HAILO

Powerful Edge AI to Empower **Intelligent Transportation Systems**

Growing Adoption of AI-Based **Video Analytics in Intelligent Transportation**

Intelligent Video Analytics (IVA) has penetrated many applications across industry verticals.

Edge AI has made it possible for cameras and other small devices to recognize objects and people, track movement and even identify behavior. However, these capabilities first arrived at the edge in a limited capacity and, as it happens with many nascent technologies, disappointed users with lackluster performance: low-quality detections and tracking and unreliable alerts.
The number of AI-based on-device analytics solutions is growing fast.

Research firm Omdia estimates that in 2021, 26% percent of cameras and devices sold had AI capabilities. They forecast that by 2025 this share will reach over 60%, with AI-capable cameras making up 64% of all IP camera shipped worldwide. (1).

Intelligent Transportation Systems (ITS) is one vertical that is increasing enjoying the tremendous benefits of powerful edge AI, as it looks to help tackle such complex issues as traffic congestion and law enforcement, as well as manage public and commercial services like parking and toll roads. ITS detect and track vehicles on the road, count them and read their license plates. They are also used to measure driving speed, to determine whether a vehicle is in a permitted area and whether the occupants are wearing their seatbelts.

The Benefits of **High-Performance Edge AI**

Why do you need more AI performance on your camera or device?

Edge AI is transformational for the video surveillance market, pushing video analytics from the fringes of the market to the mainstream. This is propelled by the new, more powerful generation of IVA, now possible on the camera and local device, meeting power and bandwidth challenges inherent in most devices or installations. These high-performance edge AI analytics are a game changer because they enable:

Low latency and **higher frame rates**

- Fast-moving vehicle detection
- Timeliness – video is processed and alerts and insights are generated in real-time, allowing systems and operators to take immediate actions (important in applications like smart traffic light control, non-stop tolling and vehicle access control)

Higher **accuracy** and **reliability**

- Accurate analytics algorithms can be run on high-resolution video, resulting in accurate and timely alerts
- High resolution allows the camera to cover more of the road, while capturing the smallest details, such as a license plate number or a phone in the driver's hand

Efficiency and **cost-savings**

- Automation and greater operational flexibility are enabled by better ITS systems performance
- Lower TCO due to better capabilities and greater level of aggregation. For instance, you can cover a given road segment with fewer cameras
- Edge AI saves video storage and bandwidth costs, as only metadata (like number of vehicles) can be transmitted

More robust capabilities, **richer applications**

- More powerful AI processing on the camera or edge device enables multiple tasks and applications to run at the same time. This means that the IVA application can do more better (i.e. generate more data points on the vehicles and the situation on the road)

Better **privacy** and **compliance**

- Video does not need to be transmitted and stored and any PII (personally identifiable information) can be excluded in advance. This may include driver faces and license plate numbers (in some applications)

Powerful ITS Enablers:
A New Generation of Edge AI Processors

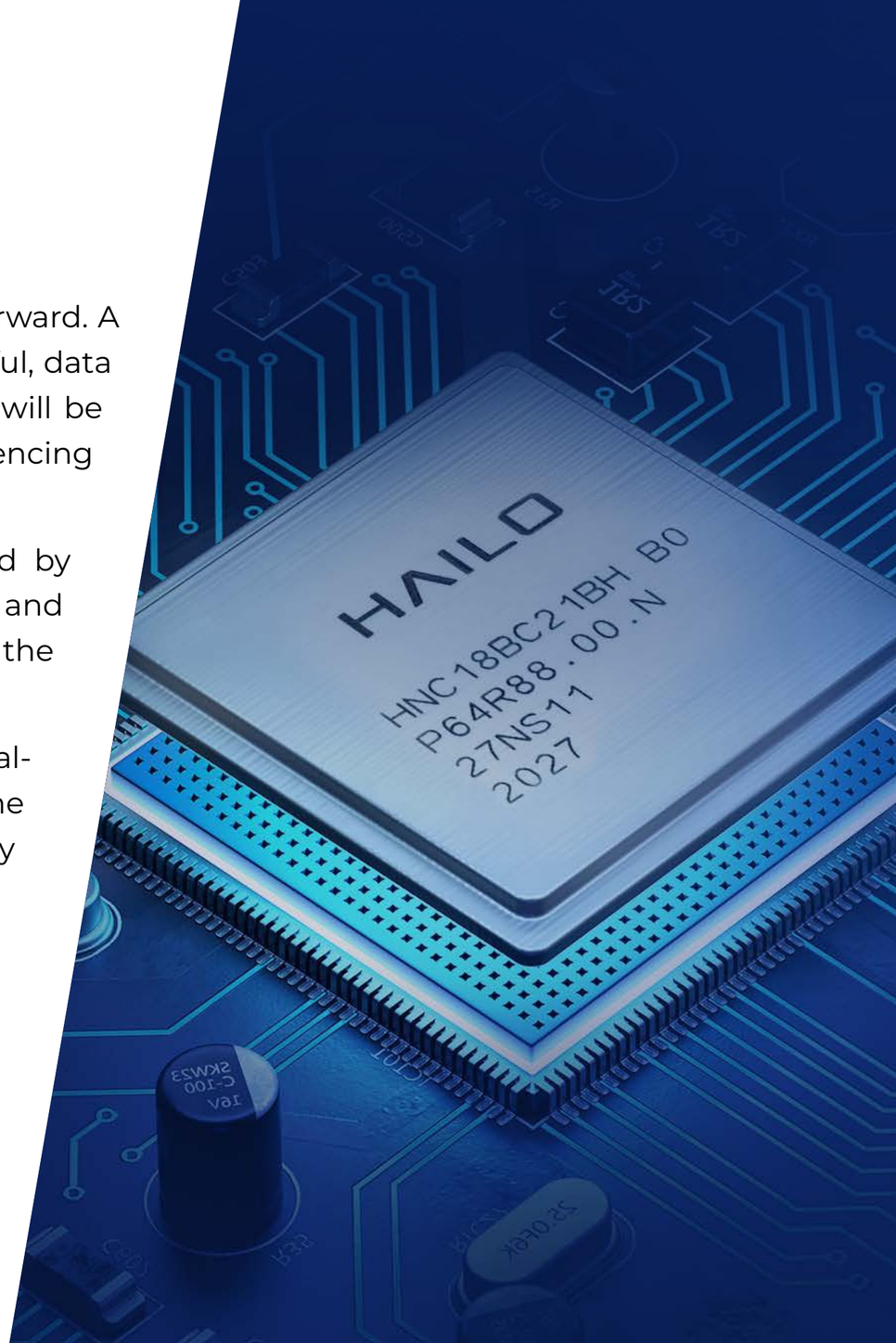
IVA quality, which has gradually improved from its early days, is currently taking a big leap forward. A new generation of AI accelerators and SoCs is starting to see adoption, bringing more powerful, data center-level processing capabilities to the edge. The market growth of the new AI cameras will be driven by the development of new, powerful AI processors that enable extensive edge AI inferencing to be performed on camera, or on other dedicated video analytics devices.

While some Intelligent functionality is currently already possible, today's SoCs are limited by processing power and efficiency, unable to fully power the applications that the surveillance and security markets require. The development of more powerful accelerators and SoCs allows for the deployment of **more accurate, reliable and complex video analytics**.

These processors empower cameras and devices to perform complex AI processing, such as real-time deep learning processing of multiple high-resolution video streams. These also enable the devices' capability to cover a larger RoI (region of interest), detect more objects and better identify them, or provide additional analytics data points.

The increase in processing power that is accompanied by lower power requirements means that reliable and robust analytics are available in small, fanless and ruggedized systems, suitable for outdoor ITS deployments in dynamic and demanding environments.

Powerful AI processing is a key enabler of better, more accessible and cost-effective intelligent transportation.



Intelligent Video Analytics for Transportation Applications

Traffic management
- Real-time traffic and congestion management
- City planning

Traffic law enforcement
- Speed & traffic light enforcement
- LPR, vehicle tracking and profiling
- Mobile patrolling

Public transport management
- Bus Lane enforcement
- Quality of service analytics

Tolling
- Free flow tolling

Parking enforcement & management
- Access control
- Car park and city parking management
- Mobile parking enforcement

Monitor Traffic for Real-Time Congestion Management and Long-Term Planning

Monitoring is done by multiple traffic cameras deployed on intersections and select streets and roads. For IVA, these traffic cameras need to be intelligent cameras (i.e., support AI-based analytics on-camera). Alternatively, regular traffic cameras can be connected to a dedicated local AI-based analytics device, such as an Edge AI Box or edge AI server.

Whatever the deployment, this type of intelligent traffic monitoring system can:

- Detect and track vehicles in its FOV to recognize slow downs, irregular or obstructive driver behavior
- Count vehicle for measuring road occupancy and level of congestion
- Identify emergencies and other irregular event on the road

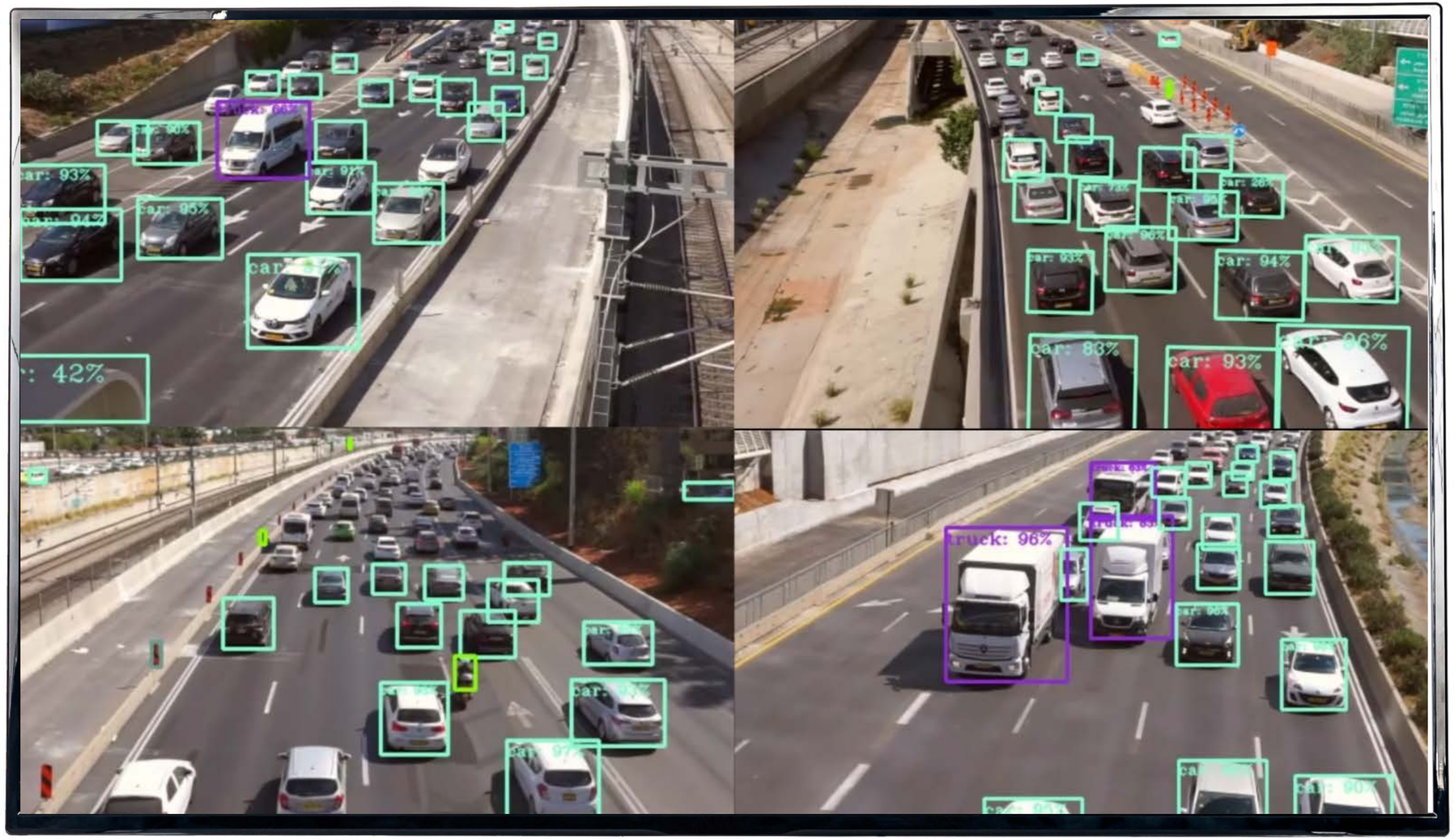
These video analytics functions are basic building blocks that cities can use, both in real time and cumulatively for planning purposes.

For instance, real-time road occupancy analytics can be operationalized by smart traffic lights, which adjust road signals in accordance with the situation in the intersection in real time. Vehicle type recognition can also be used for those traffic lights to prioritize the passage of emergency and service vehicles, as well as public transportation.

Such intelligent, ongoing monitoring can also be used after-the-fact. Municipalities can adjust road markings, create new signage, make repairs and other adjustments as needed to prevent dangerous and congestion-causing situations. Data can be accumulated and aggregated across various time periods and locations to generate valuable insights about road use and inform city planning.

IVA deployments in such dynamic environments that include multiple cameras, some of which may be high-resolution ones, require robust AI processing, especially when they are expected to provide both real-time alerts and varied forensic insights (i.e. rich metadata).

Powerful edge AI-based **traffic management** systems allow real-time traffic monitoring based on accurate vehicle detection across multiple lanes on a busy highway.



Processed using a single Hailo-8 AI processor

Enforce Traffic Laws for Safe and Optimized Roads

Monitoring the road enables traffic law enforcement, necessary both for road safety and for traffic regulation. Deterring drivers from running red lights, speeding, entering busy intersections unlawfully to disrupt crossing traffic, parking or stopping outside of designated areas and so on, prevents traffic accidents and goes a long way to minimize ad hoc disruptions that create or contribute to congestion.

Intelligent video monitoring can do this through:

- Vehicle detection and LPR for identification and taking enforcement actions
- Tracking vehicle direction and driving speeds for speed enforcement
- Detecting and tracking dangerous driver behavior such as frequent or unlawful lane changes , vehicles tailing or cutting off others, vehicles stopped or driving on the shoulders
- Detecting entry into restricted/limited areas, such as bus lanes, cross section areas at given times (such as when there is a red light or in a case of a time-of-day conditional turn)
- Detection of safety measures use like seatbelts in cars and helmets for motorcycle and bike riders
- Driver mobile phone use and other distractions

Alongside the traffic camera systems deployed across cities and highways, law enforcement often chooses to deploy its own means of monitoring for violations. These include speed traps and specialized fixed poles on the side of the road employing video and other sensors, as well as mobile systems. The latter are usually dedicated multi-sensor systems with on-board processing installed on vehicles or deployed ad-hoc on the side of the road next to the stopped police car.

Enforcing safety and traffic laws are also important in the inter-city space. Inter-urban areas are usually multi-lane motorways with higher-speed but lower vehicle density. Here, traffic accidents are often fatal and road obstacles are potentially more disruptive and dangerous. Monitoring traffic for speed limit enforcement, rules of the road compliance, helmet and seatbelt use and so on, not only saves lives and safeguards people's health but also minimizes disruptions to the regular flow of traffic.

To be able to detect vehicles and read license plates or see the seatbelt or phone inside their cabin in scenarios of congestion and/or where the vehicles are moving at high speeds requires real-time (or better) analytics that run on high-resolution video. The deployment may even require more that one camera and video stream. This is the type of deployment powerful, state-of-the-art edge AI processing is meant for.

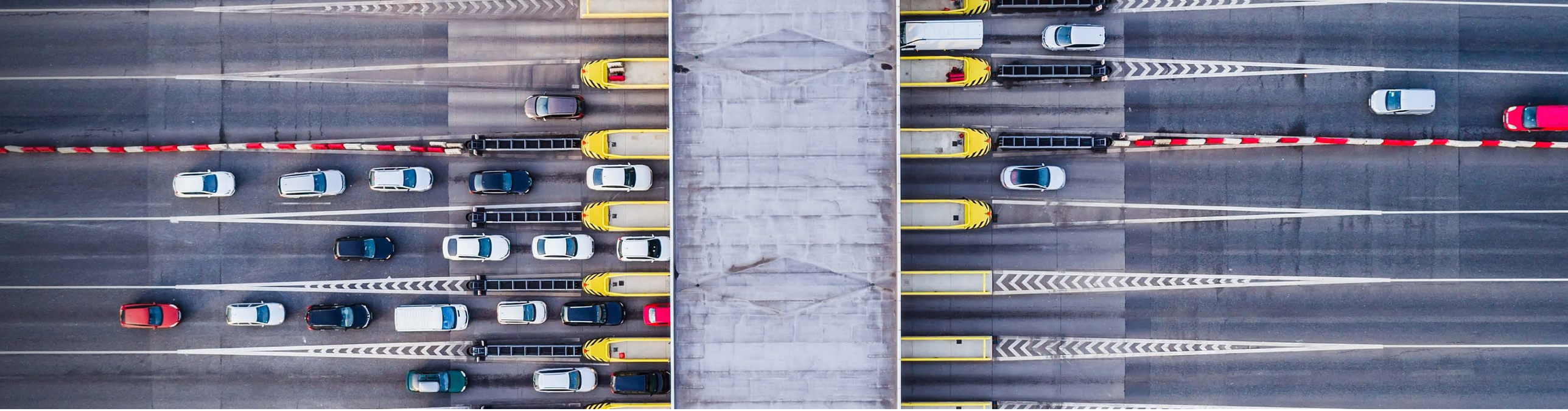
Improve **Public Transport** Management

One dominant strategy chosen by cities to fight traffic congestion is improving public transportation services (2). A single bus can get 40-60 private vehicles off the road (3) on the morning commute.

ITS systems can help by supporting planning and real-time management of public transport to **increase its efficiency and quality of service.** First, real-time traffic management can serve authorities in enforcing lanes and prioritizing buses, light rail and even ride-sharing traffic on the road. In addition to the reduction in the number of vehicles on the road, it will optimize arrival times to make them even more attractive alternatives for getting around.

Additionally, important insights can be gained from anonymized real-time monitoring and various analytics from inside train and bus stations, as well as the vehicles themselves. Analytics can ensure passenger safety, manage occupancy (or social distancing), ensure gracious and accessible service from transport operators and contribute to route and schedule planning to create the best passenger experience, as well as the most efficient transportation option.

Powerful IVA capabilities on the edge make such multi-camera, privacy-aware and insight-rich deployments possible, be it on a congested street or a busy transportation station.

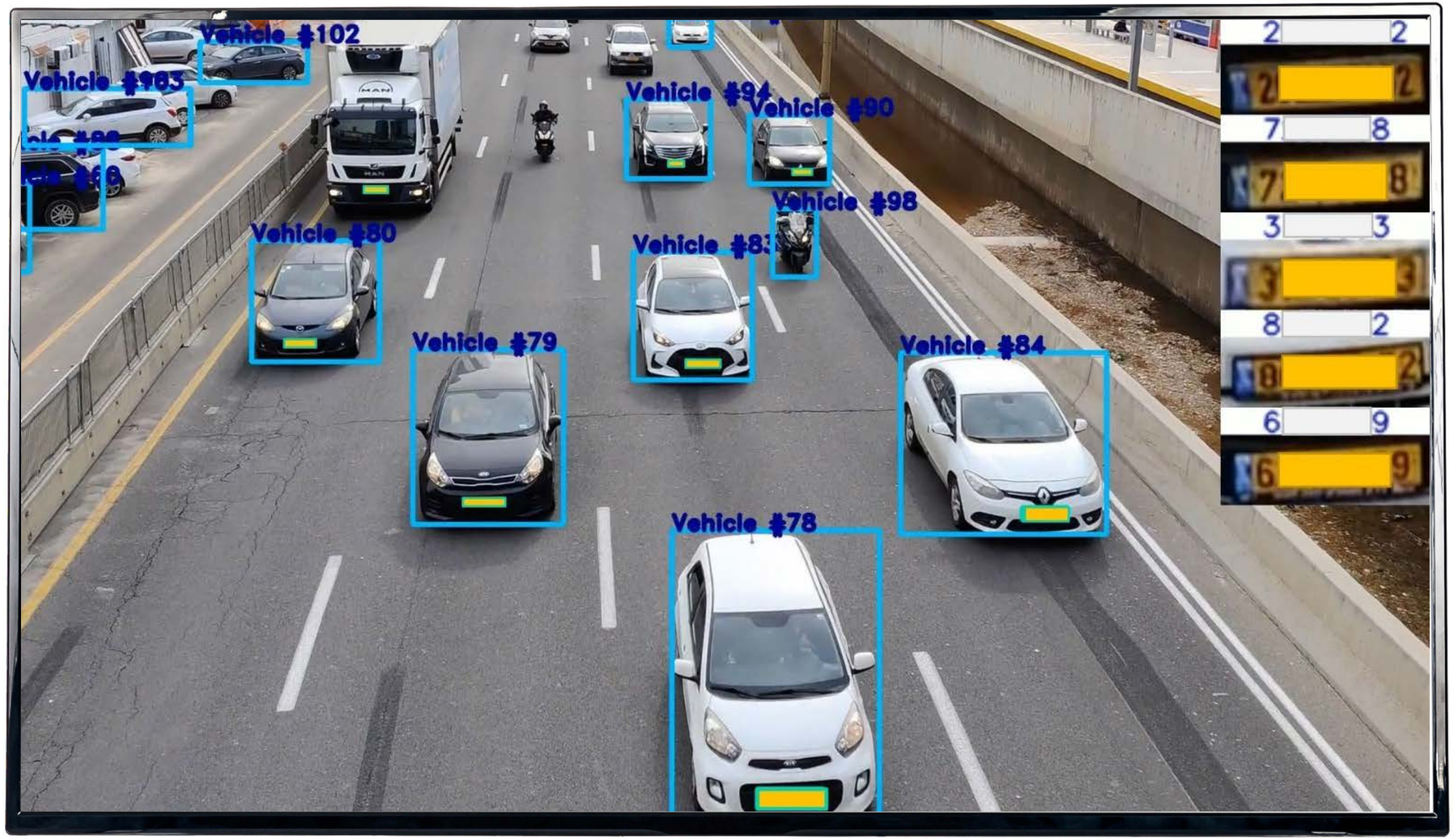


Supercharge **Tolling** Solutions

AI-based computer vision can automate tolling and make it more efficient. Cameras that identify vehicles, read their license plates (a function known as LPR: License Plate Recognition or ANPR: Automatic Number Plate Recognition) and charge the owner/ subscriber automatically mean a shorter slow-down or stop at a toll checkpoint or even no stop at all on some highways that use free-flow tolling solutions.

Free-flow tolling is an especially challenging application due to Vehicle speeds. The camera has mere seconds to identify the vehicle, locate and read its license plate before it moves out of view. Moreover, free-flow tolling systems usually use multiple high-resolution and long-range cameras and thus require more powerful AI capabilities for automation.

License plate detection running on high-resolution video from a high-speed motorway. The vehicles are detected and their license plate is detected and read in real-time.



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Enforce **City Parking** or Manage **Car Parks** Effectively

Analyst estimates vary, but the global smart parking market is valued at about $4.5 billion in 2021 and is growing at double-digit CAGR (4). AI, among other technologies, is enabling automation in this sector, thereby **increasing efficiency and allowing cost-savings.** Such solutions are used not only by commercial parking facilities but also to manage city parking, ensuring that vehicles that spend too long in a parking space are ticketed.

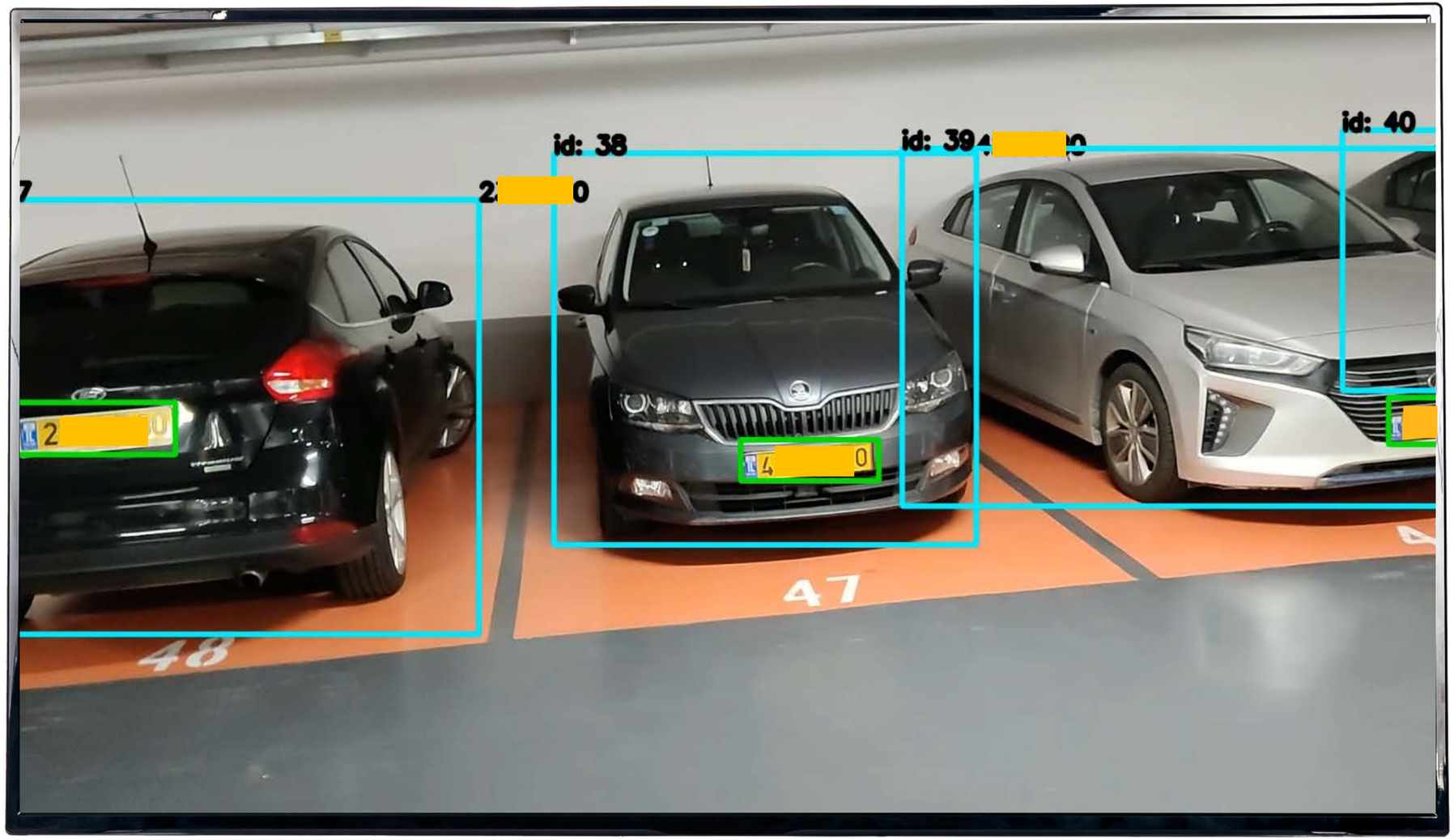
One way IVA can increase efficiency is by creating a **seamless access control experience.** Imagine that you don't have to stop for the camera to read your license plate and open the turnstile; that leaving the arena after a game or show together with everybody takes so much less time because the flow of vehicles through exit points is steady – they are recognized from a distance, charged automatically and let through without stopping.

Whers basic machine vision and other types of sensors can provide good occupancy data in an indoor car park, very large outdoor parking lots and managing parking on city streets (not to mention mobile parking enforcement) would require more capable and intelligent solutions. A powerful intelligent parking system designed for these conditions would need to:

- **Cover a large RoI** by using multiple high-resolution cameras and do so efficiently
- Provide **robust IVA functionalities**. including multiple vehicle detection and tracking, vehicle counting and occupancy analytics, LPR for tracking, billing and enforcement, segmentation and line detection to recognize parking spots and drivable areas and so on. These will most likely need to run simultaneously and on multiple video streams
- Provide **anonymization** for PII (personally identifiable information) protection.

This smart parking system will not only need to be very capable, but it will also need to be cost-effective for city authorities or a commercial operator. This can only be achieved using powerful and power- and cost-efficient edge AI, be it on-camera or on a local IVA device that connects multiple cameras.

LPR in a commercial underground parking lot. Vehicles are detected, counted and their license plates are detected and read in real-time, in this instance, from a camera installed on a patrolling vehicle.



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About Hailo

Hailo has developed the world’s best-performing AI processors for edge devices

The company is focused on building AI processors efficient and compact enough to compute and interpret vast amounts of data in real-time — processors that can be embedded in the edge devices themselves.

Now, complicated AI applications that could previously only run on the cloud can run on the edge, and the best part – with a fraction of the power consumption.

Hailo’s solutions bridge the gap between existing and future AI technologies and the compute capacity needed to power these applications.

Hailo-8-Powered Intelligent Analytics Devices

The Hailo-8 AI processor is field-proven and production-ready from leading ODMs. It is designed for outdoor deployment, with a wide operating temperature range and low heat dissipation. With guaranteed product longevity and abundant capacity, it is **a future-proof AI processing solution for ITS vendors.**

Hailo-8 has been designed into multiple cameras and dedicated analytics appliances.

Lanner

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