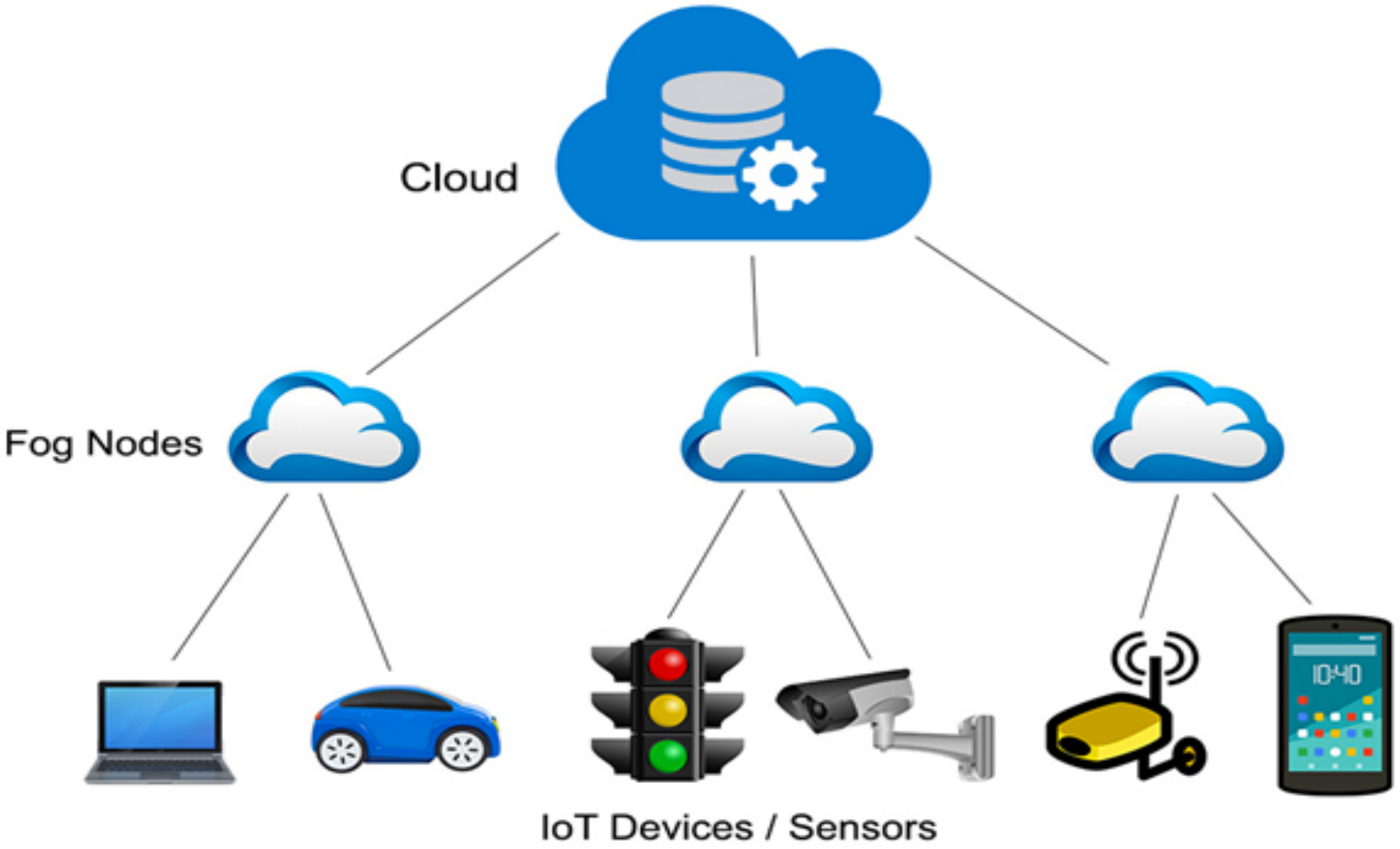
Waterford Institute *of* Technology

EDGE AND FOG COMPUTING

SAMITHA SOMATHILAKA

Department of Computing & Mathematics, WIT

Fog Computing Architecture



WHAT IS EDGE COMPUTING

A part of a distributed computing topology in which information processing is located close to the edge – where things and people produce or consume that information. - *Gartner*

WHAT IS EDGE COMPUTING

- At its basic level, edge computing brings computation and data storage closer to the devices where it's being gathered, rather than relying on a central location that can be thousands of miles away
- Edge-computing hardware and services help solve this problem by being a local source of processing and storage for many of these systems.
- These edge devices can include many different things, such as an IoT sensor, an employee's notebook computer, their latest smartphone, the security camera or even the internet-connected microwave oven in the office break room.

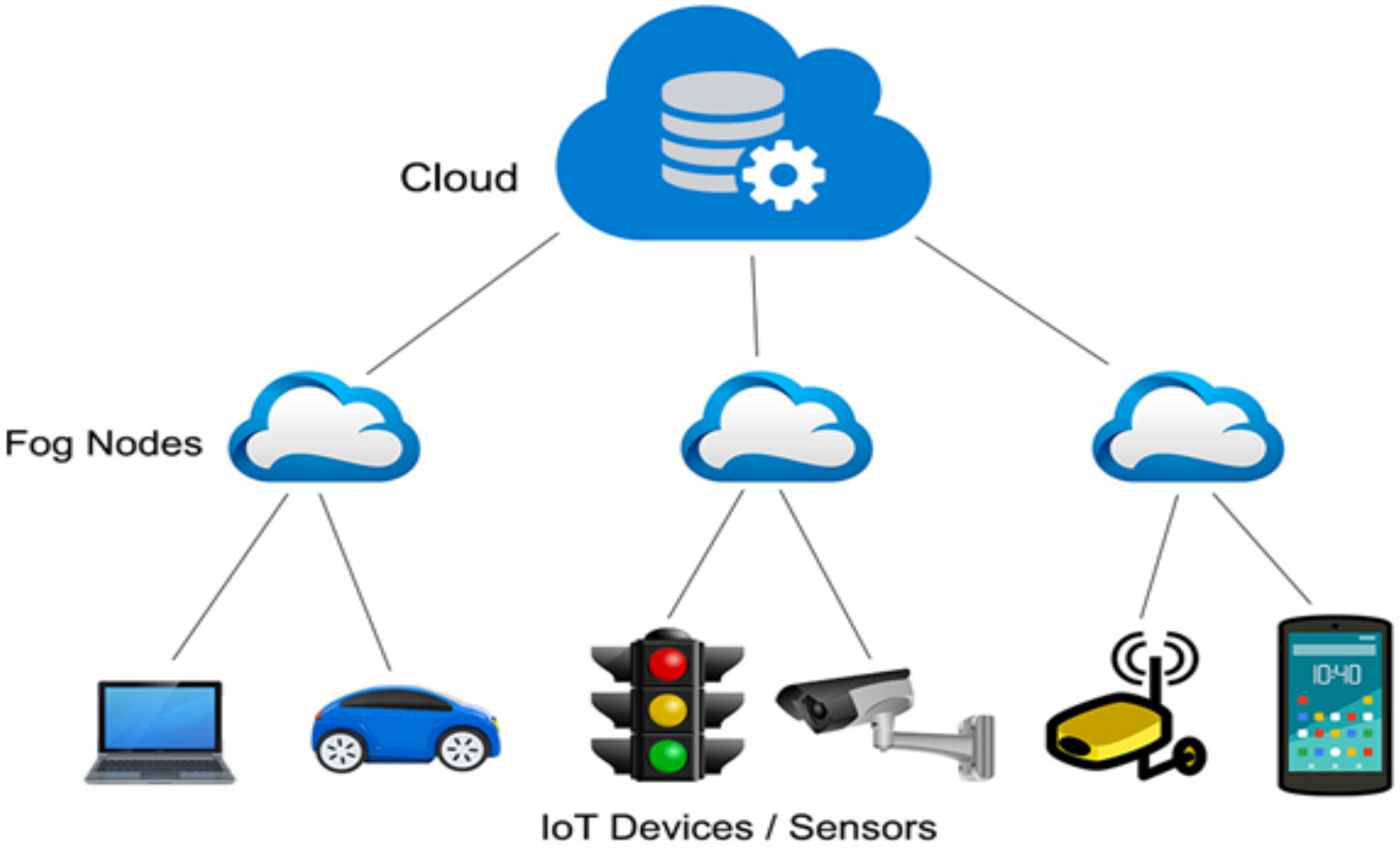
FEATURES OF EDGE ANALYTICS PLATFORM

- Ingestion of device event or video streams
- Manage device configuration and properties in a flexible schema
- Maintain durable message queues per device for commands and actions
- Enrich real-time of streaming data with context tables and historical data on the fly
- Notify real-time event processing services in case of detected changes/anomalies

FOG COMPUTING

- Fog computing is a decentralized computing infrastructure in which data, compute, storage and applications are located somewhere between the data source and the cloud.
  - **Bandwidth conservation.** Fog computing reduces the volume of data that is sent to the cloud, thereby reducing bandwidth consumption and related costs.
  - **Improved response time.** Because the initial data processing occurs near the data, latency is reduced, and overall responsiveness is improved. The goal is to provide millisecond-level responsiveness, enabling data to be processed in near-real time.
  - **Network-agnostic.** Although fog computing generally places compute resources at the LAN level -- as opposed to the device level, which is the case with edge computing -- the network could be considered part of the fog computing architecture

Fog Computing Architecture



FOG VS EDGE COMPUTING

- In a strictly foggy environment, intelligence is at the local area network (LAN), and data is transmitted from endpoints to a fog gateway, where it's then transmitted to sources for processing and return transmission.
- In edge computing, intelligence and power can be in either the endpoint or a gateway. Proponents of edge computing praise its reduction of points of failure because each device independently operates and determines which data to store locally and which data to send to a gateway or the cloud for further analysis.

THE INDUSTRY USE CASES OF FOG/EDGE COMPUTING

THE IOT EDGE DATA ANALYTICS USE CASES: MANUFACTURING

- From creating semiconductors to the assembly of giant industrial machines, edge intelligence enhances manufacturing yields and efficiency using **real-time monitoring** and **diagnostics**, **machine learning**, and **operations optimization**.
- The immediacy of edge intelligence enables **automated feedback loops** in the manufacturing process as well as predictive maintenance for maximizing the uptime and lifespan of equipment and assembly lines.

THE IOT EDGE DATA ANALYTICS USE CASES: IN HAZARDOUS ENVIRONMENTS

- Mining faces extreme environmental conditions in very remote locations with little or no access to the Internet. As a result, mining operations are relying more and more on edge intelligence for real-time, **onsite monitoring** and **diagnostics**, **alarm management**, and predictive maintenance to **maximize safety**, **operational efficiency**, and to **minimize costs** and **downtime**.

IOT DATA EDGE ANALYTICS USE CASES: TRANSPORTATION

- As part of the rise in the Industrial Internet, trains and tracks, buses, aircraft, and ships are being equipped with a new generation of instruments and sensors generating petabytes of data that will require additional intelligence for analysis and real-time response.
- Edge intelligence can process this data locally to enable real-time asset monitoring and management to minimize operational risk and downtime. It can also be used to **monitor and control engine idle times to reduce emissions**, **conserve fuel** and **maximize profits**.

IOT DATA EDGE ANALYTICS USE CASES: POWER AND WATER

- The unexpected failure of an electrical power plant can create substantial disruption to the downstream power grid.
- The same holds true when water distribution equipment and pumps fail without warning.
- To avoid this, edge intelligence enables the proactive benefits of **predictive maintenance** and **real-time responsiveness**. It also enables ingestion and analysis of sensor data closer to the source rather than the cloud to reduce latency and bandwidth costs.

IOT DATA EDGE ANALYTICS USE CASES: RENEWABLE ENERGY

- Solar, wind, and hydro are very promising sources of clean energy.
- However constantly changing weather conditions present major challenges for both predicting and delivering a reliable supply of electricity to the power grid.
- Edge intelligence enables **real-time adjustments** to maximize power generation as well as **advanced analytics for accurate energy forecasting and delivery.**

IOT DATA EDGE ANALYTICS USE CASES: HEALTHCARE

- In the healthcare industry, **new diagnostic equipment**, **patient monitoring tools**, and operational technologies are delivering unprecedented levels of patient care but also huge amounts highly sensitive patient data.
- By processing and analyzing more data at the source, medical facilities can optimize **supply chain operations** and **enhance patient services** and **privacy at a much lower cost**.

IOT DATA EDGE ANALYTICS USE CASES: SMART BUILDINGS/ CITIES

- Among the many benefits of smart building technology are **lower energy consumption**, **better security**, **increased occupant comfort and safety**, and better utilization of building assets and services.
- Rather than sending massive amounts of building data to the cloud for analysis, smart buildings can use edge intelligence for more responsive automation while reducing bandwidth costs and latency.

- Integrating data from a diverse collection of municipal systems (e.g. **Street lighting, traffic information, parking, public safety, etc**.) for interactive management and community access is a common vision for smart city initiatives.
- However the sheer amount of data generated requires too much bandwidth and processing for cloud-based systems. Edge intelligence provides a more effective solution that distributes data processing and analytics to the edges where sensors and data sources are located.

IOT DATA EDGE ANALYTICS USE CASES: CONNECTED VEHICLES

- Connected vehicle technology adds an entirely new dimension to transportation by extending vehicle operations and controls beyond the driver to include external networks and systems.
- Edge intelligence and fog computing will enable **distributed roadside services** such **as traffic regulation**, **vehicle speed management**, **toll collection**, **parking assistance**, and more.

THE EDGE/ FOG COMPUTING CHALLENGES

Any IoT environment is hugely dynamic and stuffed with a large number of edge and fog devices. Every device is to be blessed with one or more RESTful APIs for exposing their unique services to the outside world.

- Fog/Edge Device Discovery, Governance, Management, Integration, Orchestration and Security
- Optimal device resource allocation and utilization
- Mapping services/applications with edge device(s)
- Edge Device Traffic Management, data and protocol translation, etc.
- Forming clouds out of edge and fog devices

ENVISIONING THE FUTURE FOR FOG/EDGE COMPUTING

- The overwhelming adoption and adaption of Docker-enabled containerization is to facilitate the deployment of containerized software into edge devices and their networks.
- The realization of enhanced clouds (the hybrid version of edge and enterprise clouds) is obligatory
- The convergence of the blockchain technology and the IoT era promises the IoT security in trust-less environments