Solution Brief

AI and Computer Vision
Traffic Control

Avalue streamlines traffic flow with AI-enabled traffic control

Machine vision optimized with the Intel® Distribution of OpenVINO™ toolkit reduces traffic congestion in the major metropolis of Taipei

"Deployment sites are located at the most-crowded spots—Xinyi, Nangang, and Songshan Districts—of Taipei City, which urgently need to improve intersection congestion. The Avalue solution, powered by Intel® Pentium® processors, leverages the Intel® Distribution of OpenVINO™ toolkit ready-to-use models that help optimize our intelligent traffic solution."

—Kevin Lien, vice president, Avalue Technology

10 to 15%

decrease in rush hour congestion[1]

With the Avalue AIoT solution in Taipei, Taiwan

Traditionally, outdoor traffic signals have been enabled by microcontroller units (MCU) with no intelligent capabilities, and transportation departments would need to manually measure traffic flow. The process was tedious, inefficient, cost a lot of payroll hours, and ultimately produced data that was neither insightful nor easy to verify. Radar-based solutions have been used to help with traffic flow management. But radar suffers from high cost and the inability to discern traffic type—commercial, passenger vehicles, and so on—which influences traffic behavior. As population density in major metropolitan areas continues to rise all over the globe, traffic congestion continues to generate excess pollution and is a huge barrier to personal comfort for billions of drivers everywhere.

Challenge: High visual data loads in harsh environments

Cities like Taipei, Taiwan, are increasingly turning to Artificial Intelligence of Things (AIoT) traffic signal devices that use machine vision to observe traffic type and flow. However, these devices require enormous compute power, especially compared to legacy MCU-based signal devices. And they are most often found outdoors where they are subject to extreme weather conditions, including heat, humidity, wind, and rain. Additional network resources to send data back to a central repository for processing can also result in higher infrastructure costs and slowdown in data pipelines, making it harder to act on real-time traffic data.

Solution: Edge AI with embedded Intel® processors and accelerators

The **Avalue Dynamic Traffic Control solution** enables both visual machine data collection and inference at the edge—in the traffic control signals—to allow real-time traffic insights and help reduce the need for network infrastructure. Optimized with the Intel® Distribution of OpenVINO™ toolkit, this smart traffic signal solution is able to use an embedded Intel® Pentium® processor combined with a power-efficient Intel® Movidius™ Myriad™ X vision processing unit (VPU) for machine vision workloads. Because data inference takes place in the AIoT traffic signal devices, less network infrastructure is required. Using this solution, the Taipei City Traffic Engineering Office was able to lower their network communication costs by 85 percent.[1] And they were able to act on real-time insights to smooth out rush-hour traffic, resulting in a 10 to 15 percent decrease in traffic congestion.[1]

How it works

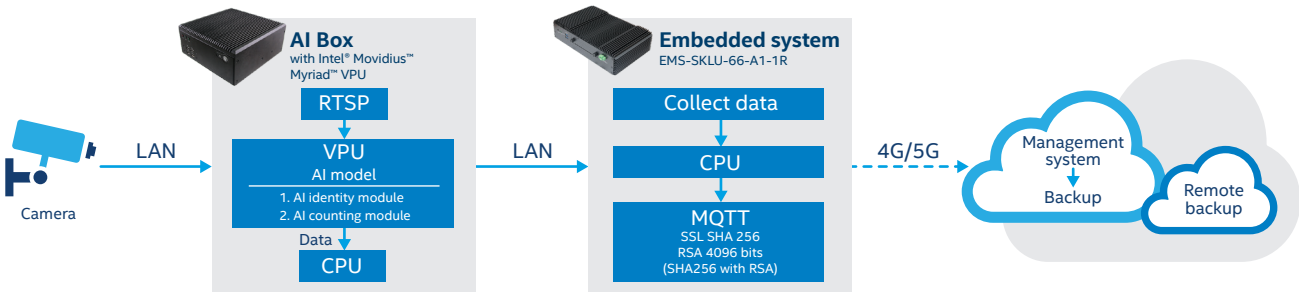
Cameras connected to embedded devices with Intel® Pentium® CPUs and Intel Movidius Myriad X VPUs serve as the endpoint that handles object detection, behavior identification, and traffic-flow counting. The Intel Pentium processor is dedicated to logic control, allowing the Intel Movidius Myriad X VPU to handle

the graphics processing workload and machine vision AI inference. These devices are placed at major intersections and connected junctions and can obtain granular details concerning traffic flow and direction, vehicle type and model, road occupancy, yellow-light hesitation, and pedestrian flow.

Data moves upstream to a centralized system in the cloud, but first it passes through a **wireless intelligent traffic controller** that assists with computing a dynamic time of day (TOD) signal time plan. This process combines the result of pattern matching with real-time traffic flow to generate precise TOD data. This controller, enabled by an Intel® Core™ i7 processor, also features a rugged chassis for environmental hardening and facilitates remote manageability for traffic engineers. As a result, there is a reduced need to dispatch maintenance crews to either the site of the controller or the endpoint smart camera devices.

Once in the cloud, the data flows into a management system for big data processing, and pattern matching remote backup. This allows the specialists at the Taipei City Traffic Engineering Office to make data-informed decisions about how to program signal timing and optimize traffic flow.

Dynamic traffic control system architecture



Smart camera with AI appliance
- AI-enabled sensor with machine vision for object detection, behavior identification, and traffic-flow counting
- Intel Atom® processor
- Intel® Movidius™ Myriad™ X VPU

Wireless controller
- Rugged platform
- Enables remote manageability
- Intel® Core™ processor
- Pattern matching

Analysis system
- Big data processing
- Pattern matching remote backup

Figure 1: The Avalue AIoT intelligent traffic management workflow.

Fast time to market with pretrained AI

Avalue's key to success was being able to accelerate and optimize AI inference within the smart camera configuration. According to Kevin Lien, vice president of Avalue, "The Intel Distribution of OpenVINO toolkit was instrumental in developing the solution and speeding time to market with pretrained models."

The Intel Distribution of OpenVINO toolkit provides templates, algorithm models, and sample programs for training. This helped Avalue developers quickly learn how to code the AI models at the heart of their smart camera solution. The toolkit also enabled Avalue to achieve cost-effectiveness in helping to balance data workloads across both the embedded Intel Pentium processor, the dedicated logic controller, and the Intel Movidius Myriad X VPU, which handled the totality of visual processing. In pushing all of the compute workloads to edge-level devices, Avalue was also able to reduce the typically high cost of streaming data over a network.

Understanding AI vision in a traffic environment

AI vision operates on the same principles as human vision, meaning that a smart camera will see the world in the same way the human eye does. AI inference includes three primary behaviors: object detection, image segmentation, and object classification. Object detection is the process of recognizing a new object that enters the camera's field of view. Image segmentation occurs when the camera isolates specific pixels that make up that object. And finally, object classification applies a label to that object by matching the object's profile to what is contained in the trained AI model. Figure 2 represents the typical end result of these processes working in conjunction.

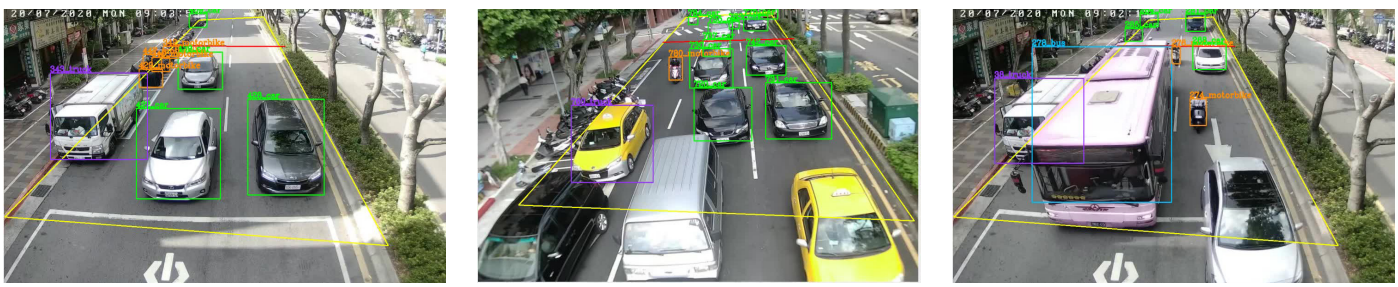


Figure 2: AI vision uses pretrained models to recognize and label objects.

Intel-enabled, real-time traffic flow monitoring

One of Avalue's key considerations in developing their AIoT solution was the ability for cameras to observe and process traffic patterns in real time. Although the embedded Intel Pentium processor offers great resiliency for environments with variable thermal conditions, it required additional throughput to handle the massive graphics processing loads required in machine vision systems. That's why the Avalue solution pairs the Intel Pentium processor with an Intel Movidius Myriad X VPU. The CPU handles logic processing while the VPU takes on the visual processing burden demanded by AI-powered machine vision. The system also pushes processed data upstream for big data analysis—with a low network footprint—because most of the visual processing takes place on the edge device.

Intel Movidius Myriad X VPU features:

- **Optimized data flow:** Less data movement on chip vs. traditional CPUs via singular-data scratchpad memory, resulting in lower power requirements
- **Compute-efficient engines:** Hardware vision and image processing accelerators combined with 16 programmable very long instruction word (VLIW) processors
- **Deep learning inference accelerator:** Neural Compute Engine with raw performance to support object detection, image segmentation, object classification

The benefits of AI-enabled traffic control

Many factors influence the speed and pace of traffic, including whether the majority of vehicles are commercial or passenger cars, each of which behave differently and generate unique traffic patterns. For example, yellow-light hesitation distance is an important measurement for calculating the duration of yellow lights. Too short of a duration may result in drivers speeding through intersections after the light has turned red, leading to potential collisions. The right yellow-light signal timing is an important factor in improving the overall flow of traffic.

Because the Avalue AI–enabled solution is able to automatically observe and analyze information at the granular level, traffic control engineers have access to minute details such as vehicle type, flow, density, and yellow-light hesitation distance. The smart camera configuration with the Intel Pentium processor and Intel Movidius Myriad X VPU is able to make these determinations using AI inference, rather than passing data-heavy graphical representations to a centralized data center for processing. Instead, the AIoT system only needs to upload refined data over the network, reducing overall bandwidth requirements.

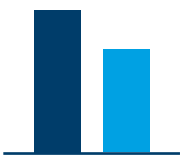
The deployment unlocked a substantial 85 percent communication cost reduction for the Taipei City Traffic Engineering office.[1] And in terms of quality of life improvement for Taipei City, the solution also helped reduce overall traffic congestion by 10 to 15 percent.[1]

Hardening for rugged environments

Unlike IoT endpoint devices that technicians might deploy in controlled environments, such as an office or factory setting, traffic signal cameras and controllers must persist in harsh outdoor conditions. Device failure also requires engineers to travel to the site of the signal camera or controller to repair a downed system, resulting in higher costs and more time spent for transportation authorities.

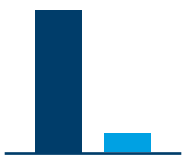
One of the primary reasons that Avalue chose the Intel Pentium processor in their embedded camera solution was that the processor could operate within a thermal range that matched general outdoor conditions for Taipei City. The device configuration can operate without additional cooling components, such as a fan or heatsink, and overall configuration cost goes down while resiliency goes up.

Traffic signal controllers with Intel Core processors—the wireless go-between devices that connect smart cameras to the cloud network—also serve as a point of remote monitoring and manageability. Traffic engineers can remotely verify equipment status and perform preventive maintenance to reduce the cost and time spent on repairs. This greater reliability in the AIoT solution, and the reduced need for service dispatches, helped deliver a 65 percent decrease in traffic flow management facilities.[2]



10–15% reduced congestion[1]

Granular observation of traffic flow leads to better traffic controls.

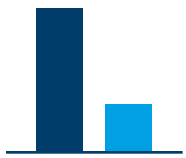


85% reduced communication costs[1]

AI inference at the edge reduces network infrastructure needs.

Real-time traffic-flow monitoring

Engineers observe traffic and respond to incidents in real time.



65% reduced management facilities[2]

Device resiliency and remote manageability reduce cost of repairs.

Figure 3: Key benefits of Avalue AIoT intelligent traffic management.

The future of AI-powered traffic control

If just five main intersections in Taipei used AI-enabled traffic management to reduce congestion by 10 to 15 percent,[1] imagine what AI systems deployed over an entire metropolis could accomplish. According to Lien, more-flexible entry points with full system-on-chip solutions could enable a more connected smart traffic management grid: "We are looking forward to having AI on chip someday to meet the AIoT demand for intelligent traffic or smart city applications."

Further down the horizon, cities may be looking at AI-enabled self-driving vehicles that also communicate data with AI-enabled traffic control to streamline traffic flow even more. In the same way that the invention of automobiles shaped city planning from the early twentieth century onward, one can expect big changes as the footprint for AI machine vision continues to shrink—while getting more powerful. Transportation infrastructure is poised to make another huge and exciting leap forward.

Learn more

Learn more about the Avalue Dynamic Traffic Control solution.

Intel Distribution of OpenVINO toolkit

The Intel Distribution of OpenVINO toolkit empowers developers with tools to help optimize AI deployments on heterogeneous Intel® hardware, along with easy-to-access libraries and pretrained models to help speed time to market for AI deployments.

Introducing Long-Term Support

Developers can now choose between standard support releases or Long-Term Support (LTS). Standard releases provide new versions of the toolkit every quarter, ideal for early-stage projects or developers looking to access the latest innovations. LTS is a great choice for late-stage projects that would benefit more from the reliability of existing features.

Long-Term Support benefits:

- Reliability and compatibility for ongoing deployments
- Critical bug fixes for one year, postrelease
- Security patches for two years, postrelease

Learn more ›

Intel DevCloud for the Edge

Intel DevCloud for the Edge is a cloud-based sandbox that empowers enterprise developers to test, prototype, and benchmark AI edge models across multiple platforms in real time. This makes it easy to identify the best hardware configurations for AI edge applications, accelerating time to market and reducing costs.

Learn more ›

About Avalue

Avalue delivers a complete range of ODM-embedded computer products for healthcare, retail, transportation, manufacturing, and gaming.

avalue.com.tw

1. "AIoT intelligent traffic management eases city traffic congestion," Avalue website, 2020. https://www.avalue.com.tw/news/AIoT-intelligent-traffic-management-eases-city-traffic-congestion_3016.
2. Source: Internal Avalue performance data.

0920/ADS/CMD/PDF