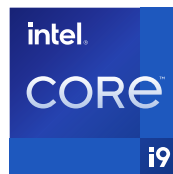


TCS and Intel Integrate 5G RAN and Intelligent Traffic Management System

Both companies have built a demonstration system that combines customized open-source based 5G software from TCS with Intelligent Traffic Management (ITM) software from Intel for a complete system that can improve traffic conditions in congested areas



Government agencies seeking to make highly populated cities more livable are adopting smart city technologies. In many of these cities, traffic congestion and pedestrian safety are two of the highest impact issues where smart city technology can provide an immediate benefit.

Intelligent Traffic Management (ITM) is a smart city technology designed to detect and track vehicles and pedestrians using security cameras with computer vision analysis in real time to provide safety alerts.

These systems offer many benefits including improved road safety and law enforcement, real-time situational awareness of traffic conditions, information sharing via message signs, and data for long-term traffic planning.



On a technical level, improvements in cameras, artificial intelligence (AI), server performance and 5G wireless networking are making ITM systems more responsive with the capacity to process more video feeds simultaneously.

One company that is architecting next-generation ITM solution with 5G is Tata Consultancy Services (TCS), an Intel® Network Builders ecosystem partner. TCS is a system integrator that delivers a complete ITM system including customized open-source based 5G network, ITM software, and other hardware including video cameras.

TCS and Intel have developed an ITM demonstration system that combines standards-based 5G network software with Intel's ITM reference implementation all running on Intel® Core™ i9 processor-based systems.

TCS Leverages 5G Experience

TCS brings 5G network software and its extensive 5G engineering services experience to the deployment of the wireless ITM system.

Through its Technology Software & Services (TS&S) Business Group, TCS has supported companies across the globe as they delivered telecom and enterprise 5G end-to-end services. The company's engineers are backed by worldwide 5G labs and centers of excellence.

The demonstration system leverages the full potential of 5G NR with mobile-edge computing technology from Intel to better utilize network capability to address needs for latency hungry applications that can make intelligent decisions to deploy low latency and high bandwidth 5G use cases and provide better user experience with performance optimization and latency improvements.

TCS's customized open-source based 5G solution (see Figure 1) for ITMS includes 5G open virtualized next-generation radio access network (NG-RAN) protocol stack and a virtualized 5G core (5GC) network protocol stack. Both of these solutions are compliant with 3GPP Release 17 architecture.

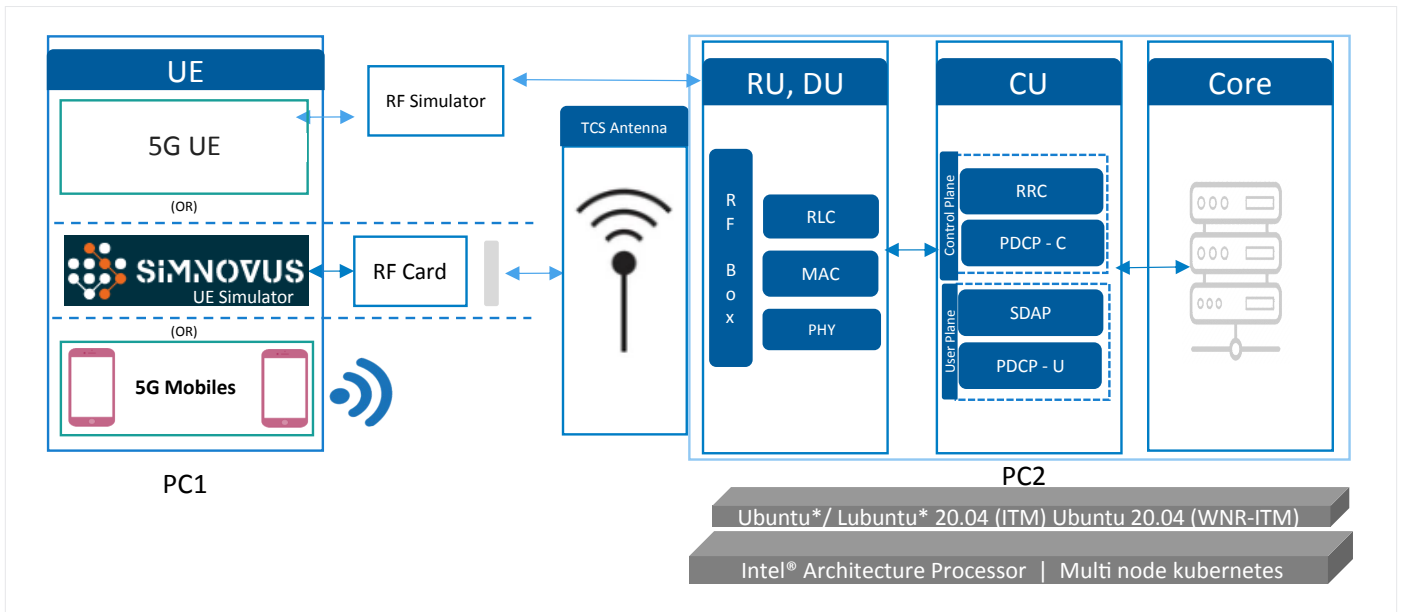


Figure 1. TCS 5G architecture diagram.

The TCS NG-RAN consists of 5G base stations (gNBs) connected to the 5GC through the NG interface. The gNBs are comprised of radio units (RU) connected to a distributed unit (DU) and a centralized unit (CU) for baseband processing of the 5G signal.

The CU provides support for layer 2 and higher layers of the protocol stack including the Service Data Adaption Protocol (SDAP), Radio Resource Control (RRC), Packet Data Convergence Protocol (PDCP) while the DU is the interface to the remote radio unit (RRU) and manages the RF signal conversion and other lower layers of the protocol stack such as radio link control (RLC), media access control (MAC) and physical layer. Multiple DUs can be connected to one CU.

The CU is connected to the 5GC. The 5GC provides data security, control plane and user plane functionality along with more than a dozen network services (such as authentication server function and unified data management). It is connected to the data network for routing packets to their destination.

Configurations/Specifications of the 5G Demonstration

- Band: n78 (license acquired), 3.3 to 3.7 GHz (FR1)
- Mode: TDD
- Bandwidth: 40 MHz
- Modulation Scheme: QPSK/QAM
- Intel® Core™ i9 processors

The architecture of the 5G setup brings the following advantages:

- Improves video streaming quality of experience (QoE) of the video feeds captured from the camera by increasing the throughput and reducing the latency.
- More intelligent and optimized networks.
- Tight integration with radio equipment makes it easy to understand traffic characteristics and needs and deal with radio conditions.



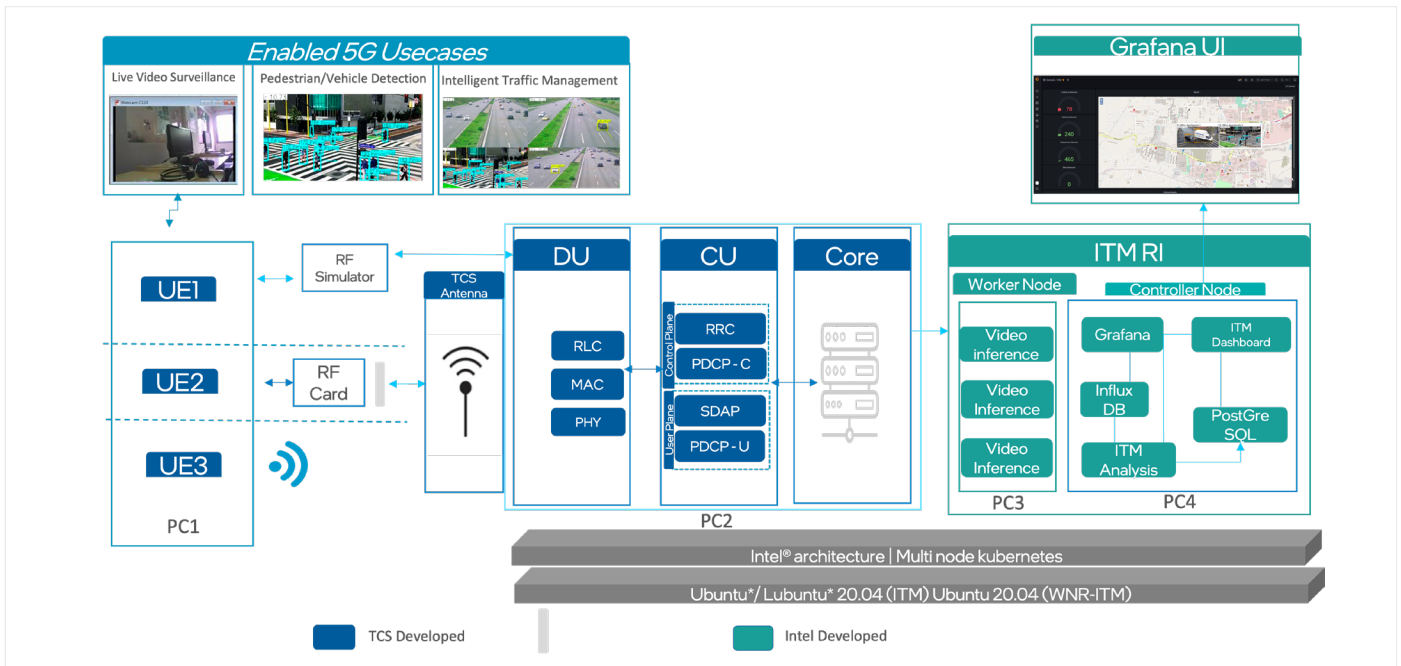


Figure 2. Block diagram of TCS 5G ITMS using Intel technology.

ITM Combines AI Inferencing and MEC Technologies

ITM is a video inferencing software reference implementation (RI) (see Figure 2) that is designed to make roadways safe by analyzing video footage of the streets and pedestrian areas to detect and track vehicles and pedestrians. This analysis is done on MEC servers which can upload data to Amazon Web Services* (AWS*) S3 storage for review.

For its video analytics, ITM relies on Intel® Deep Learning Streamer (Intel® DL Streamer), which is part of the Intel® Distribution of OpenVINO™ toolkit and delivers high performance video analytics pipelines.

For simplified deployment on MEC servers, ITM leverages Intel® Smart Edge Open Developer Experience Kit contains a Kubernetes control plane and an edge node making it easier to install and instantiate an edge cluster.

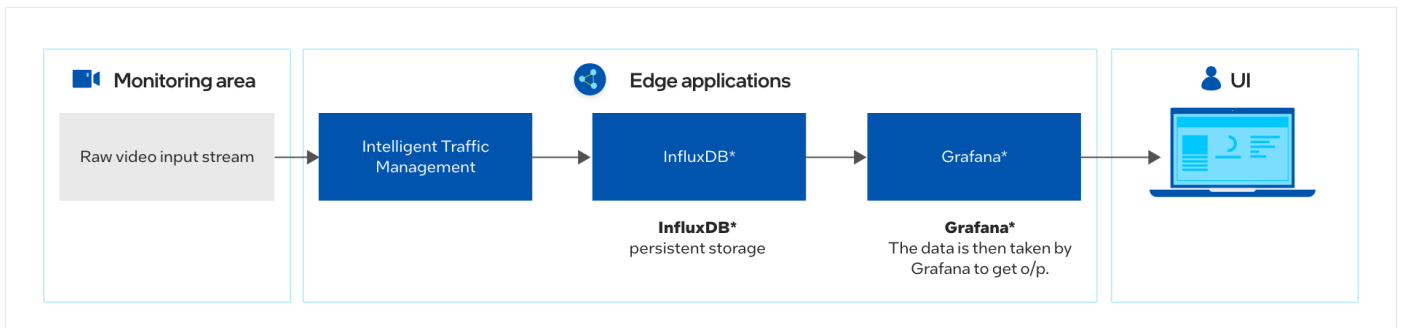


Figure 3. ITM block diagram.

Figure 3 shows how the ITM works: video cameras in the monitoring area provide raw video streams to a MEC server with the ITM applications, a database for storage and the Grafana dashboard application that reports and displays the data to the user’s computer.

The ITM application requires services pods, a database and a visualizer. The application pod takes in the virtual/actual Real Time Streaming Protocol (RTSP) data flows and performs inference before sending metadata for each stream to the InfluxDB* database.

In parallel, the visualizer displays the traffic analysis from the metadata such as pedestrians detected, observed collisions and processed video feeds.

In certain server configurations, the application can perform inferences from as many as 20 video feeds. In addition, the visualizer is capable of showing each feed separately as well as all the feeds at the same time using Grafana*. The user can visualize the output remotely over a browser, provided that they are on the same network.

Demo Setup Description

The companies developed a 5G ITM demonstration system that allows the presentation of key features of the system in a lab environment. The components of the demonstration system include:

- 5G UEs
- An Intel Core i9 processor-based system running:
 - 5G RAN (RU, DU, CU)
 - 5G core network
 - Intelligent Traffic Management System (controller node and worker node)

The prerequisites for the system include all UEs to be attached to the core network and the ITM's worker node and controller node be in the running state to receive camera streams. Once these were in place, the demo started transferring the videos through UEs, which transferred the data through 5G RAN and UPF of 5G core to ITM.

The scenarios covered in demo include live video surveillance, Intelligent Traffic Management and pedestrian/video detection. In live video surveillance scenario webcam transfers live video to the ITM node across the 5G network for video processing.

For other scenarios, a worker node receives the RTSP data streams transferred from UEs and performs video inferencing and transfers to controller node. The controller node then processes them to detect the objects and estimate near collisions etc.

After processing multiple input video streams, controller nodes display the analytics results by location using Grafana. The following metrics are provided:

- Collisions detected
- Vehicles detected
- Pedestrians detected
- Bikes detected

These demonstrations were run on Intel Core i9 processor-based system and achieved a 5G video transfer speed of 9 frames per second. The demonstration software can be run without changes on servers powered by Intel® Xeon® Scalable processors. The use of these data center class servers is expected to increase 5G network (5G RAN and 5G core) and ITM node performance significantly, which are expected to increase the throughput and latency.

Conclusion

Cities have limited space that needs to be shared by people and vehicles. And as cities grow, there is increasing traffic congestion and a higher potential for accidents. Smart city ITM systems provide data and analytics that deliver the insights needed to maximize traffic flow with increased safety of all who share the roads – vehicles, bikes and pedestrians.

TCS integrated the ITM solution from Intel with its customized open-source based 5G network technology. TCS works with its vast partner ecosystem for the cameras and other technology needed for the solution. The companies have created a demonstration unit of the system running on Intel Core i9 processor-based systems to show off the analytics and ease of connectivity of the solution.

5G-based ITM systems provide the analytics required to deliver insight that can result in less dangerous roads and more livable cities. This intelligent and integrated solution when deployed in real time can manage traffic scenarios such as detecting and tracking vehicles and pedestrians, estimating trajectories and speed of the objects, detecting collisions and near misses. The system can also adjust traffic lights to optimize the traffic flow of the intersection by analyzing traffic video streams captured in different locations of the city. Such smart city traffic management solution will generate a large amount of data from across city locations with many scenarios. The integrated solution - 5G RAN with ITM system - is designed to be reliable with high throughput, data optimization and low latency.

Key Benefits :

- Bringing the benefits of customizable RAN architecture with support multiple splits (7.2 & 8) for increased performance and scalability.
- ITM applications running on Intel's mobile edge computing platform along with 5G RAN can make the data transfer and processing of analytics faster and more reliable.
- The integrated solution is highly scalable with best-in-class performance - network efficiency, improved throughputs, visualization and analytics.

Learn More

[Tata Consultancy Services homepage](#)

[Intelligent Traffic Management](#)

[Intel Smart Edge Open](#)

[Intel Network Builders](#)

[Intel Distribution of OpenVINO™ toolkit](#)

[ETSI 5G RAN Standard](#)



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