Solution Brief

Converged Edge Solutions
Smart Road Side (RSU) Unit

Transforming the Modern City with the Intel-Based 5G Smart Road Side Unit Solution from Capgemini Engineering

Capgemini Engineering's 5G Smart Road Side Unit (RSU) uses the ENSCONCE Edge Computing Platform and cloud-native architecture to transform intelligent transportation infrastructure

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The promise of 5G for smart cities and connected infrastructure

Today more than 50 percent of the world's population lives in cities—a figure expected to reach 70 percent by 2050.[1] In response, cities are looking for ways to streamline traffic flows, reduce emissions, and improve the commuter experience.

For city planners, transport authorities, and infrastructure operators, intelligent transport systems (ITSs) may hold the key to these initiatives. These systems require city road infrastructure that supports reliable, low-latency communications between traffic monitoring cameras, sensors, vehicles, and pedestrians.

5G wireless networks provide extreme reliability and low latencies needed to support these use cases. However, ITS applications must run on computing assets located at the nearest network edge device to be viable.

Fulfilling this need requires an all-weather, 5G compute and networking node capable of hosting 5G connectivity and AI applications that enable a range of smart infrastructure use cases.

Challenges: IoT complexity and legacy infrastructure

City authorities and solution providers face several challenges when implementing smart city and ITS applications, including:

- Legacy infrastructure was not designed to support emerging smart solutions, making it difficult to deploy decentralized applications at the network edge for local processing.
- Traditional hardware solutions are typically outdated, custom-built boxes. These monolithic legacy solutions don't support the evolving needs of smart city applications that employ visual computing and AI capabilities.
- Emerging IoT solutions demand a complex convergence of compute, networking, communications, and software.
- Smart city application developers may not fully understand the complexities involved in building, testing, and deploying solutions on-premises and at the network edge. These challenges can include complex regulatory requirements, funding constraints, and lengthy deployment times.

The Capgemini Engineering Smart RSU solution

Designed in conjunction with application developers, enterprises, operators, and device makers, the Smart RSU solution enables intelligent transportation applications like traffic management, EV charging, smart lighting, and connected vehicle services. By placing computing at the network edge, the Smart RSU solution reduces network latency and processing times.

Possible use cases for the Smart RSU solution include:

- Vehicle and pedestrian detection in busy intersections using 5G-connected camera feeds and AI to optimize traffic flow
- Identifying and warning pedestrians and drivers of potential collisions through V2X
- Warning roadside workers of approaching traffic
- Alerting drivers to blind turns or unsafe road conditions
- Allowing city traffic controllers to dynamically establish green-light corridors for emergency vehicles

The Smart RSU solution incorporates Capgemini Engineering's ENSCONCE multiaccess edge computing (MEC) platform. ENSCONCE implements Intel's Converged Edge Architecture (CERA), which brings intelligence to the network edge while hosting 5G network capabilities and microservices. CERA allows solutions designers to build disaggregated nodes while converging network, compute, and AI acceleration.

ENSCONCE also integrates Capgemini Engineering 5G NGC and RAN frameworks. The 5G NR RAN is coupled with Intel's FlexRAN Layer-1 providing virtualized radio access network capability to the platform. Together, ENSCONCE and FlexRAN allow solution builders to create small, localized 5G points of presence that can cover a virtually unlimited number of traffic intersections while insulating designers from the underlying networking complexities.

The Smart RSU solution combines the following software frameworks:

- ENSCONCE MEC Platform
- Intel® Smart Edge Open
- 5G gNodeB L2/3 and FlexRAN L1
- 5G NGC
- Intel® Distribution of OpenVINO™ toolkit

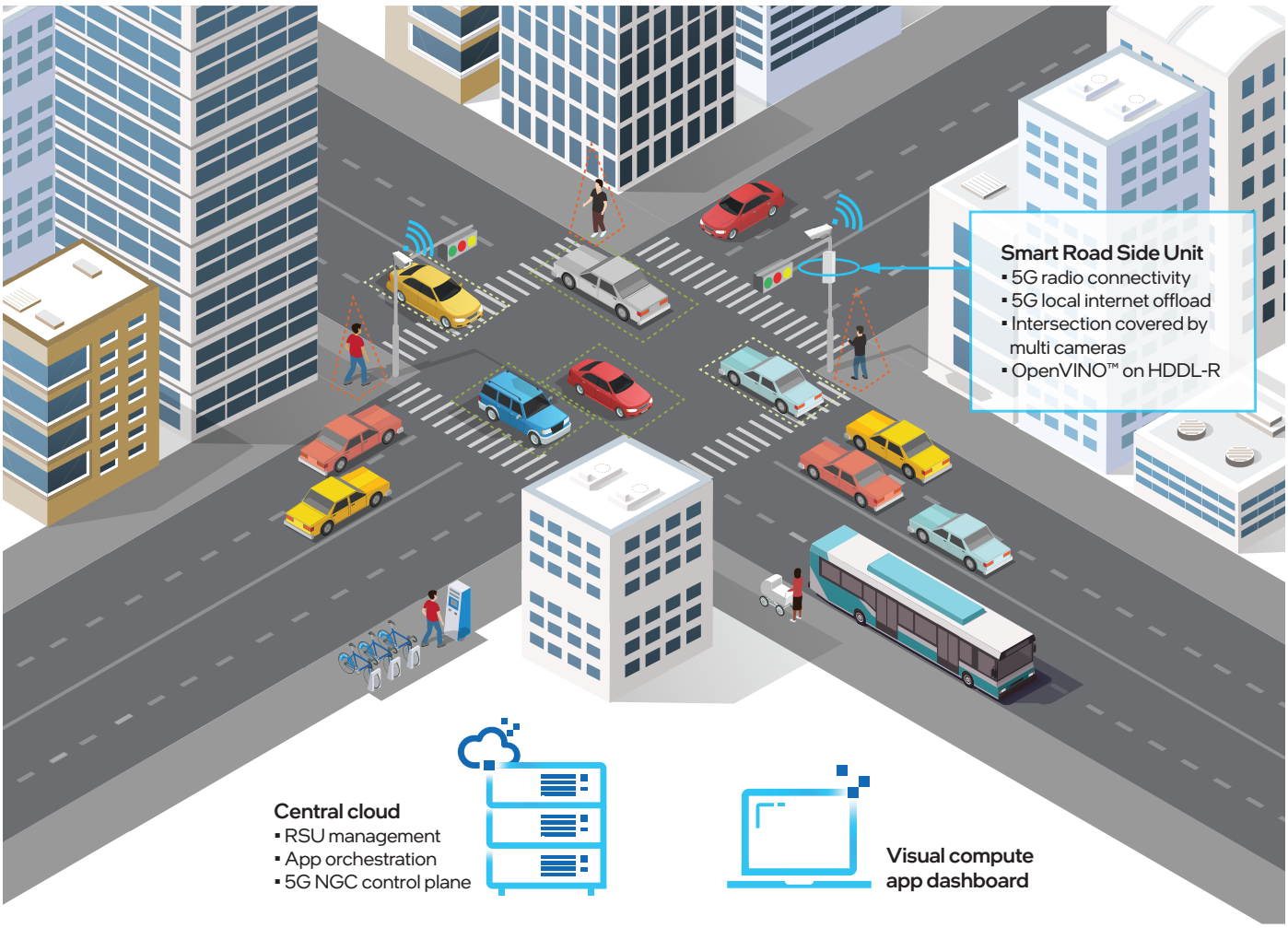

Figure 1: Capgemini Engineering 5G Smart Road Side Unit (RSU) Deployment

Solution elements

The Smart Road Side solution consists of several platform elements that work in concert to maximize 5G network, cloud, and computing performance. These include:

Intel's Converged Edge Reference Architecture (CERA)

CERA is a reference platform approach for IoT and networking workload convergence. CERA merges IoT workloads with wireless infrastructure network technology to simplify edge workload convergence while densifying wireless networks. With 5G connectivity, CERA provides networking capabilities that allow IoT devices to communicate with each other at the edge or send data to the cloud. It processes the information from cameras, radar, and a wide range of sensors.

The CERA architecture abstracts network and application complexity while streamlining service development and deployment, enabling preintegrated applications to be quickly deployed and scaled.

Capgemini Engineering ENSCONCE MEC Platform

The ENSCONCE MEC Platform is a cloud-native, edge application runtime and orchestration platform that enables application developers to deploy applications across a cluster of edge computes intelligently. ENSCONCE works in a wide range of hardware environments and enables compute, analytics, and storage functions to be located close to IoT sensors. This allows developers to leverage the benefits of low-latency computing and network differentiation provided by telecommunication operators.

The ENSCONCE MEC Platform consists of two components:

The ENSCONCE Central Platform incorporates the Application Orchestration, Developer & Enterprise Portal, and Multi-RSU Management Services. The ENSCONCE Central Platform also manages the deployment of RSUs across geographies.

The ENSCONCE Edge Pass (Figure 5) consists of the Runtime and Application Platform, Edge-App Registry, and Edge Application and Platform Management Services. These services manage the life cycle of the edge applications on the RSU.

The ENSCONCE Edge Pass also incorporates Intel Smart Edge Open platform components to provide hardware acceleration and enable platform optimizations beneficial to high-performing, latency-sensitive, network-aware applications. The combined solution addresses a primary goal of edge computing: providing efficient compute offload, reduced compute and network latency, and jitter improvements for edge applications.

The ENSCONCE advantage

The ENSCONCE edge solution enables AI inference and 5G network integration on scalable hardware platforms. It offers unique capabilities for applications designers and solution providers, including:

A developer-centric, edge-application platform. The ENSCONCE architecture supports a frictionless developer experience for building edge-native applications. ENSCONCE fully integrates with Intel Distribution of OpenVINO toolkit and Open Visual Cloud.

Cloud-native design and extensions. ENSCONCE employs a cloud-native platform design for the Road Side Unit that provides ease of extensibility and integration with analytics platforms, smart city infrastructure, and use cases for V2X. It leverages Intel Smart Edge Open plugins for Kube-native, microservice-based design.

Integrated on an Intel® Xeon® processor-powered hardware platform. ENSCONCE is designed to run on an Intel® Xeon® Scalable processor with hardware offload for 5G FEC to Intel® FPGA Programmable Acceleration Card N3000, conserving CPU resources for edge applications. Other Intel integrations include:

- Intel® HDDL-R for AI inference offload
- Accelerated networking using SR-IOV/DPDK
- Integrated on the Supermicro hardware platform for outdoor deployment

Intel® 5G FlexRAN and Capgemini Engineering 5G Frameworks

The Capgemini Engineering 5G NGC framework leverages end-to-end product engineering services and its world-class 5G NR software to enable RAN solutions based on different SoC architectures. The solution accelerates time to market for both OEMs and service providers by reducing solution development complexity and preintegrating with existing partners' L1 and RU ecosystems. It enables and optimizes macro and small-cell solutions and supports both high- and low-capacity use cases for rural and dense environments.

The Capgemini Engineering 5G RAN solution complies with all industry standards set by the 3GPP, TIP, and O-RAN. The solution's FAPI (femto application platform interface) makes it interoperable with other vendor solutions. The FlexRAN Layer-1 offloads lower Layer-1 processing to an Intel® PACN3000 FPGA as a look-aside accelerator.

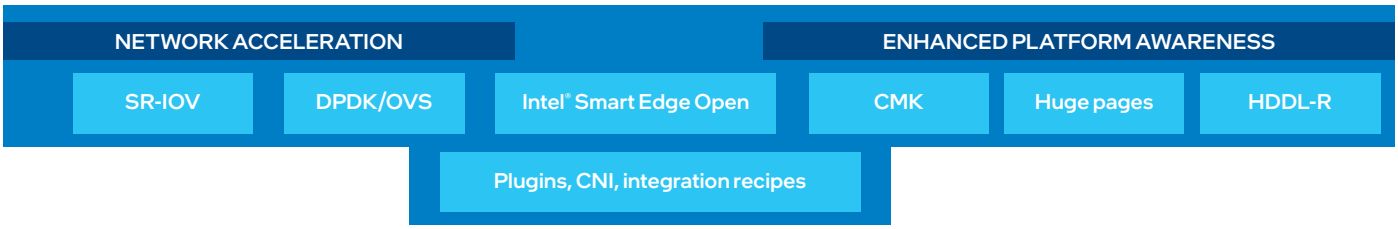

Figure 2: ENSCONCE Edge includes components from Intel® Smart Edge Open

Capgemini Engineering Visual Compute Application Platform

When integrated with the ENSCONCE Edge and Intel Distribution of OpenVINO toolkit, the Capgemini Engineering Visual Compute Application Platform provides preoptimized media analytics pipelines for use cases applicable across a range of industries and domains. The media pipelines such as GStreamer (GST) can be configured to reduce processing latency and provide detailed inference results with multiple media streams handled in parallel. The media pipelines can also utilize the underlying heterogeneous compute resources, including CPUs and HDDL-R VPUs.

The Visual Compute Application Platform speeds application development by enabling application developers to integrate computer vision capability into their applications without the complexity of optimally running vision machine learning models on compute resources.

The Intel Distribution of OpenVINO toolkit

OpenVINO (Open Visual Inference and Neural Network Optimization) enables developers to build and optimize AI-based computer vision models on Intel® hardware. Using OpenVINO, developers can take advantage of existing Intel® processor architecture to quickly build, optimize, and scale deep learning and visual inference applications. The toolkit allows the same application to be deployed across a wide range of processors and environments, including CPUs, GPUs, VPUs, FPGAs, on-premises, at the edge, or in the cloud.

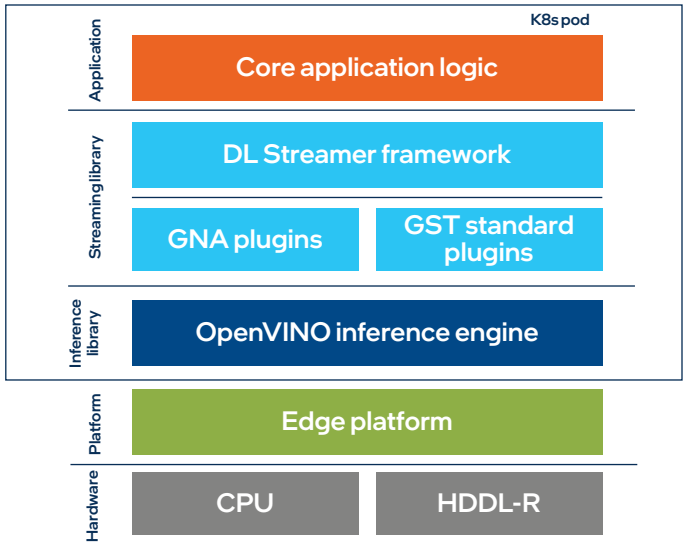

Figure 3: Visual Compute Inference Application on the OpenVino™ SDK

Intel Smart Edge Open

Intel Smart Edge Open enables collaboration and application innovation at the network and edge. It's an open source reference toolkit that allows developers to quickly and easily create and deploy new edge applications and services. With Intel Smart Edge Open, developers can access a wide range of hardware, software, and solutions to design new 5G edge applications and services.

Figure 4: Media pipeline in Visual Compute Application Platform

Capgemini Engineering and Intel—an enduring partnership

Capgemini Engineering and Intel enjoy a long-standing partnership committed to the joint development of Intel® platforms and solutions addressing various industry verticals. Beginning with a core group of 20 in 2008, the two companies now have a shared team of over 1,400 engineers dedicated to creating new IoT solutions. Today, Capgemini is an Intel® Technology Provider, Registered Partner, and an Intel® Partner Alliance member.

By integrating technologies like Intel® Smart Edge Open and Intel® Distribution of OpenVINO™ toolkit into the ENSCONCE platform, Capgemini Engineering has enhanced the capabilities of its edge computing solution with converged edge use cases while making the offering more compelling for operators and application developers.

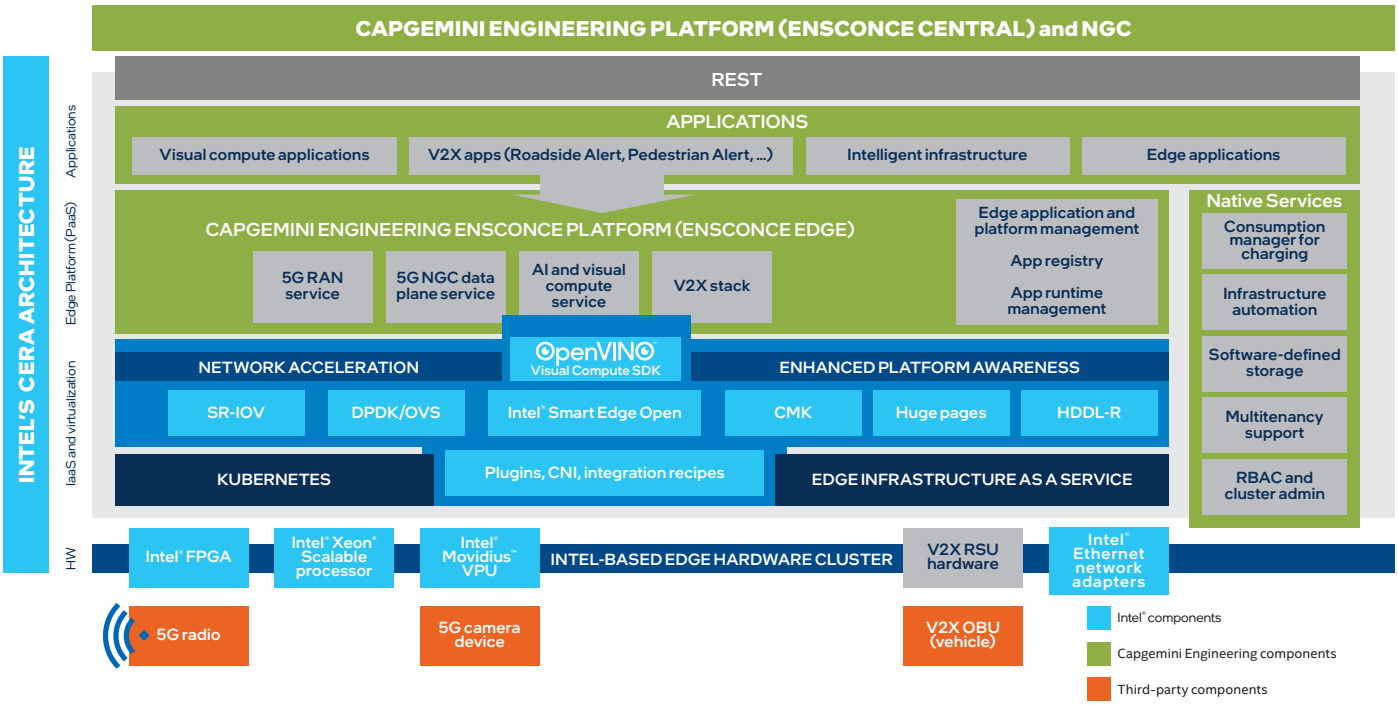

Figure 5: Platform stack

Capgemini Engineering 5G Smart RSU solution software components

Road Side Unit (RSU)

- Integrated with Edge PaaS
- Provides integrated support for OpenVINO™ SDK and Open Visual Cloud (OVC)
- Incorporates Intel HDDL-R accelerator-based VPU offload for OpenVINO apps
- Delivers 5G connectivity supported through the Capgemini Engineering 5G gNodeB L2/3 and Intel FlexRAN L1, with Intel PACN3000 FPGA offload
- Integrated 5G RAN (CU/DU) supports SA Sub-6 GHz and SA mmWave
- 5G single-cell reference configuration for RSU:
  - Bandwidth: 100 MHz, TDD mode, static TDD pattern: DDDSU with "S" slot: 8 DL symbols, 4 GP symbols, and 2 UL symbols
- 5G reference connectivity feature set:
  - MIB and SIB1
  - SSB Case B and C
  - FR 1: Numerology 1 (30 kHz SCS)
  - PRACH format B4
  - DCI format (1_1)
  - DL open loop SU-MIMO 2x2
  - DL: 64QAM
  - UL: 64 QAM
- 5G NGC UPF for local data breakout
- All integrated on a single Intel® hardware platform (single-socket 16-core Intel® Xeon® D platform)
- Software platform is capable of running on other Intel Xeon platforms based on customer requirements

Central Cloud

- Consists of the Capgemini Engineering ENSCONCE Cloud PaaS: RSU management, application catalogs and life-cycle management, resource monitoring, and other services
- Incorporates ENSCONCE Customer Self-Service Portal, Developer Portal, and RSU Operations Portals
- Includes Capgemini Engineering's 5G NGC

Reference visual compute edge applications

- Visual compute inference applications using Intel Distribution of OpenVINO toolkit and offloading to HDDL-R accelerators for vehicle/pedestrian detection and road segmentation
- Livestream metadata to V2X applications like Vulnerable Road User (VRU), Intersection Movement Assist (IMA), and other 5GAA-defined use cases

Integrated on the Supermicro hardened hardware platform

The RSU is built on the Supermicro Outdoor Edge System, which allows the Intel Xeon processor-based server to be mounted on an outdoor pole.

The pole-mounted deployment offers the following features:

- Complete server platform in IP65 enclosure for extreme environments
- Intel Xeon D or 2nd Gen Intel® Xeon® Scalable processors
- Three PCIe expansion slots for GPU or FPGA accelerator cards
- Support for virtualization and containers
- Compact and pole mountable

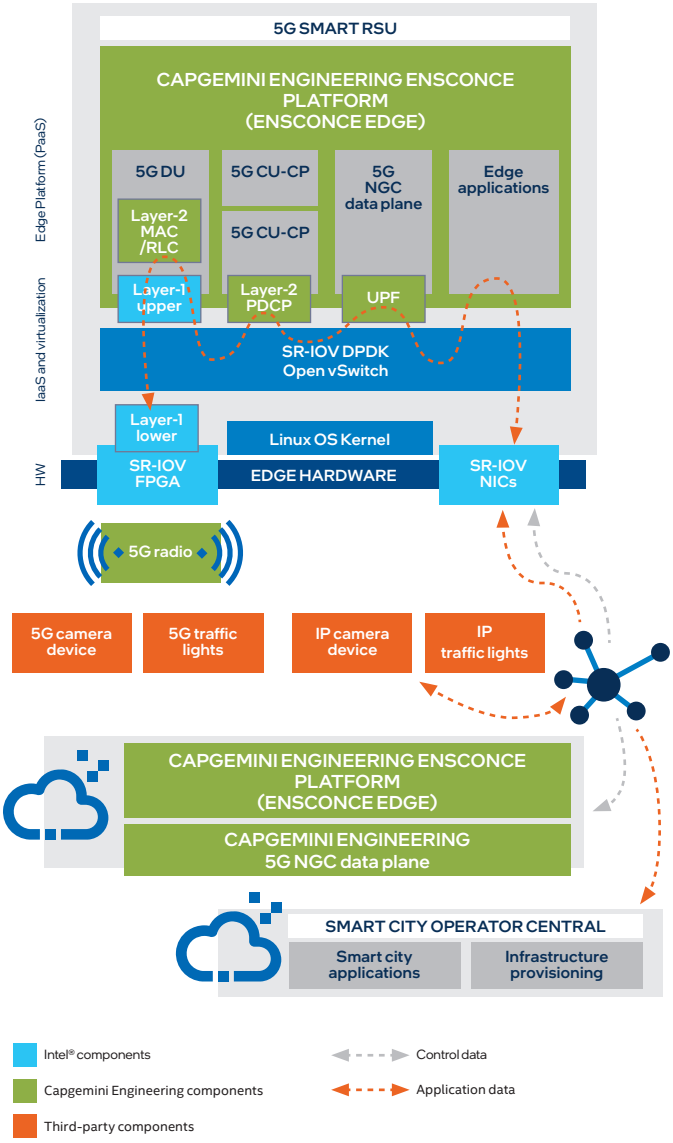

Figure 6: 5G Smart RSU journey of a packet

The journey of a packet through the Capgemini Engineering 5G Smart RSU

The Capgemini Engineering 5G Smart RSU employs network and data path acceleration to guarantee low latency from the 5G radio to the edge application.

- The RSU receives a data packet sent from a 5G device over an SR-IOV interface connecting the 5G radio.
- The packet is injected directly into the 5G FlexRAN Layer-1 through an SR-IOV Virtual Function (VF), bypassing the kernel IP stack.
- The 5G RAN stack processes the packet in user space utilizing DPDK.
- The stack then passes the packet through the Open vSwitch–based data path, where it emerges from the NGC-UPF and is made available to the edge applications.
- Edge applications can send and receive data from the 5G or Ethernet/IP connected devices.
- The Ethernet/IP connections for edge applications are also provided over SR-IOV for low-latency networking.

An evolving smart city and transportation solution

As the smart cities and transportation markets continue to evolve, the automotive industry is responding with use cases focused on collaboration between autonomous vehicles and cooperative infrastructure.

Capgemini Engineering's RSU enables that collaboration by combining multiple connectivities and sensor technologies to enhance pedestrian and vehicle safety based on a network edge platform.

By integrating Intel® technologies like 5G FlexRAN, CERA, and Intel Smart Edge Open, the Capgemini Engineering 5G Smart RSU solution provides a flexible, scalable platform for next-generation smart edge applications.

Learn more

Find out how Capgemini Engineering's 5G Smart Road Side Unit and smart city solutions are driving digital transformation for cities and municipalities.

Download our brochure ›

Visit our website ›

See how Intel is involved in smart transportation infrastructure technology.

Learn more ›

About Capgemini Engineering

Capgemini Engineering combines, under one brand, a unique set of strengths from across the Capgemini Group: the world-leading engineering and R&D services of Altran—acquired by Capgemini in 2020—and Capgemini's digital manufacturing expertise. With broad industry knowledge and cutting-edge technologies in digital and software, Capgemini Engineering supports the convergence of the physical and digital worlds. Combined with the capabilities of the rest of the group, it helps clients accelerate their journey toward intelligent industry. Capgemini Engineering has more than 52,000 engineer and scientist team members in over 30 countries across sectors including aeronautics, automotive, railways, communications, energy, life sciences, semiconductors, software and internet, space and defense, and consumer products.

capgemini-engineering.com

1. Source: The World Bank: https://www.worldbank.org/en/topic/urbandevelopment/overview