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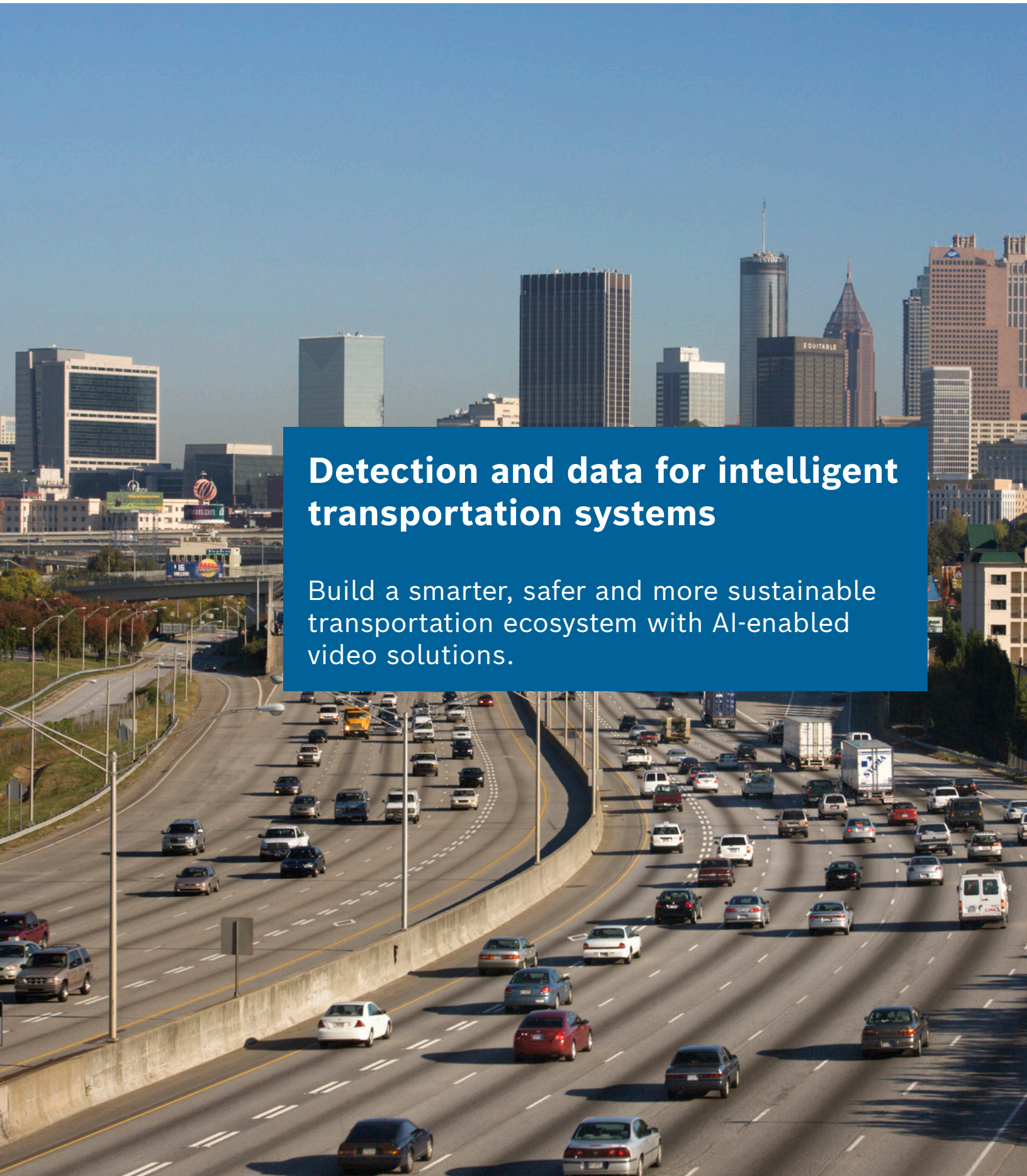


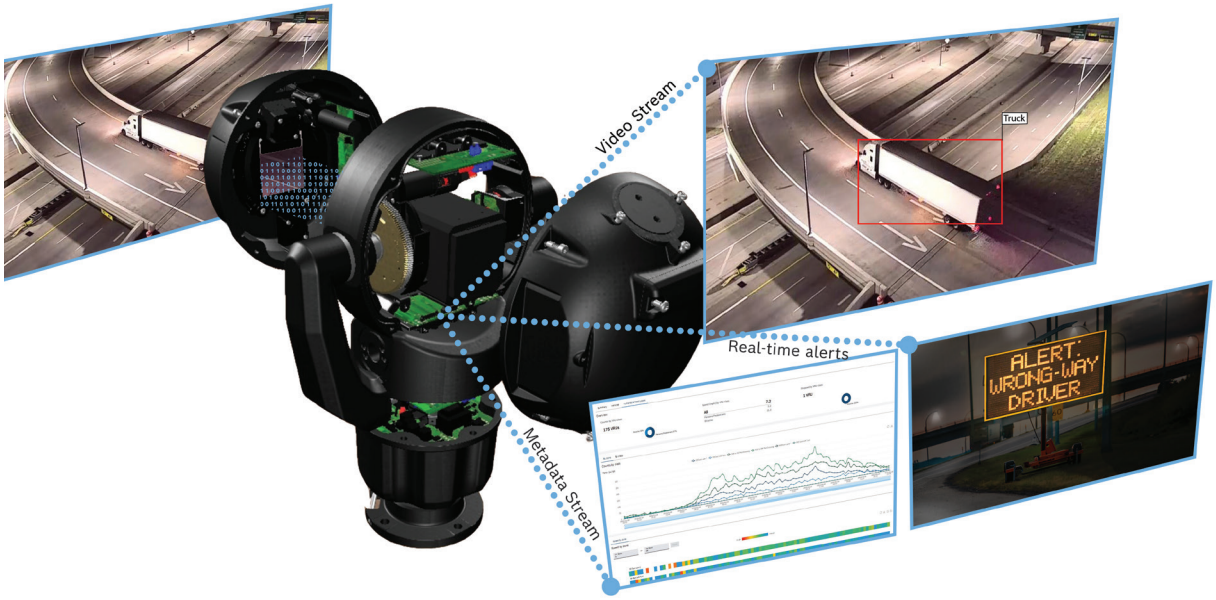
Detection and data for intelligent transportation systems

Build a smarter, safer and more sustainable transportation ecosystem with AI-enabled video solutions.

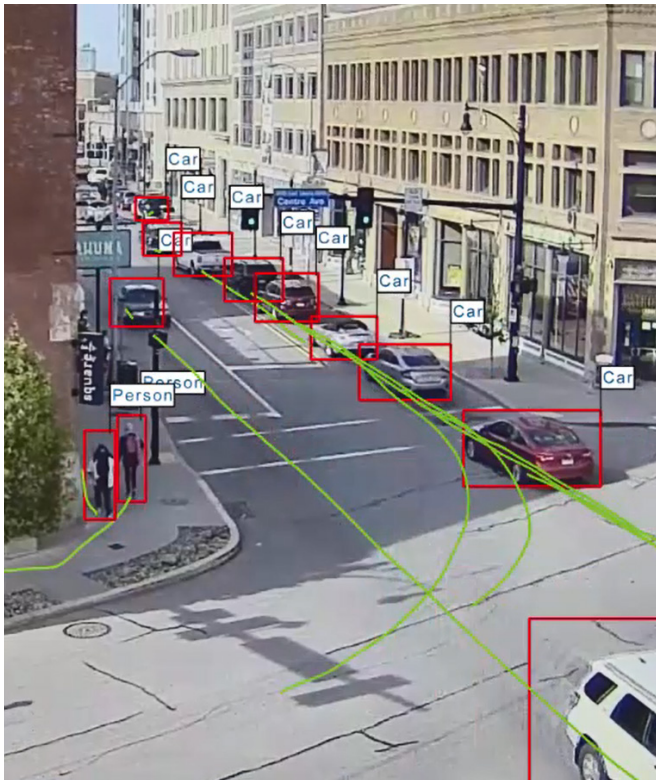
As city streets and sidewalks become progressively more congested, city planners are facing new safety challenges. At the same time, connected and automated vehicles that communicate with each other and with roadside infrastructure are on the rise in cities and on highways. The challenge for traffic engineers and planners is choosing the right technology and strategic partner to improve mobility, safety, and efficient use of roadways now and in the future.

Video cameras acting as sensors are a key component to intelligent transportation systems that help to keep roadways flowing safely and efficiently. They enable detection and monitoring solutions that instantly alert the right people to safety risks while continually collecting information on roadway usage to provide better insights for data-driven decision-making. As a result, city planners and traffic engineers can create smarter, safer and more sustainable transportation ecosystems.

Reliable data and accurate detection



Edge-based AI enables intelligent devices that can alert to safety risks and deliver valuable data for highway and urban infrastructure planning. Analytics processing is at the edge in the camera – no central server required. This enables a distributed network of cameras acting as intelligent processing nodes with no single point of failure, delivering cost-effective and reliable video-as-a-sensor solutions. A single video device provides superior video images, intelligent event detection and real-time alerts, and data collection and aggregation.



Greater accuracy with artificial intelligence

The latest Bosch fixed and moving ITS cameras offer next generation artificial intelligence (AI)-based video analytics. The cameras are built on a high performance processing platform that supports embedded neural network-based video analytic detectors for ITS detection and data. Called Intelligent Video Analytics Pro (IVA Pro) Traffic, this advanced analytics technology relies on deep learning – using artificial neural networks that attempt to mimic the human brain, allowing it to learn from large amounts of data and recognize patterns to tackle more complex tasks faster, easier, and more accurately.

IVA Pro Traffic is engineered to classify pedestrians, bicycles, motorcycles, cars, trucks, and buses. It improves detection capabilities in congested scenes to support accurate counting of overlapping vehicles queued at traffic lights or in dense traffic jams, while ignoring common disturbances caused by vehicle headlights, shadows, extreme weather, sun glare, reflections, vibration, and shake.

Enhance safety with artificial intelligence

Improve safety by alerting to risks on the road. Our ITS cameras with IVA Pro Traffic deliver automatic incident detection and verification for slow or stopped vehicles, queues of vehicles at exit ramps, vehicles traveling the wrong way, and other traffic events.

Through partnerships with highway information solution and mobility ecosystem providers, our ITS cameras can trigger third-party systems to notify drivers on the road, improving situational awareness and enabling them to take action earlier. This enables:

- Automated triggers to dynamic message signs, flashing beacons, and V2X broadcast messages for connected vehicles to ensure drivers are alerted to safety issues or congestion
- Early incident detection and mitigation by enabling traffic operations centers to implement workflows to resolve road irregularities faster, help first responders to intervene more quickly, and avoid secondary accidents

For the I-670 SmartLane project, Ohio Department of Transportation (ODOT) has deployed 30 Bosch cameras with video analytics along nine miles of highway. The cameras detect anomalies on the road, such as stopped or slow vehicles, and help ODOT monitor the hard shoulder for debris that would prohibit them from opening the SmartLane.

Ohio's first SmartLane is a nine-mile stretch of I-670 between downtown Columbus and the John Glenn Columbus International Airport. Thirty Bosch ITS cameras, including DINION fixed cameras and ruggedized MIC pan-tilt-zoom cameras with built-in video analytics, detect anomalies on the road, such as stopped or slow vehicles. During peak congestion, traffic monitors can open a SmartLane -- the eastbound shoulder -- after performing a visual check using the MIC cameras to ensure it is free from debris or other hazards. Dynamic message signs communicate to drivers when the SmartLane is open and closed, display the reduced speed limit of 45 miles per hour when the lane is open, and update drivers about road conditions. The cost to develop the SmartLane is significantly less than the cost of building an additional lane to alleviate rush-hour traffic congestion.

Intelligent intersections

With distracted pedestrians, bicyclists, and an increase in public transportation in urban environments, it is essential to implement strategies for improved safety. Include pedestrian and bicycle movement into traffic control strategies to make people more visible to motorists. Automatic detection of vulnerable road users (VRUs) enhances the safety of intersections, bicycle lanes, and pedestrian crossings.

With on-board neural networks:

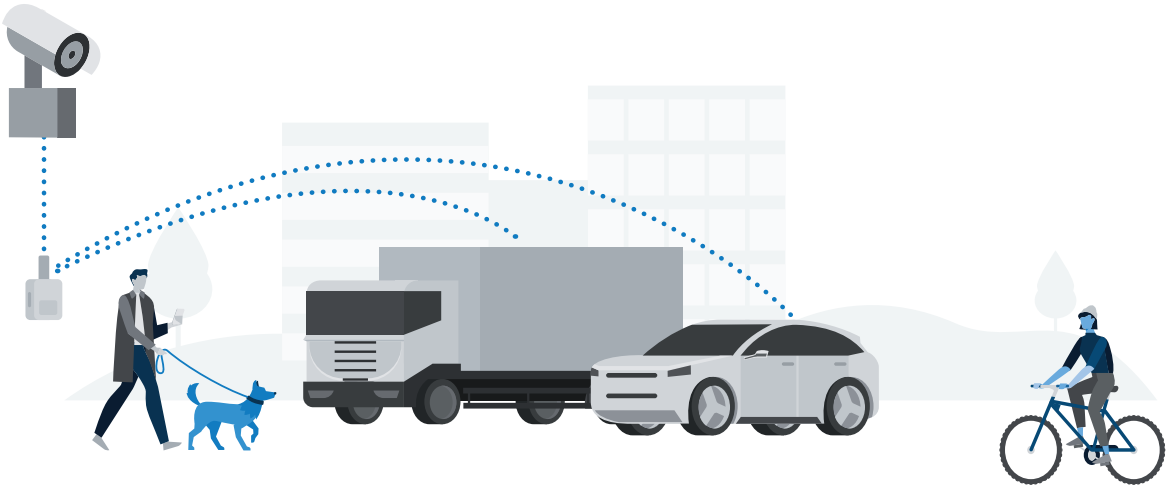
- Detection of pedestrians in a crosswalk can alert the traffic controller to preempt traffic signals to increase safety, enabling smart intersection control
- Increase visibility of pedestrians at night by using video analytics to trigger pedestrian crossing beacons, as well as the camera's optional white light illuminator. These actions help to highlight pedestrian presence to approaching traffic
- Integration with third-party technology can broadcast messages to connected vehicles, alerting them to the presence of pedestrians

ITS camera

IVA Pro Traffic on board ITS cameras sends an alert to the nearby roadside unit for communications.

Roadside unit

Communicate to the dynamic message sign and send an alert via V2X to connected vehicles.



Analyze data to extend beyond safety

With IVA Pro Traffic, the ITS camera becomes an intelligent sensor that can classify objects as cars, trucks, bicycles, motorcycles, and pedestrians, and detect their speed and trajectory. Using video as a sensor, city traffic planning professionals and traffic engineers can continuously collect real-time data to analyze flow patterns on networks of roadways for implementing new policies that result in safer and more efficient intersections.

With the optional Data Fusion service, Bosch makes it easy to collect, filter, and report on data from multiple cameras. The data can be viewed in dashboards that deliver actionable information for understanding traffic patterns, congestion points, and more for data-driven decision making. Data examples include:

- Pedestrian, bicycle, and vehicle counts
- Classification of vehicles, such as cars versus trucks
- Average speed and direction
- Road occupancy

The data seen in the dashboards can also be exported as files in easily consumable formats, csv or scsv, that can feed into other data sets and repositories.

The service also includes a rest API that enables analytics teams to seamlessly access the aggregated vehicle and VRU data for further analysis in third-party tools, such as Microsoft PowerBI.

When only traffic data is needed, low bandwidth connections can be deployed, greatly reducing the infrastructure cost needed, while increasing the speed at which the solution is placed into service.

Bosch solutions for ITS

Bosch offers a complete camera portfolio for intelligent transportation systems. NEMA TS 2 certification confirms they meet environmental requirements for traffic applications, while NTCIP compliance ensures communication with traffic management systems. Bosch ITS cameras offer best-in-class light sensitivity, excellent high dynamic range, and front and backlight compensation for clear images even in difficult conditions. Plus, all Bosch ITS series cameras can deploy IVA Pro Traffic.

MIC inteox 7100i cameras

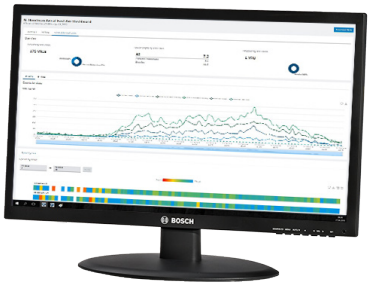
One of the most robust cameras for intelligent transportation systems, the MIC family of extremely rugged cameras withstand severe weather and environmental conditions, such as vibration on bridges and high impacts from debris. The cameras offer IP68-rated protection against water ingress without requiring a pressurized housing to reduce maintenance and costs.

FLEXIDOME 8100i IR
2 MP, 4 MP, 6 MP, or 8 MP fixed dome camera with remote PTRZ capability

DINION 7100i IR
2 MP, 4 MP or 8 MP bullet camera with integrated IR, IP 66 rated

AUTODOME 7100i
2 MP or 8 MP pan-tilt-zoom camera with starlight technology for low light, IP 66 rated

MIC inteox 7100i (ITS)
2 MP or 8 MP ruggedized pan-tilt-zoom camera with optional illuminator, IP 68 rated



Data Fusion Service
Cloud-based tool that aggregates data across multiple cameras to provide insightful dashboards and data access to help drive decision making

To learn more about how our solutions for intelligent transportation systems enhance safety, contact intelligent.transportation@us.bosch.com.

Bosch Security and Safety Systems

Protecting lives, buildings and assets is our aim. Our product portfolio includes video security, intrusion detection, fire detection and voice evacuation systems as well as access control and management systems. Professional audio and conference systems for communications of voice, sound and music complete the range.

Bosch Security and Safety Systems
To learn more about our product offering,
please visit www.boschsecurity.com