STL Partners Edge Computing Use Cases Directory

Last updated: January 2023

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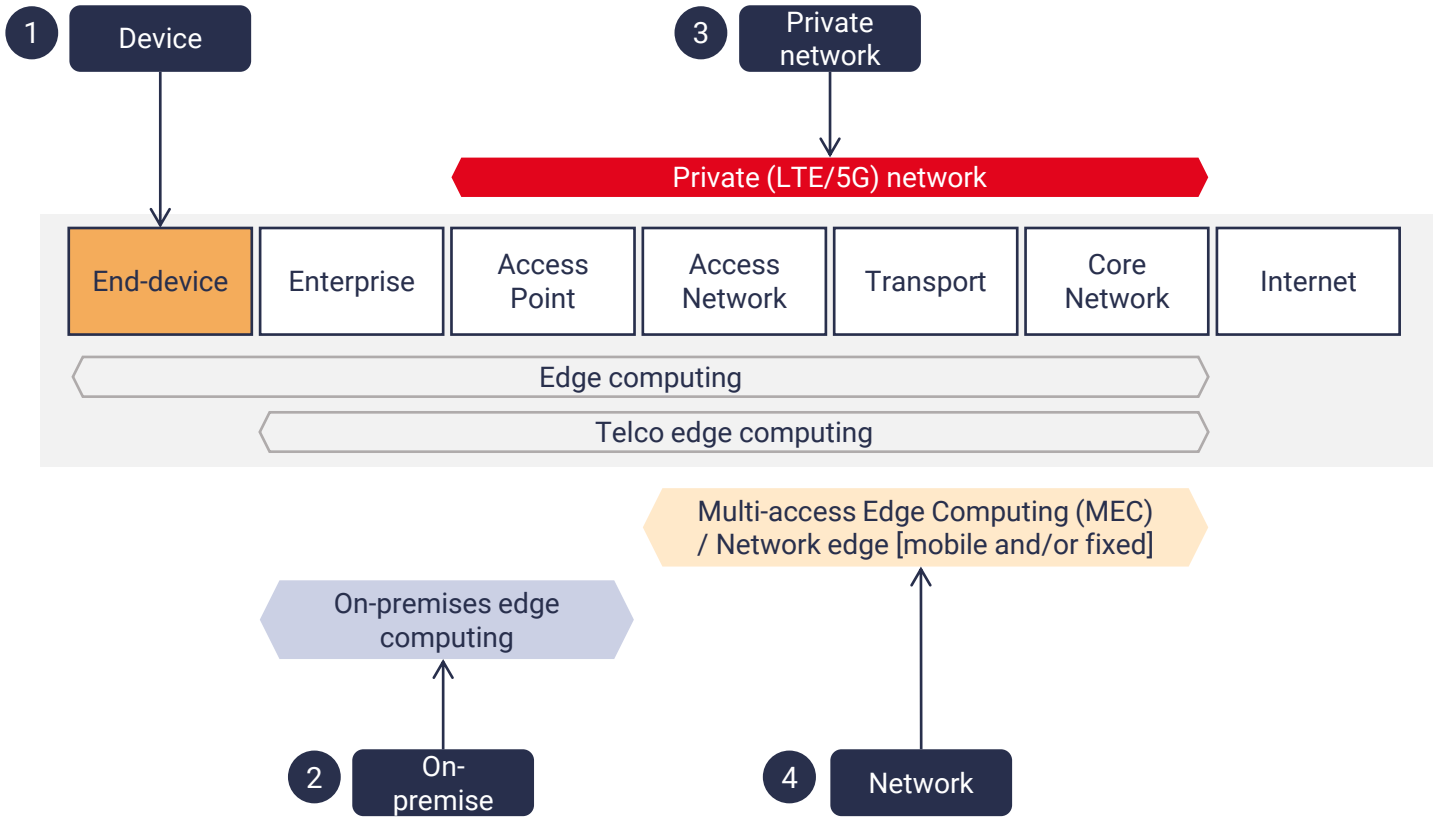
Edge use cases

Where is the edge?

LOCATION CAPABILITY A-Z

Select an edge location:

1. Device
2. On-premise
3. Private network
4. Network



Edge use cases: Network

LOCATION CAPABILITY A-Z

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Edge use cases

- AR/VR gaming and simulation
- AR in travel/tourism
- AR/VR for training
- Automated platooning for truck convoys
- Branch office compute
- Building monitoring / alarm systems
- Cloud gaming
- Connected ambulance
- Connected car driver assistance
- Contextual DOOH advertising
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- Security - video ingest and analytics
- Smart ATMs
- Smart city traffic management
- SME network services
- Sustainability monitoring / mapping
- Temporary compute/events
- Virtual PC/DaaS/VDI
- Worker safety: video ingest and analytics

Edge use cases: On-premise

LOCATION CAPABILITY A-Z

Edge use cases

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Edge use cases: Device

Edge use cases

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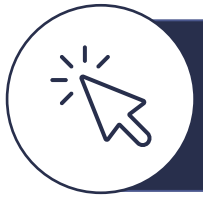

Edge use cases: Private network

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- Temporary compute/events

What are edge capabilities?

LOCATION CAPABILITY A-Z

Select a capability:

- Latency
- Reliability
- Reduced backhaul
- Data localisation
- Flexibility
- Light device
- Mobility
- Resilience

Hosting processing capabilities closer to the end user/device/source of **data reduces round trip times (down to a few ms)** compared to having to backhaul data to the core

Since data transfer **does not have to depend on the wide area network**, there is a reduced risk that an edge application will be affected if there is a network failure

Processing data at the edge reduces the volume of traffic travelling through the backhaul network, reducing costs and **avoiding strain on core servers**

Growing **concerns around data privacy**, and regulations such as GDPR, make the ability to process and store data locally (e.g. on-premise) key to some use cases

In contrast to dedicated appliances, edge compute infrastructure can host a variety of applications and can **quickly scale up/down or prioritise traffic** based on demand

Offloading compute from an end-device to the edge allows this device to be both **physically lighter and consume less power**, enabling otherwise inefficient use cases

Distributed applications across neutral edge infrastructure have **workloads that can follow mobile end-devices**, giving them access to compute wherever they need it

Applications are hosted on shared edge infrastructure so workloads can be easily moved to alternative servers **in case of hardware failure, maintaining service continuity**

Edge use cases: Latency

LOCATION CAPABILITY A-Z

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Edge use cases: Reliability

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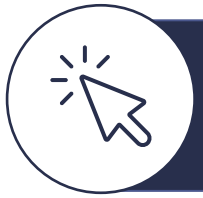

Edge use cases: Reduced backhaul

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Edge use cases: Data localisation

LOCATION CAPABILITY A-Z

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Edge use cases: Flexibility

LOCATION CAPABILITY A-Z

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Edge use cases: Light device

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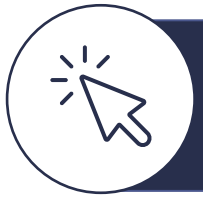

Edge use cases: Mobility

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Edge use cases: Resilience

LOCATION CAPABILITY A-Z

Edge use cases

- Legacy back office interface
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Edge use cases: A-Z

LOCATION CAPABILITY A-Z

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Edge use cases

Advanced predictive maintenance

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Predictive maintenance monitors data from sensors on equipment to ensure it is in good condition and flag pre-emptively if there is a need to repair it, eliminating the need for scheduled maintenance, adding AI to "condition-based monitoring"
- For this to work effectively, dozens of sensors need to be employed combined with machine learning/AI at the edge to accurately predict the equipment's condition
- The benefit of predictive maintenance is that it reduces downtime and increase the return on assets (up to 24%)
- Gartner predicts that spending on IoT-enabled predictive maintenance will increase to $12.9 billion in 2022 from $3.4 billion in 2018

Why edge?

- Advanced predictive maintenance requires data from 1000s of sensors to be collected and analysed – a huge amount of data, too expensive to send to a central server
- Edge computing can also simplify integration with other management systems, e.g. CRM
- Enterprises in some industries, e.g. manufacturing, are hesitant to use the cloud (data security)

Potential ecosystem partners

- **Device manufacturers** – companies are moving towards servitisation and providing maintenance services with the product/device
- **Systems integrators** to integrate outcomes of analytics into wider enterprise systems
- **Cloud providers** – solutions will move to IoT, therefore connecting to the cloud will becoming increasingly important, as insights need to be shared across multiple parties
- **Maintenance companies** who would leverage the analytics output

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

Advanced predictive maintenance

Case study: Atos

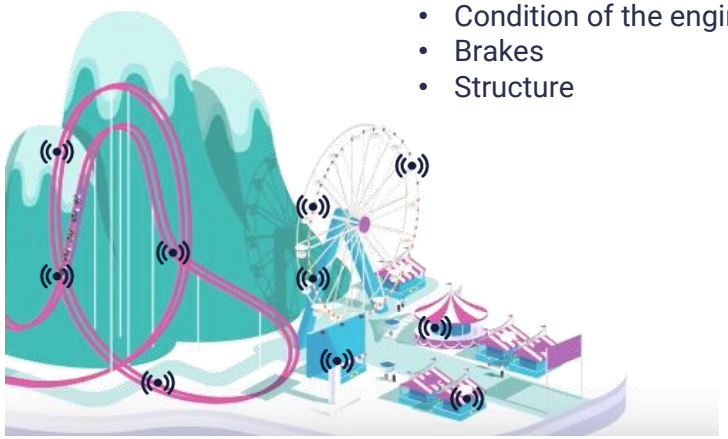
EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

1 **11,000 sensors** collect information on:

- Condition of the engine
- Brakes
- Structure



2 Data from the sensors is **continuously and in real-time sorted, stored and analysed** at the BullSequana Edge server located **on-premises**

Deep learning algorithms are executed on the edge server too ("Edge Data Analytics")

Example of this use case by others

Capgemini: Predictive asset maintenance with edge compute

Litmus Automation: Case study with boiler manufacturer

Crosser: Predictive maintenance deployed on machine gateways

Stoke Systems: Predictive maintenance for utilities companies

Key partners in this scenario

- Edge hardware → Atos has a specialised edge server: BullSequana
- Analytics → Atos's Edge Data Analytics manages the data lifecycle
- IoT platform → Atos' IoT platform is powered by Siemens' Mindsphere
- Professional service & engineering → Jacobs has integrated digital capabilities in data analytics and IoT deployment

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

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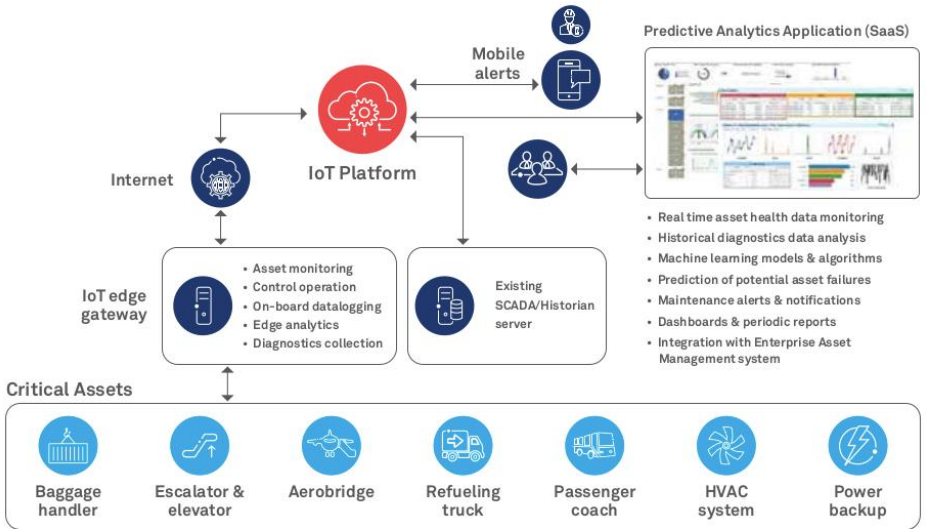
Advanced predictive maintenance

Case study: Wipro (hypothetical)

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

How it works



This example is specifically for **predictive maintenance of airport infrastructure**

Edge analytics used to monitor what is taking place in real-time, as well as being used to predict future maintenance needs

The 'edge' is typically located **on-premise, or in a (private) cloud**

Example of this use case by others

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Key partners in this scenario

Sensors

Sensors inside the baggage handling system, or with escalators, or refuelling trucks

Edge servers/ Cloud platform

Hypothetical

Azure IoT Hub

Could connect to Azure IoT Hub in the cloud, or could be on-premise servers, (HPE, Dell, etc.)

Analytics software

Hypothetical

IBM

Analytics software, possibly one that uses machine learning/AI, such as IBM Maximo APM

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Advanced predictive maintenance

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Predictive maintenance monitors data from equipment to ensure it is in good condition and flag pre-emptively if there is a need to repair it, eliminating the need for scheduled maintenance. Data from sensors across equipment can be processed at the edge to reduce backhaul and strain on the network and central server as well as minimise latency for a real-time view of the equipment.

Transition to edge

Predictive maintenance applications happen in industrial settings such as factories, warehouses, mining sites and power stations where machines are confined to specific locations. The use of on-prem edge will be helpful in such scenarios. As the adoption of edge computing solutions rise, data processing will gradually shift from central locations in the cloud to more local on-premise edge locations. By 2030, the majority of data processing will happen in on-prem edge. In some cases where devices mobile such as in transportation or when sites are temporary such as in construction, network edge will provide the necessary support for these applications.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	10-30%	0-30%	0%	60-70%
2030	0-20%	0-70%	0-40%	30-40%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing | 11-30% of total processing | 31-50% of total processing | 51-75% of total processing | 76-100% of total processing

AR/VR gaming and simulation

LOCATION CAPABILITY A-Z

How it works

- Location-based AR/VR game play is becoming increasingly popular (e.g. PokemonGO)
- This requires a lot of data processing for both location awareness and running the virtual reality game, especially for multiplayer gaming where the game needs to know where players are in real-time
- Consumers expect consistent connectivity/ quality of content
- Likely at the network edge, to enable remote multiplayer gaming, the edge platform would match players who are physically near one another to reduce latency, as well as render the game from the closest server as possible to reduce lag on the VR/AR game

Why edge?

- Hosting game servers on the edge reduces latency (20-100ms roundtrip) and allows gamers to get the fully intended experience of their multiplayer game. If gamers experience high latency when wearing a VR headset, they may feel sick.
- Edge can also remove some of the compute intensive programs off device and host on the edge, allowing end users to purchase lighter devices – decreasing costs

Potential ecosystem partners

- **Game developers** can leverage edge computing to develop games without building in constraints for lag/connectivity issues
- **eSports** is a growing industry, and being able to offer a high-performance solution with edge computing will enable eSports to be played remotely
- **CDN network providers** like Qwilt, who have existing relationships and capabilities in this space can help provide service to optimise games
- **AR/VR platforms**, such as Unreal, will need to integrate edge computing for this to work

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

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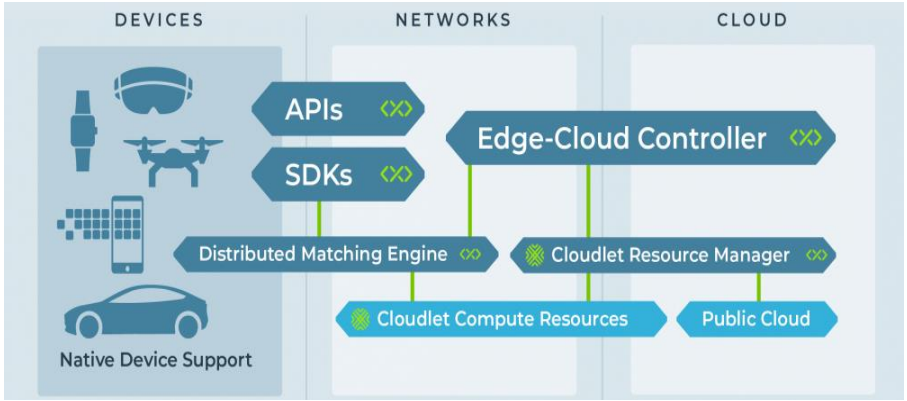
AR/VR gaming and simulation

Case study: MobiledgeX

LOCATION CAPABILITY A-Z

How it works



MobiledgeX architecture

forwARdgame, who were looking to build mobile AR games, were running into latency and game experience issues with wireless stability when users were around 2m apart from each other. To enable optimal experience, connectivity must be stable regardless of distance.

MobiledgeX enables edge servers, allowing forwARdgame to make the AR experience possible and scalable, as well as more interactive for users.

Example of this use case by others

NIANTIC

Niantic Labs & MobiledgeX:
Edge allows Niantic Labs to solve issues facing AR gaming e.g. location integrity, game player scale and evolved immersion enhancements

Key partners in this scenario

- Network edge facility → Telcos could provide edge facility and servers for the solution
- Edge platform provider → MobiledgeX: Provides edge IaaS for forwARd game to scale the number of players in a game with assured connectivity and low latency
- Gaming software provider → forwARdgame: Integrates location-based functions and AR into game functions for life-sized multiplayer gaming
- Game partners → Platform could enable different games/ sporting companies to partner in tailored solutions e.g. for training purposes

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

AR/VR for training

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- VR/AR is being used to deliver corporate training through immersive experiences, in particular for training employees in health and safety procedures in risky environments.
- The challenge today is that the options for using virtual reality headsets and ensuring rich experiences is that either the headset is heavy and impractical (e.g. Oculus Go) or it has to be connected to a high-end PC.
- Instead, the content can be stored at the edge and offload processing related to AR/VR e.g. using user's location/action to determine what to display.

Why edge?

- Application cannot be hosted in the cloud because the lag would impact the user experience, making it intolerable for the individual wearing the headset
- Training occurs infrequently, therefore it would not make sense to have dedicated servers on-site running/storing the application
- Current headsets are too heavy to be used for long periods of time, offloading at the edge can improve form factor.
- De-coupling application from headset allows enterprises to reduce costs on hardware and to upgrade the application without replacing headsets

Potential ecosystem partners

- **Device manufacturers**, e.g. Oculus, who will be able to improve their devices by using edge technology
- **VR training providers** will benefit from edge, as they can use it to improve the user experience, or run the sessions without the need to tether to a high-end PC
- **Training companies** who provide the content

Capability

Latency	Reliability	Reduced backhaul	Data localisation
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AR/VR for training

Case study: GridRaster

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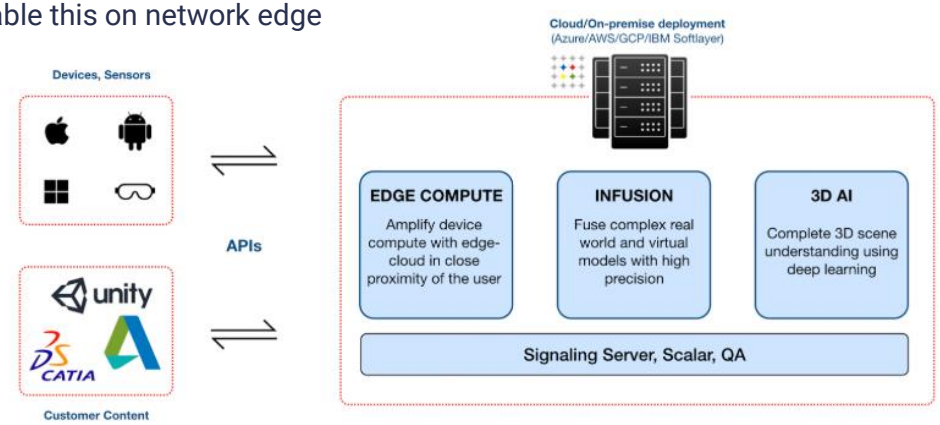
CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

Saguna and GridRaster working to enable this on network edge

- The cloud infrastructure could be at the edge
- This is critical for interaction between the end-device and the game to be latency minimal
- This also ensures the AR/VR device itself can be kept as light as possible



Example of this use case by others

Huawei white paper discussing edge computing to improve AR/VR training

1000 realities use edge computing to improve their VR and AR experiences, which can be used for training

Key partners in this scenario

- Network Edge Cloudlet — E.g. Saguna's MEC solution
- Mixed Reality Edge - PaaS — Connect to the Cloud e.g. GridRaster's specialized cloud platform for mixed reality
- VR/AR Development Platform — E.g. Unity Virtual Reality
- VR/AR applications — E.g. Luminous who develop VR experiences to train new members of staff

Edge maturity

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AR/VR for training

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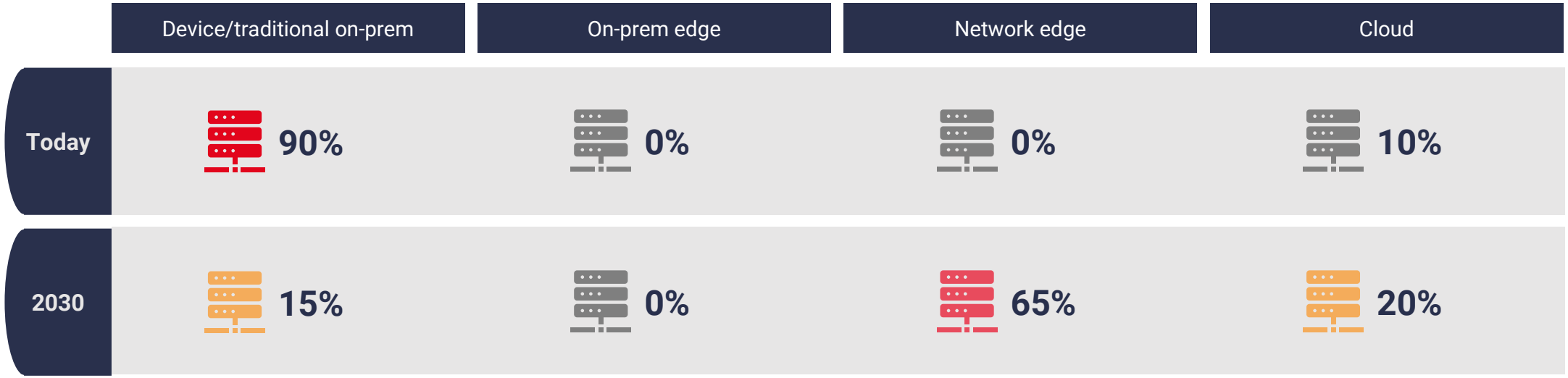
VR/AR is being used to deliver corporate training through immersive experiences, in particular for training employees in health and safety procedures in risky environments. To facilitate this, the content can be stored at the edge and offload processing related to AR/VR e.g. using user's location/action to determine what to display.

Transition to edge

Application cannot be hosted in the cloud because the lag would impact the user experience, making it intolerable for the individual wearing the headset. Current headsets are too heavy to be used for long periods of time, offloading at the edge can improve form factor. Also, de-coupling application from headset allows enterprises to reduce costs on hardware and to upgrade the application without replacing headsets. Training occurs infrequently, therefore it would not make sense to have dedicated servers on-site running/storing the application and network edge will be a more appropriate locations for enterprise to run these applications. By 2030, local processing will be more more into the cloud and network edge.



Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

AR in travel/tourism

LOCATION CAPABILITY A-Z

How it works

- In order to differentiate tourism services and applications from the competition, businesses will have to look at new ways of engaging customers
- AR represents an exciting new business opportunity for applications providers, e.g. using it to provide more information (displayed on a headset) during a museum tour
- Edge compute capabilities could enable AR features such as scene recognition, and interactive content as well as providing real time updates on crowded attractions/visiting times, allowing holiday makers to avoid busy periods and skip queues
- Tour operators can ensure a reliable quality of service and using the edge can be easier than investing in expensive devices or risking lower quality of experience by streaming from the cloud

Why edge?

- Hosting game servers on the edge reduces latency (20-100ms roundtrip) to avoid a poor user experience
- Offloading compute to edge, rather than mobile device, allows tourists' device battery life to last longer
- Can easily add new functions/attractions vs traditional on-premise or if the software is tied to the end-device

Potential ecosystem partners

- **Edge providers** e.g. operators to be able to synthesise vast amounts of data reliably and efficiently
- **Software/application developers** to provider immersive AR experiences that will engage viewers
- **Tour companies, tourist attractions, entertainment venues**, who will need to find innovative ways of differentiating themselves from their competition

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

AR in travel/ tourism

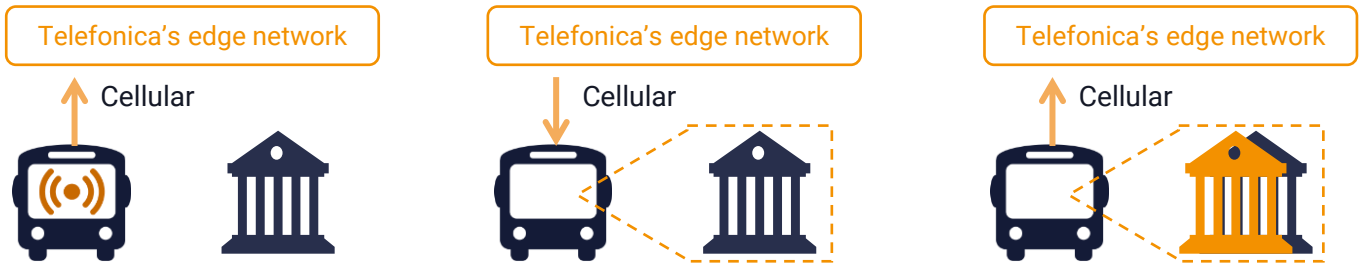
Case study: Telefónica

LOCATION CAPABILITY A-Z

How it works

Streaming of geolocated content in real-time. Tourists on bus can view AR content with data and information of the places encountered on the tour, through the screen of their bus.

1. Location data from vehicle sensors
2. Location and visual data processed in real-time at the edge
3. Animated visual is overlaid on landscape, providing info about the scene being viewed.



Example of this use case by others

tmforum

TM Forum Catalyst Project: 5G-enabled tourism experience (currently testing with MEC)

EPSON EXCEED YOUR VISION

Epson Moverio AR glasses and Brescia museums: AR tourism experience (not edge)

NAVTEK SOLUTIONS Connecting ideas with business

Navtek Solutions: AR for Tourism (not edge)

Key partners in this scenario

Edge/ network provider	Telefónica: Content processed at network edge, enabling real-time streaming
Software/ content provider	MEDIAPRO: Software with tourist information content and AR technology able to run at network edge
Vehicle provider	TMB: Technology set up on buses to enable images to appear on front screen

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Automated guided vehicles (AGVs)

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Many industrial sites use vehicles, operated by humans, for transportation and haulage of goods and materials.
- Manned vehicles are subject to high labour costs, labour shortages and human error, causing potential risk to others. As a result, companies are looking to replace these with AGVs.
- Edge computing can be used to ensure that AGVs execute their planned journeys efficiently by collecting and processing data in real-time to navigate around sites and obstacles to avoid incidents and stay within schedule.
- Using AGVs can help not only improve efficiency, reliability and accuracy but also reduce labour costs, eliminate human error and increase workplace safety.

Why edge?

- Requires ultra-low latency to be able to react and change course if required (e.g. if an obstacle suddenly appears)
- Data collected by the AGV itself can be processed on-board to directly feed into navigation
- Ensures reliable AGV operations even when connectivity fails
- Only data that is important to enhancing performance is sent to the cloud, unimportant routine data only needed by AGV when navigating then discarded

Potential ecosystem partners

- **Application providers** (e.g. navigation software providers) that deploy their solutions at the edge to run analyses on data from the AGV
- **Device manufacturers and hardware suppliers** that supply sensors and other devices and hardware to work with software providers (can be specialised to provide industry-grade devices e.g. to deal with harsh environments in mining)
- **AGV OEMs** that build the vehicles themselves
- **Systems integrators** to integrate with existing legacy systems

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Automated guided vehicles (AGVs)

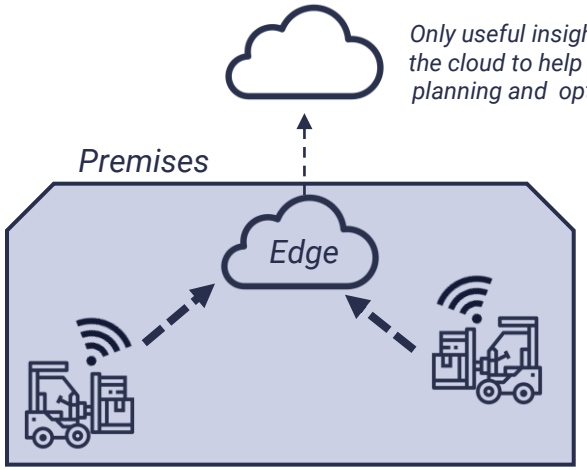
Case study: EK Automation

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

1. Autonomous guided vehicles carry materials and goods around the premises (e.g. factory floor, mine etc.)
2. 3D obstacle detection with dynamic route planning is integrated into edge cloud so images and data are analysed real-time
3. Edge can provide low latency and processing power so that AGVs can react and change their path in milliseconds to avoid any obstacles



Processing data at the edge provides low latency to avoid obstacles within milliseconds

Example of this use case by others

ThyssenKrupp uses driverless forklifts in its Fameck factory

Vodafone uses edge and 5G to operate AGVs on e.GO factory floor

Key partners in this scenario

OEMs	Automated guided vehicle (AGV) manufacturers
Application provider	Applications that provide the navigation capabilities
Connectivity provider	Provides the connectivity (in this case trials with 5G)
Network infrastructure	Infrastructure provider for 5G as the preferred form of connectivity in the premises

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Automated guided vehicles (AGVs)

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

Manned vehicles are subject to high labour costs, labour shortages and human error, causing potential risk to others. As a result, companies are looking to replace these with AGVs. Edge computing can be used to ensure that AGVs execute their planned journeys efficiently by processing data in real-time to navigate around sites and obstacles to avoid incidents and stay within schedule.

Transition to edge

AVGs mainly utilise machine or device processing capacity to filter and analyse data locally before sending key data back to the cloud. The majority of the processing is happening within the machine on site. However, edge computing will allow machines to aggregate and send data to on-prem edge where data remain local and close to the devices for latency and reliability requirements. By 2030, most data processing will occur on on-prem edge.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	70%	20%	0%	10%
2030	10%	69%	1%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Automated platooning for truck convoys

LOCATION CAPABILITY A-Z

How it works

- The automotive industry is driving towards autonomous vehicles – one of the first likely use cases will be truck platooning.
- Here, trucks follow in close formation to one another to reduce fuel consumption. Currently a driver does this, with dashboard information as to distances between trucks.
- In the future, trucks could share information about their speed and distance, as well as the surrounding traffic infrastructure, so that platooning could be automated, meaning trucks could drive even closer together. There is likely to still be human override in the short to medium term.

Why edge?

- Reduced backhaul - only relevant information from the wide scale sensor data ingest is sent and stored in the cloud
- Low latency – edge compute meets latency requirements for real time actioning
- Mobility – works across multiple edge sites, allowing widescale coverage
- Light device – can remove compute capacity from the truck/car and host it on the edge

Potential ecosystem partners

- **Specialised partners with NVIDIA (GPUS)** will potentially provide the powerful computer that is required for sensor data to be analysed and turned into actionable insights
- **IoT device manufacturers** (for sensors both on the trucks and on the surrounding traffic infrastructure)
- **Local governments and regulators** will be a key stakeholder from a safety standpoint

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

Automated platooning for truck convoys

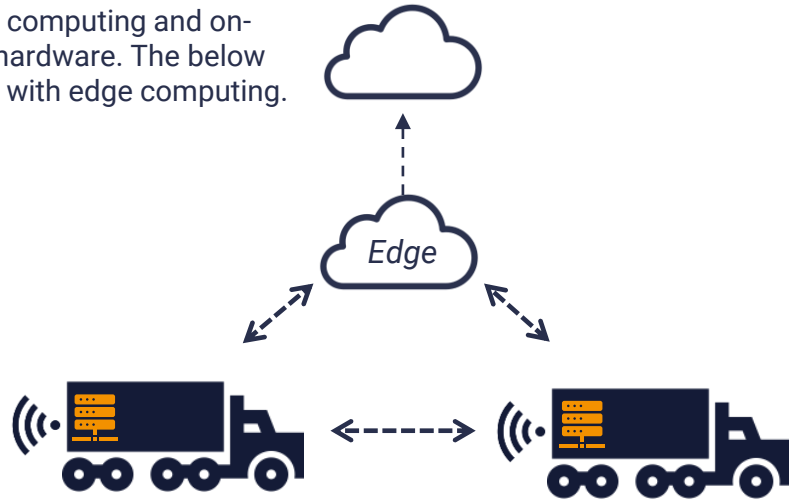
Case study: Scania

LOCATION CAPABILITY A-Z

How it works

N.B. Scania currently use 5G with no network edge computing and on-device computing may be proprietary, specialised hardware. The below depicts hypothetically how the solution could work with edge computing.

1. IoT sensors detect road conditions, speed of vehicle etc.
2. On vehicle edge compute analyses data from IoT sensors and provides automated responses.
3. Data streamed to edge node for communication between vehicles in a platoon.



Example of this use case by others

Cohda Wireless:
Have an automated platooning solution and a whitepaper on the potential of edge computing for autonomous vehicles

Peloton Technology: Have an automated platooning solution which uses their own Network Operations Cloud (NOC)

Key partners in this scenario

- Network infrastructure — Ericsson has provided 5G infrastructure
- Transport solution provider — Scania R&D provides the facilities for testing the platooning solution
- Research partner — Swedish National Road & Transport Research Institute are research partners
- Research partner — KTH Royal Institute of Technology in Stockholm is a research partner

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Branch office compute

LOCATION | CAPABILITY | A-Z

How it works

- Extending the use of CPE for non-network functions for branch offices, such as print servers, Windows services, authentication server, access control, inventory management, etc.
- Offices would be able to deploy virtual applications / functions, using spare capacity in uCPE boxes.
- Could migrate to vCPE over time (i.e. running applications in cloud or at network edge)

Why edge?

- On-premise branch IT applications can be expensive and time consuming to deploy, manage and upgrade
- Edge cloud enabled branch office compute offers a more flexible and easily deployable solution , allowing excess and/or transitional compute on uCPE to host IT applications
- It brings cloud flexibility while maintaining a high level of reliability and data privacy

Potential ecosystem partners

- **Traditional vendors** (e.g. Cisco, Juniper) have strong existing relationships and capabilities (inc. hardware) in CPE and the move to u/vCPE
- **Open source partners** (e.g. OpenStack) will enter the partner ecosystem. The trajectory towards uCPE and virtualisation of functions brings a shift towards exploration of open source

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

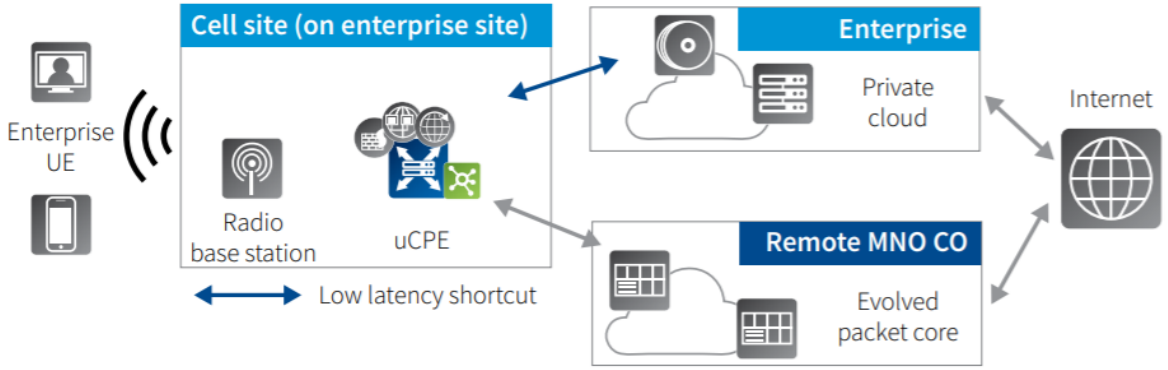
Branch office compute

Case study: ADVA

LOCATION CAPABILITY A-Z

How it works

- This universal CPE runs primarily network functions (e.g. router, firewall, SD-WAN) on-premise.
- Spare capacity can be used to run enterprise/cloud applications using the same white box.
- This provides cost savings and reliability for enterprise/cloud applications which need to run on-premise .



Example of this use case by others

Juniper Networks:
Contrail edge cloud

Key partners in this scenario

Enterprise/cloud application	IT, enterprise, and cloud functions run on the uCPE e.g. windows/print servers
Edge platform	ADVA's Ensemble connector acts as a virtualised hypervisor to flexibly manage workloads
Hardware/edge device	ADVA provide the edge hardware (the uCPE box). Can also run on 3rd party hardware (e.g. HPE)
Connectivity/ channel	Verizon resell ADVA to its own enterprise customers as a holistic uCPE offering

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Building monitoring/alarm systems

LOCATION CAPABILITY A-Z

How it works

- IoT, low-cost sensors, cameras and geo fencing are set to revolutionise the building monitoring/management market
- Alarm systems are either complex to install, relying on dedicated hardware and are prone to false positives, or starting to be cloud-based
- Sensors monitor, listen and watch the ambient background (noise patterns and visual data) then send these data for analysis by AI systems in the edge cloud. They will recognise out of normal patterns or events and alert the building management system and end-users. Geo fencing will further reinforce the accuracy of the system.

Why edge?

- Processing the sensors data continuously in the cloud may be too costly (particularly in B2B2C segment)
- Paranoia and real threat of cybersecurity will drive use of edge computing to ensure data is kept secure
- Integrating various devices can be easier to do on an edge computing platform
- Can be risky to have an expensive, heavy processing end-device – may be stolen

Potential ecosystem partners

- **Smart home suppliers**, e.g. Cocoon
- **Smart home devices** to integrate into, e.g. Amazon Alexa, Google, etc.
- **Building management systems vendors**, e.g. Johnson Controls, Honeywell, etc.

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

Building monitoring/alarm systems

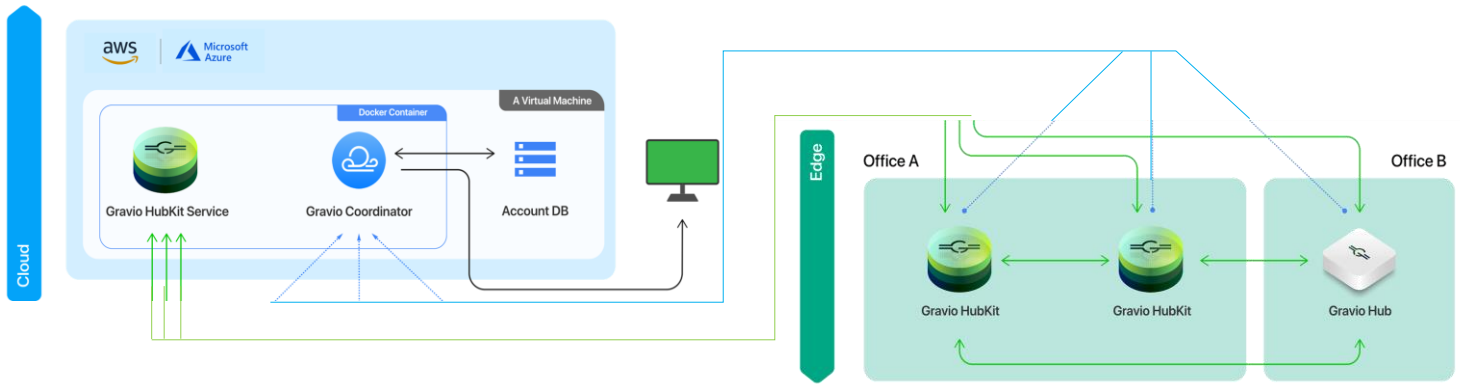
Case study: Gravio

LOCATION CAPABILITY A-Z

How it works

1 Gravio provides HubKits and Hubs that act like edge servers and are synched on a distributed ledger and via the Gravio coordinator in the cloud

2 This system can be used for running an IoT-based alarm system



Example of this use case by others

Cocoon:
AI-based system, uses cloud today

NXP:
Automating building security using edge

Abode:
Gateway-based smart security systems

Key partners in this scenario

IoT edge hub

Gravio

Gravio has an IoT edge platform that includes the physical hardware (hub) and the software allowing connected IoT devices to be integrated and managed

Cloud providers

aws Azure

IoT distributed cloud system connect to the cloud, e.g. application for coordinating and management of devices

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Cloud gaming

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

- Processing and rendering games from the cloud, which are then streamed to an end-device
- This can be for both hardcore, multiplayer games or mass-market games
- Edge computing helps to reduce latency between the end-user and end-device and the (edge) cloud where the game is hosted and being rendered
- For example, Google Stadia launched with many complaints on the latency
- Cloud gaming companies often bundle infrastructure with the games (e.g. Google Stadia)

Why edge?

- End-gamers have to spend huge amount to build a PC for running (hard core) games and/or purchase a high-end console, offloading processing reduces the expense of the end-device
- However, using the cloud results in lag and/or jitter – two KPIs gamers track
- Offloading processing from the end-device also allows games to be easily accessed and played anywhere

Potential ecosystem partners

- **Cloud providers** – some games may run across a distributed architecture and some publishers may run on public cloud (e.g. AWS) or private, which may be their own data centres
- **Specialised hardware partners with NVIDIA (GPUs)** will potentially provide the high processing power that is required to run the games

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

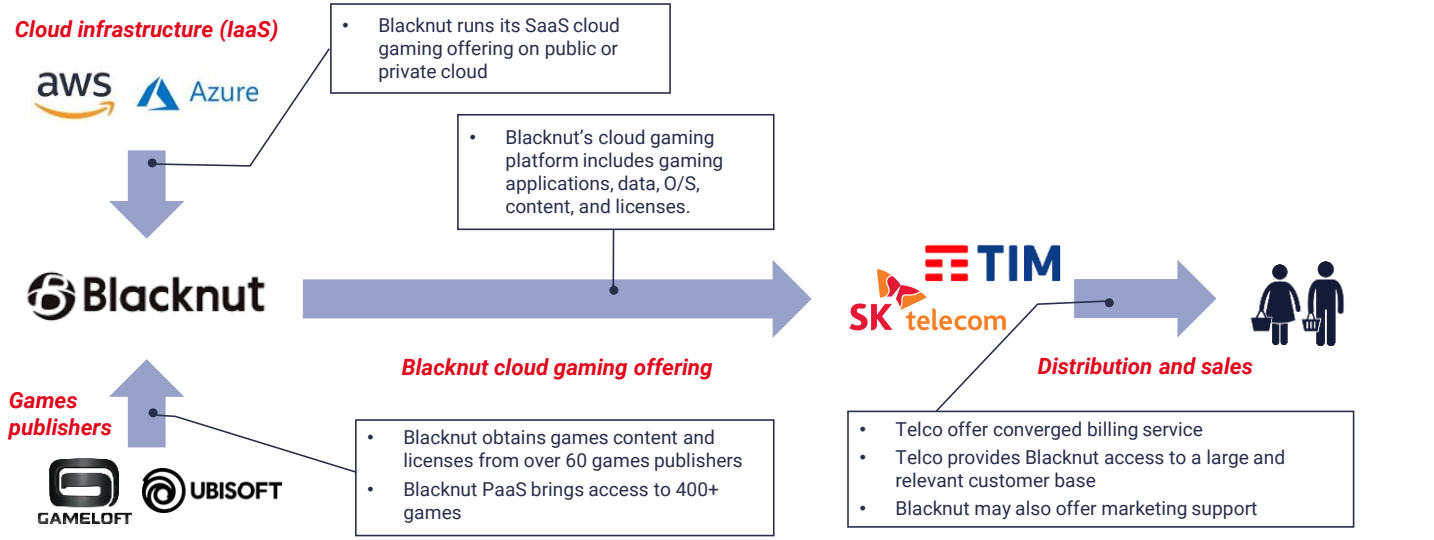
Cloud gaming

Case study: Blacknut

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works



Example of this use case by others

playgiga

PlayGiga: White-labelled gaming-as-a-service – working with Rakuten using MEC

STADIA

Google Stadia: Google's cloud gaming service

HATCH

Hatch: Games-on-demand services (mainly Europe) - working with Packet to use edge computing

Key partners in this scenario

Cloud IaaS
aws Azure
Cloud IaaS companies such as AWS and Azure currently provide infrastructure

Games publishers
GAMELOFT UBISOFT
Studios that publish games – often also have their own gaming developers

Cloud gaming platform
Blacknut
Provide platform that contains a catalogue of 400+ games running from a cloud

Distributor
Distribute games via platform or could be white labelled

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Cloud gaming

Case study: SK Telecom and Project xCloud

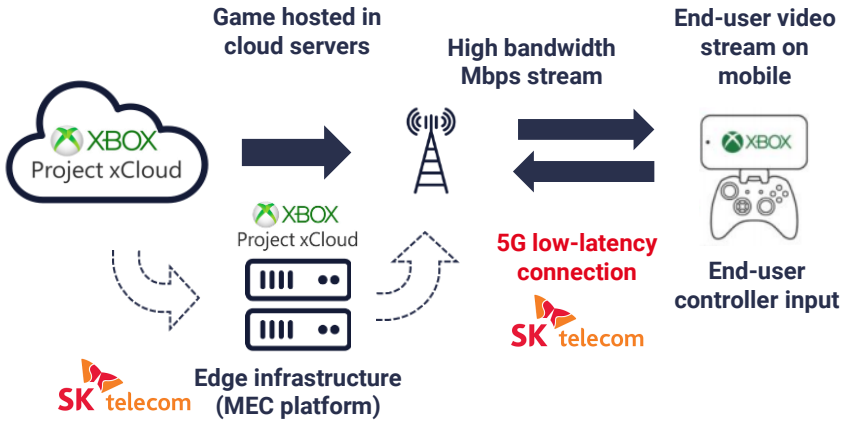
EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- SK Telecom has partnered with Microsoft's new cloud gaming service Project xCloud to offer the service in beta phase to its customers.
- Project xCloud is currently hosted on Microsoft's cloud servers. The software and hardware of the games sit here, and a stream is fed to the gamer via a low-latency 5G connection
- SK Telecom are building out their MEC (multi-access edge computing) infrastructure. **In future, Project xCloud could be hosted at these MEC sites next to 5G base stations – this would improve latency**

How this works – Project xCloud currently leverages Microsoft's cloud, but could move to the edge



Example of this use case by others

SHADOW

Shadow:
PC-renting service using specialised low-latency edge servers

STADIA

Google Stadia:
Google's cloud gaming service

HATCH

Hatch:
Games-on-demand services (mainly Europe) – working with Packet to use edge computing

Key partners in this scenario

5G connectivity	SK telecom 5G means mobile gamers can play with low-latency and high bandwidth
Edge infrastructure	SK telecom MEC infrastructure that could host cloud gaming platform
Cloud infrastructure	Azure Microsoft hosts the cloud gaming service in its cloud
Cloud gaming platform	XBOX Cloud gaming platform for mobile containing catalogue of games
Games publishers	XBOX UBISOFT Studios that publish games – often also have their own gaming developers

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Telco role

Note: Microsoft's Project xCloud is still in beta phase

Cloud gaming

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Reducing latency for cloud gaming by rendering high-end games (e.g. AAA titles) from an edge (rather than cloud) and/or optimising multi-player gaming by pairing nearby gamers and processing their game from an edge.

Transition to edge

Cloud gaming is being introduced to offset the need to render hardcore (triple AAA type) games on the end-device and more easily support multi-player gaming. Over time, the network edge will be used to reduce latency (and ping time) caused by processing gaming in the cloud and improve the gamer's experience. An on-prem edge is not appropriate as it is unable to target a large enough population of gamers.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	29%	0%	1%	70%
2030	20%	0%	40%	40%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

Condition-based monitoring

LOCATION CAPABILITY A-Z

How it works

- Manufacturers are moving towards providing services rather than selling one-off products
- Real-time data analysis of assets detects faults so maintenance can be carried out before failure occurs
- Edge computing used to collect data, label and manage the data and send it to the right user, which may be the OEM, the customer or the maintenance company
- Alerts can be sent to the end-enterprise customer and the OEM to notify when a maintenance service is required

Why edge?

- An edge compute is added to the asset so the OEM can monitor the asset's conditions, but not add processing to the end-device itself
- Edge allows the processing to occur regardless of where the end-customer is and whether the asset moves
- Using an edge helps to remove the pain of collecting data from many disparate systems /machines

Potential ecosystem partners

- **Device manufacturers** – companies are moving towards servitisation
- **Systems integrators** to integrate outcomes of analytics into wider enterprise systems
- **Cloud providers** - solutions will move to IoT, therefore connecting to the cloud will becoming increasingly important, as insights need to be shared across multiple parties

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

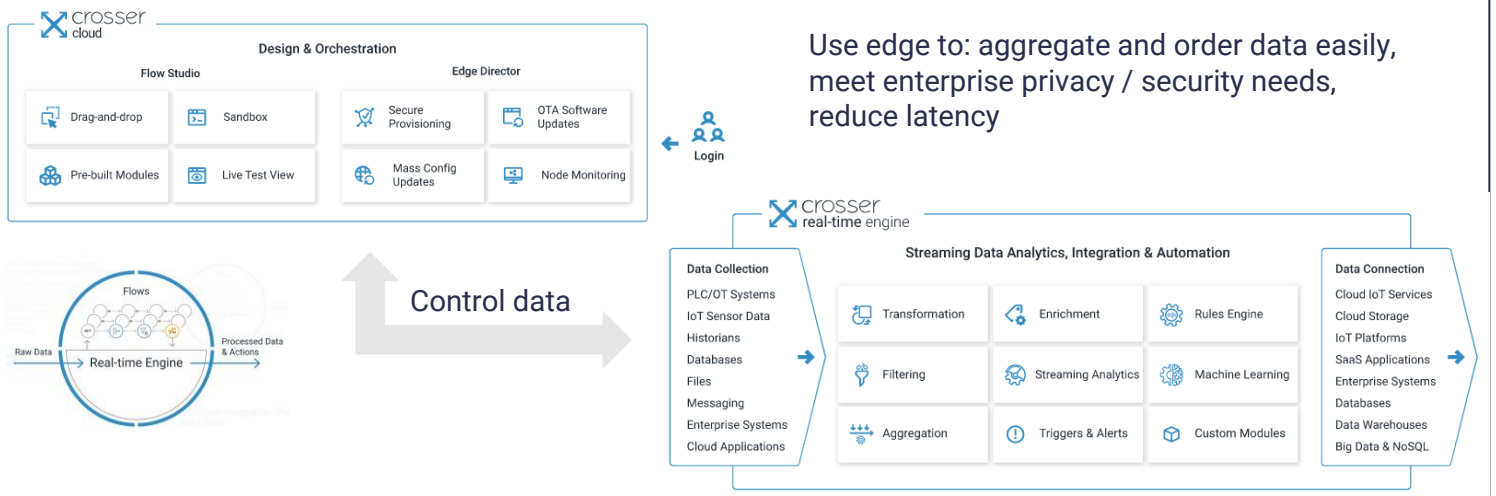
Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Case study: Crosser

How it works



Use edge to: aggregate and order data easily, meet enterprise privacy / security needs, reduce latency

Example of this use case by others

Litmus Automation:
LoopEdge platform provides real-time insights for industrial customers

Foghorn Systems:
IoT edge platform for multiple industries

Key partners in this scenario

- **Edge hardware** → SIEMENS: E.g. Siemens PLC, but can use others' PLC and other hardware (even on-prem data centre)
- **Analytics platform** → crosser: Software platform to run analytics at the edge
- **Cloud** → Azure IoT Hub: Connect to Azure IoT Hub in the cloud (or to the Crosser cloud)
- **Enterprise applications** → SAP: Output can be fed directly into enterprise application / system, e.g. SAP ERP

Edge maturity

Scaled commercial solution	**Commercial solution**	POC / trial leveraging edge	Does not currently use edge

Connected ambulance

LOCATION CAPABILITY A-Z

How it works

- In current emergency services systems, paramedics are typically only able to brief emergency doctors once the ambulance transporting the patient has arrived at the hospital
- Edge computing (alongside 5G) can enable faster and more accurate diagnosis and treatment by paramedics on-site as well as more granular information at the hospital on the status and location of incoming patients.
- This can primarily be achieved through:
    - Live video streaming of a patient to the hospital (enabled through 5G)
    - Analysis of patient information (such as blood pressure) at the edge for real-time diagnosis and recommendations
    - Augmented reality glasses (rendered at the edge) to display information about patient history and complex treatment protocols

Why edge?

- Data localisation and sovereignty – lower risk for patient data
- Low latency – real-time analysis of patient vitals and symptoms triggering specific information to be overlaid on smart glasses
- Increased efficiency– connecting emergency doctors with the paramedics before they reach the hospital enables an efficient pre screening process, informing on-site teams of priority cases and allowing them to better prepare for the patients arrival

Potential ecosystem partners

- **Specialised healthcare IT consultants and SIs** to enable integration of solution into existing systems e.g. electronic medical records systems
- **Hardware providers** (e.g. smart glasses) who will need to provide lightweight SIM-enabled devices
- **Augmented reality application developers**
- **Data analytics platform provider** for analysis of patient information and also the correct security, storage and removal of the data afterwards

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Connected ambulance

Case study: Vodafone Italy

LOCATION CAPABILITY A-Z

How it works

Symptoms and vital signs of patient sent to edge node

Video stream from paramedic direct to hospital doctor

Information on treatment for overlay on smart glasses sent from edge node to paramedic

Real-time analysis of symptoms and storage of patient medical history

Patient's medical history sent to edge node for temporary storage

N.B. Information on the PoC is limited – this is our interpretation based on publicly available documents

Example of this use case by others

BT:
Connected ambulance trial – also includes use of haptics for remotely guided procedures

Key partners in this scenario

Connectivity provider	Vodafone Italy are providing the MEC site and 5G connection
Infrastructure provider	Nokia are involved presumably to provide the 5G network infrastructure
Hardware provider	Qualcomm are involved presumably to provide 5G hardware
Healthcare research specialist	I.R.C.C.S are involved presumably to provide healthcare expertise

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Connected car driver assistance

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

- Connected car driver assistance aims to increase road safety by providing information and warnings to road users
- Vehicles communicate with each other and roadside infrastructure using 5G
- 5G enables more comprehensive vehicle sensor information (e.g. video stream) which can be analysed at local edge node
- Roadside analytics taking place on edge compute enable more intelligent V2X (vehicle to anything) communication which can reduce risk of accidents

Why edge?

- Low latency – data must be processed in real-time in order to effectively issue warnings and recommendations. Edge enables real-time analytics as data is processed locally
- Reduced backhaul and data localisation – high volumes of data generated from video put strain on network. Analytics at edge eliminates need to send to more centralised data centre and reduces strain on network
- Flexibility – different sources of data must be pooled as the car moves (e.g. pedestrians, traffic, other vehicles). Edge can pool and process data in real-time
- Light device – analytics at the edge means that vehicles do not need to be equipped with compute intensive hardware

Potential ecosystem partners

- **Automotive manufacturers** want to install the latest V2X modules on vehicles to enable new capabilities
- **Public transport** want to improve safety for road users by ensuring vehicles can respond in real-time to dangers
- **Local council** want to communicate repairs being made to roadworks and infrastructure and speed limits
- **ISVs** are building the software and applications to enable connected car solutions

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Connected car driver assistance

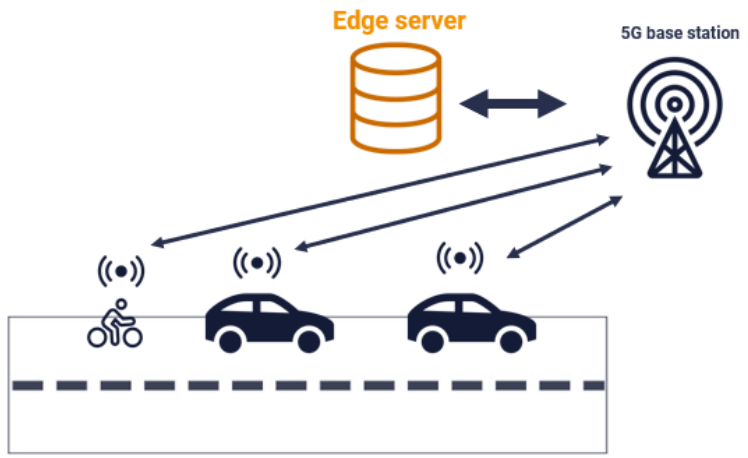
Case study: Continental

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works



1. Data collected from sensors on vehicles and road-users (pedestrians or cyclists) are sent via 5G to a local cell tower and then to a road-side edge server
2. Edge sites located close to the video feeds enable low-latency services
3. Data from sensors is processed and analysed with AI on the edge platform
4. AI software detects potential hazards and sends back warning signal via 5G to road-users
5. Road-users are notified about hazards and respond accordingly, thereby improving road-safety

Key partners in this scenario

5G connectivity	vodafone: Enables break out at the access network and deployment at the network edge
Edge infrastructure	vodafone: X86 platform for compute and networking at edge locations
MEC software platform	Saguna: Edge software platform that hosts AI analytics
AI application	Continental: AI application analysing sensor data
End-customer	Automotive manufacturers *Case study in PoC stage*

Other examples of connected car driver assistance (not using edge)

Telstra

Telstra partnered with VicRoads and Lexus to provide drivers with more awareness of potential risks via low-latency cellular. Trial used 4G network, but plans to utilise 5G following deployments.

Ericsson | **Scania**

Next generation transport use cases being researched including **driver assistance use cases**. Initial focus will be on public transport – e.g. ensuring buses and trucks with human drivers receive environmental information.

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Connected car driver assistance

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

Connected car driver assistance aims to increase road safety by providing information and warnings to road users. 5G enables more comprehensive vehicle sensor information (e.g. video stream) which can be analysed at local edge node. Roadside analytics taking place on edge compute enable more intelligent V2X (vehicle to anything) communication which can reduce risk of accidents

Transition to edge

As connected cars and their in-built systems become more sophisticated and the volume of transactions increasing, data processing will increasingly be done at the on-premise edge. Low latency will be key in providing quick information and alerts to drivers (or completely autonomous vehicles), therefore ensuring safety at all times on the road and keeping people safe. Minimising number of hops in the network will be key to rapid and safe outcomes on the road.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	10%	0%	0%	90%
2030	10%	0%	50%	40%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Contextual DOOH advertising

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

- In order to make digital-out-of-home (DOOH) advertising more relevant to the consumers walking in front of the signage, real-time analytics on the individuals needs to be captured and processed quickly to deliver a contextual advert. Contextual advertising is more lucrative to the publisher than untargeted advertising.
- By pushing this out to an edge, either on-site (e.g. in a mall) or on the network, personal data can be processed locally and generate real time, relevant advertising on DOOH screens.
- Also, there has been a turn in the advertising market against aggregation of personal data at the cloud that is liable to security/privacy breaches and big public backlash.

Why edge?

- The analytics required to push a contextual advert could be processed on the device itself (as Permutive does for mobile contextual advertising), however this results in more expensive screens and makes it more difficult to scale/change the platform/application
- In some cases, there may be a regulatory issue with processing consumer-related data in a remote cloud

Potential ecosystem partners

- **Advertising exchange platform providers**
- **Data management platforms** that provide the algorithms to help buy and sell side determine which adverts to display to whom
- **Publishers/out of home advertising devices** that have real estate used for advertising (could be digital or physical)

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

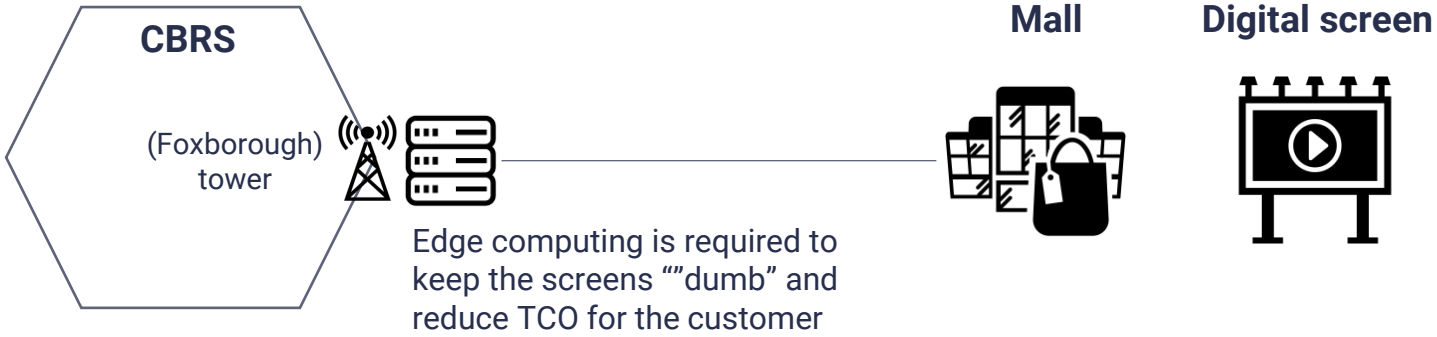
Contextual DOOH advertising

Case study: AlefEdge

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works



Edge computing is required to keep the screens ""dumb" and reduce TCO for the customer

Example of this use case by others

JCDecaux:
In 2017, launched contextual advertising display boards at Changi Airport (Singapore), displaying weather information of passengers' destination city [used cloud, not edge]. In 2013, personalised Coca Cola greeting on OOH billboards in Tel Aviv (Israel)

Stratacache:
Working with MobiledgeX to leverage edge computing for DOOH solutions

Misapplied Sciences:
Working with Delta Airlines to give airport travellers tailored messages

Key partners in this scenario

Edge compute	packet — Provide bare metal servers
CBRS network	federated wireless — Network provider (uses shared spectrum in the US – CBRS)
MEC platform	alef — Edge IaaS platform for managing resources, hosting edge workloads / application
Connected screens application	alef — Contextual DOOH ad application that uses video analytics to determine the advert to push

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Contextual DOOH advertising

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Contextual advertising is more lucrative to the publisher than untargeted advertising. By pushing data processing to the edge, either on-site (e.g. in a mall) or remote, personal data can be processed locally and generate real time, relevant advertising. Processing at the edge, rather than in an aggregated data centre, ensures sensitive personal data is kept more private, reducing attack surface.

Transition to edge

On-premise edge and network edge will become much more important for contextual advertising by 2030, moving the bulk of processing away from the device. This movement of processing is so that devices in the same vicinity can share a common data source and react accordingly based on the movement of consumers. The amount of data processed will also increase hugely, with the increase in connected devices (smart watches, mobile phones).

		Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	*Smaller outlets*	90%	0%	0%	10%
	Larger outlets	70%	20%	0%	10%
2030	*Smaller outlets*	15%	0%	65%	20%
	Larger outlets	10%	69%	1%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing

11-30% of total processing

31-50% of total processing

51-75% of total processing

76-100% of total processing

Edge use cases

Drone detection

LOCATION CAPABILITY A-Z

How it works

- The use of commercial drones is increasing and, although large enough to cause disruption/security concerns, these drones are too small to detect through traditional radar technologies
- Edge compute processing of high-definition video or radio frequency information is used to detect whether a drone has entered a geo-fenced zone and trigger necessary alarms / actions as defined by the security teams managing site security
- Edge is essential to meet the latency requirements, process high-definition video, and maintain privacy/security for sensitive sites
- Examples of enterprises / types of sites which would demand are those which may deem drones as a safety or security threat including: airports, prisons, hospitals, etc.

Why edge?

- In the event of a drone being detected, certain actions and alarms would need to be triggered immediately, therefore it makes sense to keep the processing closer to the location of detection
- Some customers, such as the government, would prefer to keep the data on-site, or at least within their jurisdiction

Potential ecosystem partners

- **Security companies** (e.g. G4S) can detect and respond quickly to threats from trespassing drones, rather than relying on manual processes
- **Systems integrators** would be necessary to help integrate data from drone detection with site security systems
- **Drone device manufacturers** could engage with new industries e.g. surveillance and emergency services
- **Application providers** can bring software capabilities to develop new use cases around drone detection

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

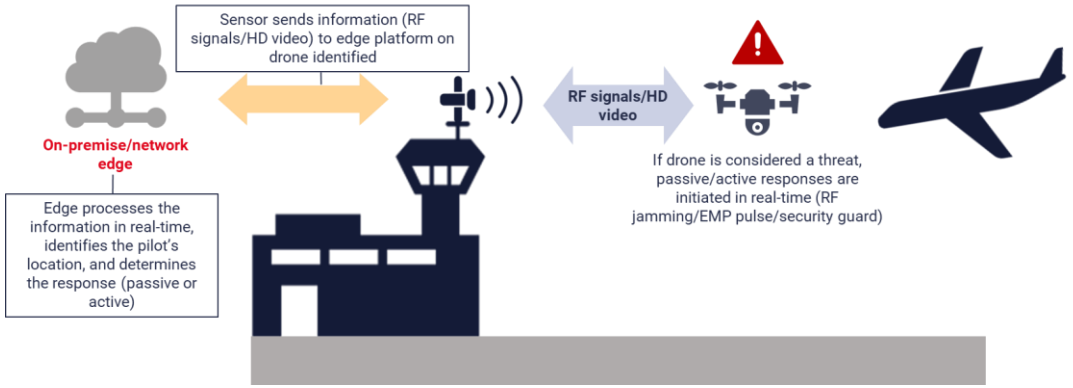
Drone detection

Case study: Drone Seeker

LOCATION CAPABILITY A-Z

How it works

- HD video/RF signals from Drone detection sensors is analysed by Drone seeker at the edge
- Hosting analysis at the edge enables low-latency actions/alerts e.g. security guard notification, EMP pulses, active jamming
- Edge could be on premise for data security/privacy or at the network edge



Example of this use case by others

Aeroscope: Have both a temporary and permanent solution – currently runs on proprietary hardware but could move to the edge in the future

Dedrone: Are working with Vodafone UK and AWS to test how their drone detection software could leverage the network edge

Key partners in this scenario

End devices

Application

Connectivity

(Edge) cloud services

Drone Seeker

DroneSeeker provide the drone detection sensors (RF + video) and the mitigation measure (jammers)

Drone Seeker

Drone seeker provide the software platform and application – allows edge analytics and identification of drone

Telco could provide hosting on their cloud platform, as well as the connectivity to allow sensors, the drone, and the applications to reliably communicate

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Drone inspection

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

- Large sites can be monitored and changes to the landscape or site can be analysed using drones.
- This is often done by the drones capturing high quality images or video footage. These images can then be analysed to ascertain if the environment / site has changed e.g. if arable land has become too dry.
- Using drones saves time and can lead to more accurate insights than with manual inspection.

Why edge?

- Today, images and videos captured by drones are uploaded to a cloud-based analysis programme via a high-end laptop.
- This is an expensive and time-consuming process, especially for high quality video and images; any time-sensitive insights are not collected.
- In the future, we expect more of this analysis to happen at the network edge or at on-premise edge servers where they exist.

Potential ecosystem partners

- **Edge hardware** needs to be ruggedized as likely in harsh, outdoor environments
- **ISVs/ application providers**, e.g. DroneDeploy and Pix4D provide the integrated software for the drone to collect and transform data in real-time
- **Cloud providers** –longer term trend analysis and aggregation will likely happen in the centralized cloud

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

AIRMAP

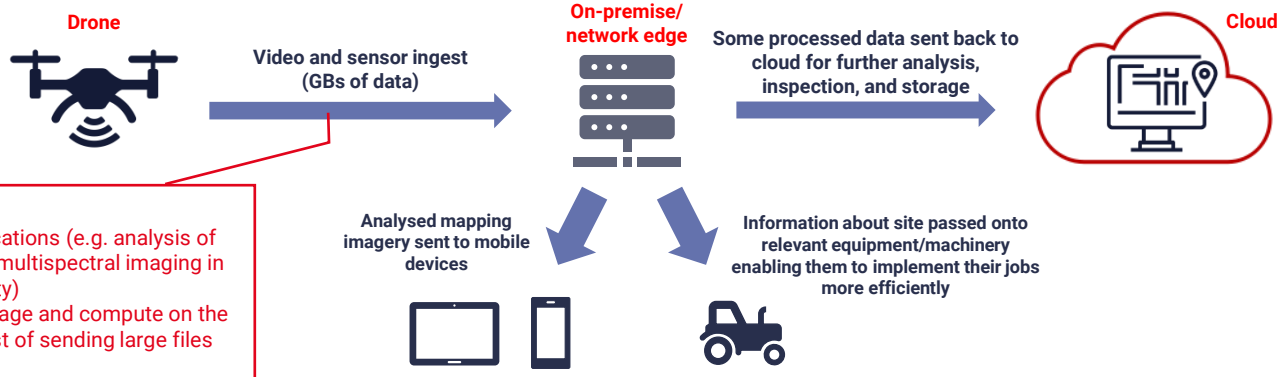
Drone inspection

Case study: Airmap

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works



Edge is used for:

- low latency applications (e.g. analysis of thermal imaging/multispectral imaging in real-time for safety)
- Reducing the storage and compute on the drone and the cost of sending large files to the cloud

Example of this use case by others

DroneDeploy

PIX4D

droneflight
reach for the sky

DroneDeploy: drone fleet management which provides site documentation and analysis

Pix4D: software for mobile and drone mapping

Droneflight: Full solution providers including drone software, training and servicing

Key partners in this scenario

Drone	DJI	Hardware partners like DJI provide the drones for Hangar
Application	AIRMAP / PIX4D	Partnerships : Pix4D (site mapping), Airmap (autonomous flight planning)
Application platform	AIRMAP	Hangar deliver the use case as a deployable platform with a service wrap
Edge capabilities	Vapor	Vapor's "kinetic edge" offering– building distributed edge system
Cloud capabilities	aws / Google Cloud	Partnerships with AWS and google cloud for cloud infrastructure

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Drone inspection

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

Large sites can be monitored and changes to the landscape or site can be analysed using drones. In general, this is done by the drones capturing high quality images or video footage. Doing this saves time and can lead to more accurate insights than with manual inspection.

Transition to edge

Today, images and videos captured by drones are uploaded to a cloud-based analysis programme via a high-end laptop. This is an expensive and time-consuming process, especially for high quality video and images; any time-sensitive insights are not collected. In the future, we expect more of this analysis to happen at the network edge or at on-premise edge servers where they exist.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	10%	0%	0%	90%
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51-75% of total processing
76-100% of total processing

Drone navigation

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- In a future where drones can navigate autonomously, there will be a need for them to communicate their location and be aware of the environment around them to avoid collisions and problems
- In order for drones to be able to be used at scale, across broad geographies, this autonomous navigation will be necessary
- Drones can be used to deliver packages for logistics, assess the situation in emergencies, monitor critical infrastructure, etc.
- Edge computing would be used to collect and share precise data on the drones' locations in real-time to enable autonomous navigation

Why edge?

- Some processing can happen on the drone, but this would require a super computer, e.g. DJI Manifold 2
- For autonomous system navigation to be trusted, a low-latency reliable solution with sophisticated algorithms to provide centimetre or millimetre level positioning accuracy is required (20-50ms roundtrip latency)

Potential ecosystem partners

- **Private network provider** – stringent low latency requirements mean the applications need to be tightly coupled with network
- **Edge hardware** needs to be ruggedized as likely in harsh, outdoor environments
- **ISVs** e.g. DroneDeploy and Pix4D provide the integrated software for the drone to collect/transform data in real-time
- **Cloud providers** –longer term trend analysis and aggregation will likely happen in the centralized cloud

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

PARTNERS

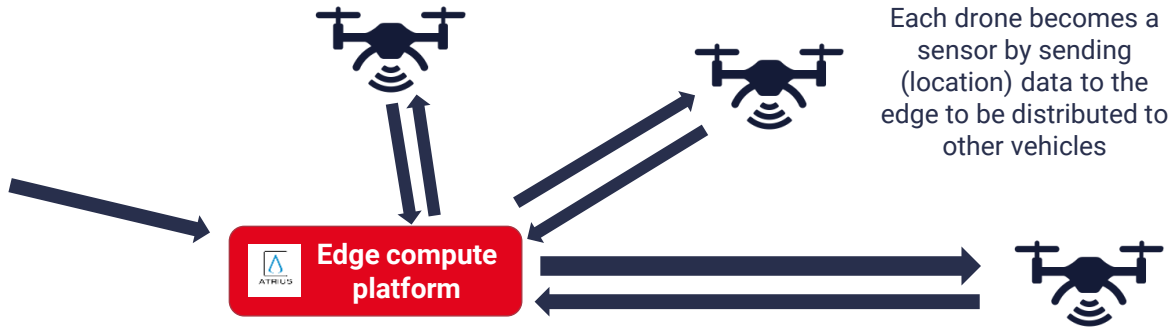
*AEC: Architecture, engineering and construction

Drone navigation

Case study: Atrius

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

How it works



Example of this use case by others

AirMap:
Currently working with Azure (IoT) but enthusiastic about edge

Enel Green Power North America:
Partnering with AI developer Raptor Maps to deploy drones for real-time inspection of solar panels

Dataiku and UAVIA have partnered to develop an autonomous AI learning system for drone navigation

Key partners in this scenario

Network operators	Need to provide a suitable network for drones: robust, low latency network
Edge compute hardware	Specialised hardware to run applications for autonomous drones
Microweather services	Additional services for autonomous drones e.g. microweather

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Edge ADN & web content optimisation

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Application delivery networks (ADN) seek to optimise how web content and apps work – through performance, scalability and security
- This is evolving, for example, application and web page content is increasingly personalised and dynamic - caching static content at the (CDN / internet exchange) edge is not sufficient
- New ADN workloads need lower latency and high processing, e.g. dynamic content delivery (depending on user location, cookies, other sites' data, etc.), image optimisation, bot mitigation, language translation on the fly, and eCommerce rendering
- Edge computing helps to distribute workloads and conduct these website optimisation tasks closer to the end-user

Why edge?

- At times of peak capacity (e.g. event in one area), demand for application optimisation peaks too, therefore these services need to be moved to an edge to maintain performance and latency
- As web content becomes more dynamic, latency becomes more critical
- Web analysis can be data-rich (e.g. creating real-time heat maps of website traffic) – more effective to process this at the edge
- Flexibility of edge cloud allows developers to only pay for what they use (useful for time-constraint use e.g. only in peak times)

Potential ecosystem partners

- **Website analytics / SEO service providers** that may use web optimisation services (even something like Google click tracking)
- **Edge facilities providers**, e.g. telecoms operators
- **Standard APIs and protocols** to make it easy to access edge computing resources
- **Edge compute/ADN platform providers**

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Edge ADN & web content optimization

Case study: Section

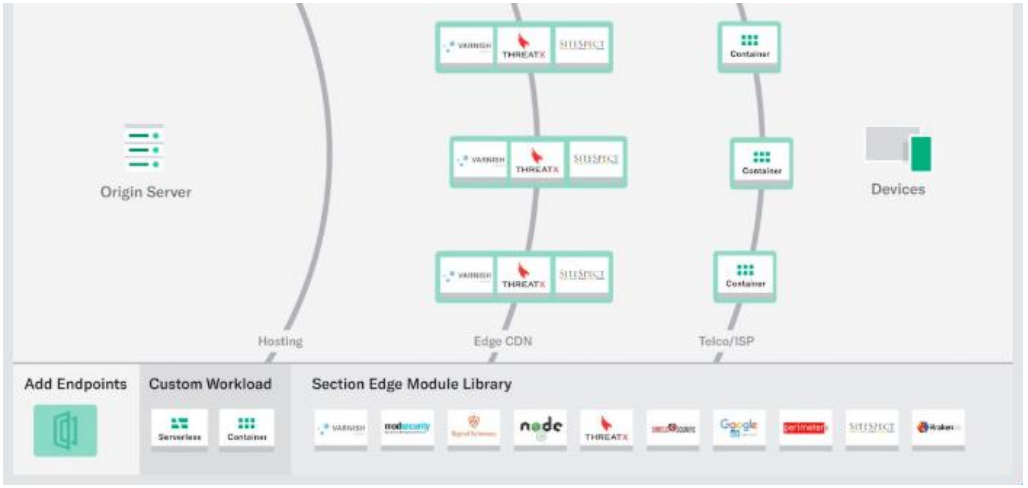
EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

Section's (software-only) edge compute platform allows developers to place any (content / web optimisation) workload / module anywhere along the edge spectrum

Today, most deployments are at the "Edge CDN" layer (e.g. internet exchange) but they are testing network edge with telecoms operators and companies like Vapor IO



Example of this use case by others

CenturyLink: Signal Sciences' web application firewall (WAF) will be delivered via CenturyLink's CDN Edge Compute product (uses Section.io technology)

StackPath: Edge computing software is being delivered via Broadcom's Stingray SmartNIC for security and app-performance optimisation

Akamai: ADN (does not use network edge today – internet exchange is closest point)

Key partners in this scenario

- Edge facility / bare metal → Section sometimes uses bare metal servers from Packet or RackCorp (for example)
- Cloud IaaS → Section also runs on cloud provider infrastructure
- Web optimisation (& CDN) platform → Section: Edge compute platform for managing workloads
- Software modules → Companies like Kraken and Varnish Cache provide modules, e.g. image optimisation, web app acceleration

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Edge ADN & web content optimisation

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

Application delivery network and services optimise the way in which web applications and websites work, by reducing latency (e.g. page load times) and improving security. Edge computing is used in regional data centres today, but can use the network edge to be able to further optimise apps/websites, as the data required to do so increases (e.g. translations on the fly, creating heat maps based on website visitors' actions, etc.) and mobile usage increases.

Transition to edge

Today, most ADN is done at traditional CDN points of presence, which are usually in regional data centres / at internet exchanges. Applications that need network edge computing (in mobile or fixed networks) will need to distribute a significant amount of processing to those locations, albeit temporarily (e.g. when the network is particularly congested, or if some website content needs to be cached for a small amount of time).

	Device/traditional on-prem	On-prem edge	Network edge	Cloud (including regional data centres)
Today	10%	0%	0%	90%
2030	10%	0%	50%	40%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Edge CDN

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- 4G was a key driver for video streaming on demand, removing long buffering times and allowing consumers to ingest content on the go
- Now, consumers expecEdge t seamless streaming of high-quality online content to their mobiles/laptops/smart TV's/consoles etc. and this is reliant on their network connection speeds and therefore their proximity to where the content is stored
- CDNs increase streaming speeds by caching content locally to the user, however CDNs need to be built and scaled as demand dictates
- Operators can allow 3rd party CDN functions to be run on the network edge instead of within their own locations/infrastructures

Why edge?

- Edge CDN allows for a better customer experience, as the CDN is located deep in the network, resulting in lower latency
- Offloading traffic to the edge means fewer requests are routed to the central cloud – frees up bandwidth and reduces risk of overloading servers
- Running functions as a vCDN removes the need to deploy individual customer owned sites, which can be expensive and difficult to scale as more customers require their use, enhancing flexibility
- Consumers can access fast streaming of content from any location connected to the network

Potential ecosystem partners

- **Content providers** can offer quality streaming by caching content at the network edge
- **CDN providers** (e.g. Qwilt) can run workloads on different hardware located at the network edge
- **COTS hardware** (e.g. Dell) located in PoPs at the network edge, closer to end users
- **Operators** can provide PoPs for (v)CDN providers or partnered solution providers

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Edge CDN

Case study: Qwilt

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION | CAPABILITY | A-Z

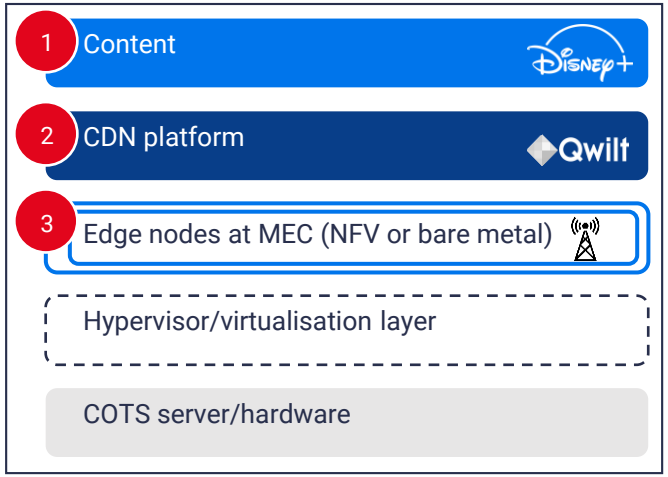
How it works

Single API to access global open caching network: Qwilt provides a software platform that can run a CDN workload (virtual) with different deployment models

Edge vCDN enables content publishers to offer high quality and reliable video streaming to end users:

✓ Low latency and higher QoS

✓ Flexibility and scalability



SP-owned and -operated MEC facility

Example of this use case by others

CenturyLink: CDN edge compute

CDNetworks: CDN360, access control at the edge

StackPath: Edge computing software to enhance video streaming

IQIYI: Leveraging China Telecom's MEC nodes to create a CDN for VR content

Key partners in this scenario

- Edge facility — Operators could provide space for (v)CDN solution providers/ content providers with their own CDN
- Server/hardware — Shared, multi-purpose servers/ hardware (COTS) close to end users
- Application provider — Virtualised software platform can run CDN workloads on different hardware to scale for demand
- Content provider — Can provide high-quality streaming with more PoPs/flexibility than traditional CDN

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Edge CDN

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

CDN optimises the delivery of media applications and services, e.g. video streaming platforms. Historically, this has been done by caching content at a regional node. Network edge is beneficial to be able to further optimise media delivery, by caching content even deeper in the network/closer to the end-user, but also improving real-time video processing (e.g. for live streams) and running these functions at the edge too.

Transition to edge

Today, most CDN is done at traditional CDN points of presence, which are usually in regional data centres / at internet exchanges. Applications that need network edge computing (in mobile or fixed networks) will need to distribute a significant amount of processing to those locations, albeit temporarily (e.g. when the network is particularly congested, or if some video platform content needs to be cached for a small amount of time).

	Device/traditional on-prem	On-prem edge	Network edge	Cloud (including regional data centres)
Today	10%	0%	0%	90%
2030	10%	0%	50%	40%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Electronic health data

LOCATION CAPABILITY A-Z

How it works

- The amount of patient generated health data is increasing, in part due to data generated by new monitoring devices and documentation required for each patient
- Hospitals therefore hold a host of unstandardized, but sensitive, data which poses a challenge for secure storage
- Different stakeholders (doctors, pharmacists, GPs, etc.) need access to this data but, today, this is a manual and cumbersome process
- Patient data could be uploaded to the cloud for storage and sharing but privacy concerns and patient data protection rule this out
- Edge computing makes data sharing easier, processing data on-premise or at a network edge, to abide by data protection rules

Why edge?

- Edge systems are inherently distributed and can enable a collaborative platform to share data and manage access across stakeholders
- Data stays local to ensure compliance with hospital and (local) government rules on patient data
- Reduces the need to process data in the central cloud / application

Potential ecosystem partners

- **Edge facilities and/or hardware provider**
- **Solutions providers and systems integrators** to ensure the edge computing platform works with other (legacy) healthcare systems
- **Platform/application providers**
- **Healthcare providers** and other stakeholders who will want access to the data

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

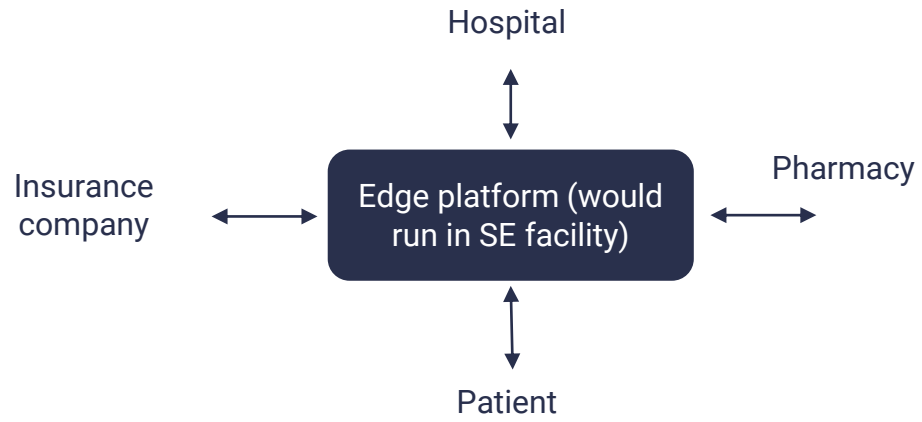
Electronic health data

Case study: Schneider Electric

LOCATION CAPABILITY A-Z

How it works

Data can appear on different devices through a user interface, but all data is stored at the edge, not on user devices.



Note: This diagram is not from Schneider Electric (SE), but reflects our understanding of how EHR data could be stored at the edge to enable multiple parties access to synthesised and secured patient information.

Example of this use case by others

Apple Health Records: allows patients to access records in one place (not edge)

Key partners in this scenario

Edge facilities provider	Small, localized data centres (1 to 10 racks) will store and process electronic health record data
Management services	Enables platform integration with data centre software management capabilities
EMR platform/ application provider	Interface for end-users to verify their information and gain access to EHR

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Environmental condition monitoring

LOCATION CAPABILITY A-Z

How it works

- Remote assets are often difficult and time-consuming to monitor, given they may span across a vast area but failures can be disastrous (e.g. oil pipeline explosions, water pipeline leakages)
- By having a mechanism to monitor and analyse conditions on the asset (e.g. temperature, pressure, vibration etc.), owners of the assets can ensure that the asset is fixed before failure.
- Bringing compute and processing power to the asset itself can help run analyses on data collected from the assets to detect anomalies or unexpected behavioural patterns.
- With more proactive monitoring, companies can reduce risk to operations, people and reputation.

Why edge?

- With potential significant risks on critical systems and safety of those in near proximity, alarms would need to be triggered immediately, therefore it makes sense to keep the processing closer to the location of detection, that doesn't rely on the quality of the network connection.
- Most raw data collected isn't that useful if it indicates normal behaviour, therefore does not need to be sent to the cloud.

Potential ecosystem partners

- **Hardware providers** to provide ruggardised products, equipped to handle harsh conditions and environments.
- **Analytics platform providers** who can provide the capabilities to make sense of the data.
- **Systems integrators** to integrate data and insights to other systems within the organisation.

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Environmental condition monitoring

Case study: Stratus Technologies

LOCATION CAPABILITY A-Z

How it works

System used to gather and analyse data in real-time from sensors deployed that monitor pipeline components, and can detect when problems or abnormal behaviour happens.

In that case, the technology can identify the cause immediately and take action to mitigate the risk or damage (eliminating need for someone to come out and investigate problem), or alert a technician if required.

Action is trigged when anomalies are detected, and alerting notifies customer and/or Stratus when intervention is required

Example of this use case by others

Crosser offers real-time streaming analytics, e.g. for remote water pollution measurement

Foghorn provides real-time analytics on streaming data in real-time on pipelines

ADLINK provides ruggedized products and platforms, equipped to deal with harsh conditions

Key partners in this scenario

- Hardware provider
- Platform provider
- Systems integrator
- Enterprise customer

Stratus

Stratus provides the hardware, OS and software platform – each ftServer system has its own processors, memory and storage to keep applications and data services running at all times.

HTE

The role of the SI is to help integrate the data and insights to wider systems within the customer

Jinhua Duohu Central Business District Construction Investment

Customers benefit from better reliability, control and visibility, as well as reduced risk

Edge maturity

Scaled commercial solution	**Commercial solution**	POC / trial leveraging edge	Does not currently use edge

Environmental hazard detection

LOCATION CAPABILITY A-Z

How it works

- Climate change is driving high temperatures, droughts and extreme hazard conditions across the world such as hurricanes and earthquakes
- Early detection and alerting are key to minimising the impact of hazards with wildfires, help responders to fight the fire more effectively and with lower costs and less risk to life
- In remote areas there is often limited connectivity, causing further delays in communication which is critical in saving lives - fires can spread up to 200 meters per minute with the right conditions
- Edge solutions use data from sensors/cameras located near the hazard which is then processed and analyzed in real time at the edge of the network, near the source of data
- This allows for quicker analysis and faster response times which is critical in these solutions

Why edge?

- Enables low latency required for real time detection of hazards
- There is no need to transport all the high-volume data (e.g. from video cameras) to central cloud making it possible to deploy applications and processes closer
- Increased reliability as reduced risk that the edge application will be affected if there is a wide area network outage
- Leveraging network edge means that high performing applications can be deployed quickly and without dedicated infrastructure

Potential ecosystem partners

- **Smart camera and sensor OEMs** – equipment needed for detection and monitoring of hazards
- **Data analytics platforms** – platform for data aggregation and visualization for real time analysis
- **Systems integrators** - analytics software at the edge will require all end cameras/sensors for analytics to be integrated with existing solutions

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Environmental Hazard Detection

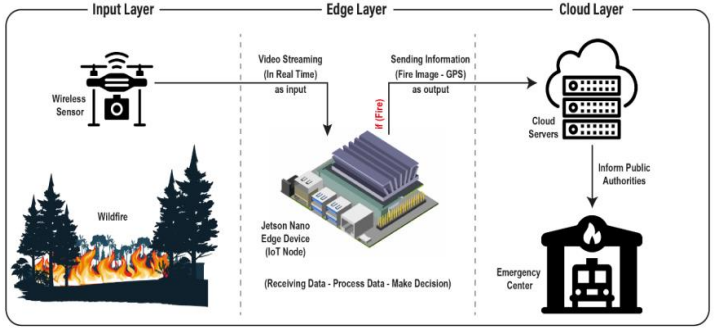
Case study: Ericsson SmartForest

LOCATION CAPABILITY A-Z

How it works

Ericsson SmartForest allows for the running of machine learning applications on edge devices such as sensors and cameras for real time detection to stop forest fires and prevent major destruction:

- Cameras and weather sensors (temperature etc.) detect real time environmental changes
- The SmartForest software platform runs AI applications with machine learning that processes the data on the device itself
- When a fire is detected, feedback is immediately communicated to a centralised location and the emergency services are alerted
- Edge device can either operate on existing mobile networks or radio coverage can be extended through a network mesh extension



Example of this use case by others

Moraga-Orinda Fire district in California have launched a wildfire early detection IoT solution with several partners

Minsait have launched their Onesait Phygital Edge platform that uses electrical towers/power lines as watchtowers for fire detection

Vantiq have launched a solution for real time detection of hazards such as earthquakes and hurricanes with sensors

Key partners in this scenario

Smart sensors and cameras	Sensors/ smart cameras to detect hazards and wildfires
Connectivity provider	ERICSSON — Ericsson to provide existing mobile networks or radio coverage extended through a network mesh extension
Software provider	ERICSSON — Ericsson developed SmartForest software with machine learning applications

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Fleet management: IoT data ingest and analytics

LOCATION CAPABILITY A-Z

How it works

- Edge compute can be used to analyse sensor data, e.g. the vehicle's mechanical information and driver behaviour
- This data could be leveraged for predictive maintenance and route optimisation, but also to enable immediate action, preventing the problem from escalating (such as monitoring driver fatigue levels or sudden equipment malfunctions)
- The analytics can be hosted on a device edge in the vehicle itself (this may be a proprietary appliance) allowing real-time analytics and actioning
- Such analytics could cut costs and resource expenditure through more efficient fleet management and breakdown avoidance. Furthermore, driver safety could be improved, by monitoring their behaviour and letting them know if they show signs of fatigue

Why edge?

- Edge compute means there is no need to transport all the high volume data to central cloud, reducing backhaul and the cost of bandwidth, as relevant information is sent
- Edge compute meets latency requirements for real time actioning
- Edge infrastructure can easily and quickly accommodate increases in workloads/data volumes
- The technology is mobile, as it works across multiple edge sites, allowing widescale coverage

Potential ecosystem partners

- **ISVs/IoT platform providers** who create the analytics software
- **Original equipment manufacturers**, particularly in the automotive sector
- **Cloud providers** e.g. hyperscalers to enable use of the cloud to run the analysis

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Fleet management: IoT data ingest and analytics

Case study: Samsara

LOCATION CAPABILITY A-Z

How it works

Sensors track the vehicle's mechanical information and driver behaviour.

The edge analytics could be hosted on a device edge in the vehicle itself (this may be a proprietary appliance) allowing real-time analytics and actioning, such as sending notifications to the driver in the event of a mechanical fault or the detection of driver fatigue.

Edge can also be used for predictive maintenance, with AI/ML models tracking the vehicle's mechanical information collected by the sensors

Example of this use case by others

Verizon: currently cloud-based

Teletrac Navman: produce proprietary hardware that can be installed in fleet vehicles

Solution Analysts offers fleet management with Cloud backed IoT networking, installing sensors in the fleet

Key partners in this scenario

Sensors/Hardware	samsara: Sensors to monitor the vehicle's mechanical information as well as driver behaviour
Edge hardware/Cloud network	Azure IoT Hub: Cloud (e.g. connect to Azure IoT Hub in the cloud)
Analytics Provider	samsara: Platform that takes the data and analyses it. May use machine learning/AI

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Flow analysis: video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

- Increasing use of video technology by organisations to gain more "modal" insight into how customers, employees, users, and/or products move through their premises (e.g. how customers move through a retail store or how cars move through a car park/city).
- Analysis of these video feeds can provide the organisation with usable insights (e.g. where to stock high-value goods, where to re-direct traffic, or crowd tracking & management)
- To do so, the network of cameras generate vast quantities of footage which is both costly and time consuming to send back to and analyse in the core cloud
- Using edge computing, footage can instead be analysed and "neutralised" on the edge cloud located on the organisations' premises in a way that is compliant and privacy-safe

Why edge?

- Ideally, the solution should work on multiple different types of video/CCTV cameras and models
- There is no need to transport all the high-volume data to central cloud, reducing the cost of bandwidth
- The data is secure, as the extracted data is modal (not PII), which means the footage would not leave the premises

Potential ecosystem partners

- **Systems integrators:** edge cloud is useful is for its ability to utilise any end camera system for the analytics (as intelligence is on the edge), which requires integration with existing/legacy systems
- **Smart camera solutions vendors** to better understand the technology with which to integrate
- **Data analytics platforms** (e.g. City Cloud) who provide cloud management, secure servers, storage and global private networks.
- **Hyperscalers** could enable use of the cloud to run the analysis

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Flow analysis: video ingest and analytics

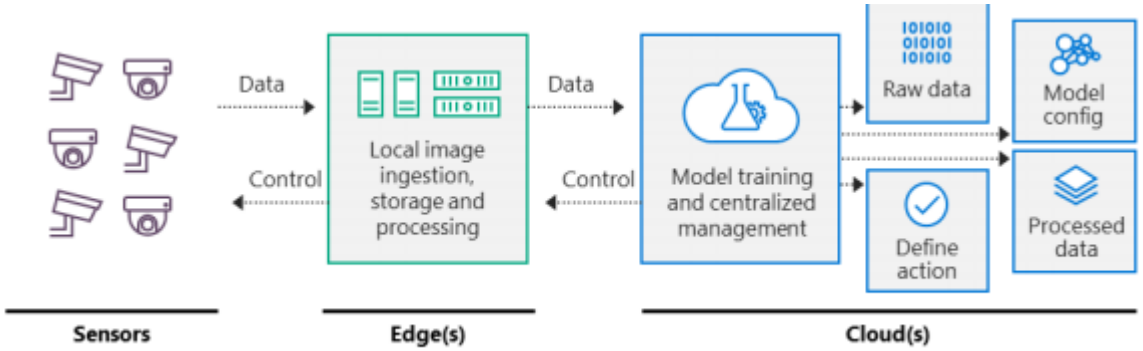
Case study: Hewlett Packard Enterprise

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

The use of edge computing means that there is no need to transfer all the high-volume data to the central cloud, which reduces the cost of bandwidth



Example of this use case by others

Microsoft

Microsoft offers live video analytics using both Azure cloud and edge computing

Informatica collects all forms of streaming data and processes it at the edge

Key partners in this scenario

Video Cameras	Any camera able to transmit data over for processing (e.g. Hitachi)
Edge Hardware	Hewlett Packard Enterprise Hardware (e.g. HPE Datacenter)
Datacentre/ Cloud	Azure IoT Hub Cloud (e.g. connect to Azure IoT Hub in the cloud
Analytics Platform	ACCUWARE E.g. Accuware's Sentinel platform. which provides video analytics using cameras

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

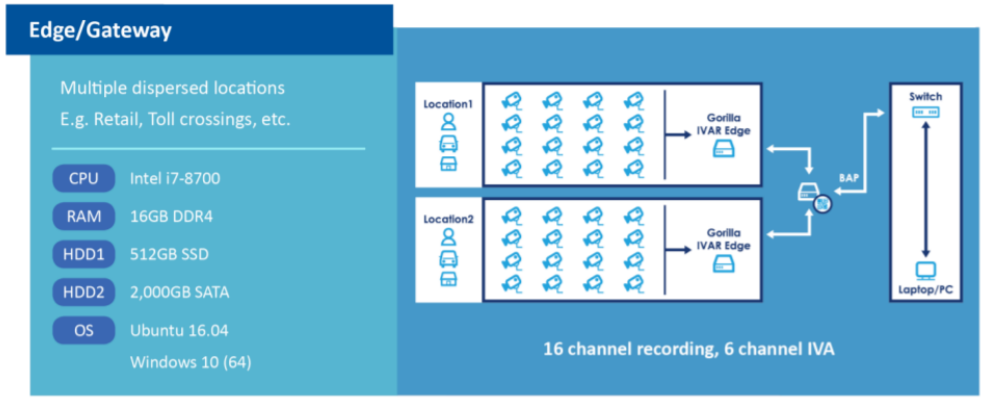
Case study: Gorilla Technology

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

The use of edge computing means that there is no need to transfer all the high volume data to the central cloud, which reduces the cost of bandwidth



Example of this use case by others

Microsoft

Microsoft offers live video analytics using both Azure cloud and edge computing

Informatica collects all forms of streaming data and processes it at the edge

Hewlett Packard Enterprise

HPE and Accuware offer a video analytics solution that can work with any camera

Key partners in this scenario

- Video Cameras — Any camera able to transmit data over for processing (e.g. Hitachi)
- Edge Hardware — Hardware (e.g. Intel Xeon Gold)
- Analytics Platform — Gorilla IVAR Edge AI (Intelligent Video Analytics Recorder)
- Telecoms Operator — Provides connectivity to the centralized cloud

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Flow analysis: video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Retail outlets and other public venues can use video footage to analyse customer behaviour and optimise the layout of a building. To do this, they need to aggregate and analyse information from many video streams. Doing this at the edge means raw footage can be filtered and key data points abstracted before being sent to the cloud, reducing backhaul costs and ensuring data security.

Transition to edge

Today, any analytics on video footage occurs on premium, AI-enabled video cameras. Over the next ten years, we would expect more of this compute to happen at the edge. For use cases where there is a large fixed premise, e.g. a stadium, the analysis is likely to run on on-premise edge servers. For use cases where there is no one fixed premise or where those premises are space-constrained, e.g. for smart city applications taking in feeds from numerous locations, the network edge is more likely to be leveraged (assumptions below show this scenario).

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	90%	0%	0%	10%
2030	15%	0%	65%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing

11-30% of total processing

31-50% of total processing

51-75% of total processing

76-100% of total processing

Gaming matchmaking and optimisation

LOCATION CAPABILITY A-Z

How it works

- Gamers are likely to turn off or switch games if the game is lagging, freezing or glitching
- They are also likely to turn off if they are playing multi-player and they are out of sync with the other player
- Therefore, some gaming companies are placing their own servers (or leveraging the infrastructure of others) to run their games closer to end users
- They are also using software located at the edge to help match users for multi-player play based on their location, ping and internet speeds
- This can help to improve the customer experience of the game and increase the amount of time spent playing

Why edge?

- One of the key reasons to leverage edge computing is to reduce the latency and ping experienced by gamers – this is achieved by placing the servers running game software closer to end users and through leveraging specialised optimization software for elements like matchmaking
- The edge is also important from a scalability perspective – gaming companies only want to place the game on servers where there is customer demand so will often be looking for an IaaS solution that they can spin up and spin down accordingly

Potential ecosystem partners

- Gaming studios and companies are likely to be the end customer of this solution
- Specialised gaming platform and software companies, like Edgegap, enable the gaming companies to manage their software centrally and decide which distributed locations they want to push it to
- Server providers (e.g. Dell, Cisco, Intel, Nvidia) are likely to provide the hardware – this may need to include GPUs for high-definition video rendering

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

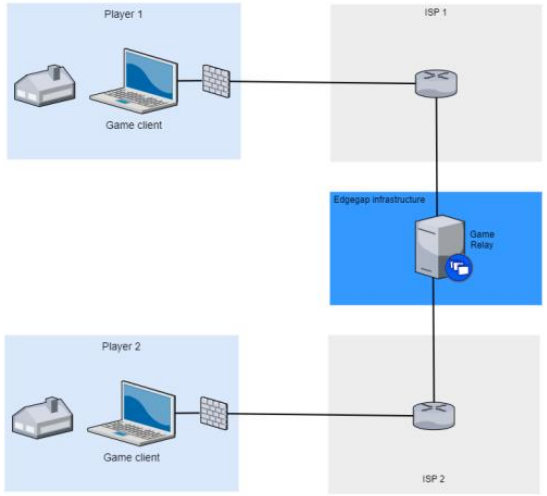
Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Case study: Edgegap

How it works



Source: Edgegap

Example of this use case by others

WTFast
Provide optimised networking and routing to lower latency and ping

Zenlayer
Have 270+ PoPs, optimised networking and high-performance servers for the gaming industry

StackPath
Edge platform provider helping to optimise game content, streaming and downloads

Key partners in this scenario

Edge data centre provider
Edgegap deploys their software in a number of locations including AWS Local Zones sites

Hardware provider
Gaming companies can own their own servers or consume them as-a-service

Gaming software
Edgegap provides the platform to allow gaming companies to provision their games where they want to and the matching software

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

High Frequency Trading (HFT)

LOCATION CAPABILITY A-Z

How it works

- High Frequency Trading (HFT) began in the 1930s where traders would buy and sell positions on the physical exchange floor and use high-speed telegraphs to communicate with other exchanges
- Rapid technological advancement means that modern HFT is now performed by computer algorithms with order execution capabilities, and they buy and sell volumes of shares at high turnover rates
- Advanced AI programs can take advantage of ultra low-latency networks to trade minor discrepancies in prices
- Trading firms continuously seek to optimise their HFT output by investing into advanced compute technology and spending large sums on colocation to the exchange

Why edge?

- Enables the low latency required for HFT ~1ms – particularly interesting for smaller firms that may not be able to invest in large amounts of top specification dedicated infrastructure
- High speed data processed locally often with on-premises servers to reduce bottlenecks and allow for much quicker data distribution
- Dependence on external networks is minimized as they are run on site at the edge

Potential ecosystem partners

- **MEC platform provider** – would be needed to host processing capabilities closer to the end user
- **ISV vendors** – specialized software such as latency monitoring systems will be included in HFT systems
- **Systems integrators -** to integrate existing IT applications & trading networks into a new MEC network

Capability

Latency	Reliability	Reduced backhaul	**Data localisation**
Flexibility	Light device	Mobility	Resilience

Edge location

Device	**On-premise**	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	**Financial services**	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

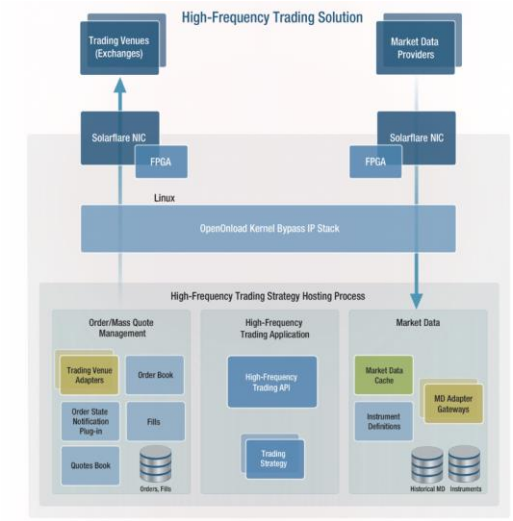
High Frequency Trading

Case study: Argo Software Engineering

How it works

The use of edge with HFT is still conceptual and at early stages of development but could offer further reduced latency to current HFT applications. Argo Software Engineering have developed a platform to enable HFT:

- Argo HFT platform takes the market trading data and enables on premises edge hardware e.g. edge servers and low latency switches
- Platform then integrates low latency Trading API, market data distribution facility with in-process trading venue order management and market data adapters
- The solution comes in one lightweight Linux package and allows for efficient high frequency trading



Example of this use case by others

VIRTU FINANCIAL

Virtu Financial currently offer a low latency HFT proposition

InfoReach

InfoReach have developed a HFT software for algorithmic trading

DRW

DRW Trading offer low latency HFT proposition focusing on cryptocurrencies

Key partners in this scenario

Edge hardware	Powerful edge servers and low latency switches provided by OEMs such as Dell or Cisco
Edge platform provider	Edge platform providers provide the ability to deploy specialised software on the edge hardware
Software platform	ARGO Software Engineering Software providers developed algorithmic trading platforms such as Argo Software Engineering

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Immersive experiences

LOCATION CAPABILITY A-Z

How it works

- Retail stores and advertising agencies increasingly using interactive digital media
- In retail, the objective is to extend customer time and spend in stores
- Retail stores want to encourage consumers to shop in store, not just online
- Edge cloud can be used to run certain applications with the capacity for real time human interaction (e.g. mixed reality mirror in changing room) while also enabling retailers to innovate, test and change applications

Why edge?

- Low latency means that customers and visitors will be able to interact in real time
- An edge compute solution is more scalable relative to a traditional on-premise solution or running the application on device would be more constrained in compute capacity
- Retailers can innovate and change their applications easily
- Optimise rental space – reduce the amount of space required to host dedicated hardware to run these applications

Potential ecosystem partners

- **MEC platform provider** would be needed to host processing capabilities close to the end-user
- **Application/digital solutions providers** e.g. Vivid could innovate, test and change products and improve user experience
- **End-enterprise customers** e.g. retailers

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

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Immersive experiences

Case study: Intel

LOCATION CAPABILITY A-Z

How it works

1. Video ingest from smart mirror/ sensors/ additional cameras
2. E.g. Updates to the experience such as changing the background/ scenario or adding new features/ products
3. Video/ information sent to smart mirror and person engaging with experience e.g. video of customer wearing items in retail setting

Example of this use case by others

Tanishq (part of Tata Group): visual merchandising experience

Accedian: interactive mirror (blogpost, no POC or partnership with retailer)

Key partners in this scenario

Hardware provider	Compute processing (with NUC Mini PC technology)
Platform provider	Digital mirror technology using AI and AR for immersive user experience
Enterprise customers (retailers)	Retailers benefit from real-time analytics to refine customer experiences

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

In-hospital patient monitoring

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Currently, monitoring devices (e.g. glucose monitors, health tools and other sensors) are either not connected, or where they are, large amounts of unprocessed data from such devices are stored on a 3rd party cloud based electronic health record
- Edge compute could process data locally, compiling information from multiple sources and extracting relevant information
- Edge enables right-time notifications to practitioners of unusual trends (through analytics/AI), creation of 360-degree view patient dashboards for full visibility, and/or sending relevant data to be stored securely in a cloud system
- This creates significant resource efficiency for clinicians, increasing productivity and decreasing cost per patient

Why edge?

- Security is improved, as the relevant information is processed locally and only encrypted data is sent to the cloud.
- Many sensors will consume significant bandwidth to send data, so a localised device will reduce backhaul and increase reliability for detecting emergency situations e.g. in the ICU
- Edge computing reduces need to have separate appliances for gateway and server, thereby reducing the cost of hardware. As IoT sensors are used more, the hospital would scale up quickly, thus reducing time to deployment

Potential ecosystem partners

- **Systems integrators** to integrate outcomes of analytics into wider enterprise systems
- **Healthcare providers** could monitor patients remotely and more cloud-like applications, but still ensure data is handled in a secure way and reduce the amount of data transmitted over the network
- **Application providers** (e.g. AliveCor, DeepMind/Streams)

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

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In-hospital patient monitoring

Case study: Nvidia (EGX)

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

- Patient data is analysed on an Nvidia on-premise edge to, for example, identify early signs of kidney damage
- Information from multiple sources can be analysed **securely with low latency AI at the edge** and give clinicians a 360-degree view of their patients
- Deeper analytics against a patients' behavioural/regional patterns can give clinicians and epidemiologists better insights into patient treatment measures and regional trends in healthcare

Example of this use case by others

DeepMind

Google Health: AKI identification

care.ai™

Care.ai

Key partners in this scenario

- Hardware → NVIDIA: Nvidia's EGX edge stack provides capabilities for low-latency, compute intensive, processing
- Operating software → Red Hat: Red Hat provides OpenShift containerisation software
- Cloud IoT services → AWS Greengrass: Connection to cloud IoT platforms and gateways such as AWS Greengrass and Azure IoT Edge
- Systems integrator (reseller) → GE Healthcare: Healthcare specific SIs act as key channel to resell and implement the solution

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

In-hospital patient monitoring

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

Healthcare professionals care for multiple patients at any one time. Information about each patient tends to be logged in handwritten records at each bed. In the future, instead of checking monitoring devices and recording the information by hand, professionals could access this information online – and even receive automated alerts if the patient's status changes.

Transition to edge

Currently, monitoring devices (e.g. glucose monitors) are not connected (the information is gathered and processed on the device for a healthcare professional to check manually). Centralising storage of this information would enable automated alerts for healthcare professionals and trend analysis for longer term health analytics. However, storing large amounts of unprocessed, sensitive data in the cloud is expensive and there are concerns about data privacy – so edge computing offers an attractive alternative.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	70%	20%	0%	10%
2030	10%	69%	1%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Infotainment on transport

LOCATION CAPABILITY A-Z

How it works

- Transport companies (train, planes, coaches, etc.) are providing content services through Wi-Fi such as video on demand, commerce, advertising and infotainment for travellers to improve the customer experience
- Current solutions use dedicated servers on-board to store and deliver content, but an edge cloud solution would use more generic hardware, allowing customers to scale up services offered more easily and reduce the amount of space hardware takes up on board
- Another scenario would be doing infotainment software updates quickly from a cache at the edge, e.g. from airport edge, once a plane lands

Why edge?

- Flexibility and scalability – transport operators can add and change the services they offer passengers in an easier way
- Faster time to deploy – less likely to face issues related to software integration
- Reduce hardware (on board) – assuming more dedicated appliances would take up more space and/or are not easy (costly) to replace if there are hardware upgrades needed

Potential ecosystem partners

- **Transport companies** (e.g. train operators, airlines, bus companies, etc.)
- **Specialist ICT providers** who provide solutions in this space, e.g. Nomad Digital
- **Content platform providers** (likely specialising in transport industry), e.g. GoMedia

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	**Light device**	Mobility	Resilience

Edge location

Device	**On-premise**	**Network**	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	**Media & entertainment**	Professional services	Retail	**Tourism**	**Transport**	Utilities

PARTNERS

*AEC: Architecture, engineering and construction

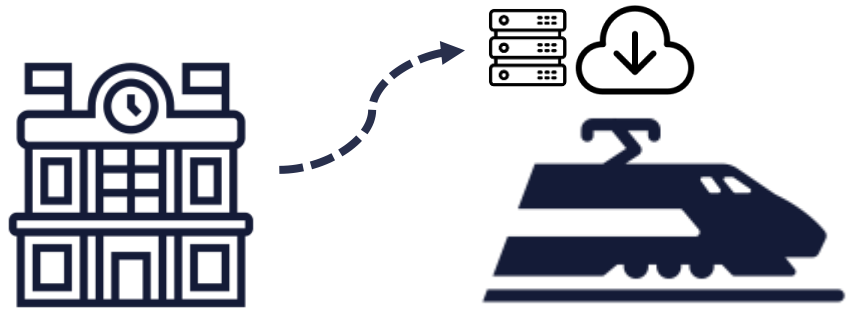
Infotainment on transport

Case study: Nomad Digital

LOCATION | CAPABILITY | A-Z

How it works

Go Media's infotainment (hosted on the train) is updated at St Pancras International station by connecting to the station's Wi-Fi infrastructure



Example of this use case by others

National Express: Coach company worked with GoMedia to provide entertainment services on-board

Indian Railways: Exploring 'Smart Coaches' to provide entertainment services e.g. on Chennai-Madurai Tejas Express

Passengera: Infotainment solutions across different types of transport

Key partners in this scenario

'On-train data centre'	Nomad Digital: Hosts on-train media content (and Wi-Fi gateway)
On-board connectivity	Nomad Digital: **Aggregated** multiple train-to-shore 3G/LTE networks to provide Wi-Fi
Infotainment provider	GoMedia: Transport entertainment content, e.g. TV, film, news, weather, etc.
Installer	SNCF: Installs hardware (mainly for Wi-Fi) on trains during servicing

Edge maturity

Scaled commercial solution	**Commercial solution**	POC / trial leveraging edge	Does not currently use edge

IoT analytics for building management

LOCATION CAPABILITY A-Z

STL PARTNERS

How it works

- Industry/customer problem: as smart infrastructure continues to advance, buildings have an increasing amount of IoT sensors and management systems to control multiple in building processes (e.g. lighting, heating)
- Edge opportunity: Building Management Systems (BMS) functions and applications can be hosted on an on-premise edge for better integration and management of the various protocols and data sources
- Examples include: data consolidation, protocol normalisation (from different types of connections), IP encapsulation, sensor data processing ((HVAC, energy, building automation, etc.)

Why edge?

- Edge reduces the investment and footprint required for on-prem consolidation, enables more efficient usage of compute resource and removes the expensive maintenance of legacy/dedicated hardware on customer premises
- Using edge cloud also brings benefits of replicability and scalability, including when it comes to integration with legacy systems
- By filtering data at the edge, edge improves resilience, cost and data security as exposure to and data stored in the public cloud is limited

Potential ecosystem partners

- **BMS and device providers** (e.g. Honeywell) will be pivotal, as integration with existing BMS systems and processes will be essential
- **Hyperscalers** in the ecosystem – if data is not stored on-premise it will likely be stored in public cloud (assuming non-sensitive data e.g. light/heating usage)
- **Systems integrators** will be essential in implementing an edge based solution, given the amount of legacy equipment and processes

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

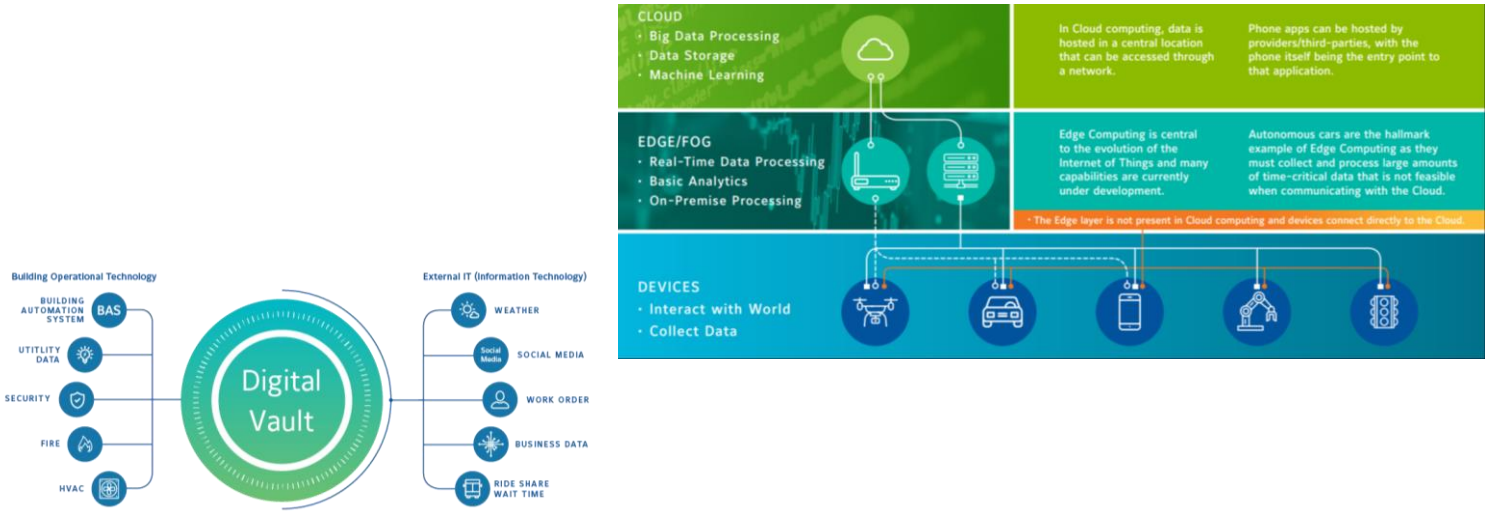
*AEC: Architecture, engineering and construction

IoT analytics for building management

Case study: Johnson Controls

LOCATION CAPABILITY A-Z

How it works



Example of this use case by others

75F: Building Intelligence System, leveraging IoT to optimise energy efficiency in buildings in India (not edge)

Schneider Electric: EcoStruxure Building solution (not edge)

Key partners in this scenario

Edge IoT* — Azure IoT Edge, managed compute service (deployed on device) to process data

Data aggregation platform — Johnson Controls Digital Vault gathers, stores and standardises data

Building administrator — bee'ah: Able to leverage data from platform to gain insights and predict actions related to building

Edge maturity

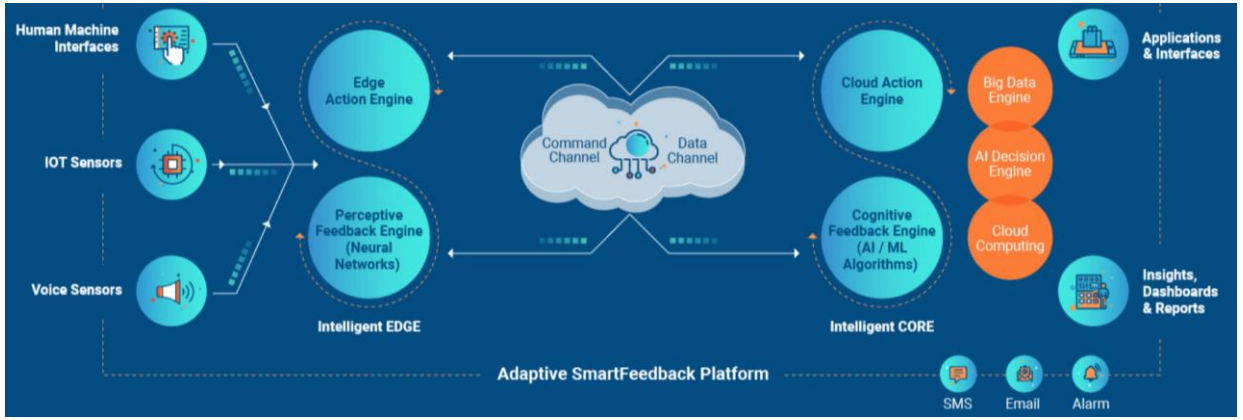
Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Case study: Gaia Smart Cities

How it works

- Data from sensors (e.g. temperature, humidity, power) collected, aggregated, and analysed at the edge
- Edge enables real-time analysis and creation of closed-loops for control and process automation
- Key driver for edge is reducing data and noise sent back to core cloud from vast number of sensors



Example of this use case by others

Honeywell

Honeywell: Building management solutions

IBM Watson

IBM: Watson IoT for Smart Buildings

Fraunhofer IIS

Fraunhofer: Edge computing for building management

Key partners in this scenario

- Systems integration
- Data management and analytics platform
- Connectivity
- Cloud compute and storage

gaia

Gaia smart cities provides the systems integration and the platform for IoT management and analytics. Gaia works agnostic of the existing sensor base and the hardware.

BSNL

Key partnership with BSNL as value- added reseller for Gaia into the public sector

Microsoft Azure

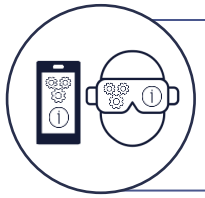
Gaia is cloud infrastructure-agnostic but a key reseller and incubation partner of Microsoft's

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Edge use cases



Legacy back office interface

LOCATION CAPABILITY A-Z

How it works

- Many branches of larger corporations (e.g. a specific branch of travel agent like Thomas Cook) rely on connectivity to access and communicate with "back office" systems (e.g. price lists, billing protocols, patron data), which are often located physically distant from the branch itself
- These back office systems can often be legacy/antiquated, meaning trying to access/interact with them with right-time reliability can be difficult. This issue is exacerbated at times of high-traffic where strain on bandwidth can cause delays in communication
- Transforming these legacy back office systems can take significant time and resource investment
- Instead, edge cloud offers a solution through local caching and processing of necessary data and protocols (e.g. price lists/point of sales systems), which reduces the need for real-time connection to back office systems

Why edge?

- Resilience – local compute means functions can be completed even when core cloud connectivity is underperforming
- Reduced backhaul – on-premise edge cloud allows trickle back processing so bandwidth isn't overloaded
- Low latency – proximity to end user allow certain functions to happen in real-time, improving UX
- Scalability – Edge cloud flexibility means bursts in traffic can be handled without the need to buy expensive spare capacity in traditional on-premise solutions. Easy spin up/down

Potential ecosystem partners

- **SIs/MSPs**
- **Front end application developers**
- **Customers e.g. airlines, online retail platforms, stores**

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

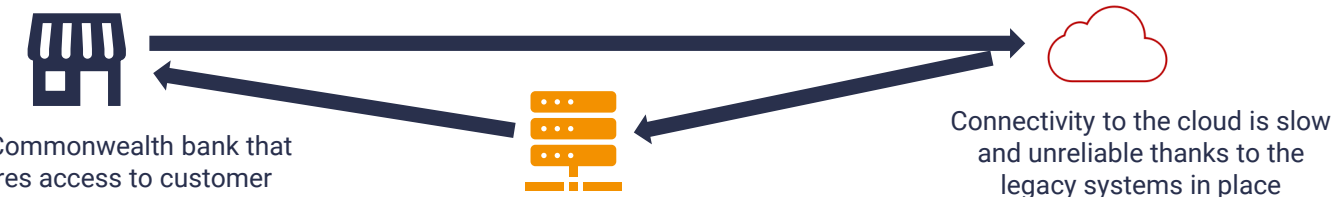
*AEC: Architecture, engineering and construction

Legacy back office interface

Case study: Commonwealth Bank

LOCATION CAPABILITY A-Z

How it works



Local Commonwealth bank that requires access to customer data and company wide policies and rates

Information required can be cached at edge site (either network or on-premise) to ensure access in real-time even if the cloud down

Connectivity to the cloud is slow and unreliable thanks to the legacy systems in place

NB. This trial uses 5G and edge computing technology and will both help enhance the reliability and performance of existing applications (e.g. similar to legacy back office interface described) and enable new applications (more likely to be used at flagship stores only).

Example of this use case by others

Microsoft

Microsoft Branchcache

Proprietary distributed caching either on servers or the clients' computers

Key partners in this scenario

Telco	TELSTRA Telstra providing 5G connectivity
Network equipment provider	ERICSSON Ericsson are providing the 5G network infrastructure
Bank	CommonwealthBank Commonwealth Bank are looking to improve customer experiences with edge and 5G

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Live video/broadcast

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Live broadcast uses a lot of bandwidth and there is a need to optimise streams quickly, rather than transport raw data through the network
- As streams become more complicated (e.g. many-to-many) and higher quality (8K+) this becomes more difficult to do
- Optimising live video streams at the edge significantly reduces the latency – companies such as SML can go down to 250ms end-to-end latency on a 5G network

Why edge?

- Latency is critical – for example, viewers even at the venue can stream the event on their mobile in real-time
- Having the solution at the edge means there are fewer cables, shorter set-up times and it is easier to integrate with existing production facilities

Potential ecosystem partners

- **Private network provider** – in some cases, a private LTE/5G network at the venue may be required to reduce latency even further
- The broadcast nature of this use case means that it is essential to work with the **broadcaster, production companies and the venues or event organisers** themselves

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Live video/broadcast

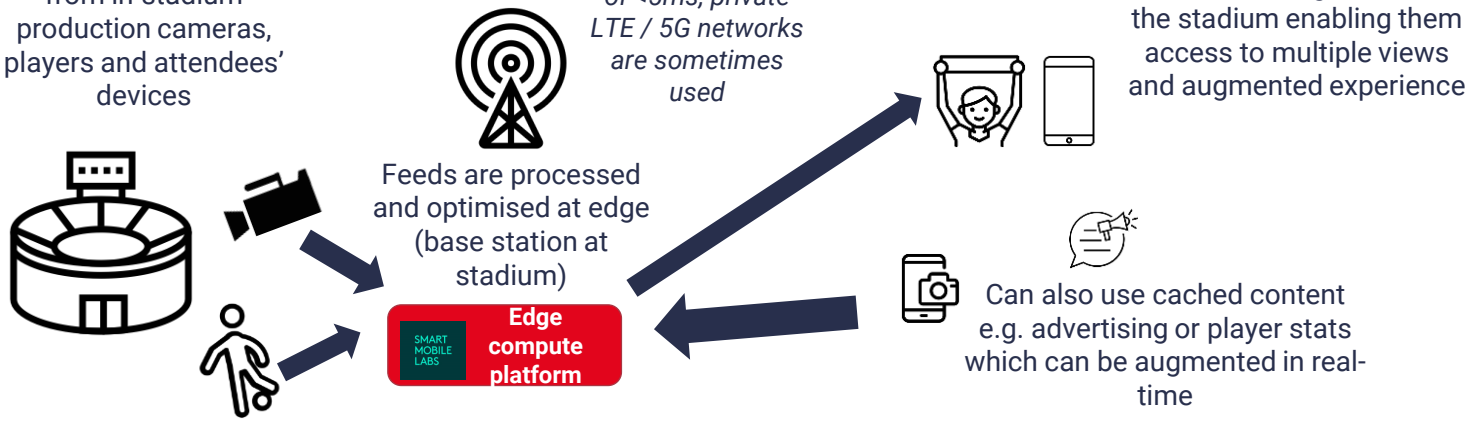
Case study: Smart Mobile Labs

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

How it works

Video camera feeds from in-stadium production cameras, players and attendees' devices

To ensure latency of <5ms, private LTE / 5G networks are sometimes used



Example of this use case by others

MobiledgeX

Texel: Working with MobiledgeX on enhancing delivery of live immersive media

Key partners in this scenario

Video optimisation software	Edge Video Orchestrator optimises delivery of (live video)
Network equipment provider	Provide equipment for private LTE infrastructure (if necessary)
Broadcaster	Production and broadcast facilities at venue
Venues / (sports) leagues	Sports venues that will implement this to improve experience

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Live video/broadcast

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

Processing raw video streams at an edge (e.g. for a live sporting event) to optimise the broadcast and keep latency/processing time to a minimum. This avoids the need to have computing power at the event and improves flexibility (can change the underlying processing platform/software more easily).

Transition to edge

For live events, having sufficient processing power at the event can be challenging. For remote events or those that are mobile (e.g. Formula 1), it requires having heavy vans/other vehicles that collect the streams and process them on-site in servers. For fixed venues, although there isn't a need for mobility, there are often multiple broadcasters needing such equipment on-premises and it can take time and incur additional costs to implement the apparatus. It would be easier to use a network edge to do the live broadcast stream processing.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	90%	0%	0%	10%
2030	15%	0%	65%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Metaverse

LOCATION CAPABILITY A-Z

How it works

- The Metaverse is becoming the accepted term for a set of interconnected virtual worlds – the end vision is that organisations and individuals will have their own 3D worlds, rather than 2 web sites
- To fully immerse in the Metaverse, users will need to access it through virtual reality headsets, although phones, laptops and TVs could also be used
- The Metaverse is likely to rely upon a virtual economy which enables digitals goods to be bought and sold
- It will likely support new use cases in retail and entertainment as well as in sectors like education, training and tourism

Why edge?

- Virtual reality applications will drive a huge increase in traffic both downlink and uplink (which traditionally today is much lower) – reducing the required backhaul for at least some of this data traffic by processing it at the edge will reduce costs for the telecoms operators
- The Metaverse will also require immediate responsiveness and edge can be used to deliver that low latency and jitter experience

Potential ecosystem partners

- **Virtual world builders** e.g. Meta, Nvidia (their solution is called Omniverse), Improbable and Microsoft (through Microsoft Mesh)
- **NFT companies** that can provide the virtual economy
- **Telcos** that will be providing the connectivity backbone but might also provide services like digital identity authentication

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

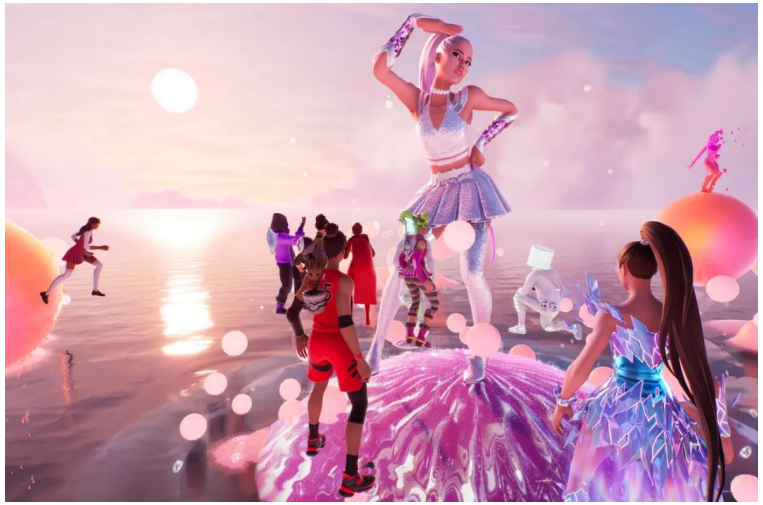
*AEC: Architecture, engineering and construction

Metaverse

Case study: Fornite Rift Tour

LOCATION CAPABILITY A-Z

How it works



The metaverse is still a very nascent concept – but Fornite's series of virtual concerts with artists like Ariana Grande and Travis Scott indicate what the customer experience could look like.

Source: https://www.epicgames.com/fortnite/en-US/rift-tour

Example of this use case by others

SK telecom

SK Telecom: Designed the Ifland platform with virtual meet up capabilities

Meta

Meta: Launched Horizon software that developers can use to build virtual worlds

NVIDIA

Nvidia: Launched Omniverse which helps support the design of virtual worlds

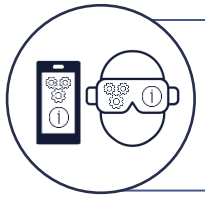
Key partners in this scenario

- Hyperscale cloud — aws — AWS stated they were supporting Epic Games with their gaming servers and analytics capabilities
- CDN providers — Akamai — Akamai are one of several CDN providers that provide caching closer to end users
- Video game developer — EPIC GAMES — Epic Games produce the content for Fornite

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS



MR for worker safety and productivity

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Some machinery requires highly skilled (and potentially scarce) workers to come on-site to perform maintenance, configuration or unscheduled repairs. This can be expensive both in terms of time and money.
- Augmented reality can support the on-site maintenance teams to complete tasks in place of (or supervised by) someone who is highly skilled/specialized.
- A mixed reality overlay on a tablet or smart glasses could show a worker how to safely interact with the environment / complete the task.
- As bulky, expensive headsets are not viable and hosting in the cloud can cause too high latency, edge computing is necessary to ensure real-time interactions and MR rendering on simpler devices.

Why edge?

- By processing the data and rendering imagery at the edge instead of on-device, lighter headsets (at lower cost with improved battery life) can be used in place of bulky ones.
- Edge also maintains the necessary low-latency requirements to reduce nauseating lag and jitter.
- (If it runs on-premise) the solution will function even in remote areas with limited / no connectivity.

Potential ecosystem partners

- **Application providers** such as Space 1, Arvizio, 1000 realities bring the AR/VR software capabilities to the solution.
- **Silicon providers** e.g. Nvidia will provide the high-tech spec (e.g. GPU) hardware required for high-resolution edge rendering
- **Smart glass hardware providers** (e.g. HoloLens) will need to provide LTE-enabled devices.

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

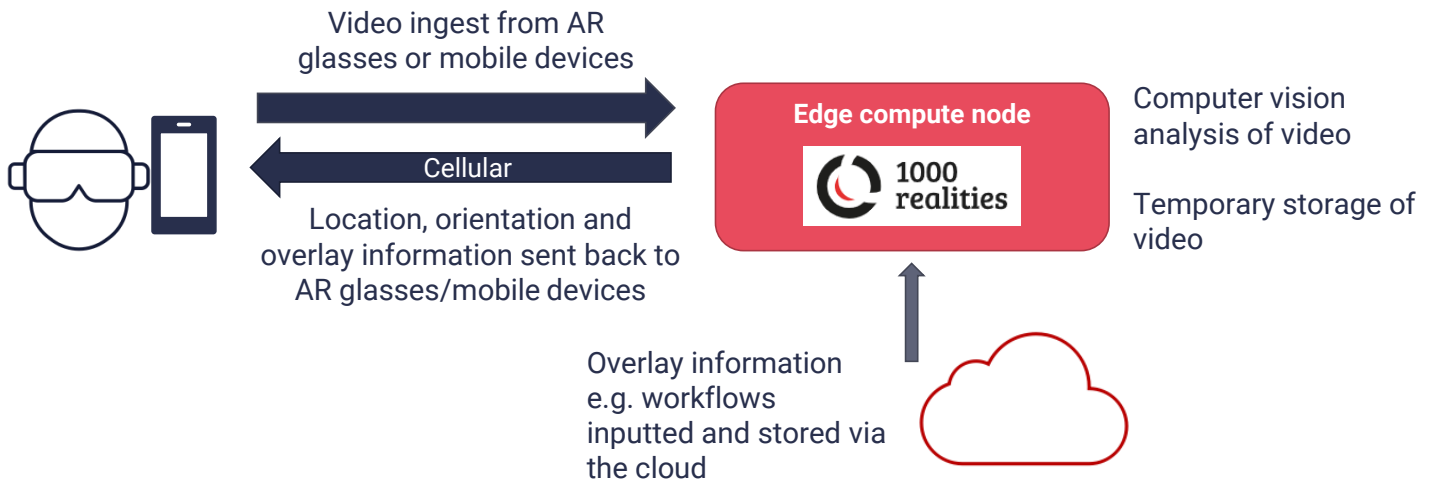
MR for worker safety and productivity

Case study: 1000 Realities

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works



Example of this use case by others

Brochesia: B Safe solution (does not currently use edge)

Yeppar: Provides mixed reality solutions for automobile in India

Simulanis: XR for pharmaceuticals, automotive and oil & gas

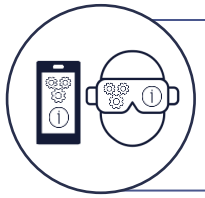
Key partners in this scenario

- Hyperscale cloud — aws, Microsoft Azure: Long term storage of information to be overlaid stored in hyperscale cloud
- End application — 1000 realities: End application of AR expert for industries
- Hardware — Microsoft HoloLens: Smart phone or smart glass manufacturers with LTE connectivity
- Systems integrator — SIEMENS: Integration into the enterprise's existing IT systems e.g. for worker productivity management

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS



MR for worker safety and productivity

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Some machinery requires highly skilled workers to come on-site to perform maintenance, configuration or unscheduled repairs. This can be expensive in both time and money. Augmented reality can support the on-site maintenance for teams supervised by someone who is highly skilled/specialized. A mixed reality overlay could show a worker how to safely complete the task.

Transition to edge

As bulky, expensive headsets are not viable and hosting in the cloud can cause too high latency, edge computing is necessary to ensure real-time interactions and MR rendering on simpler devices. By processing the data and rendering imagery at the edge instead of on-device, lighter headsets (at lower cost with improved battery life) can be used in place of bulky ones. Edge also maintains the necessary low-latency requirements to reduce nauseating lag and jitter. In most cases, when using edge, MR will be supported by network edge. By 2030, as the number of devices per location increases and more edge locations arise, the majority of the MR data processing will shift from the device to network edge.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	90%	0%	0%	10%
2030	15%	0%	65%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing | 11-30% of total processing | 31-50% of total processing | 51-75% of total processing | 76-100% of total processing

Network-enabled location based services

LOCATION CAPABILITY A-Z

How it works

- If an edge system is part of a local wireless network (Wi-Fi or 3GPP), a local service can use signalling information to determine the location of each connected device
- This enables location based services for enterprises in areas where GPS coverage is not available, such as sports venues, retail outlets or offices
- Business opportunities through data analytics: location spoofing, footfall tracking, capacity tracking/occupancy rates and planning (e.g. trains), crowd management, geofencing etc.

Why edge?

- Further business opportunities through AI - footfall analytics enables crowd management & targeted advertising in remote locations
- GPS not required for location tracking
- Reduce the amount of data going to cloud

Potential ecosystem partners

- **Application providers**
- **Device manufacturers** (e.g. Bluetooth beacons) can use edge compute to reduce the quantity of data that travels through the network
- **MNOs**
- **Sensor network providers** (Bluetooth, Wi-Fi)

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Network-enabled location based services

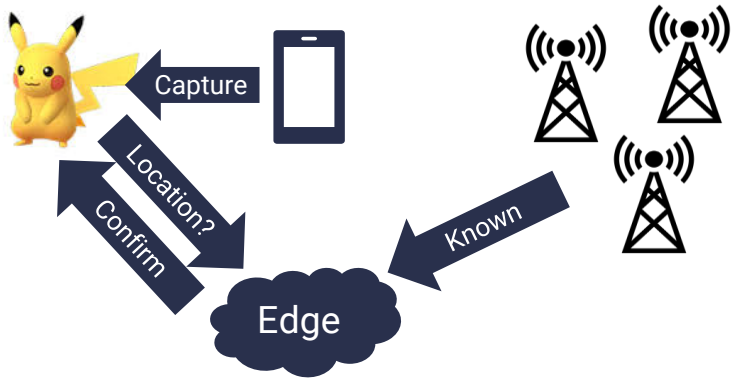
Case study: Niantic

LOCATION CAPABILITY A-Z

How it works

Pokémon players have been able to "spoof" their GPS location and thereby cheat. This undermines the game and reduces the incentive to buy game currency. Niantic therefore needed a means of validating that players were indeed where the characters were.

By sending Pokémon character co-ordinates to a localised network-aware edge application, the game can detect physically remote spoofers without compromising anonymity or relying only on device parameters.



Example of this use case by others

Here | Thinknear (Telenav) | World Wide Technology | Radius Networks

Key partners in this scenario

- Network — Mobile network (could also be fixed)
- Edge IaaS — Could also be 3rd party edge with network location
- Edge platform — Provides orchestration for distributed cloud
- Game — Could also be platform

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Object and vehicle tracking

LOCATION CAPABILITY A-Z

How it works

- Edge compute can be used for real-time video analytics, which could be deployed for various uses, such as detecting vehicles using license plate recognition or to recognise objects in real time
- Detecting vehicles using edge computing could be useful for numerous cases, including:
  - Monitoring vehicle access in restricted areas
  - Coordinating supply vehicles that are required to be in certain places at certain times to ensure smoothly running operations, such as tarmac supply vehicles in airports
  - Edge compute, combined with machine learning algorithms that train the software to detect and recognise a specific object. This could be useful to detect obstructions (e.g. on roads)

Why edge?

- Edge compute makes real-time analysis possible as there is no lag, given that the data is being analysed at the source
- Reduces the need to process data in a data processing warehouse or cloud, opening that bandwidth to be used for other purposes, as well as reducing the cost of bandwidth
- Security is improved, as the relevant information is processed locally and only encrypted data is sent to the cloud

Potential ecosystem partners

- **Independent Software Vendors** who develop the analytics software
  - AI/ML could be used for facial recognition, which could improve customer experience
  - AI/ML could also be deployed to help schedule flights, a key issue as the number of flights continue to increase
- **Equipment manufacturers**
- **Cloud players or hyperscalers** could enable use of the cloud to run the analysis

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Object and vehicle tracking

Case study: Gorilla

LOCATION CAPABILITY A-Z

How it works

- The 'edge' is typically located on-premise, or in a (private) cloud
- Video cameras/sensors send data to the edge device, which analyses it in real-time and create actionable points
- This can be used to monitor what is taking place in real-time, as well as being used to predict future needs and act on these predicted needs, improving the efficiency of operations
- Real-time knowledge of the location of vehicles can also help with safety and collision-avoidance, as well as being able to detect unauthorised vehicles/objects if they enter a restricted zone

Example of this use case by others

SIEMENS

Siemens offer a set of solutions that enables digital baggage tracking throughout the airport

AInfinity

AInfinity has developed real-time object recognition technology that uses edge computing and AI

Key partners in this scenario

Sensors

Sensors, such as video camera, that collect data and send it to the edge device to be analysed

Edge servers/Cloud platform

Azure IoT Hub

E.g. Cloud (e.g. connect to Azure IoT Hub in the cloud), or they could be on-premise servers, as offered by HPE, Dell, among others

Analytics software

Gorilla

Analytics software, possibly one that uses machine learning/AI, such as offered by Gorilla

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Payment gateway

LOCATION CAPABILITY A-Z

How it works

- Edge compute would enable the filtering of sensitive data to be completed on the edge of the network - confidential information other than the payment service requirement is removed
    - E.g. facial recognition: edge compute node converts the image into biometric data, and only submits the data points feature to the payment gateway - it does not submit face images, protecting users' personal information and reduces risk
- In some cases, blockchain and distributed ledger technology can be used to authenticate payments – would need to do this processing at the edge to avoid latency problems
- Key business benefits also include lower costs - combining it with DLT can remove intermediaries and authenticate payments at a fraction of the fees charged today

Why edge?

- Reduce the amount of data going to the cloud; becomes more relevant as video/biometric sensors are used to authenticate payments
- Improves the level of privacy and security, as the relevant information is processed locally, and only encrypted data is sent to the cloud
- Edge compute can also be used to provide accurate location and time information, making transactions more authentic and reliable
- Virtualising the payment gateway makes it more flexible to deploy (e.g. at an electric car charging station)

Potential ecosystem partners

- **Existing payment gateway providers**
- **Banks/payment companies** will be crucial, as they need to be on board with this technology, particularly with respect to its security
- **Edge hardware and software providers**
- **Hyperscalers/cloud providers**, which can be used for big data and machine learning, security and management services as well as remote operation and maintenance

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

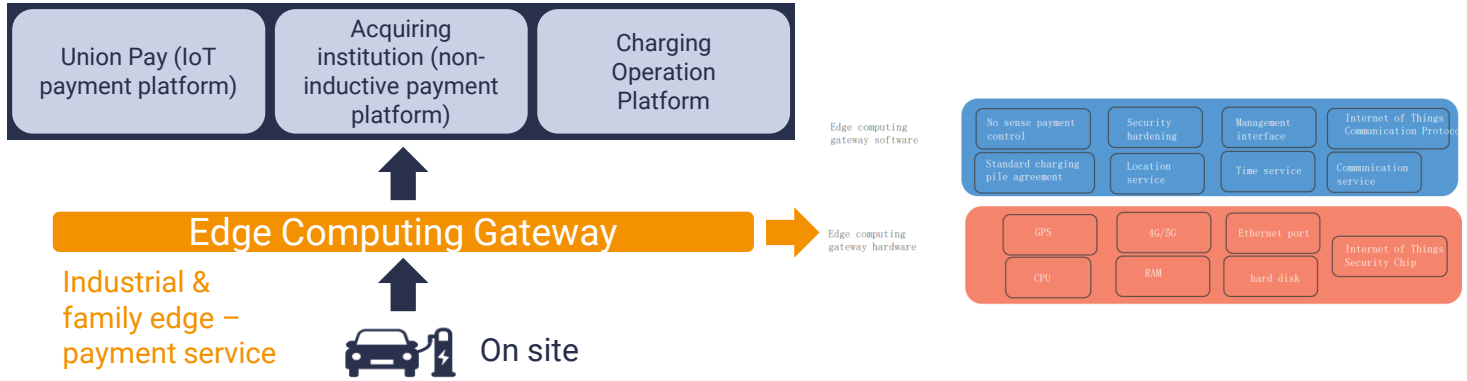
Payment gateway

Case study: China UnionPay & StarlingX

LOCATION CAPABILITY A-Z

How it works

Cloud: security service, management service and payment entry



Example of this use case by others

XENIRO™

Xeniro enabling the orchestration and processing of M2M transactions at scale, using 5G, MEC and DLT

Key partners in this scenario

- **Vehicle manufacturer** — Any vehicle manufacturer that develops charging cars (or bicycles)
- **Edge computing hardware** — DELL EMC — E.g. Dell
- **Edge software platform** — STARLINGX — StarlingX – open-source, industry-leading software platform designed for edge deployments
- **Cloud Provider** — Azure — *Hypothetical*
- **IoT Payment platform** — UnionPay — e.g. UnionPay's IoT payment platform

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Personalised energy consumption analysis

LOCATION CAPABILITY A-Z

How it works

- Granular insights about the energy consumption of individual white goods within a household can come with a number of benefits:
  - Increase the lifetime of the white goods with predictive fault detection (e.g. Verv offering)
  - Predict surges in demand for energy and incentivise energy usage when renewable energy is available (e.g. when it is windy)
  - Enable peer-to-peer energy marketplaces to reduce energy bill (e.g. Vlux offering)
- However, for these insights to be generated very large amounts of data need to be collected and analysed in real-time, introducing a need for edge computing

Why edge?

- Real-time information on energy demand requires low latency (e.g. to ensure surges can be dealt with)
- Very large amounts of data will be collected every second, making backhaul to the centralised cloud expensive and inefficient
- Customers may wish to know that their energy consumption data will be stored locally
- Edge computing enables flexibility as generic hardware can be used, regardless of the make of white goods

Potential ecosystem partners

- **White good manufacturers** (who may be able to use the insights to provide predictive maintenance of their goods)
- **IoT device manufacturers**
- **Local governments and electric grid managers**
- **Systems integrators** (particularly when the solution is being implemented within a specific locale e.g. a managed apartment or office block)

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

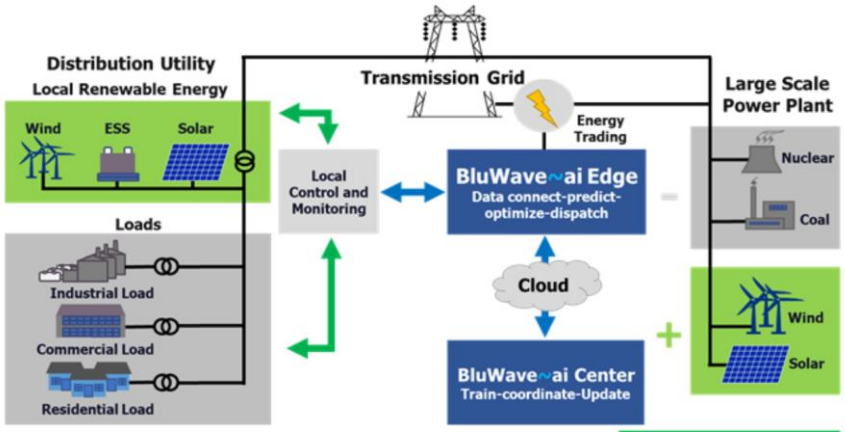
Personalised energy consumption analysis

Case study: BluWave-ai*

LOCATION CAPABILITY A-Z

How it works

- BluWave-ai Edge connects to IoT sensors and meters, using historical and real-time data to provide AI assisted optimisation of local energy generation and storage.
- BluWave-ai Center manages multiple BluWave-ai Edge locations, applying machine learning with new data to continuously adapt and improve the AI models used by BluWave-ai Edge to predict, optimize, and dispatch control



Example of this use case by others

Vlux: P2P energy trading to reduce cost of green energy

Verv: AI-enabled analysis of white good energy demand and performance (not currently using edge)

Key partners in this scenario

Cloud provider	Microsoft: Bluewave-ai IoT edge is built on Azure IoT Hub
Machine learning platform	BluWave-ai: BluWave-ai platform supports ML both at the edge and at the command centre
Research partners	Ecofuel, IBM: Research partners include Ecofuel, IBM, Canmet Energy, Canarie etc.

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Precision agriculture

LOCATION CAPABILITY A-Z

How it works

- The global population is growing, putting pressure on agricultural resources
- With environmental and sustainability concerns, there is growing pressure to change the food production process, starting from the way crops are grown
- IoT devices enable vast amounts of data on the growing environment to be collected to optimise the production process at a granular (per crop) level
- Data from connected devices must be acted on quickly – processing data at the edge would create lower latency, and enables solutions to be scaled easily

Why edge?

- By processing data at the = edge, additional data sources can be integrated more easily to enable deeper insights e.g. on air quality or levels of moisture
- Less data is transmitted through the network to the cloud, creating lower latency, which is needed to efficiently monitor each crop
- Farms are often in remote location which may not have broadband coverage – may need on-prem or network solutions to ensure they have access to IoT services

Potential ecosystem partners

- **Edge infrastructure provider** – either at the network edge or on-premise (mainly for situations like indoor farming)
- **IoT device manufacturer** – data from devices will be used to carry out functions within the farm
- **Application/technology provider** – data from device sensors will be stored/ processed at the edge, but will need to be analysed to optimise output

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

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Precision agriculture

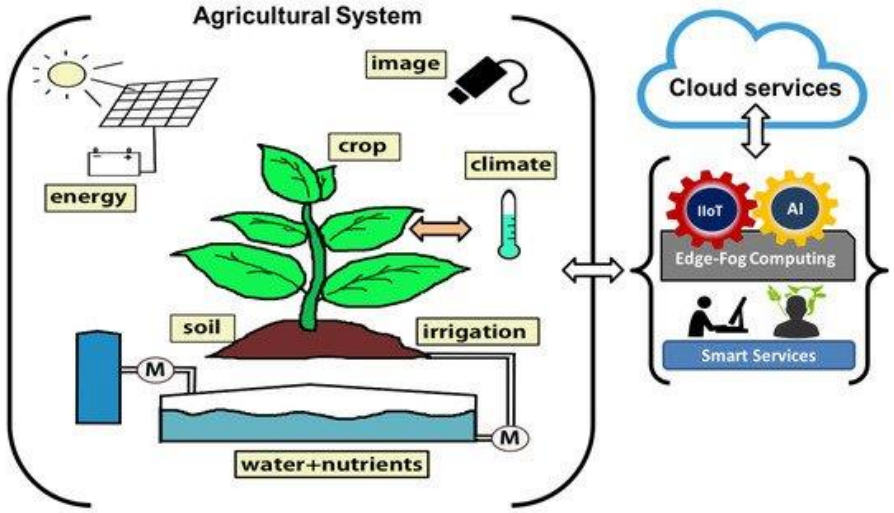
Case study: Dell & Intel

LOCATION CAPABILITY A-Z

How it works

Sensors and cameras gather data about the operating and growing environment and send it to Dell IoT Edge Gateways to be processed.

This can be analysed and monitored on tablets.



Example of this use case by others

FREEWAVE

Freewave: precision farming at the edge with the ZumIQ™ Edge Computer

FUJITSU

Fujitsu: examples of connected devices in Indian agriculture (not edge)

TRILOGY

Trilogy Networks: Trilogy is combining its distributed cloud platform with Chat Mobility's network assets in the U.S. for precision agriculture

Key partners in this scenario

- Edge hardware provider — Dell IoT edge gateways with Intel core processors: Processing data captured from sensors
- Cloud provider — Microsoft Azure: AeroFarms may use Azure to conduct more analytics in the clodu with data backup across multiple farms
- IoT device manufacturer — Connected devices and sensors are needed to gather data on the farm environment
- Farming technology provider — AeroFarms: Uses patented technology and data-driven insights to scale local farming

Edge maturity

Scaled commercial solution	**Commercial solution**	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Private mobile network

LOCATION CAPABILITY A-Z

How it works

- Run (custom) network functions for a third-party to create a private LTE/5G network (may also need localised spectrum allocation)
- Certain enterprises may want their own network either because:
- They are in remote locations without/with limited mobile coverage
- They may have particular requirements (e.g. low latency applications, security)

Why edge?

- The enterprise can run additional security functions and also ensure data is controlled, so sensitive data does not leave premises
- Compute infrastructure can be used to run enterprise applications, unrelated to the network
- Enterprises can ensure data and application availability, either because of improving the network, or because the data is stored and processed on premise
- Mobility – Customers can extend their network to the wide area through roaming/slicing
- Future-proof – 3GPP standards and scale ensures supplier and device ecosystems

Potential ecosystem partners

- Systems integrators
- Industry-specific solutions providers
- Network equipment providers
- Device and sensor OEMs
- Alternative VNF providers

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Private mobile network

Case study: Vinci airports

LOCATION CAPABILITY A-Z

How it works

- Coordinating airport operations
- Developing air-related and other business activities
- Ensuring ramp handling activities
- Providing passenger services
- Maintenance of equipment
- Ensuring safety and security
- Managing the freight

VINCI Airports is a global integrator that develops, finances, builds and provides everyday operations of 46 airports in 12 countries.

Asset tracking

Tracking of thousands of assets including air-side vehicles, tools and in-terminal assets
Trackers connected to private network allow for real time location and staff provide the correct assets to the correct location across airport operation
IoT sensors are connected to the network to reveal live status information of certain assets for staff to monitor and ensure that the asset is available for use and is correctly serviced

Multisite Networks

Vinci operate Gatwick airport and uses a multi-site system to manage the multiple sites used by travellers as well as warehouses and aircraft hangers that need integration and functions that will work across and between them.
Each site is seamlessly connected and communications between them and connected assets moving between the sites happens simply

Example of this use case by others

Flir: Using edge computing on camera for machine vision applications

Advantech: Case study of Taiwanese factory implementing (on-prem) edge computing solution

Key partners in this scenario

Sensor/Devices	Sensor/Device provider and management system
Networking	Nokia Private LTE (Core and RAN)
Data management	Standard platform
SI and MSP	Industry specialised

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Production and maintenance - video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Real-time detection of problems during operational processes (e.g. on manufacturing line) using video cameras and analytics
- For example, monitoring of assets to identify wear-and-tear and enable predictive maintenance
- The benefits of automating this through video analytics reduces chances of human error that can frequently happen when done manually and increases the likelihood of mistakes being identifies – random quality control checks do not check every single product, plus the human eye cannot always see certain errors
- Edge computing used to collect video data, label and manage the data and run the analytics
- Being able to identify a fault in real-time can mitigate customer satisfaction problems and significantly reduce the risk of further defects (i.e. identifying a machine is producing defects immediately and stopping production)

Why edge?

- Expensive to replace existing camera real estate to introduce more advanced analytics
- Can use edge for multiple video analytics applications
- Very expensive to transport all the real-time video data to a central server / the cloud (standard cameras stream 24/7 at 5mb/s, HD cameras consume double this and new cameras stream 200-350mb/s)
- Ability to identify faults in real-time, even on fast production lines

Potential ecosystem partners

- **Device manufacturers** – companies like Bosch are enhancing on-device edge analytics capabilities
- **Video analytics application providers** – fragmented ecosystem of different types of application
- **Systems integrators** to integrate outcomes of video analytics into wider enterprise systems

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Production and maintenance - video ingest and analytics

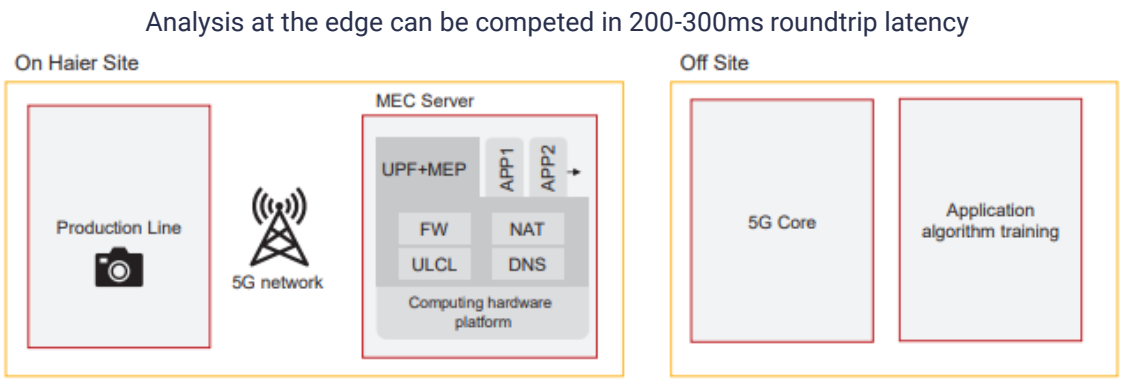
Case study: Haier

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

In this POC, Haier factory mounted a 500W industrial camera onto a robotic arm, with high intensity lighting, to be able to scan the refrigerators as they come off the production line. In the 5G core edge, the application's machine learning algorithms are trained.



Example of this use case by others

FLIR

Flir: Using edge computing on camera for machine vision applications

ADVANTECH

Advantech: Case study of Taiwanese factory implementing (on-prem) edge computing solution

Key partners in this scenario

Network	HUAWEI, 中国移动 China Mobile: 5G network to provide network with 42Mb/s upstream
Edge computing platform	HUAWEI: Dynamically allocates and adjusts available compute resources
Machine vision application	Mstar provided the machine vision application
Systems provider	中国移动 China Mobile: Integrate the 5G network and MEC platform

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Production and maintenance - video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

Enterprises with complex and expensive machinery want to try and reduce the instances of the machines breaking or performing at a less than optimal rate. Information from video streams can be analysed to identify warning signs that a machine needs a service, such as changes in the alignment of parts or speed of operation, allowing pre-emptive action which can prevent a full breakdown.

Transition to edge

Today, any analytics on video footage occurs on premium, AI-enabled video cameras. Over the next ten years, we would expect more of this compute to happen at the edge. Since the information about the machine performance is operational data that can be highly sensitive, most enterprises would use an on-premise edge to analyse the data so that it never leaves their premises. Aggregated, non-sensitive data may then be sent to the centralised cloud for longer term model training and trend analysis.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	70%	20%	0%	10%
2030	10%	69%	1%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Push-to-talk/video (PTX)

LOCATION CAPABILITY A-Z

How it works

- Push-to-talk/video (PTX) applications allow for people to communicate with one another in real time
- PTX is useful in mission-critical situations where human safety is at risk and / or when you have extensive teams out in field. The aim is to enable people to communicate without having to dial a phone number
- Data generated by PTX applications can be processed at the edge of the network – this ensures latency is low and removes reliance on wide area network coverage that may not be available
- When combined with a private network those communicating can also be sure of the data privacy and sovereignty of the solution – critical in use cases such as military operations

Why edge?

- Enables the low latency required for next-generation PTT capabilities e,g, high quality video, real-time location tracking
- Allows mission critical communications to remain secure and private
- Removes the need to use expensive proprietary systems and specialist devices
- Apps run locally / independently at the edge and its dependence on external networks is minimised

Potential ecosystem partners

- **Device manufacturers** – companies manufacturing walkie-talkie devices and other communications devices
- **Application providers** – push to talk/video requires a software application to offer chat options and emergency buttons
- **Systems integrators** - to integrate from traditional LMR solutions and modernise 2G/3G technology

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

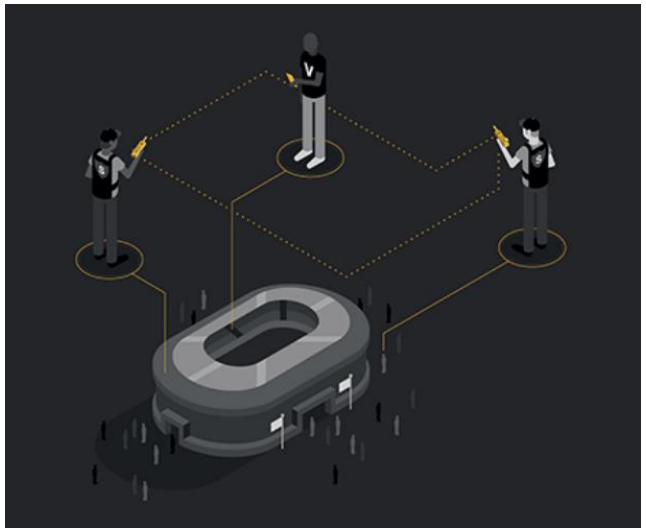
*AEC: Architecture, engineering and construction

Push-to-talk/video (PTX)

Case study: Grouptalk

How it works

Push to talk/video devices (mobile phones, headsets, buttons etc.) will instantly transmit data over a private LTE/5G network deployed on premise or over the top (in the cloud) in mission critical environments such as in manufacturing plants or at extractive mines.



Example of this use case by others

Simoco wireless solutions have deployed PTX solutions across a number of industries

Instant Connect provide a software platform for PTX communications

NybSys has developed Sentra PTT mobile software application & provision of PTX devices

Vodafone have launched PTX applications as part of their collaborative worker solution

Key partners in this scenario

PTT device manufacturer	Supplier of PTT hardware e.g. PTT button, headset and device (phone etc.) e.g. Affini
Network provider	RADTONICS — Provider of private 5G network for data transmission from PTT devices
Software provider	grouptalk — Provision of mobile software application to offer chat options and emergency buttons etc.

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Edge use cases

Real-time collaboration in design and engineering

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION | CAPABILITY | A-Z

How it works

- In certain industries, particularly those related to design (of buildings, products, etc.) and engineering, many different parties need to collaborate on a particular project and the files used can be very large (e.g. 3D CAD models in engineering)
- AR/VR software can be used to visualise a design project (e.g. so you can walk through the proposed lay out for a house)
- Currently this is only possible when the smart glass is tethered to a laptop and cannot support multiple parties (in different locations) viewing the same AR/VR image
- With edge computing, the large image can be hosted nearer to each individual end user so that all parties can see real-time changes while maintaining their own unique POV.

Why edge?

- Low latency – real-time changes are synced between users without lag or jitter which can make smart glass wearers feel queasy
- Accessibility – employees can access files remotely
- Light device – compute offloaded from device so less expensive, lighter weight smart glasses can be used
- Mobility – smart glass no longer needs to have wired connection to laptop

Potential ecosystem partners

- **Application providers** such as Space 1, Arvizio, 1000 realities bring the AR/VR software capabilities to the solution.
- **Silicon providers** e.g. Nvidia will provide the high-tech spec (e.g. GPU) hardware required for high-resolution edge rendering
- **Smart glass hardware providers** (e.g. Hololens) will need to provide LTE-enabled devices.
- **Hyperscale cloud** needed to ensure syncing between the local edge nodes of different users.

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

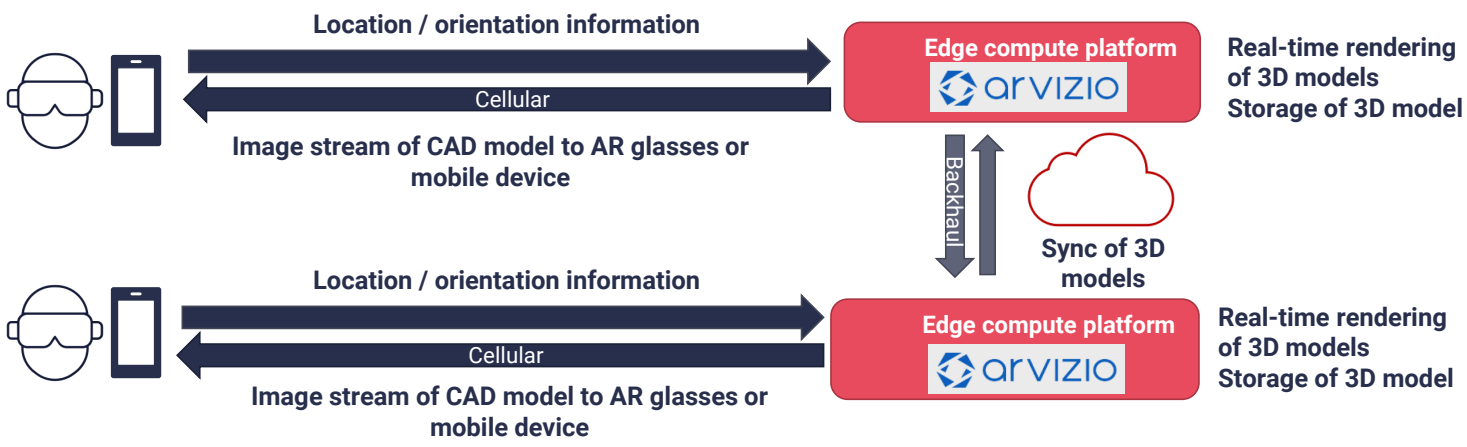
Real-time collaboration in design and engineering

Case study: Arvizio

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works



Example of this use case by others

1000 realities

1000 Realities: Computer vision analysis at network edge

Holo-Light

Holo-Light: CAD model analysis and rendering at network edge

Yeppar

Yeppar: Provides mixed reality solutions for automobile in India

Simulanis

Simulanis: XR for pharmaceuticals, automotive and oil & gas

Key partners in this scenario

Cloud	aws, Microsoft Azure Hyperscale cloud for long term storage of 3D CAD models
Edge	***Testing with several US operators*** Real-time rendering of 3D CAD models
End application	arvizio Mixed reality platform and end application
Hardware	magic leap Smart glass hardware manufacturer

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Real-time collaboration in design and engineering

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

In certain industries, particularly those related to design (of buildings, products, etc.) and engineering, many different parties need to collaborate on a particular project and the files used can be very large (e.g. 3D CAD models in engineering). AR/VR software can be used to visualise a design project (e.g. so you can walk through the proposed lay out for a house).

Transition to edge

Currently this is only possible when the smart glass is tethered to a laptop and cannot support multiple parties (in different locations) viewing the same AR/VR image. With edge computing, the large image can be hosted nearer to each individual end user so that all parties can see real-time changes while maintaining their own unique POV. Network edge will provide the necessary low latency and level of mobility required for this use case as adoption increases. As the number of devices per location increases, the majority of the MR data processing will shift from the device to network edge.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	90%	0%	0%	10%
2030	15%	0%	65%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Real-time inventory management

LOCATION CAPABILITY A-Z

How it works

- Organisations are having to handle rapidly increasing number of online retail orders alongside customer demand for same or next day delivery.
- To do this, they need to have awareness of what stock is where in the supply chain at any given time, at the granularity of individual product level.
- This can be achieved by collecting large amounts of data on the real-time position and status of goods (for example, monitoring the temperature of fresh produce throughout the supply chain).

Why edge?

- In high speed production lines, bottlenecks and faults in production must be detected in real-time, requiring low latency
- Many sensors per product generating data every second needs to be analysed on-premise to reduce backhaul
- Warehouses will want to store proprietary, potentially sensitive information about their operations on site (rather than in the cloud)

Potential ecosystem partners

- **Data analytics platform providers –** GPUs may be required for machine learning
- **Hyperscalers** – the cloud can be used to share learnings between warehouses and with others along the supply chain
- **Systems integrators** – specialist firms who understand the warehousing industry may be required
- **IoT device manufacturers** – eventually these many come in-built into machinery

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

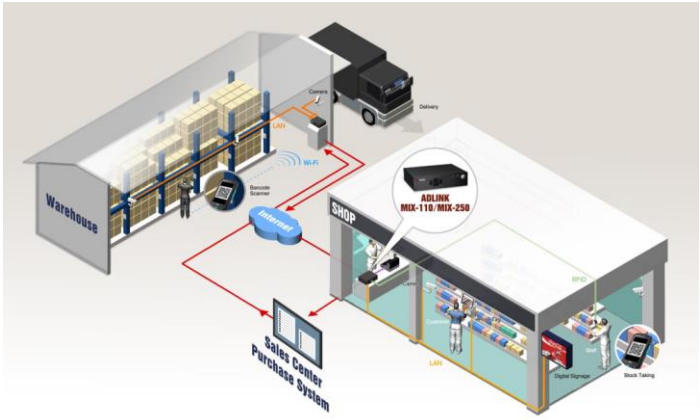
Real-time inventory management

Case study: ADLINK

LOCATION CAPABILITY A-Z

How it works

- The position and status of a pallet can be monitored – in the case of ADLINK it primarily uses smart cameras that can scan the barcode on the pallet to know what stock has been placed where
- ADLINK Data River analyses the data in real-time and can alert staff of fraudulent barcodes or pallets in the wrong place
- Data is streamed real time between the edge devices, the warehouse management system, ERP software, cloud, and warehouse employees.



Example of this use case by others

Ocado Technologies: the Ocado Smart Platform (does not currently use edge computing)

Swim ai: blog post on edge computing and RFID use cases

Key partners in this scenario

Cloud provider	AWS provides central cloud to enable syncing of information
Compute hardware provider	ADLINK edge provides specialised hardware for the edge IoT analytics
IoT device manufacturer	Intel IoT Group provides IoT sensors

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Real-time precision monitoring and control

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Some manufacturing processes require maximum quality (e.g. engine and blade parts in airplanes) to ensure their safety.
- Unpredictable machine vibrations and "chatter" mean that parts have to be reworked – the need to do this is often not discovered until the end of a lengthy production process.
- An edge-enabled solution could enable processes to be monitored in real-time and adapted to minimise defects and ensure optimal production.
- To do this data on machine performance and product conditions and quality need to be converged, analysed, and resulting actions carried out, in real time.
- This analytics and actioning can be hosted on the edge.

Why edge?

- Using an edge platform allows swift deployment of new analytics applications/increasing sensor numbers/handling of shifts in volumes of workloads (Vs. a traditional on-premise solution)
- Only relevant information from the wide scale sensor data ingest is sent and stored in the cloud
- Allows for testing and failures on infrastructure which is separate from where mission critical applications are hosted. Affecting one will not affect the other
- Requires millisecond latency to identify any anomalies

Potential ecosystem partners

- **UAV application providers** (e.g. Dronedeploy, Agisoft, Pix4D) – have existing customer base as well of application capabilities
- They can bring the necessary technical requirements for the solution
- **Systems integrators** would be necessary in the ecosystem to help integrate data and information from the drone into existing protocols/processes

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

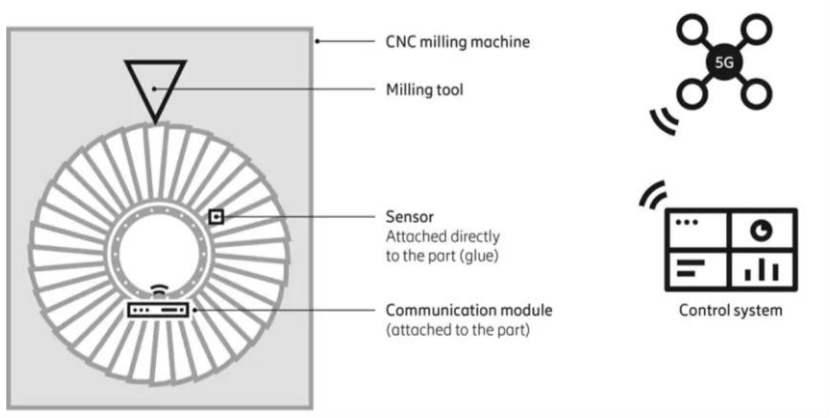
*AEC: Architecture, engineering and construction

Real-time precision monitoring and control

Case study: MTU Aero Engines

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

How it works



- Many sensors attached to both machine and product
- Real-time sensor data streamed (using 5G) to control system
- Automated changes to machine (e.g. speed at which the milling tool rotates) made based on alerts of potential defects
- Reworks needed initiated earlier in the process (25% of BLISK blades are currently reworked)

Example of this use case by others

FUJITSU

Fujitsu: IoT solutions at the edge

Key partners in this scenario

Technology provider	Ericsson are testing solution as part of their 5G for Industries research series
Research partner	Fraunhofer Institute is working with Ericsson to develop solutions
Manufacturer	MTU Aero Engines manufacture BLISK blades

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Real-time precision monitoring and control

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

This use case is the pinnacle of IoT in industrial (and agricultural) settings, as it refers to using operational data to optimise industrial equipment in real-time, by changing the way in which they behave (e.g. changing the speed at which a blade rotates based on parameters such as temperature, vibration, etc.). In agriculture, it could entail changing crop irrigation in real-time, for example.

Transition to edge

Edge computing would be used to offload the machine's control system to a nearby compute device to reduce the amount of processing happening on the device (thus making it cheaper). This allows for greater flexibility, as operational process could use IT, OT and contextual data to continuously change processes. Today, since the software is tied to the hardware, enterprises find it very difficult to make any changes to the operational system and it can take decades to do so (i.e. when the equipment is end of life). The below shows the transition for the manufacturing version of this use case, in agriculture, we would assume most would use a network edge as it would be more effective to scale across such a large area.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	70%	20%	0%	10%
2030	10%	69%	1%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Remote monitoring and care

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Life expectancy is increasing leading to an increase in treatment of chronic, non-communicable diseases - this adds pressure to healthcare and long term social care, so remote monitoring could help save costs and increase access to healthcare
- IoT, e-health devices and patient wearables can provide real time visibility of a person's status providing visibility, alarms and alerts (missed medication, increased blood glucose levels, severe fall, heart rate monitoring etc)
- However, it is often perceived as unsafe to run these applications in the cloud
- Processing data on the device edge can ensure the protection of sensitive data transmitted between patient and healthcare provider, as well as reduce 'noisy data'

Why edge?

- Processing data on an edge device, rather than passing to a smartphone or tablet, maintains security of sensitive data
- Can be cost effective to use edge to reduce the cost of the end-device
- This involves continuously collecting raw data, which is expensive to transmit to the cloud
- Low latency needed when anomaly is detected and need to trigger an alarm

Potential ecosystem partners

- **Connected device manufacturers** e.g. blood glucose monitors
- **Application developers** to provide user-friendly ways for healthcare providers/ patients to review data collected from IoT devices
- **Solution providers** to offer end-to-end solutions to the healthcare service
- **Clinicians and healthcare governing bodies**

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

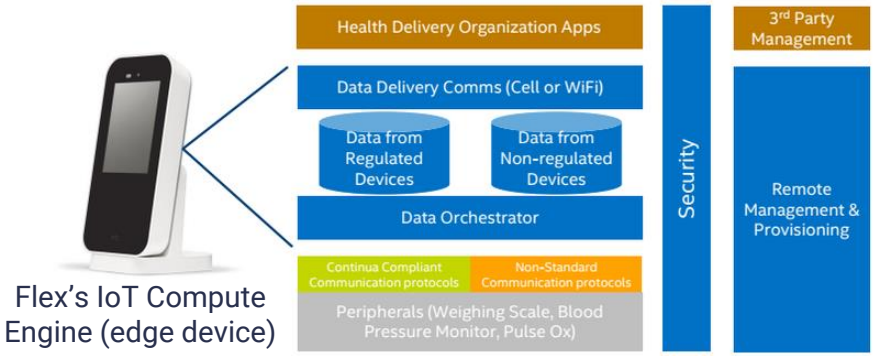
Case study: Intel

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- The Intel Health Application Platform software can power multiple hardware designs offered by Flex, using its edge device, providing a model to build a new category of edge devices
- HAP offers a trusted software environment to connect applications and IoT devices (e.g. blood pressure monitors) to collect, store and transmit patient data



Flex's IoT Compute Engine (edge device)

Example of this use case by others

TATA CONSULTANCY SERVICES

Tata Consultancy Services: fog computing services for remote patient monitoring.
Fog Computing Platform that helps providers access, store, monitor, and diagnose patients' key health parameters in a localized manner, via a mobile application or portal.

vodafone

Vodafone: several case studies (not yet using edge) for remote patient monitoring

Key partners in this scenario

Application platform provider	HAP enables data from the connected device to be collected, stored and transmitted to healthcare providers
Edge device	Flex's IoT compute engine enables sensitive data to be processed locally, alleviating security concerns from data passing across tablets etc.
Remote healthcare service provider	Provide applications and other services to bring solutions to customers

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Remote monitoring and care

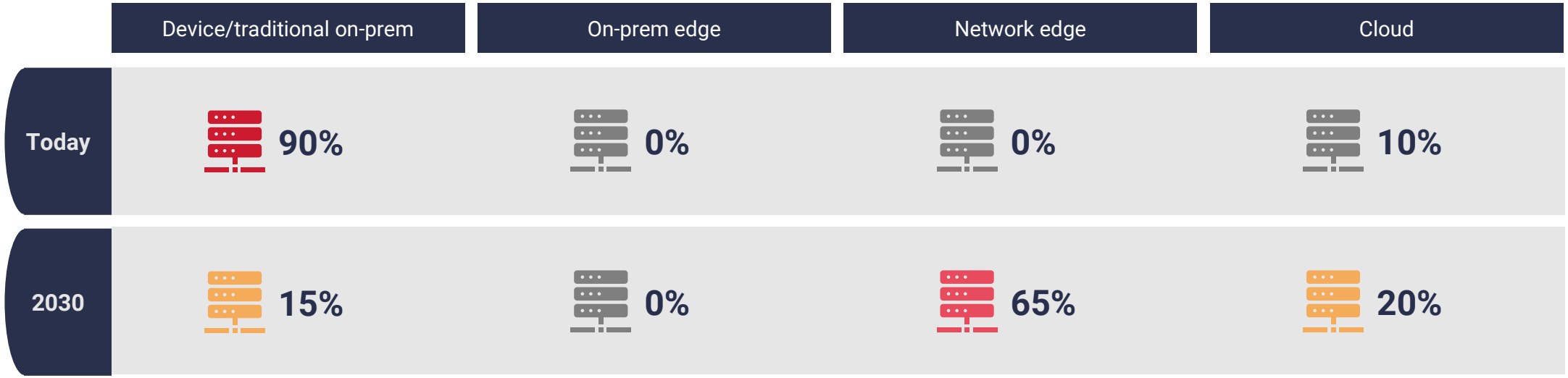
EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

Life expectancy is increasing leading to an increase in treatment of chronic, non-communicable diseases - this adds pressure to healthcare and long term social care. Patient wearables can provide real-time visibility of a patient's status and enable automatic alerts to be sent (e.g. for missed medication or for a fall).

Transition to edge

Today, the information is stored and processed on the device – but this has drawbacks including making the device relatively expensive and reducing its battery life, thereby reducing the amount of time it is likely to be worn for. Processing the information at the network edge instead will allow the information to be securely stored, without relying on a central cloud provider.



Percentages denote an estimate for the amount of overall application processing that occurs at each location

Security - video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- There is increasing use of video surveillance in cities / municipalities and enterprises, with data volumes growing both because number of cameras is increasing as well as the quality of video
- Instead of routing the video traffic to central control for analysis, local break-out of traffic and analysis on an edge site can enable:
  - Aggregation of video streams from different types of cameras
  - Filtering of events (i.e. only send footage back when movement is detected)
  - Real-time facial recognition and/or incident detection
  - Real-time alarms and actioning

Why edge?

- A purely cloud solution would not meet the latency requirements for real-time analytics/actioning
- Furthermore, data (e.g. from facial recognition) could be extremely sensitive – edge cloud maintains data security and sovereignty vs public cloud
- Analytics at the edge reduces burden on network connectivity and cloud infrastructure
- Running analytics on the edge in place of on the device means more simple (cheaper) cameras can be used for smarter use cases

Potential ecosystem partners

- **Systems integrators**: edge cloud is useful is for its ability to utilise any end camera system for the analytics (as intelligence is on the edge), which requires integration with existing/legacy systems
- **Application providers** to deliver specific security use cases (e.g. facial recognition - AI developers)
- **Camera/device OEMs** to better understand the technology with which to integrate
- **Governments and local councils** will likely be prime consumers of this use case

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

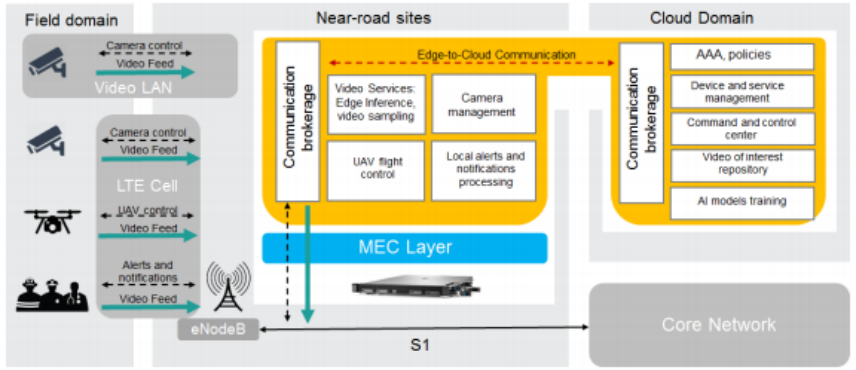
Case study: AWS

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Video feeds from body cams, CCTV, drones ingested on MEC platform
- Edge sites located close to the video feeds enable low-latency services
- New services include: facial recognition, real time situational analysis, object/threat classification
- Cloud hosts applications which do not require low-latency or lots of bandwidth (e.g. remote updates/device management/data storage)
- More compute intensive functions such as AI model training could also be run in the cloud



Example of this use case by others

AgentVI - innoVi

Trace: detect intrusion, loitering, and license platers

Key partners in this scenario

Edge infrastructure	Hewlett Packard Enterprise: X86 platform for compute and networking at edge locations
"MEC" vRAN platform	Saguna: Enables break out at the access network and deployment at the network edge
Application enablement platform	aws: Enables users to build, deploy, and maintain applications between the edge and the cloud
Hyperscale cloud infrastructure	aws: Enables users to build, deploy, and maintain applications between the edge and the cloud

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Security - video ingest and analytics

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

Public spaces and venues have used CCTV to ensure the safety and security of sites like prisons, car parks and construction sites for some time. With the addition of video analytics, incidents can trigger automatic alerts rather than someone having to monitor the live video stream.

Transition to edge

Today, any analytics on video footage occurs on premium, AI-enabled video cameras. Over the next ten years, we would expect more of this compute to happen at the edge. For use cases where there is a large fixed premise, e.g. a prison, the analysis is likely to run on on-premise edge servers (assumptions below show this scenario). For use cases where there is no one fixed premise or where those premises are space-constrained, e.g. for monitoring open air sites like parks, the network edge is more likely to be leveraged.

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2030	10%	69%	1%	20%

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76-100% of total processing

Smart ATMs

LOCATION CAPABILITY A-Z

How it works

- Banks are pursuing digital transformation and looking to deploy smart ATMs as many are currently operating on legacy technology and Windows XP operating systems which Microsoft has ceased support for, which can pose risks
- Edge-enabled smart ATMs can enable new capabilities:
  - **Cybersecurity:** Network edge workloads can run security and fraud detection applications to prevent card fraud or malware attacks
  - **Biometric authentication**: Banks have begun trialling camera facial recognition as a second-factor authentication for more sensitive transactions which could replace the need for debit cards
  - **Revenue opportunities:** Smarter ATMs can bring new marketing opportunities for targeted loans, retail offers or mobile top-up

Why edge?

- Enables the low latency required for real-time biometric finger and facial recognition technology which will prevent fraud and also avoid user frustration
- Allows sensitive customer data to remain secure and private on site
- Apps run locally/independently at the edge and its dependence on external networks is minimized which allows for more intense workloads (biometric authentication etc.)
- Reduced onsite visits with immediate fault location and immediate troubleshooting

Potential ecosystem partners

- **ATM OEMs** – many current ATMs will need to be replaced with new systems
- **ISV vendors** – camera manufacturers can provide the specialist sensors and lenses require for biometric authentication
- **Systems integrators** – integration of cameras or sensors into the broader ATM infrastructure

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Smart ATMs

Case study: InHand Networks

How it works

InHand Networks launched a SmartATM solution to decrease ATM downtime:

- ER800 series cloud managed SD-Wan edge router provided alongside the InCloudManager SaaS service
- Gives customers a high speed secure connection and ensure efficient centralised management of up to tens of distributed sites with these workloads stored in the cloud
- Data processed on InHand Smart ATM platform for remote monitoring and management e.g. real time fault alerts

1. *Smart ATM machine*
2. *Edge Router800 with InCloud Manager SaaS service*
3. *InHand Smart ATM analytics platform*

Example of this use case by others

Virtusa offer a smart ATM solution with biometric access, remote teller assistance, image enabled deposit and online assistance

Milesight developed a solution to ensure stable cellular connectivity for ATM machines in the US for reliability and security

Intel with their Active Management Technology allows IT teams to securely manage Smart ATM devices remotely

Key partners in this scenario

Smart ATM OEM	NextATM: Manufacturer of Smart ATM machines e.g. Next ATM
Hardware provider	InHand Networks: Provision of EdgeRouter800, a series of cloud managed SD-WAN edge routers
Cloud provider	Use cloud provider e.g. AWS to move workloads to clouds and run the inCloud Manager SaaS service
Analytics platform	InHand Networks: InHand Smart ATM platform which provides ATM operation analysis alongside real time fault alerts

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

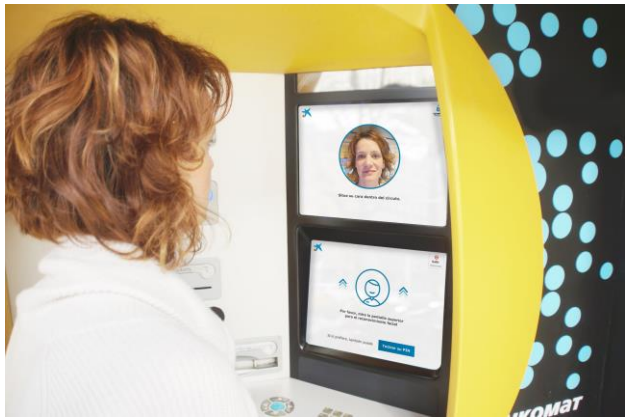
Smart ATMs

Case study: Caixa Bank

How it works

Caixa Bank launched a solution where customers can use facial recognition to withdraw cash from ATMs:

- Smart cameras and software platform allow the validations of up to 16,000 points on the image of the user's face which allows for a totally secure identification
- Data would be processed on the on the edge server which would allow for the reduced latency and intense workloads required for the facial recognition technology



Example of this use case by others

Bank of New Zealand have developed a solution so customers can make a deposit with their card or make coin deposits

Maya Labs have developed a solution to replace traditional ATMs at retail stores to run multiple applications

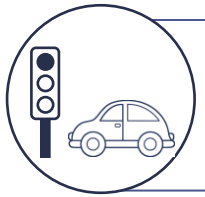
Virtusa offer a smart ATM solution with biometric access, remote teller assistance, image enabled deposit and online assistance

Key partners in this scenario

Smart ATMs	Caixa Bank have deployed Smart ATM machines across Spain
Smart cameras	Partnered with Fujitsu to provide smart cameras required for facial recognition
Edge server	On-premise servers, as offered by HPE, Dell, among others.
Software provider	Facephi uses smart learning patterns and ML technology to allow for biometric authentication

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge



Smart city traffic management

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Edge compute can enable more effective city traffic management, and optimise transport/transit systems, using the vast quantities of data that are already being collected and analysing them with edge compute
- Examples of this includes optimising bus frequency given fluctuations in demand, managing the opening/closing of extra lanes, changing light sequencing and managing future autonomous car flows
- Data that is already being collected includes data on real-time mobile location and speed of movement (as collected by Vodafone, and as was sold via API to TOMTOM previously), as well as historic data, weather, citywide traffic flows, events, cameras and sensors

Why edge?

- There is no need to transport all the high volume data to central cloud, reducing the cost of bandwidth
- Flexibility will allow the system to scale how based on much compute is needed, ensuring the client is only paying for what they use
    - For example, scale up the compute power during rush-hour, and down at night when there is less traffic

Potential ecosystem partners

- **Traffic management developers**, such as Siemens, who provide the required hardware, software and strategic traffic management and coordination solutions
- Integrating new systems with existing/legacy traffic management systems is imperative, so partnerships with **Systems Integrators** in the space are important

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

STL PARTNERS

*AEC: Architecture, engineering and construction

Smart city traffic management

Case study: Swim.ai

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

- Combines edge computing, machine learning and self-training 'digital twins
- Edge could be on servers across the city or on devices themselves
- The software is self-training and operates in real-time, so it is possible to act on the insights immediately
- The image shows an example of real-time visualisation produced by swim, using machine learning to provide real-time insights and predictions about local traffic conditions

Example of this use case by others

Siemens offer a range of solutions for road traffic management, including smart traffic detection

Dell: white paper discussing smart cities, highlighting traffic control as a 'high-value use case'

Bhubaneswar Smart City has installed smart traffic infrastructure

Key partners in this scenario

Sensors — Real-time mobile location, traffic lights etc,, as well as historical data, events data etc.

Edge servers/cloud platform — E.g. Cloud (e.g. connect to Azure IoT Hub in the cloud), or they could be on-premise servers, as offered by HPE, Dell, among others

Analytics software — e.g. Swim's EDX software with machine learning/AI capabilities

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Smart city traffic management

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

Using inputs from a series of strategically placed cameras and sensors to optimise the flow of traffic (for motorised vehicles, cyclists and pedestrians), reduce emissions, maintain highway safety and compliance to speed limits. Low latency edge compute will allow for rapid processing of huge amounts of data at a localised level.

Transition to edge

Today traffic data is collected and processed on devices (traffic lights and cameras), which affects the management of traffic relating to that endpoint or the immediate area. Over the next few years, an increasing number of endpoints will become more interconnected and a range of sensors will be integrated into the traffic management technology ecosystem. This will result in massive amounts of data that will need to be processed and analysed at a centralised local point (e.g. within metro area), the network edge. The result of the analysis will then permeate through the adaptive traffic management system to re-balance its cadence or re-route traffic.

	Device/traditional on-prem	On-prem edge	Network edge	Cloud
Today	90%	0%	0%	10%
2030	15%	0%	65%	20%

Percentages denote an estimate for the amount of overall application processing that occurs at each location

0-10% of total processing
11-30% of total processing
31-50% of total processing
51-75% of total processing
76-100% of total processing

Smart microgrid management

LOCATION CAPABILITY A-Z

How it works

- Microgrids can:
  - Make power delivery more reliable
  - Increase the amount of renewable energy consumed
- Smart microgrids will respond to real-time changes in supply and demand to make decisions such as whether power is also needed from the centralised grid or what form of energy (renewable or not) is needed at what time
- This control of the microgrid must not come from somewhere that could be a single point of failure for the system and it must be able to function if connectivity to the main electric grid is lost
- Edge computing can ensure these requirements are met

Why edge?

- By distributing compute across the microgrid, the resilience of the system is increased, by removing a single point of failure
- By avoiding the centralised cloud, the microgrid can continue to function even if there is a loss of power or connectivity to the main electric grid
- Resilience, reliability and lowlatency are particularly important for mission-critical communication

Potential ecosystem partners

- **Centralised energy providers** (e.g. Centrica, EDF, Siemens, Scottish Power, etc.)
- **Energy start ups / resellers** (e.g. Affect, Ecotricity) because microgrids may enable new business models for energy consumption
- **Power generator hardware providers** (renewable and non-renewable)
- **Local governments** may be an ecosystem enabler to encourage more local greener energy solutions

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	**Resilience**

Edge location

Device	**On-premise**	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	**Utilities**

*AEC: Architecture, engineering and construction

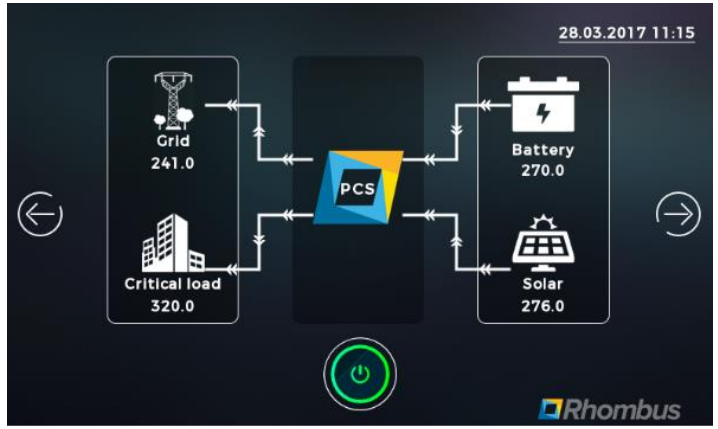
Smart microgrid management

Case study: Rhombus Energy

LOCATION CAPABILITY A-Z

How it works

- Multiple signals (voltage, current, frequency, thermal, etc.) are continuously processed and output signals to control power switches.
- Each machine has an embedded controller (VectorStatTM) that runs data acquisition logging, data bases, external communications and power applications.
- VectorStat operates in a peer-to-peer configuration allowing multiple machines to communicate as a system. The computer processing capabilities enable complex optimisation algorithms.
- The distributed design ensures all electrical demand is satisfied while eliminating single points of failure.



Example of this use case by others

WIND&SUN Powering the future Since 1984

Wind and Sun: Have established microgrids in various locations (not currently using edge)

2019 research paper on using fog computing to orchestrate the consumption and production of energy in microgrids

ADLINK TECHNOLOGY INC.

Adlink: Case study on Edge IoT solution for mobile generators after an emergency

Key partners in this scenario

Microgrid component manufacturer	Rhombus manufactures components including power converters
Microgrid operations software	Rhombus also develop software for the management of the microgrid
Research partner	University of St.Thomas are a research and testing partner

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

SME network services

LOCATION CAPABILITY A-Z

How it works

- SMEs have many of the same requirements as a Large Enterprises. This includes network and compute functions such as SD-WAN, Firewall, DHCP/DNS, Web, Database, as well as data processing and security.
- However, most CPE-based solutions are too expensive for an SME and require many "boxes" – one for each application.
- Instead, these network functions can be run on an edge cloud sitting on an on-premise edge (or universal CPE) to deliver a dedicated and customised virtual network to an SME.
- Eventually, the edge cloud could run from a network PoP (i.e. network edge).

Why edge?

- Gives SMEs access to higher performance networking services at much lower cost by removing the dedicated appliance (i.e. traditional approach from Cisco and Juniper)
- The (zero touch) flexibility will be particularly important for SMEs, who often have limited IT resource and expertise. The simplicity of edge cloud over fully owned trad-on prem brings real value to customers.

Potential ecosystem partners

- **COTS hardware providers** will provide the underlying hardware, e.g. HPE, Dell, Lenovo, ADVA, etc.
- **Switches / access point providers**, e.g. Aruba, Dell, HPE, Cisco, Huawei, etc.
- **Enterprise network software vendors**, e.g. Versa Networks, to provide the network functions that would run on the edge cloud
- **Application providers** can develop cybersecurity apps e.g. firewalls and access permissions
- **Managed service providers** will be necessary to set up and monitor the network, managing cybersecurity applications and IT infrastructure whilst ensuring compliance with data regulations

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

SME network services

Case study: ADTRAN

LOCATION CAPABILITY A-Z

How it works

(Proprietary) SD-WAN edge appliance but this is "open and virtualised", targeting SMEs

Most of the software runs in the cloud, plus redundant circuits in PoPs across the US that are at internet exchanges

Types of functions:
Load balancing
Firewall
Dynamic QoS
IP address failover
Cloud gateway

Distributed architecture to leverage a dedicated backbone network and making it easier for managed service providers to configure the solution and their SME customers

Example of this use case by others

Bigleaf Networks: Edge router-based SD WAN targeted to SMEs (proprietary appliance)

NetFoundry: Software networking services that can run on any edge hardware

Verizon: Deploying virtual network services with universal CPE

Key partners in this scenario

CPU → Intel: Adtran's hardware is based on x86 architecture from Intel

Adtran → Adtran: Adtran's 934 SDN WAN edge platform is a flexible hardware solution

Managed service providers → Sotel Systems: Key channel for bringing network solutions to the SME segments e.g. Sotel Systems

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Sustainability monitoring / mapping

LOCATION CAPABILITY A-Z

How it works

- We are seeing altering environmental conditions both due to climate change and human driven processes such as agriculture and deforestation
- Use of satellite data e.g. from NASA alongside sensor data can be used to monitor deforestation areas, agriculture practices, changes in ocean parameters etc.
- This can help monitor both human and physical impacts on environment e.g., can monitor levels of deforestation, carbon emissions in supply chains alongside tracking crop heath and agricultural practices that promote sustainability
- NGOs and governments can quantify progress towards Sustainability Development Goals and ensure progress towards emission commitments

Why edge?

- Processing large volumes of geospatial data at the edge reducing the volume of traffic travelling through the backhaul network
- Leveraging a network edge enables a highly performant application to be deployed flexibly and without the need for dedicated infrastructure – this can enable governments or NGOs to temporarily deploy the solution for monitoring and mapping without the need for significant investment or set up time

Potential ecosystem partners

- **Satellite monitoring stations** – use satellite imagery to monitor changing environmental patterns on earth
- **Data analytics platforms** – platform for data aggregation and geoprocessing for analysis
- **Governments/NGOs-** use metrics to track progress towards Sustainable Development Goals
- **Cloud providers –** store large volumes of satellite data etc. for processing

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Sustainability monitoring

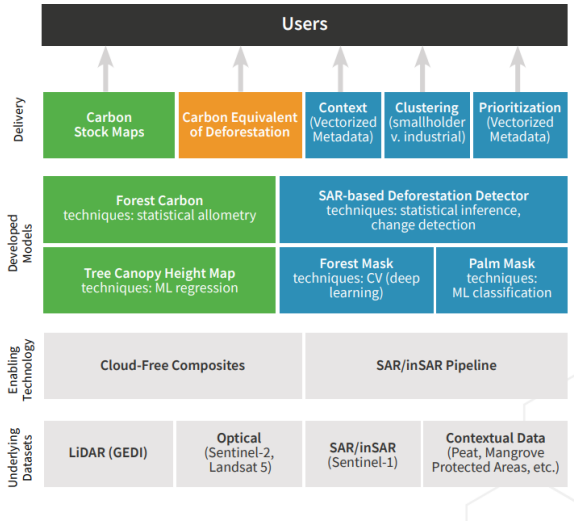
Case study: Descartes Labs

LOCATION CAPABILITY A-Z

How it works

Descartes Labs have developed a **Tropical Deforestation Monitoring solution** which is powered by remote sensing, machine learning and the fusion of multiple datasets:

- Solution combines satellite imagery and space-borne LiDAR from NASA's GEDI instrument to estimate aboveground biomass and carbon stocks in the world's forests, and to monitor forest carbon loss due to deforestation.
- First, region-specific machine learning models are trained on point measurements from GEDI where satellite imagery can be used to produce spatially continuous maps of tree canopy height and coverage.
- Second, allometric models are applied to those canopy height/coverage maps to produce spatially continuous maps of aboveground biomass and carbon at 30 m resolution



Example of this use case by others

astraea

Astraea uses geospatial analytics to detect conservation efforts and monitor climate change

planet.

Planet provides satellite imagery data for agriculture and forestry mapping

Copernicus Europe's eyes on Earth

Copernicus marine service is a cloud based platform focused on analysing various ocean parameters

Key partners in this scenario

Geospatial data provider	Global sensor/geographic data alongside satellite imagery from NASA Landsat and ESA Sentinel missions etc.
Hardware provider (processors)	intel. Solution runs on the 96-core Intel Xeon Scalable processor
Cloud provider	aws Use AWS to store huge volumes of data + enable highly scalable compute capabilities
Analytics platform	Descartes Labs Descartes Labs geoprocessing platform provides real time actionable insights for sustainability monitoring

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Temporary compute for events

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

LOCATION CAPABILITY A-Z

How it works

- Temporary, emergency or seasonal events mean that businesses have to provision compute to remote or temporary locations and then remove this when the event has finished.
- An edge solution would involve a generic light weight server that could be provisioned at short notice hosting edge applications instead of specialist infrastructure.
- Examples of these would be short term logistics hubs for peaks in demand, large scale emergencies and seasonal events such as festivals and sports events.

Why edge?

- Resilience – local compute means functions can be completed even when core cloud connectivity is underperforming or unavailable
- Low latency – proximity to end user allows low latency applications and real time analytics
- Scalability – Allows customers to scale up and down their compute load and their sites of operation as needed
- Generic server – TCO reduced through reducing need for dedicated specialist infrastructure

Potential ecosystem partners

- **Temporary event connectivity providers** (as edge computing capabilities is likely to be sold as part of a broader bundle of services including event Wi-Fi etc.)
- Potential for **specialised hardware providers** (e.g. Nvidia for GPUs) depending on event requirements (e.g. events where audience members wear VR headsets)

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

Temporary compute for events

Case study: Formula One

EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL

CLICK HERE

How it works

- F1 have replaced their on-premise data centres and instead migrated to AWS
- SageMaker can support the machine learning needed for customer experiences such as "battle forecast" which tells fans the predicted likelihood an overtake will be successful
- In the future, by using edge computing, F1 would be able to reduce time taken to extract these insights and reduce backhaul costs

Example of this use case by others

DHL: Logistics-as-a-service offering includes modular cloud platform

Key partners in this scenario

Connectivity provider

Telecom operators could provide the specialized event connectivity

Cloud provider

AWS provide the cloud and machine learning platform

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

STL PARTNERS

Temporary compute for events

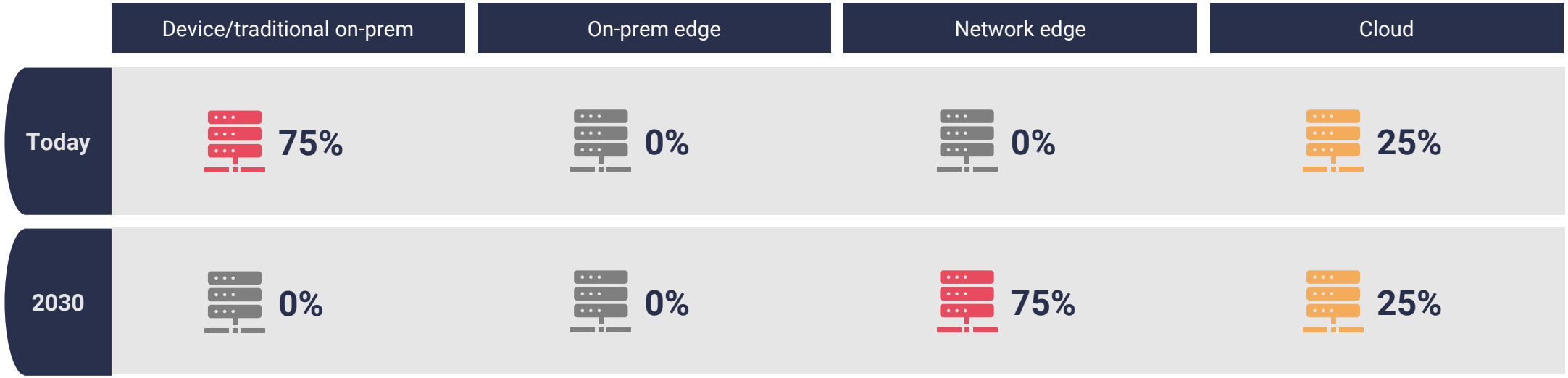
EXPLORE THE REVENUE POTENTIAL OF THIS USE CASE IN OUR MARKET FORECAST MODEL
CLICK HERE

LOCATION CAPABILITY A-Z

Temporary, emergency or seasonal events mean that businesses have to provision compute to remote or temporary locations and remove this when the event has finished. An edge solution would involve a generic light weight server that could be provisioned at short notice hosting edge applications instead of specialist infrastructure. Examples of these would be short term logistics hubs for peaks in demand, large scale emergencies and seasonal events such as festivals and sports events.

Transition to edge

Currently with most servers being deployed ad hoc where the events take place, most of the processing occur on on-premise edge servers and the rest is done in the cloud. When/where network edge becomes available, capacity can be provisioned in the network and on-premise servers become unnecessary as processing moves deeper in the network at an edge node.



Percentages denote an estimate for the amount of overall application processing that occurs at each location

Virtual PC/DaaS/VDI

LOCATION CAPABILITY A-Z

How it works

- Moving compute/graphics intensive processing from the PC/desktop and hosting the compute on an on-premise/network edge on a virtual high-end PC
- Uses for this include:
  - Genomics & research
  - Simulations
  - Gaming
  - Computer-aided design
  - Video and heavy graphics editing
- This is sometimes also known as DaaS (Desktop-as-a-Service) or VDI (Virtual Desktop Interface)
- Customers would be able to spin-up a virtual PC accessible via any device (including BYOD). They would also be able to rent and archive as many vPC's as they need, allowing scalability and flexibility for the business
- Although compute is hosted on the edge, saved and archived data could be stored in the cloud or on device

Why edge?

- Virtual PC often needs high processing, including GPUs
- Edge cloud offers the flexibility and low price entry point of cloud hosting along with the low latency necessary compute intensive applications
- Taking compute off device and hosting on the network edge significantly reduces the cost of the desktop / end-device
- It can also help business comply with data privacy laws (e.g. HIPAA, GDPR and PCI) by accessing cloud locally

Potential ecosystem partners

- There are existing **DaaS (desktop as a service) providers** who can bring the capabilities in vPC and develop edge-based solutions
- This includes the **hyperscalers**, who offer cloud based solutions today but may leverage edge infrastructure in the future
- To meet requirements for creative/compute intensive industries, GPU capabilities to render high-quality models would be essential
- **Application providers** such as Altair run applications on the infrastructure

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

*AEC: Architecture, engineering and construction

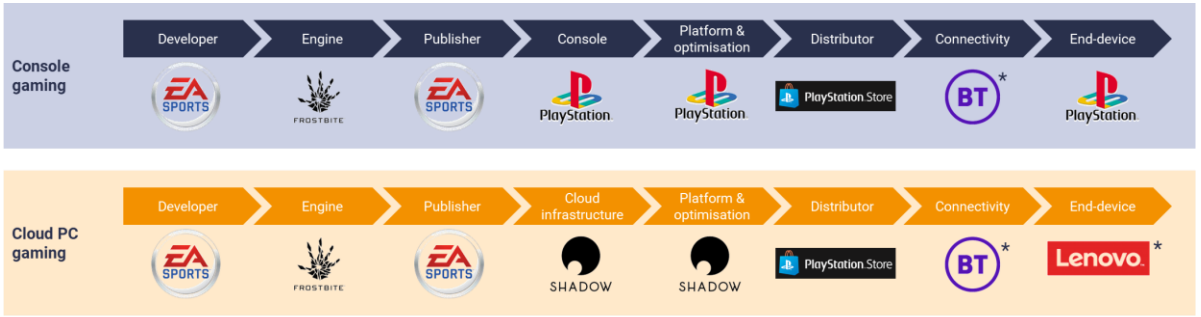
Virtual PC/DaaS/VDI

Case study: Shadow.tech

LOCATION CAPABILITY A-Z

How it works

- Shadow provides cloud infrastructure for virtual PCs for gaming
- The cloud could be at the edge to ensure the interaction between the end-device and the game is latency minimal



Example of this use case by others

Spectrum Virtual: 'Desktop as a Service' using edge computing

AWS: High Performance Computing clusters (currently does not use edge)

Citrix Workspace: Virtual desktop on the on-prem edge with Cisco hyperconverged infrastructure

Edgegap: Provide computing infrastructure for gaming

Key partners in this scenario

Edge facility	Telecom operator and/or regional data centre (plus hardware) to run edge cloud gaming
Virtual PC	SHADOW Underlying infrastructure and optiisation to host virtual PCs- mainly for gaming
Games publisher	GAMELOFT Studios that publish games – often have their own gaming developers
Distributor	Distribute games via platform or other means – could be white labelled

Edge maturity

Scaled commercial solution | **Commercial solution** | POC / trial leveraging edge | Does not currently use edge

Worker safety: video ingest and analytics

LOCATION CAPABILITY A-Z

How it works

- There has been increasing use of video analytics to ensure compliance with safety requirements across workforces
- Video footage captured by cameras can be analysed at the edge to screen workplaces and generate alerts when policy violations occur or unsafe health conditions are detected
- Key applications for this use case include:
  - Health monitoring: cough detection, hand washing, elevated temperature detection etc.
  - Safety monitoring: wearing the correct personal protective equipment (hard hats, footwear etc.), ensuring exclusion zones are followed
  - Hazard detection: leak detection, equipment safety zones, spill hazards etc.

Why edge?

- Enables low latency required for real time detection of safety incidents and quick preventative action / alerts
- There is no need to transport all the raw footage from high-quality video streams to central cloud reducing backhaul and bandwidth costs
- Offloading the compute from the camera to the edge allows for the use of simple cameras that cost less
- Reduced need for the wide area network ensures the resilience and reliability of the solution

Potential ecosystem partners

- **Systems integrators** - analytics software at the edge will require all end cameras for analytics to be integrated with existing/legacy camera solutions
- **Data analytics platforms** – platform for data aggregation and visualisation for non-real and real-time analysis
- **Video intelligence software providers** - helps to detect potential incidents and objects using AI/ML

Capability

Latency	Reliability	Reduced backhaul	Data localisation
Flexibility	Light device	Mobility	Resilience

Edge location

Device	On-premise	Network	Private network

Industry vertical

Agriculture	AEC*	Defence	Emergency services	Extractive industries	Financial services	Government	Healthcare	Logistics	Manufacturing	Media & entertainment	Professional services	Retail	Tourism	Transport	Utilities

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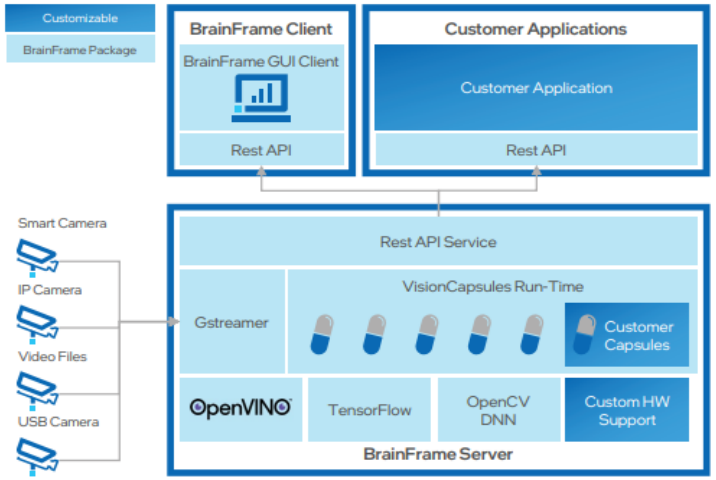
Worker safety: video ingest and analytics

Case study: Aotu

How it works

Aotu's BrainFrame Architecture

- Brainframe connects thousands of live video feeds at the edge in under an hour with no coding required and starts extracting actionable data to provide real-time analytics
- BrainFrame is provided on a preconfigured Intel Core with engineering services available to help customers or their system integrator partners train custom algorithms to meet their needs



Example of this use case by others

Telus uses edge to develop safety solutions for workers using AI/ML capabilities

IBM Maximo Worker Insights service analyses information from cameras/IoT sensors to deliver alerts to workers on sites

Edge Impulse launched a solution to determine if construction workers are wearing hard hats

Key partners in this scenario

Cameras	Any camera able to transmit data over for processing (e.g. Hitachi)
Edge hardware	Intel provide the edge hardware e.g. servers and processers to run the edge AI workloads
Video analytics platform	Aotu through their BrainFrame platform use AI to track zones, objects and behaviors that trigger real time alerts etc.
Systems integrator	Trains custom algorithms to meet their specific customer needs e.g. Atos

Edge maturity

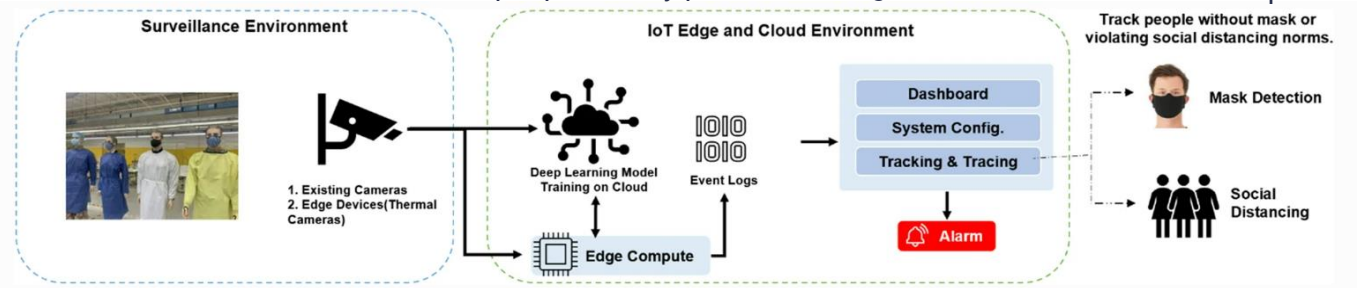
Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

Case study: Foghorn

How it works

Foghorn have utilised edge to help minimise virus transmission with Covid-19 with these use cases applicable in a number of other scenarios. This includes cough, mask, body temperature and PPE detection alongside hand washing and social distancing monitoring. An example deployment is below:

1. Video ingest from smart cameras
2. Executes deep learning models to detect people + body parts etc. and generate alerts
3. Ensure implementation of health policies



Example of this use case by others

Microsoft describe a solution to help provide Covid - 19 detection and prevention at a theme park. Microsoft also describe a Covid-19 safe solution that can be implemented across workplace facilities.

IBM Edge Application Manager places analytical workloads with edge-enabled cameras that can recognise face masks and determine if they're being worn effectively.

Key partners in this scenario

Camera	Any camera able to transmit data over for processing (e.g. Hitachi).
Edge server	On-premise servers, as offered by HPE, Dell, among others.
Software Platform	FogHorn's platform brings advanced analytics and machine learning to on-premises edge environments.

Edge maturity

Scaled commercial solution	Commercial solution	POC / trial leveraging edge	Does not currently use edge

If you are interested in understanding how STL Partners can support you...

Contact us!

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