Democratising the “Edge”

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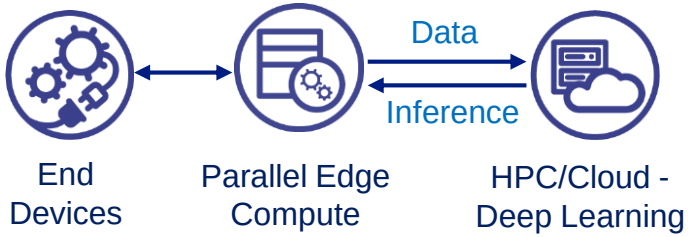
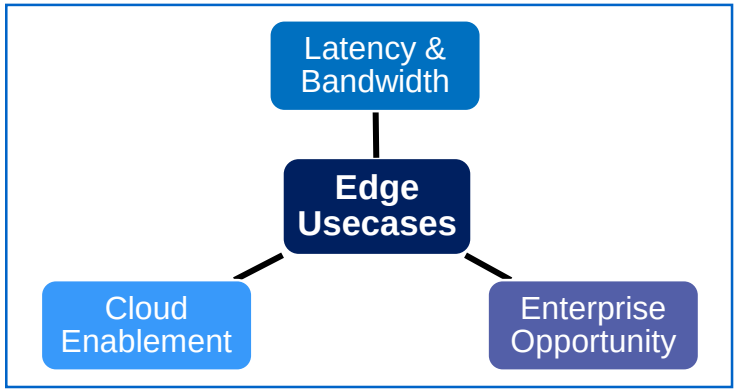
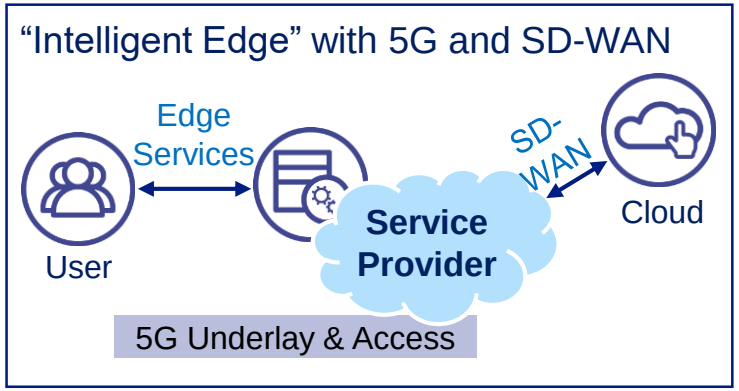
Global Industry Perspective: Edge Computing

Edge Computing already exists as a growing segment today. It will accelerate with 5G and Telco Cloud roll out

Edge devices range from IOT to parallel processors, feeding data into the Cloud







Edge Devices

A range of enterprise and consumer edge devices have proliferated:

- Nvidia Jetson Nano: AI at the edge
- Google Coral: ML at the edge
- Raspberry Pi 4: video output in 4K
- Pocket sized edge compute controller
- Compact NFVi from Telco vendors

Market and Industry Usecases

Global Market is $175-$215bn by 2025
(Source: McKinsey)

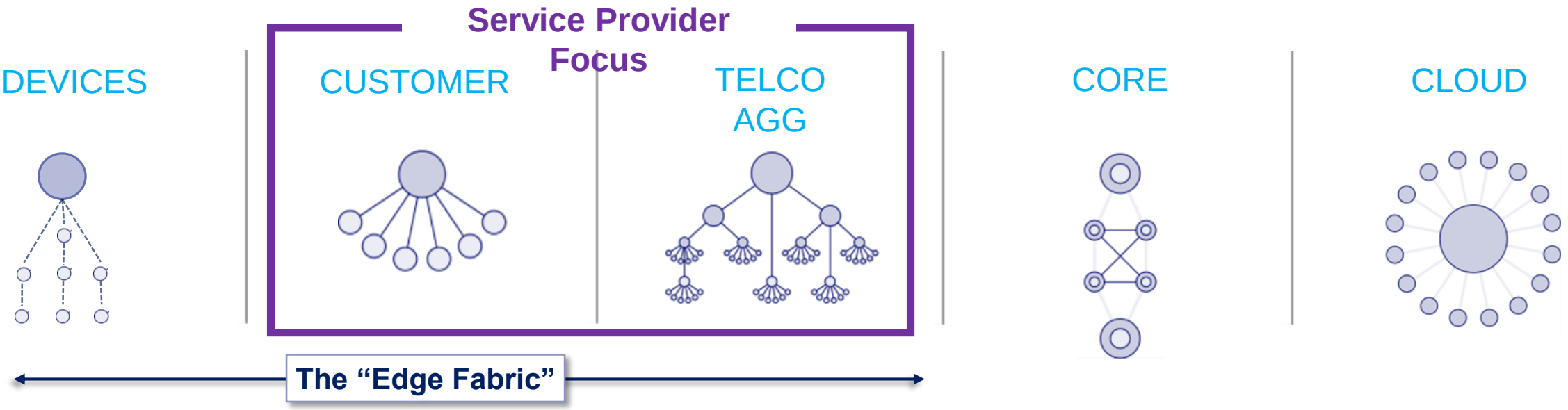
Industry Updates

Service Provider, Hyperscaler, and Open Source Community efforts:

- AT&T multi-access edge with Azure
- SK Telecom edge for enterprise and devs
- Telecom Infra Project: Intel and Telefonica
- Amazon Outpost and MS Azure Stack
- Global consortium: MobileEdgeX
- Linux Foundation: Akraino, ONAP Edge

The “Edge” Context

The “edge” has different meaning in different contexts

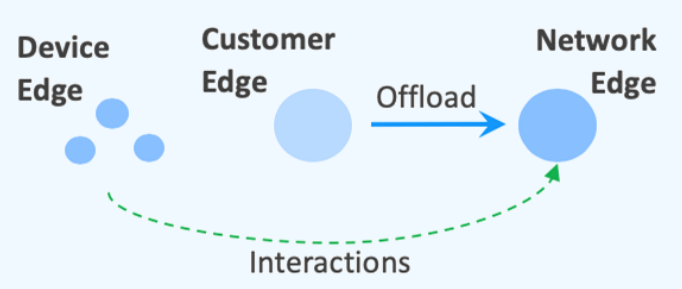


Far Edge / Device Edge	Enterprise Customer Edge	Telco Network Edge	Regional Locations	Central & Partner Locations
Devices with local processing, connected as per needs, e.g. IoT, drones	Devices connected in a premises, possibly using different Telco Agg providers	Physical extensions of existing datacentre, exchange or premises locations	When datacentres are connected on a map, an edge is the “line” drawn between sites	High-performance devices, from multiple providers and multiple core networks

Edge Computing “Patterns”

Common value propositions observed from customer

Cost Reduction



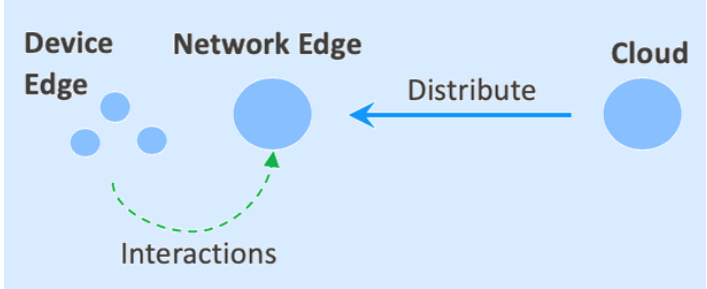
Offloading complex infrastructure from customer to network edge

Untethered workforce

Infrastructure free branch

Fast scale up and down

Performance



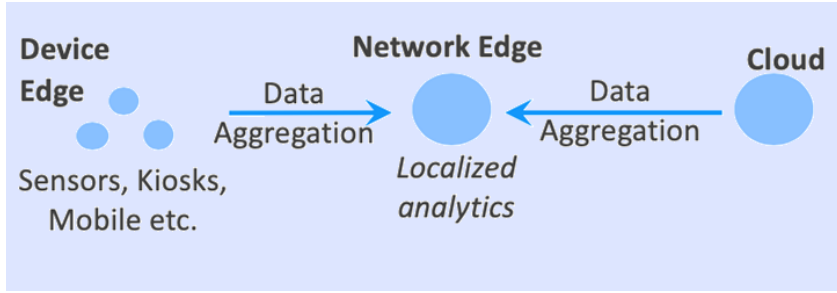
Running latency and bandwidth sensitive apps workload

Reliable performance

Modularised resiliency

Better responsiveness

Monetisation



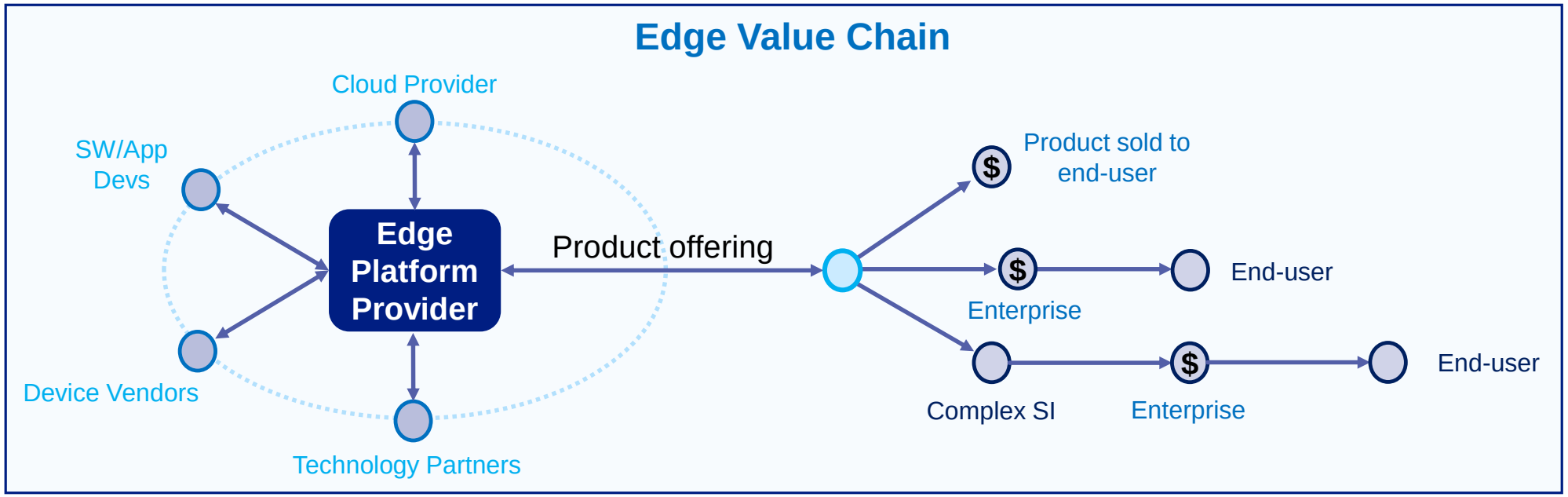
Aggregating data with context to drive customer experience

Personalisation and Surveillance

AI/ML-powered decisions

Managed service offering

Edge Opportunities and Usecases



Verticals	Example Usecase
Immersive Experience	Cloud gaming
Retail & Banking	Branch offload
Mining & Energy	Operational technology
Automotive	Connected vehicle
Public Safety	Video analytics

Different business models can be leveraged

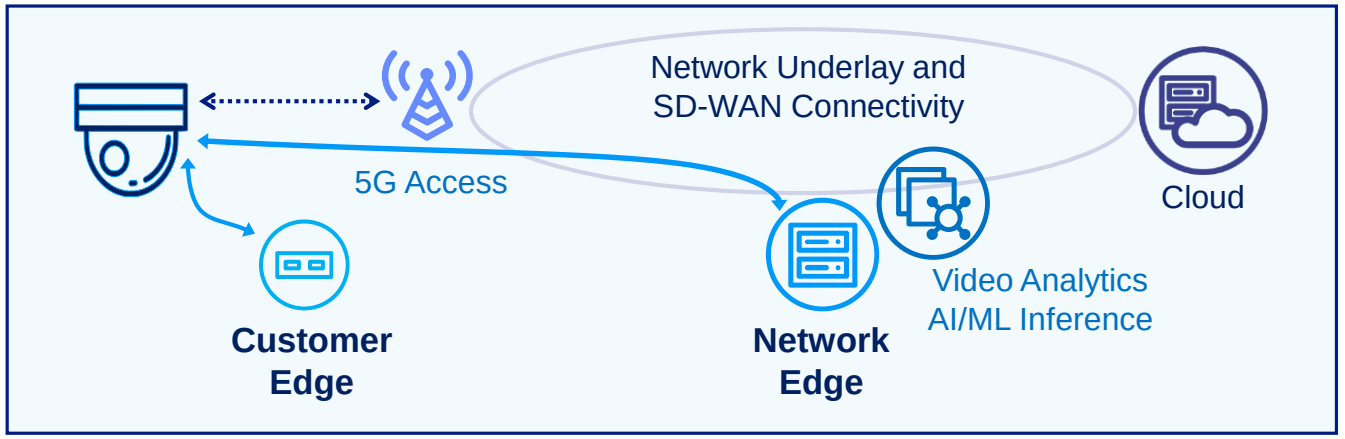
Dedicated Edge Hosting

SI and Managed Offering

B2B2x and End-user Apps

Representative Usecase: Video Analytics at the Edge

Business logic closer to end-user to improve experience and operational



- In-store immersive marketing (smart kiosk, proximity tracking)
- Store automation
- Queue management
- Sentiment analysis
- Cyber security
- Public safety and surveillance

Realisation Challenges

- Complex system integration across network, edge technology stack, and apps
- Managed service operation between multiple parties
- Seamless connectivity across customer locations, edge and cloud end-points
- Application-aware workload placement logic and orchestration, considering session anchoring, service state and failure management

Building the Edge Foundations

Service provider capabilities need to evolve and/or augmented to enable computing at the edge

Large scale edge host management

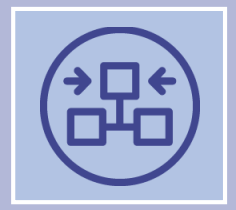
Hybrid Cloud integration

AI/ML model acceleration

Stateless distributed datastore

Edge Enablers

Edge Hardware and Software Stack



Locations, Connectivity and Network Topology

Apps Workload Placement and Orchestration

De-facto Edge APIs

Edge application on-boarding

Integrate with vertical solution

Secure tenant partition

- Edge is a “network of clouds” across geo-locations
- Edge locations are based on population (humans and machines) coverage, strategic significance, and customer demands
- There is a consistent view (inventory, service modelling, routing, resource utilisation, performance) towards the edge

Hardware and Software

The Computing Continuum

Over time, Edge Computing will cover the whole computing continuum

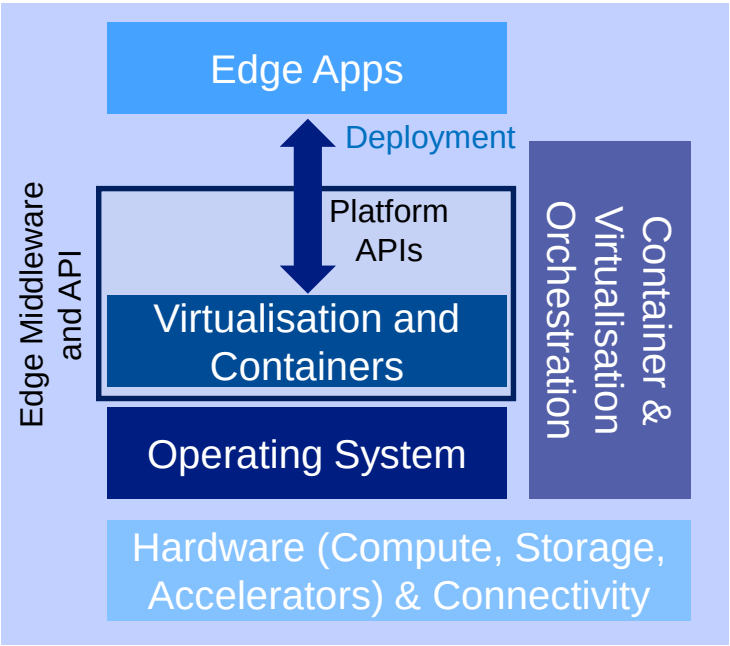
Consumer Devices	Servers	Server Clusters	Datacentres
Small Footprint	Medium Footprint		Large Footprint

Vendors are developing compact devices with smaller footprint and lower form factor that are suitable for edge deployment

Appropriate run-time system and programming model is required to enable dynamic orchestration and AI-powered automation for multi-cloud, multi-edge, and multi-device management

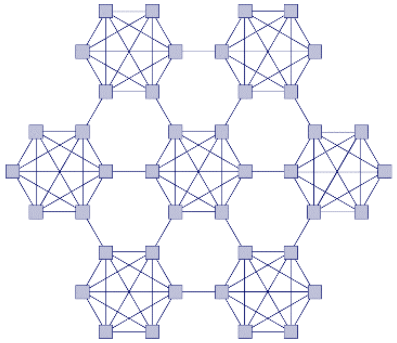
Edge Software Stack

Highly available and container-based, potentially leveraging open source



Location, Connectivity and Topology

Edge footprint is directly proportional with horizontal scaling of apps workload, influencing a customer-centric network topology



The “Edge Fabric”

Common network and data plane

Central configuration management

Scalable Network infrastructure

Integrated Connectivity

- End-to-end IP and Optical transport
- IP hand-off at the edge where user terminates
- Intent-based routing and policies at the Edge

Edge Topology

- Network topology adapts to workload requirements
- Ring and meshed topologies to support low latency
- Persistent, on-demand and parallel edge compute

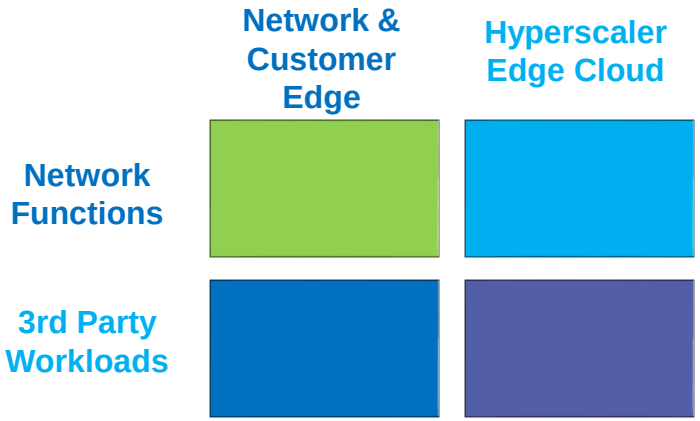
Apps Placement and Orchestration

The Apps Continuum

Larger to Smaller Components

Monolithic	SOA	Microservices	Nanoservices
Single Unit	Coarse-grained	Fine-grained 1 function = N jobs	Very fine-grained 1 function = 1 job

Workload Placement

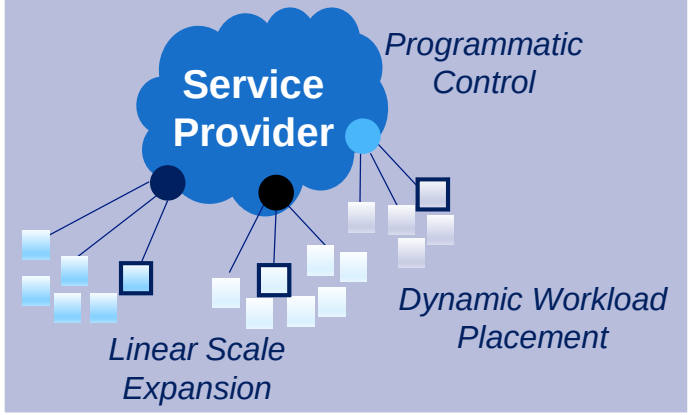


Apps Strategy

- Applications are cloud-native, micro/nanoservices-based and containerised, dictating a secure serverless approach
- Persistent and event-triggered apps
- Use CI/CD for rapid deployments
- Trade-off between apps security vs delivery speed may be required

Orchestration

Across service and resource layers

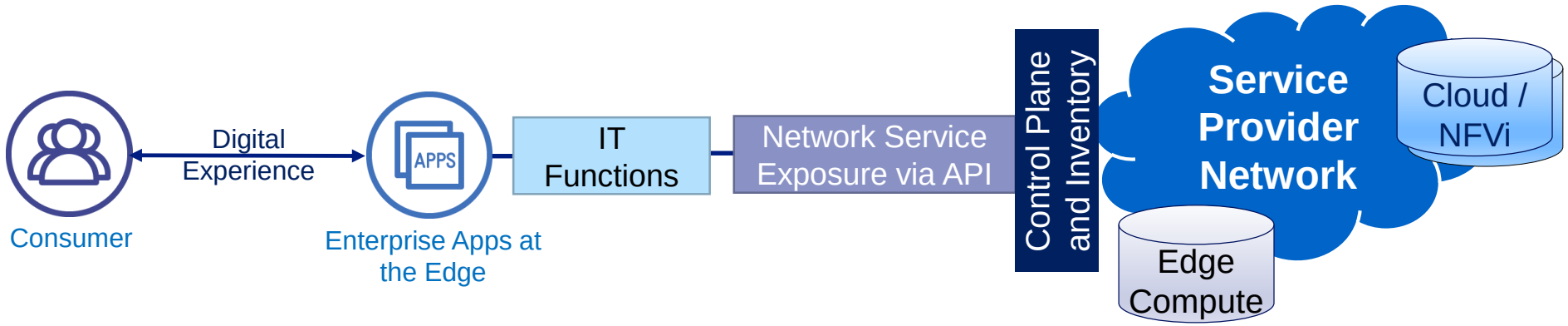


Example Workload:

- Internal network functions and Enterprise Apps running on Network & Customer Edge
- Real-time analytics running on Hyperscaler Edge Cloud

Bringing Edge to Life

End-to-End realisation across Networks and IT technology stack is required, supported by Closed Loop DevSecOps operations



Security and resiliency features need to be enabled across apps, networks, and hosting platforms

End-to-End Security and Resiliency

Edge applications are likely to adopt highly available application architecture, including ability to run in atomic mode (where applicable)

Security elements need to be present at each edge locations and devices, so that authentication and security (scanning, validation, anomaly detection) can be performed with or without persistent network connection to the edge

Monitoring

- Real-time visibility via service view of the network and usage-based predictive analytics

Platform

- Edge node autonomy when disconnected, and automatic reconnection recovery

Network

- A/B path, diverse links, alternative access methods and overlapped coverage zone

Edge Deployment

- Plug-and-Play edge node. Templated rapid edge node deployments and replacements

Key Takeaways

Edge computing exists today!
Differentiations will occur through the ability to instantiate an edge service and provide managed services, in cognisance of the required connectivity in the E2E

Usecase-driven approach: Edge computing capabilities are driven by the underlying usecase, characterised by performance, cost reduction, and monetisation opportunities

End-to-End realisation: The whole ecosystem of apps, networks, operations and consumption needs to be enabled to extract the full benefits of edge

Multi-provider partnership: Edge computing maturity and adoption will accelerate through co-creation and enabling partnered and managed product offerings