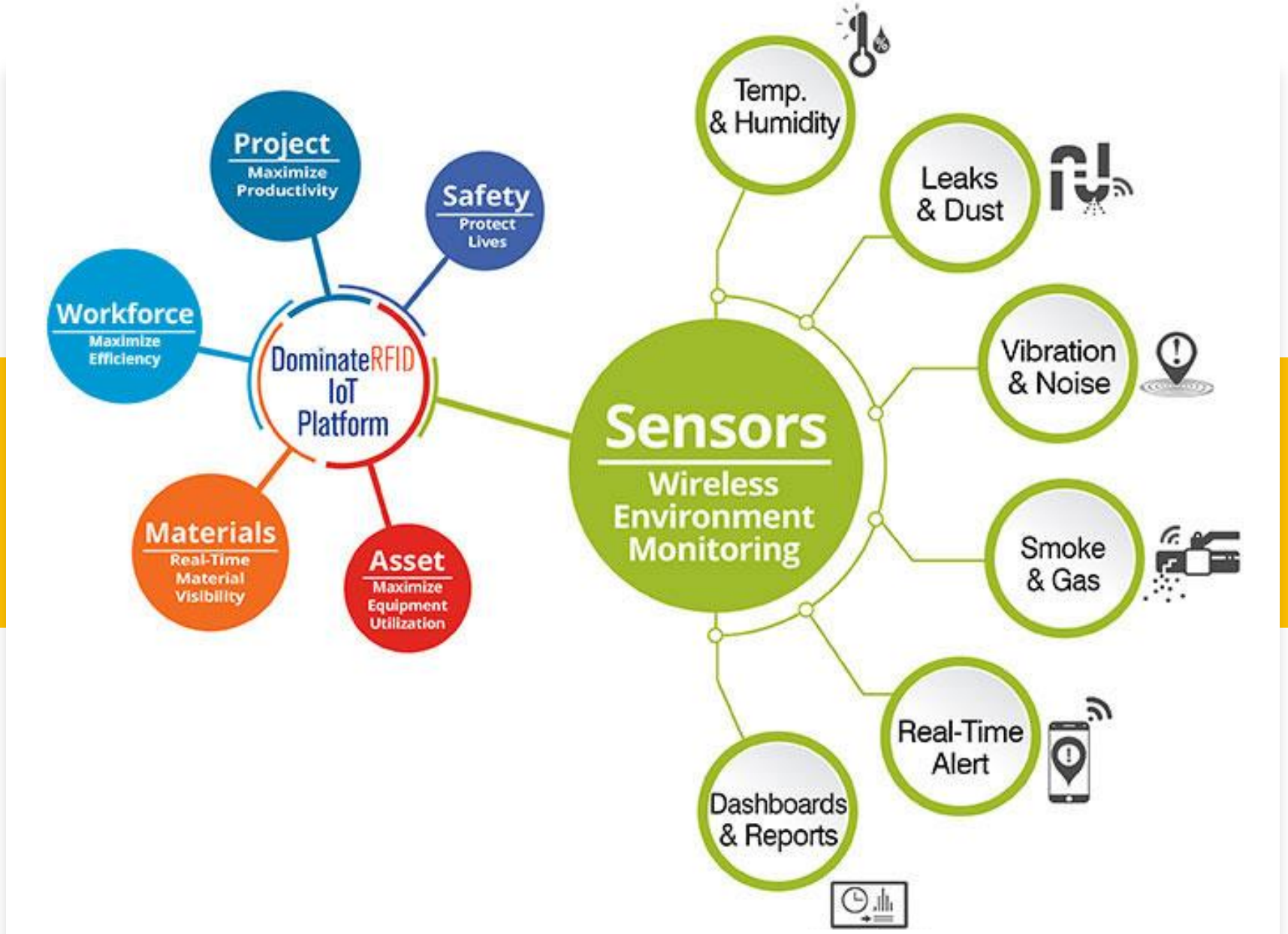
Real-time guarantee

IoT Demands

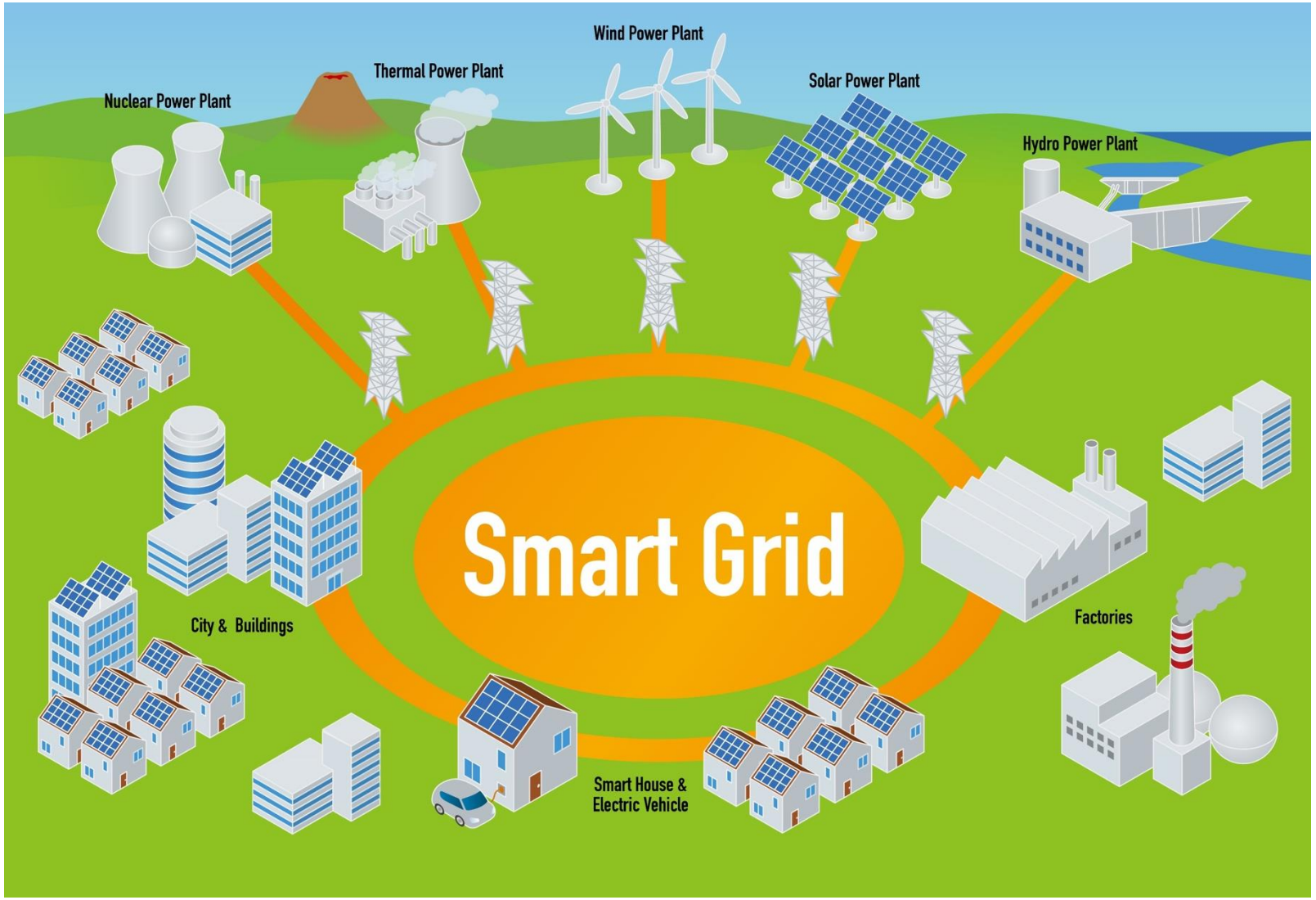

Low-power, low-cost and low-memory footprint (RAM&ROM)
Provision for IPv6 with 6LoWPAN adaptation layer
Separate routing protocol for low power and lossy networks
New light-weight application protocols, some similar to HTTP
Header compression for IPv6 against 802.15.4 MAC


Traffic Management
Education
Air Pollution
Open Data
Internet of Things
Smart Street Lights
Smart Parking
Electromagnet
Emissions
Smart Health
Water Quality
Smart Buildings
Public Safety
Smart Hon
Gas & Water
Leak Detection
Smart Environmen
Smart Energy
Electric Vehicle Charging
Waste Management

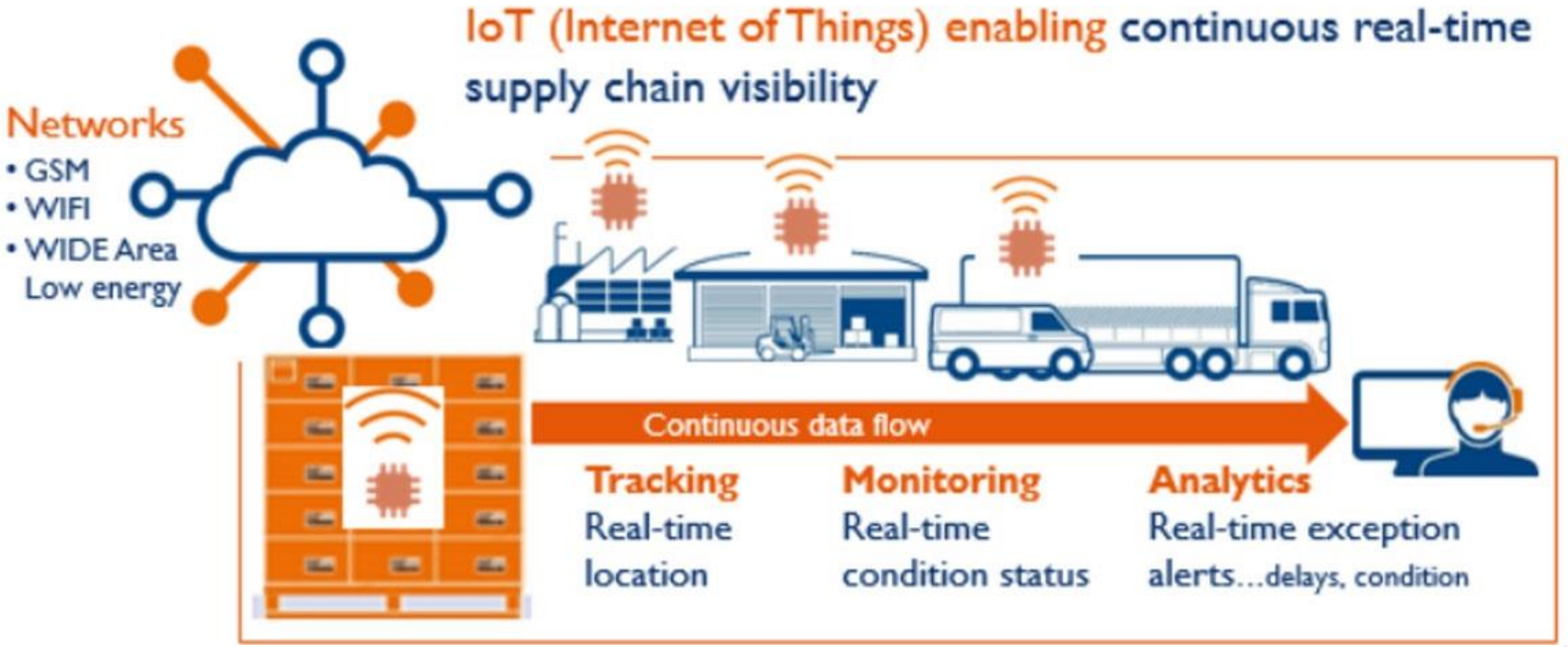
Smart City



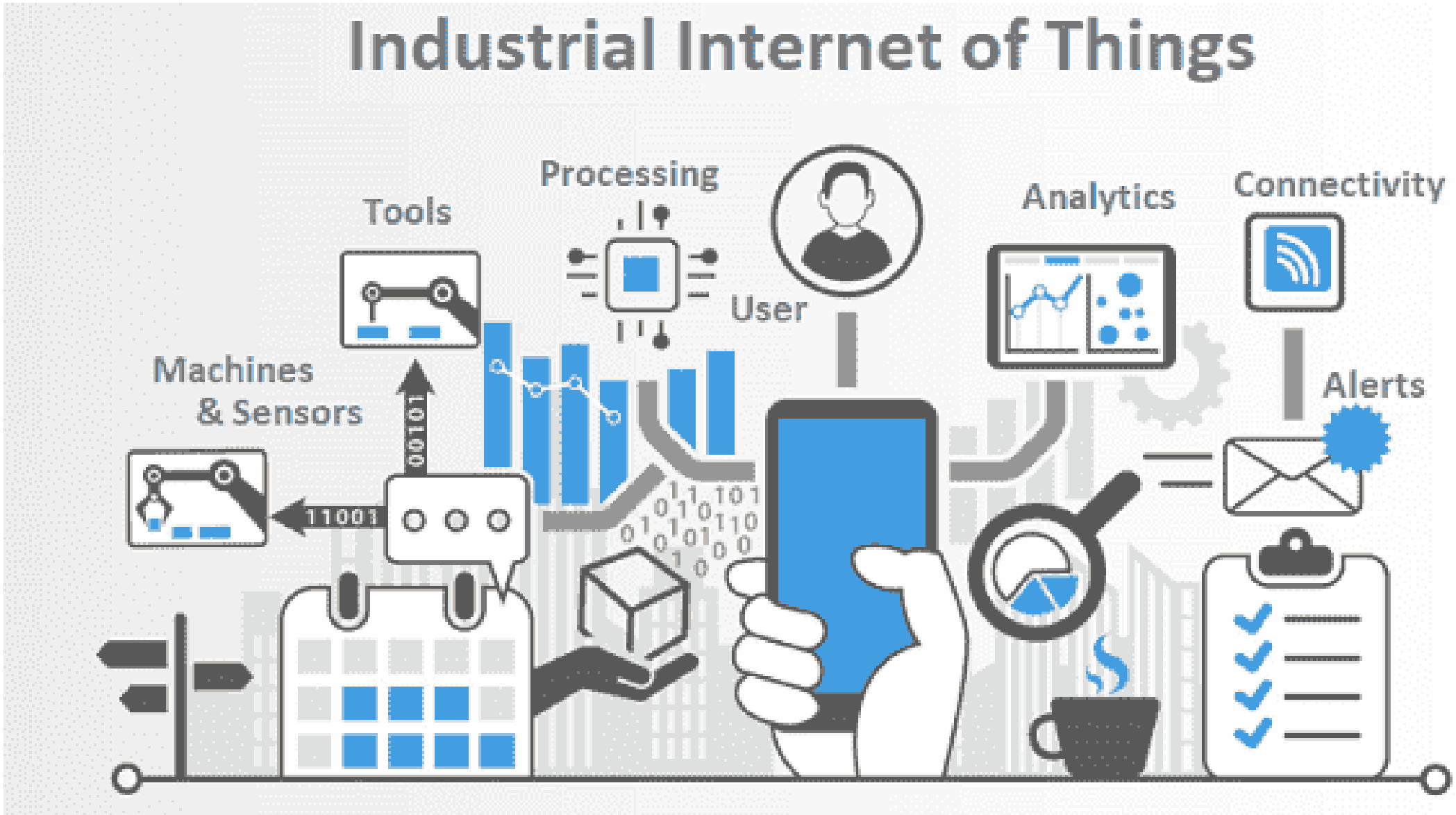
Environment Monitoring



Energy Distribution


IoT (Internet of Things) enabling continuous real-time supply chain visibility
Networks
• GSM
• WIFI
• WIDE Area Low energy
Continuous data flow
Tracking
Real-time location
Monitoring
Real-time condition status
Analytics
Real-time exception alerts...delays, condition

Industrial Internet of Things



Some Tech Stuff

- Networking is key component (Different layers)
- Addressing schemes (IPv4 vs. IPv6)
- Data transmission (ZigBee, WiFi, 5G, LTE etc.)
- Transfer speed (kbps, Mbps, Gbps)
- Medium control (MAC layer and Data Link Layer)
- Cross-geography (CoAP, MQTT etc.)

OSI Layers vs. IoT Layers

HTTP, FTP etc.	CoAP, MQTT etc.
TCP, UDP, ICMP	UDP, ICMPv6
BGP, SPF, OLSR	IPv6, RPL
IPv4, IPv6	6LoWPAN
802.3, 802.11 MAC, Data Link	802.15.4 MAC
802.3, 802.11 PHY	802.15.4 PHY

Characteristics

- Small packet size
- Low bandwidth (10s-100s kbps)
- Star and mesh topology
- Low power, battery operated
- Low cost
- Ad-hoc network, device has limited accessibility
- Unreliable wireless medium

When is a device suitable for IoT?

- Adaptation layer (6LoWPAN)
- No method exists to run IP over 802.15.4 networks
  - IPv6 MTU is 1280bytes
- Not all ad-hoc protocols may be immediately suitable for 6LoWPAN
- Security for multi-hop networks needs to be considered

802.15.4

- Small packet size – 128 bytes including MAC, 103 bytes payload
- Uses 64-bit MAC addresses, has provision for 16-bit short addresses
- Support for multiple topologies
- Data rates between 20kbps and 250kbps
- Range between 10m and 30m

Why IPv6?

- Pros
  - More suitable for high density
  - Stateless mandated
  - No NAT necessary
  - Possibility of adding innovative techniques such as location aware addressing
- Cons
  - Larger address width
  - Complying with IPv6 node requirements (IPSec is mandated)

Considerations

- Cost of deployment
- Time to market
- Complexity in deploying
- Hazards due to human error
- Scalability

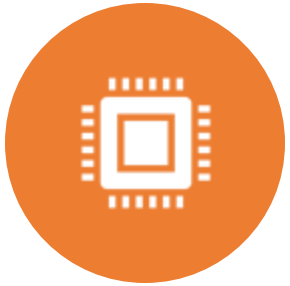
IoT Levels & Deployment Templates

Device: An IoT device allows identification, remote sensing, actuating and remote monitoring capabilities.

Resource: Resources are software components on the IoT device for accessing, processing, and storing sensor information, or controlling actuators connected to the device.Resources also include the software components that enable network access for the device.

Controller Service:Controller service is a native service that runs on the device and interacts with the web services. Controller service sends data from the device to the web service and receives commands from the application (via web services) for controlling the device.

IoT Levels & Deployment Templates



Database: Database can be either local or in the cloud and stores the data generated by the IoT device.

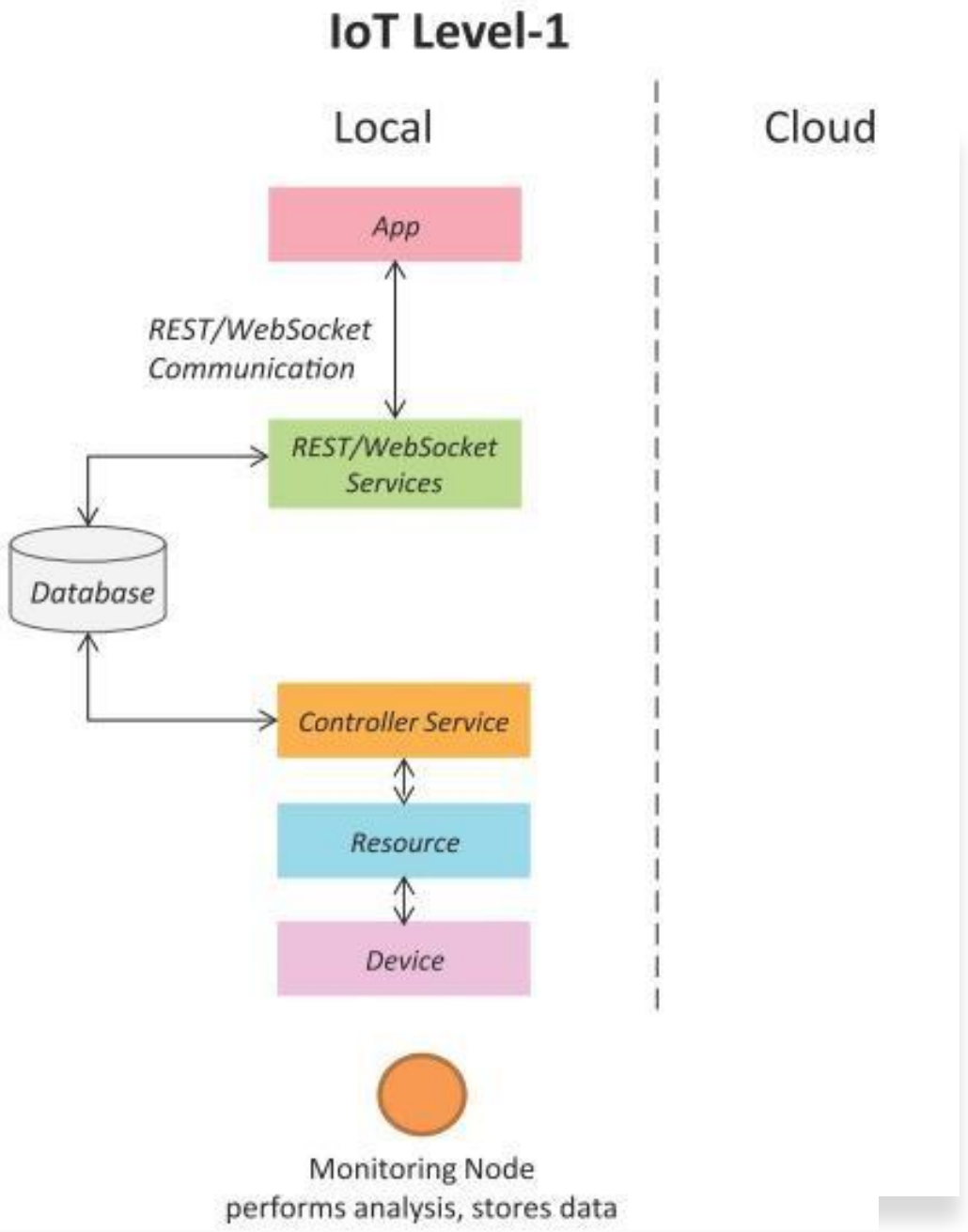
Web Service: Web services serve as a link between the IoT device, application, database and analysis components. Web service can be either implemented using HTTP and REST principles (REST service) or using WebSocket protocol (WebSocket service).

Analysis Component: The Analysis Component is responsible for analyzing the IoT data and generate results in a form which are easy for the user to understand.

Application: IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and view the processed data.

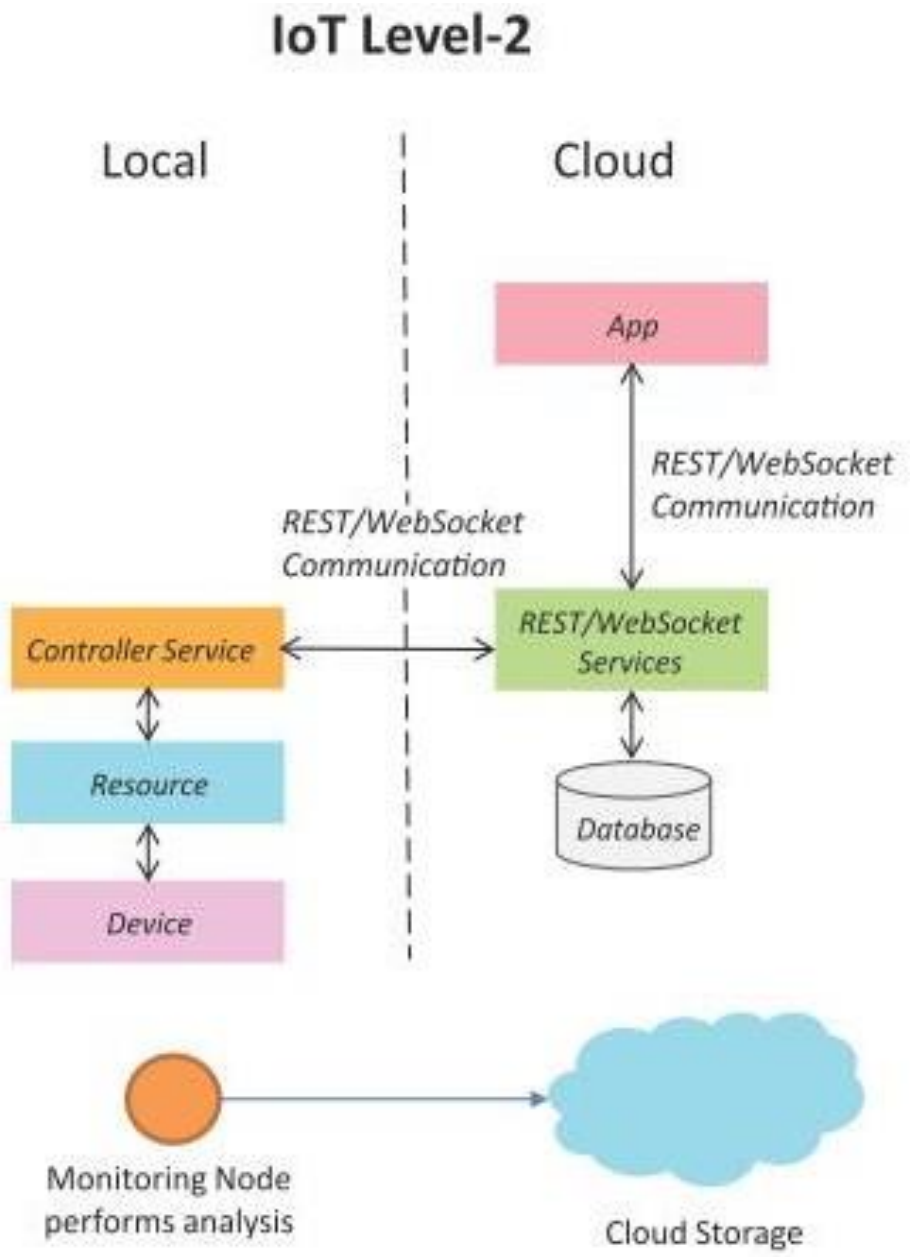
IoT Level-1

- A level-1 IoT system has a single node/device that performs sensing and/or actuation, stores data, performs analysis and hosts the application
- Level-1 IoT systems are suitable for modeling low- cost and low-complexity solutions where the data involved is not big and the analysis requirements are not computationally intensive.



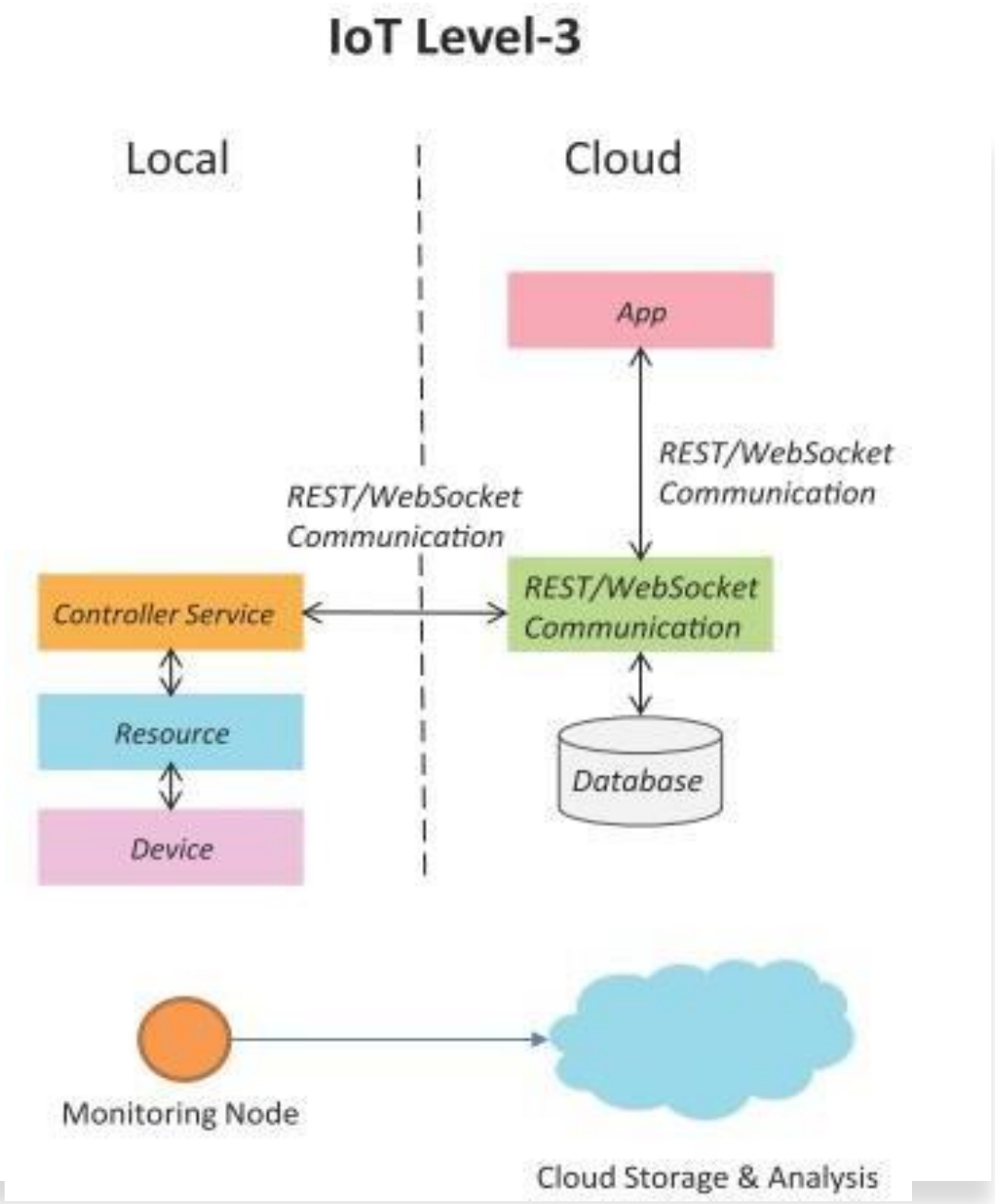
IoT Level-2

- A level-2 IoT system has a single node that performs sensing and/or actuation and local analysis.
- Data is stored in the cloud and application is usually cloud- based.
- Level-2 IoT systems are suitable for solutions where the data involved is big, however, the primary analysis requirement is not computationally intensive and can be done locally itself.



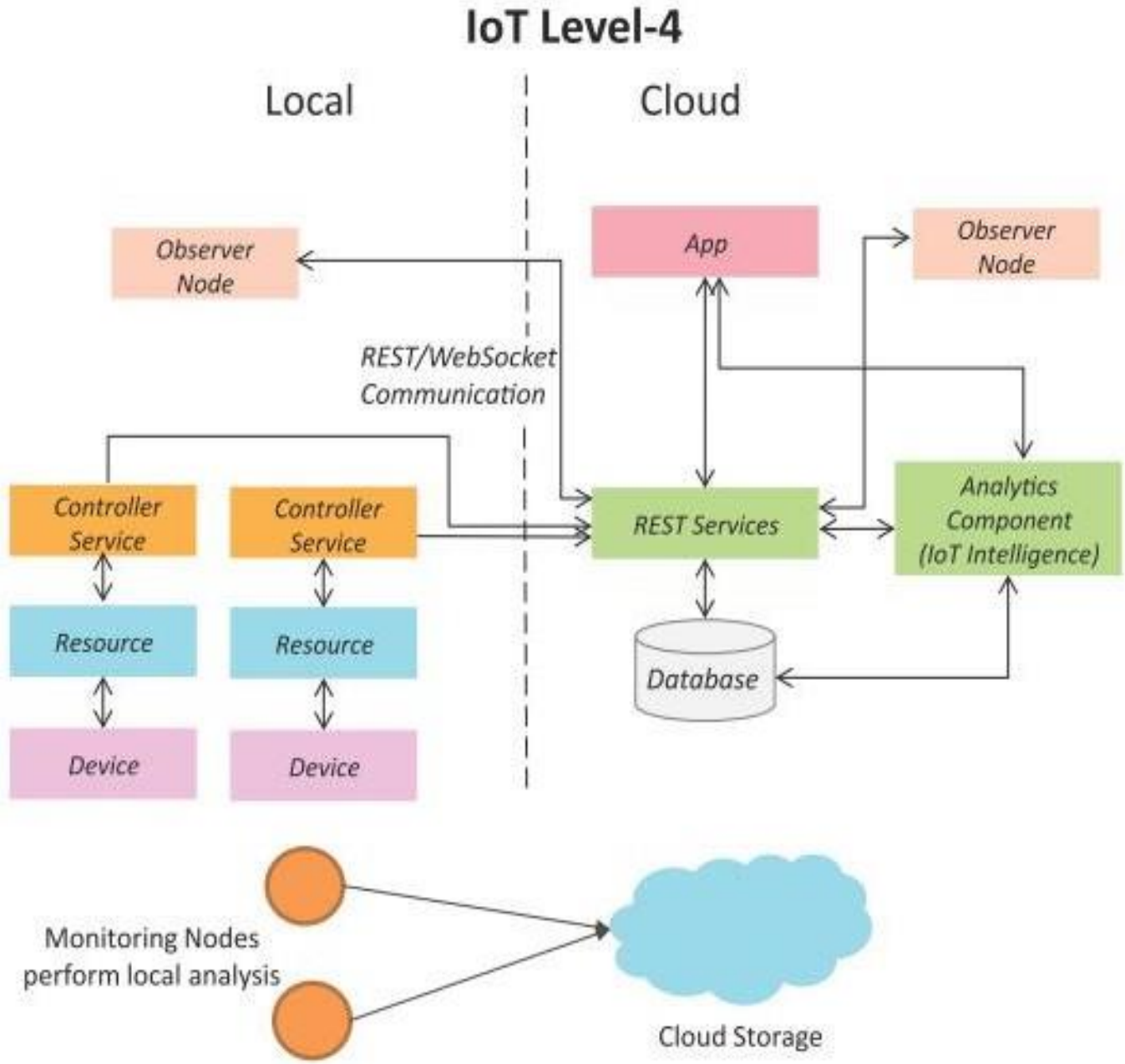
IoT Level-3

- A level-3 IoT system has a single node. Data is stored and analyzed in the cloud and application is cloud- based.
- Level-3 IoT systems are suitable for solutions where the data involved is big and the analysis requirements are computationally intensive.



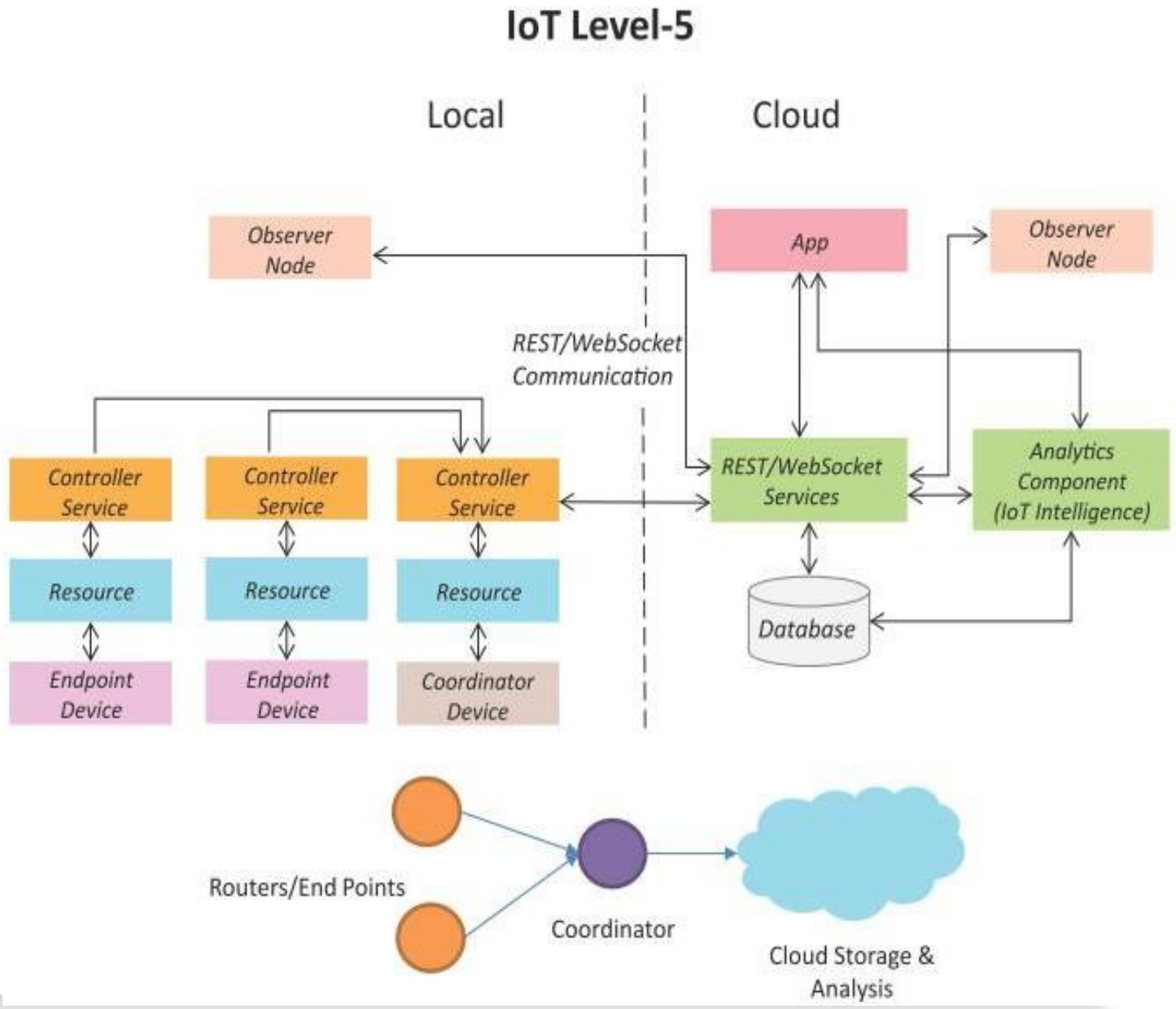
IoT Level-4

- A level-4 IoT system has multiple nodes that perform local analysis. Data is stored in the cloud and application is cloud-based.
- Level-4 contains local and cloud- based observer nodes which can subscribe to and receive information collected in the cloud from IoT devices.
- Level-4 IoT systems are suitable for solutions where multiple nodes are required, the data involved is big and the analysis requirements are computationally intensive.



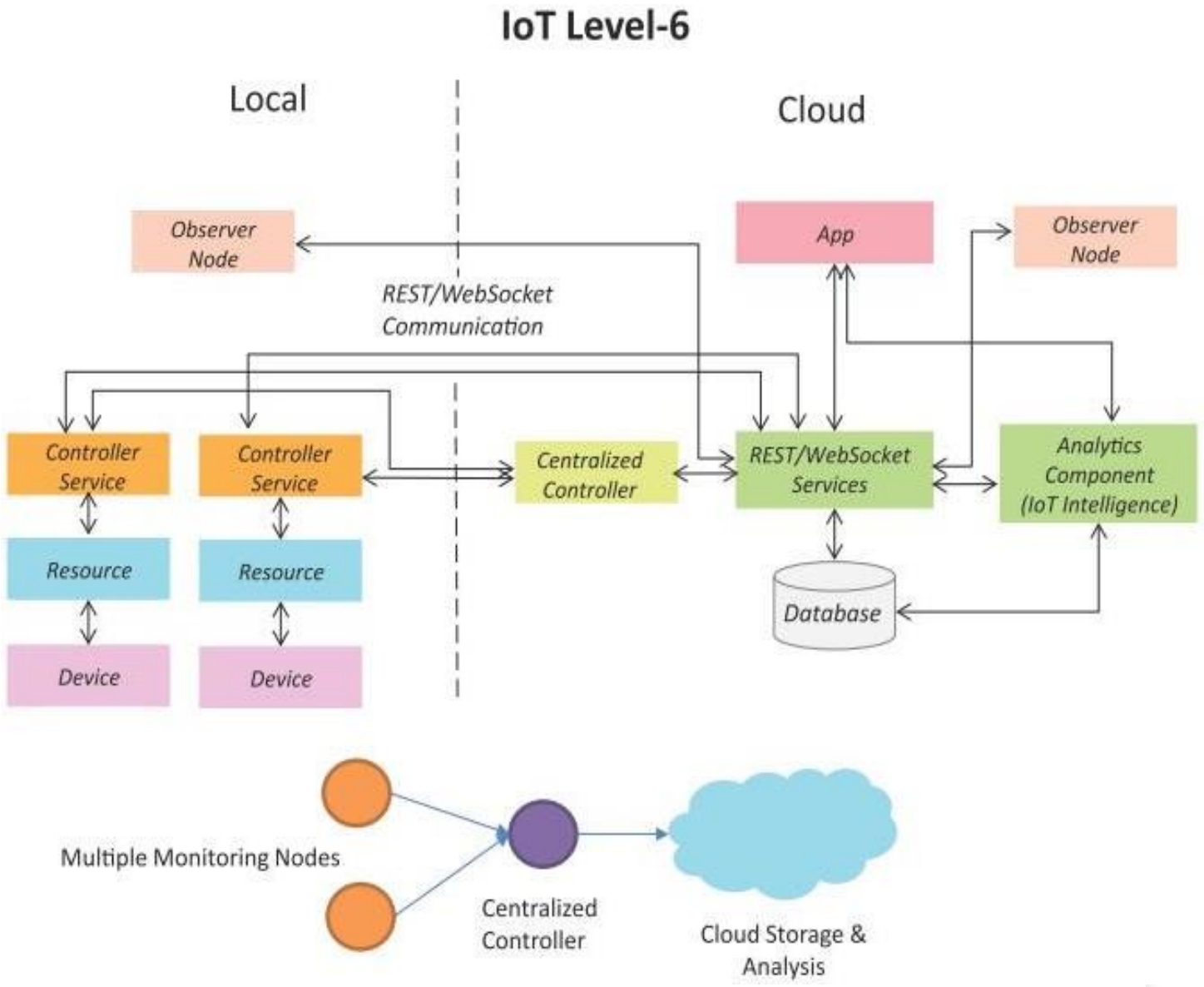
IoT Level-5

- A level-5 IoT system has multiple end nodes and one coordinator node.
- The end nodes that perform sensing and/or actuation.
- Coordinator node collects data from the end nodes and sends to the cloud.
- Data is stored and analyzed in the cloud and application is cloud-based.
- Level-5 IoT systems are suitable for solutions based on wireless sensor networks, in which the data involved is big and the analysis requirements are computationally intensive.



IoT Level-6

- A level-6 IoT system has multiple independent end nodes that perform sensing and/or actuation and send data to the cloud.
- Data is stored in the cloud and application is cloud-based.
- The analytics component analyzes the data and stores the results in the cloud database.
- The results are visualized with the cloud-based application.
- The centralized controller is aware of the status of all the end nodes and sends control commands to the nodes.



These slides contain materials from

- Internet of Things - A Hands-On Approach

  Book website: http://www.internet-of-things-book.com

  Bahga & Madisetti, © 2015