A NEW SOLUTION

EDGE AS A SERVICE (EaaS)

This White Paper gives an overview of D-Link's plans to offer clients secure, private computing at the edge of the centralized network.

Market opportunity

As the demand for real-time processing and low latency connectivity increases, **Multi-access Edge Computing (MEC)** is becoming increasingly important to the successful operations of leading enterprises, as well as an essential element for 5G, mobility and the Internet of Things (IoT).

Solution providers like D-Link have a critical role to play at the edge, being uniquely positioned to deploy the right infrastructure close to the user, securely and tightly integrated with the transport and access network.

This Paper discusses the need for distributed cloud and hardware requirements in different scenarios. It describes how **an edge cloud infrastructure platform** based on international standards can be used to improve subscriber experience and optimize network utilization through, for example, self-operational networks with Wi-Fi, Bluetooth, NarrowBand IoT, etc., according to customer needs.

Edge computing provides many advantages, not least an opportunity for our customers to differentiate themselves in the marketplace, while protecting their critical and sensitive information from the open cloud ecosystem.

From a technical viewpoint, **content and applications hosted closer to the user also perform better** than those hosted at a distance. While, for many basic services such as email and messaging, distance is not an issue, for others it is absolutely crucial, e.g. in industrial control systems, or connected vehicles for transport and logistics services.

The imminent deployment of 5G, the next generation of mobile communications, and the Internet of Things revolution will see exponential growth in the numbers of connected machines and individual users feeding into and off cloud services at much faster data transfer rates. D-Link has established that there is now a considerable demand for **fast private enterprise networks with differentiated advanced services that offer our customers a high-quality experience.**

Gain an “edge” over the competition

There are three main arguments why our customers should make the transition to edge computing:

01 — **Low latency**.
This is critical in many industrial scenarios where timing is key. Using the power of **local processing**, you can make smarter, more precise decisions, faster than if that processing were done in the centralized cloud.

02 — With **Edge-as-a-Service (EaaS)**,
you keep data transfers and processing closer to you. Whether it’s agriculture, oil refining, mining, container ports, or any other vertical you’re in, D-Link will let you **grow all the large-scale critical communications to meet your needs.**

03 — **More privacy**.
With **your own private Long-Term Evolution (LTE) standard network**, you can now process sensitive data collected from Internet of Things devices more securely. LTE is the high-performance choice for a wide range of industry verticals from factories to ports and power plants.

D-Link’s **EaaS solution** can be set up in one of three ways, as:

- a fully private network, independent from the Mobile Network Operator (MNO), or
- loosely integrated with the MNO for subscriber authentication, or
- as an extension of an MNO network.

Our EaaS solution provides:

- enterprise access control with service definition, and
- up-to-date radio network information, such as information per small cell, per user equipment, location and radio conditions.

USE CASES

Cloud RAN and MEC: benefits of co-deployment

Edge presence is viewed as crucial for enabling certain use case classes defined for 5G, the next generation of mobile communication technologies. These represent three types of service:

- eMBB (enhanced Mobile Broad Band)
- URLLC (Ultra Reliability and Low Latency Communications), and
- mMTC (massive Machine Type Communications).

The URLLC service type includes uses related to Tactile Internet, Interactive Gaming, Virtual Reality, connected vehicles, industry and automation. These all need low end-to-end latency but cannot physically be performed in the conventional "deep" or "remote" cloud.

The eMBB service type represents another kind of challenge – an unprecedented volume of upstream data associated particularly with **high-definition video sharing**. Finally, mMTC use cases involve applications where multiple IoT devices such as sensors are sending data upstream, collectively creating large data volumes through the network. Such data is highly localized and often cannot cross certain domain boundaries for privacy or data ownership reasons.

Consequently, all these 5G use cases call for some data processing and proximity at the edge of the main Radio Access Network (RAN). This is what we know as edge computing, a paradigm shift in network organization that will prove essential to exploiting fully new technologies such as 5G, IoT, Artificial Intelligence (AI) and Augmented and Virtual Reality (AR/VR).

Industrial plants

Industrial companies often operate in remote locations or on temporary sites - such as mines, power stations, wind farms, offshore oil platforms, drinking water purification or sewage treatment plants, factories, warehouses, ports and so on – and therefore have important local connectivity needs. Stand-alone LTE networks for devices and users within these localities improve performance and reliability, but connectivity in these industrial settings is still quite a challenge.

Companies want more automation and analytics at their industrial sites, so they add myriad sensors, IoT devices and wireless connectivity for critical production processes. **Edge computing allows them to own and manage their own LTE networks without requiring licensed spectrum**, enjoying the high-performance benefits of LTE with a strong basis for adapting to 5G.

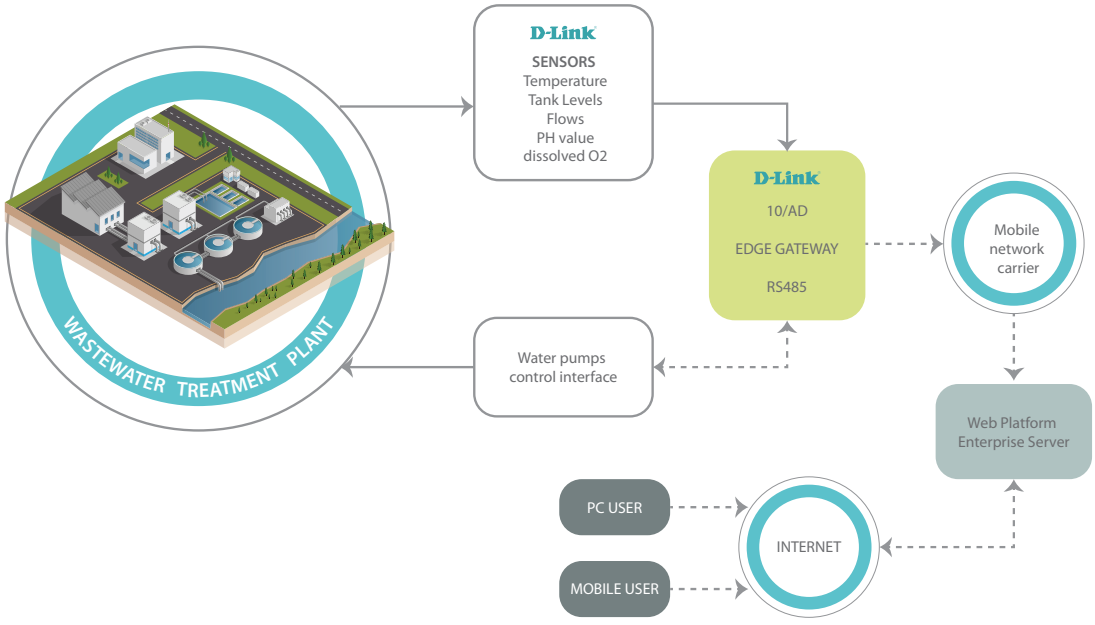


Figure 1: Typical edge-based industrial control system, in this case at a Water Treatment Plant

Smart Cities

Meanwhile, in dense urban environments, wireless projects are increasing in diversity and complexity. Chief Information Officers at City Halls across the world are seeking a reliable, simplified framework for managing this situation. They need to organize and plan an architect infrastructure for achieving goals while controlling costs.

But city organizations are usually very fragmented structures and it is difficult for city and local governments to develop an integrated communications network that will help bring Smart City applications online quickly, reducing costs.

Some cities are finding that **the solution is to invest simultaneously in diverse edge-based IoT projects**, keeping data flows away from the core of their main telecommunications networks.

An example of edge computing in the transport sector, for instance, involves parking sensors notifying drivers of free spaces as soon as they become available, thereby **reducing traffic congestion and air pollution**.

Another Smart City edge application increasingly finding favor enables traffic lights to work in sync with connected vehicles. The lights change to green when intersections are empty, keeping vehicles moving.

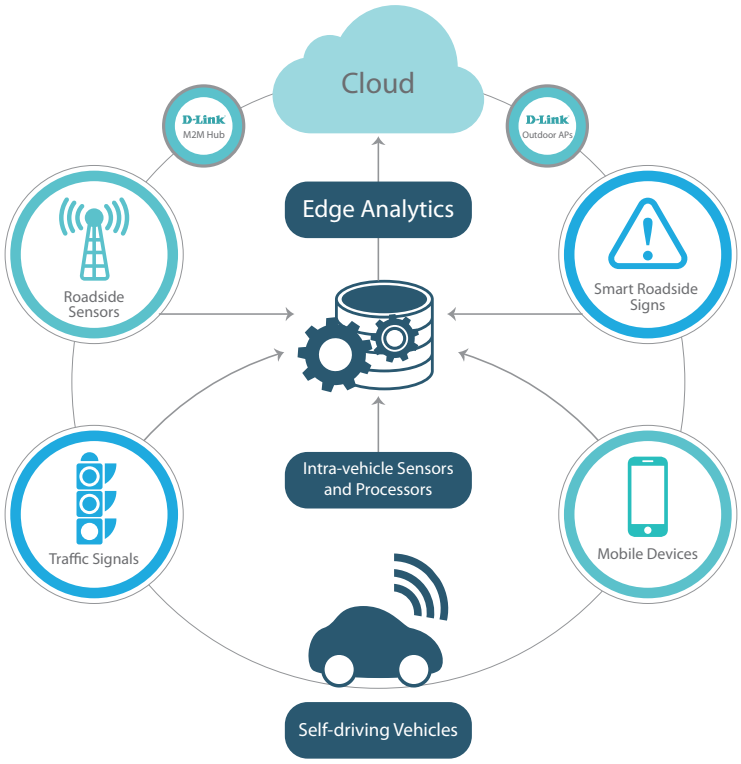


Figure 2: Smart City traffic solution based on edge analytics

Shopping Malls

As a universal access technology, MEC offers itself to any application that has locality requirements, and that goes beyond industrial plants and connected vehicles. It is also increasingly being used to serve people and businesses in **shopping malls, sports arenas, airports and rail stations**, for example. **And such networks are responsible for new and exciting uses for retail.**

By using a private network in a shopping mall (Wi-Fi or LTE), the mall owner can deliver advertising, coupons, movie trailers and other content directly to shoppers via an edge computing solution.

The mall's platform can also learn where shoppers are, where they have been and where they go next. The resulting big data from this movement information finds its way back to the mall tenants for marketing analysis.

Software applications can thus tap into local content and real-time information about local-access network conditions and, by deploying various services and caching content at the network edge, mobile core networks also avoid congestion and can efficiently fulfil their central functions unimpeded.

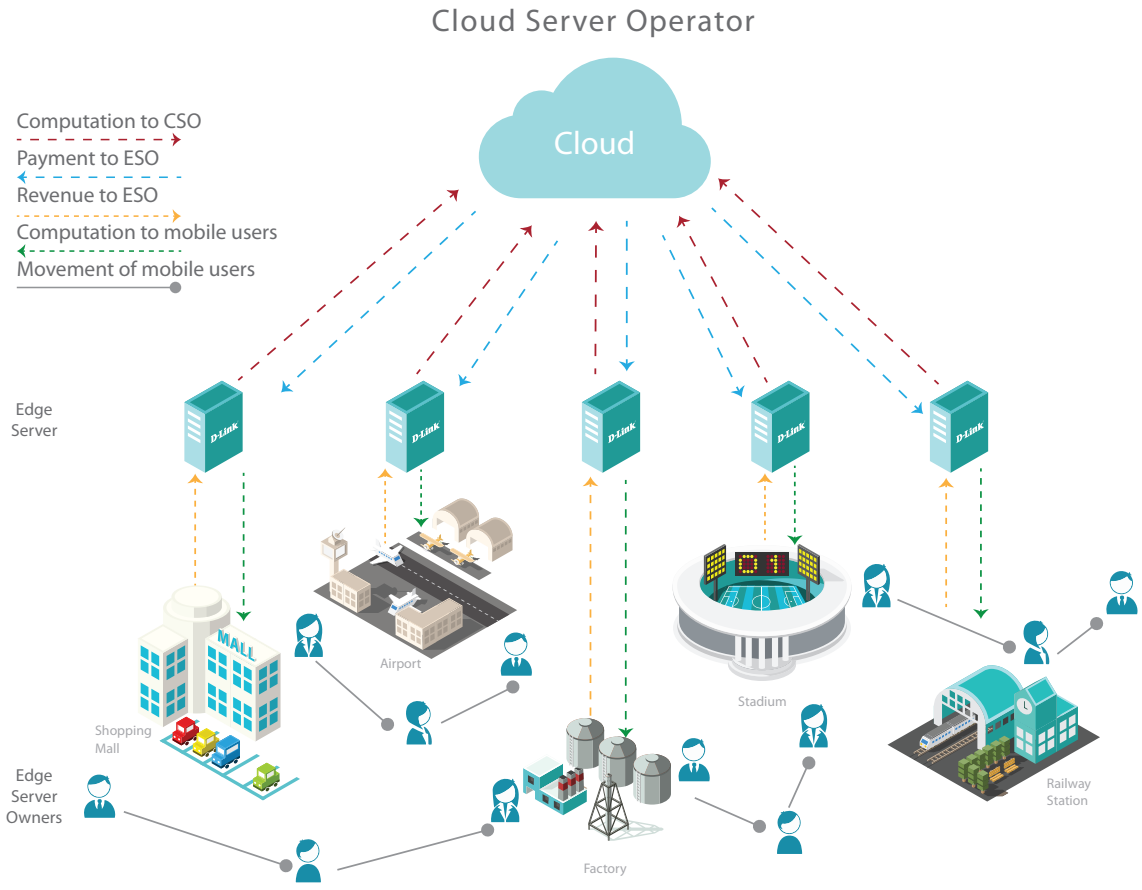


Figure 3: Businesses want to connect with the thousands of people who shop, travel and watch sport every day.

Small cells, mighty performance

D-Link's low-power base stations will bring unlimited scalability to your private LTE network. They are built to handle the intense networking demands to be expected from large enterprises and sprawling industrial, logistics, leisure and retail facilities.

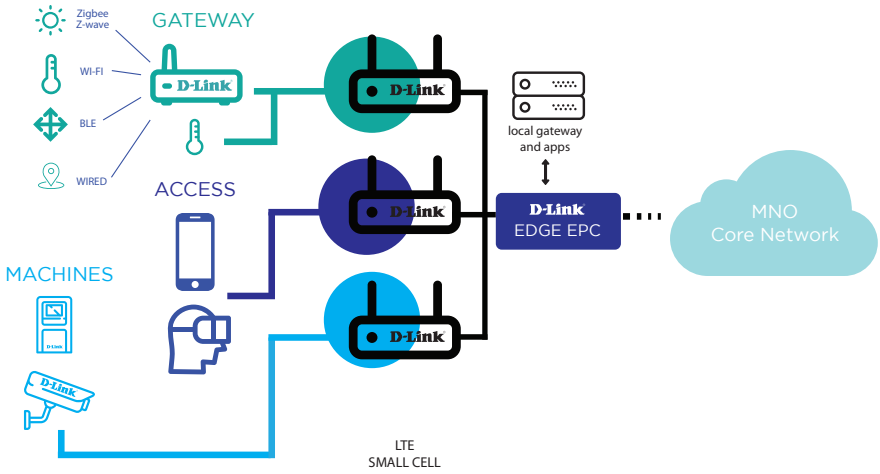


Figure 4

As can be seen from the Gartner forecast chart below, the installed base of small cell locations is set to grow rapidly in the next three years as edge computing and private networks become the norm.

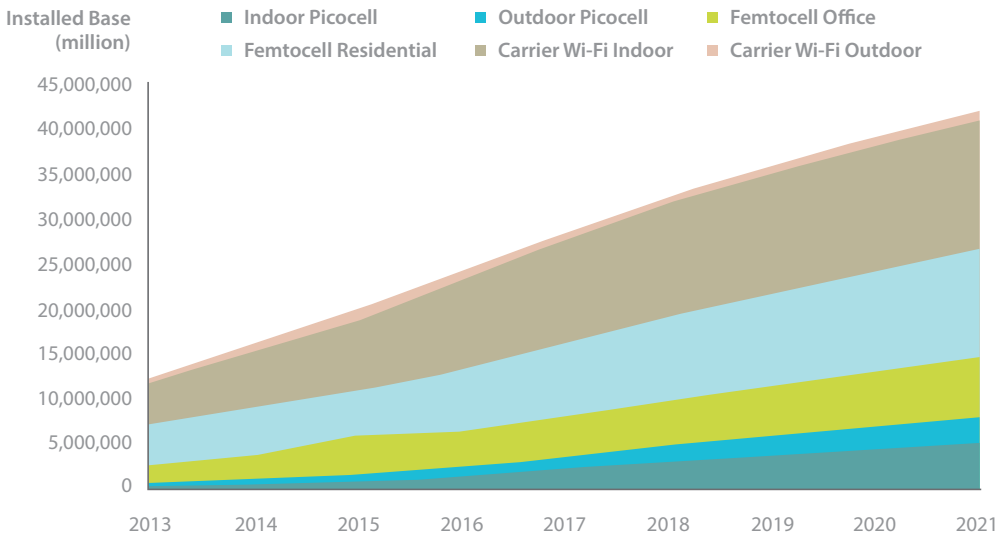


Figure 5: Summary of Small Cell Deployment Locations

As well as using fixed networks such as xDSL (digital subscriber lines) and MSO (multiple-system operators), **D-Link's small cells can also cost-effectively use fixed-satellite services (FSS) and high-throughput satellite (HTS) solutions to deploy Fixed2Wireless seamlessly.**

Your own private LTE network

The transition to edge computing will create unlimited new opportunities for industries aiming to exploit the Internet of Things (IoT).

The potential economic impact of the Internet of Things has been estimated in the trillions of dollars in sectors such as Health, Home, Office, Retail, Connected Cars, Smart Cities, Logistics and Manufacturing.

Many locations in these sectors are addressable by private networks, whether they be power plants, factories, hospitals, laboratories or transport hubs.

But, as we saw earlier, such private networks need specialized connectivity requirements:

- a dedicated independent network with own radio equipment, keeping data local for better security
- optimized for industrial applications, with a guaranteed quality of service, low latency and available spectrum
- a hosted or self-contained core network that is also self-organizing
- end-to-end system control and reliability
- interoperability with global systems
- edge computing and analytics
- the ability to manage and communicate seamlessly with advanced wireless devices from drones, robots and sensors to cameras, head-mounted displays and handhelds.

Meanwhile, the remote public LTE network, managed by the service operator, will continue to provide:

- Wide-area coverage
- Generic voice/data services
- Core cloud services
- IoT analytics and services
- Equipment shared with other users
- Network management
- Device management.

Private LTE Networks - an opportunity for MNOs

Cloud Radio Access Networks (C-RAN) and MEC are highly complementary technologies. When considered together, they will make the near-term economics of deploying C-RAN hubs very attractive, **incentivizing Mobile Network Operators (MNOs) to support and generate important revenues from 5G applications** they would not be able to support otherwise.

As such, edge computing and private networks offer **a huge opportunity for MNOs, who in the process will also be able to offload large amounts of potential traffic to small private networks managed at the edge** so that only necessary data is handled in the core network. This will allow MNOs to serve their customers comprehensively and to dedicate spectrum more efficiently.

In essence, MEC provides a new ecosystem and a new value chain. Operators can now open their Radio Access Network (RAN) edge to authorized third-parties and permit them to deploy innovative applications flexibly and rapidly and offer services to mobile subscribers, enterprises and vertical segments. So, far from being a threat to MNOs, private networks at the edge fit in with the MNOs' need to seek new revenues as they necessarily transform their business models.

Bandwidth strategy

More and more operator-licensed, shared and unlicensed spectrum is becoming available for private LTE networks and this will increase with the decentralization of mobile bandwidth, software-defined networking (SDN), network function virtualization (NFV) and network slicing, aiding the distribution of traffic and assets.

The evolution to private 5G networks on the basis of 3GPP New Radio standards will boost the transition to Industry 4.0, enabling the reconfiguration of production activities and greater use, for example, of mobile robots and Augmented Reality applications.

This will offer **new capabilities**, such as ultra-reliability and even lower latency, and **more spectrum**, from low (1GHz) to middle (1-6 GHz) to upper (mmWave, 24 GHz) bands, supporting licensed, shared and unlicensed spectrum.

Licensed or shared spectrum is available **worldwide** from MNOs in all LTE bands.

For non-MNOs in the US, shared or unlicensed spectrum is due to be deployed in 2018 in the 3.5 GHz band, also known as Citizens Broadband Radio Service (CBRS), with industrial IoT one of its main applications.

A new stand-alone global alliance, MulteFire™, is currently testing unlicensed spectrum in the 5 GHz band for creating private LTE-based networks anywhere in the world. It plans to support additional spectrum bands in the future.

These growing bandwidth options will enable industries, large enterprises and Small and Medium Businesses to own and manage their own LTE networks without requiring licensed spectrum and continue to enjoy the high-performance benefits from LTE with a strong roadmap to 5G. They will allow clients to customize LTE networks for company-specific applications, optimizing for capacity, quality-of-service and guaranteed latencies.

To meet future growth projections, **the solution must be scalable to support increased computing, storage and networking demands**. In addition, it must be:

- Cloud-based – content will also be stored at the edge as needed, and application resources may be split between the edge and the cloud to ensure a seamless end-user experience.
- Able to support a mixed Radio Frequency environment – edge computing architectures are independent of the radio network used and solutions may include both LTE and Wi-Fi, or just one of these. But, whichever the case, the benefits of edge computing can be comfortably realized.

Opportunities for
Non-Mobile Network Operators and new target audiences

Edge computing is an opportunity for both MNOs and non-Mobile Network Operators (non-MNOs), in that both will be able to open up the edges of their networks to third-party partners, allowing them to deploy innovative applications and services rapidly toward mobile subscribers, enterprises and other vertical segments.

For application developers and content providers, the RAN edge will come to represent a service environment with ultra-low latency and high bandwidth, as well as direct access to real-time radio and network information.

MEC industry standards and deployment of MEC platforms will also act as enablers for new revenue streams to operators, vendors and third-parties. Differentiation will occur through the unique applications deployed in the Edge Cloud.

In no time, D-Link's Edge-as-a-Service (EaaS) solution will be enabling private networks to self-organize away from the old system limited to licensed-only bandwidth, in order to serve new target audiences in the new era of IoT services.

How D-Link Edge EPC works

D-Link EaaS is an MEC multi-radio connectivity solution containing both hardware and software.

As well as the typical private LTE network, D-Link EaaS will consist of multi-access small cells and a management system providing Radio Network Information Service (RNIS).

MEC multi-radio connectivity enhances the capabilities of the D-Link EaaS platform by providing an overlay approach for multi-operator and multi-access network integration that is truly independent of the radio access and core networks.

MEC multi-radio connectivity can also be planned independently and meets the needs of enterprises of all sizes and can be deployed in venues of all sizes.

Creating new revenue opportunities for enterprises and venues, the solution is future proof, being **easily extendable to support newer technologies such as MulteFire and 5G.**

The Radio Network Information Service (RNIS)

Mobile edge computing consists of running mobile edge applications at the edge of the network where the environment is characterized by low latency, proximity, high bandwidth and exposure to location and up-to-date radio network information. The information on current radio conditions is shared over the Radio Network Information Service via the mobile edge platform.

RNIS is a service that provides radio-network-related information to mobile edge applications. The granularity of the radio network information may be adjusted based on parameters such as information per small cell, per user equipment (UE), per QCI (QoS Class Identifier) or it may be requested over a period of time. Typical information that may be provided includes:

- real-time radio network information regarding radio network conditions;
- the specific UEs which move in or out of a particular location area;
- information about UEs connected to the small cell associated with the mobile edge host, their UE context and the related radio access bearers;
- changes in information related to UEs connected to the small cells associated with the mobile edge host, their UE context and the related radio access bearers.

The radio network information may be used by the mobile edge applications and platform to optimize existing services and provide new kinds of services based on up-to-date information on radio conditions.

An example of a mobile edge application that uses radio network information to optimize current services is **video throughput guidance**.

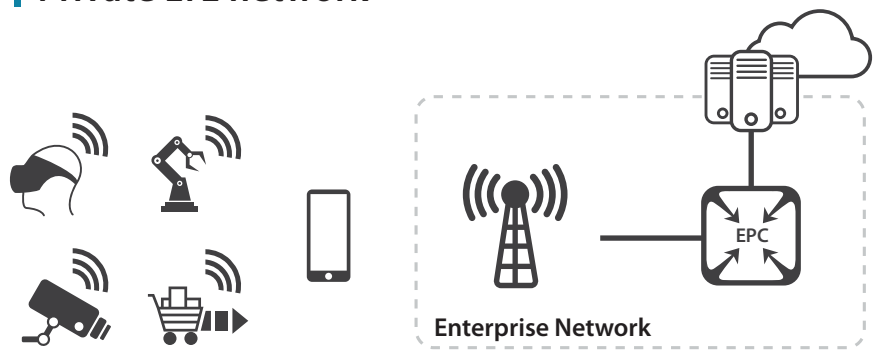
In video throughput guidance, a radio analytics mobile edge application uses mobile edge computing services to provide the back-end video server with a near real-time indication on the throughput estimated to be available at the radio downlink interface in the next time instant.

The throughput guidance radio analytics application computes throughput guidance based on the required radio network information it obtains from a mobile edge service running on the mobile edge host.

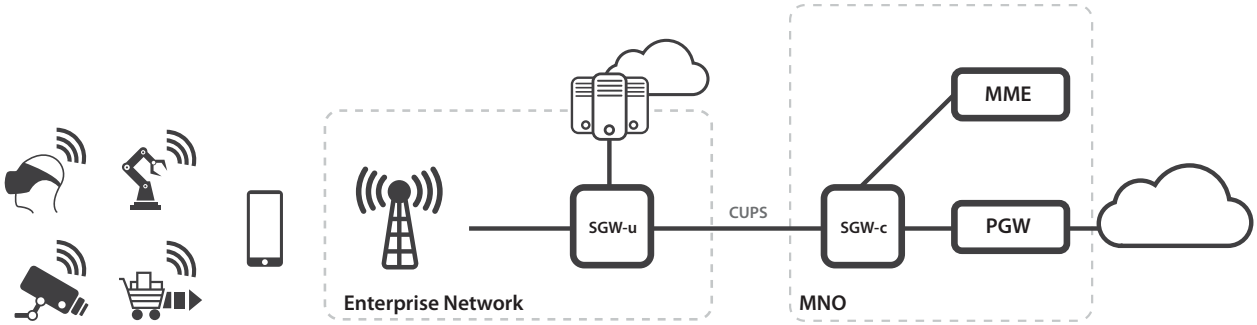
Examples of D-Link EaaS networks

EPC = Evolved Packet Core
SGW-u = Serving Gateway-user
SGW-c = Serving Gateway-control
MME = Mobility Management Entity
PGW = Packet Gateway
CUPS = Control and User Plane Separation
MNO = Mobile Network Operator

Private LTE network



Multi-Access Edge Computing



Roaming network