Smart Infrastructure Enabled by Video-as-a-sensor Technology
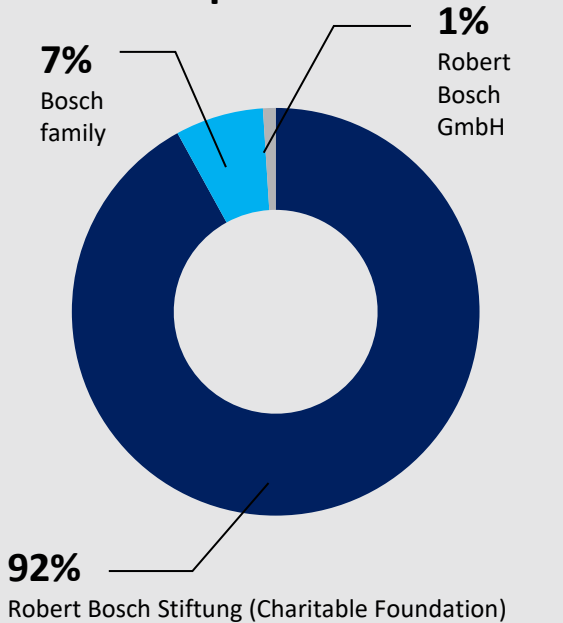
At 125 locations across the globe, Bosch employs some 69,500 associates in research and development.

Bosch – A Global Company

Ownership

7%
Bosch family

1%
Robert Bosch GmbH

92%
Robert Bosch Stiftung (Charitable Foundation)

4

Business sectors and divisions

Mobility Solutions

Industrial Technology

Energy and Building Technology

Consumer Goods

Mobility Solutions

World's largest supplier of cutting-edge automotive technology

Energy and Building Technology

Leading manufacturer of thermo, and building security technology; World's largest supplier of heat pumps

Industrial Technology

Leading in drive and control technology, packaging, and process technology

Consumer Goods

World's largest power tool manufacturer
Leading the field in house-hold appliances

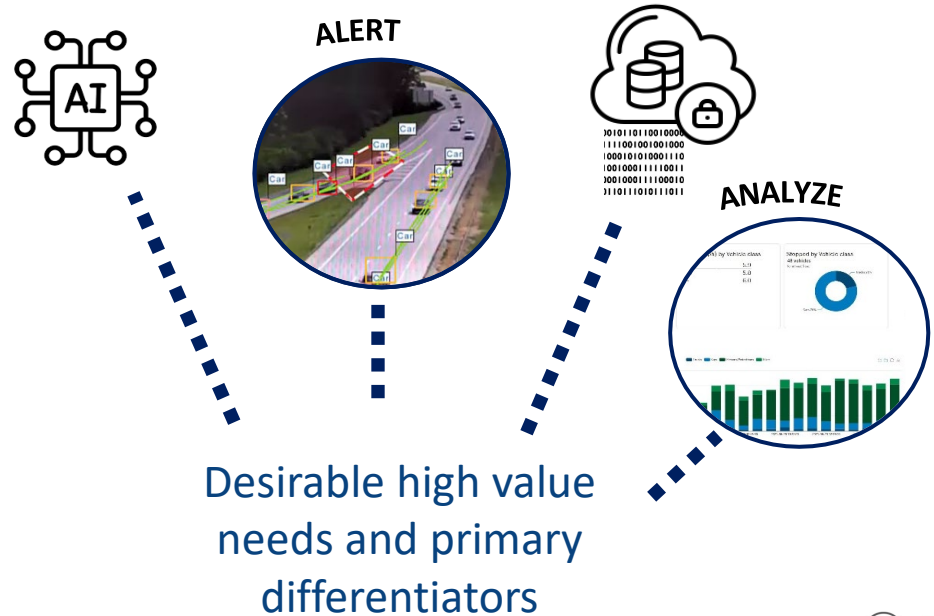**440** Subsidiary and Regional Companies

60 Countries

410,000 associates

92 billion dollars in sales

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Intelligence as the differentiator

▶ Devices used as surveillance

▶ Monitoring with no Actionable Insights

▶ Addition of AI and Neural Networks

▶ Machine Learning

▶ Analyze, detect, and generate Data

MONITOR

ALERT

ANALYZE

Desirable high value needs and primary differentiators

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Intelligence as the differentiator

What makes true edge processing?

▶ Analytics are in the camera

▶ Metadata on all objects in field of view

▶ Metadata streamed independently for any use case

  ▶ Locally or in the cloud

  ▶ Metadata reels can be forensically utilized

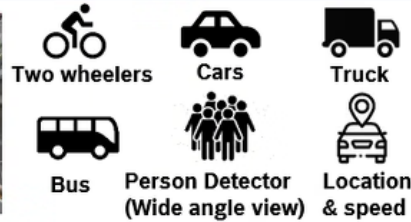▶ Metadata bandwidth represents only 5% of the video stream

Video

Metadata

Video stream

Metadata stream

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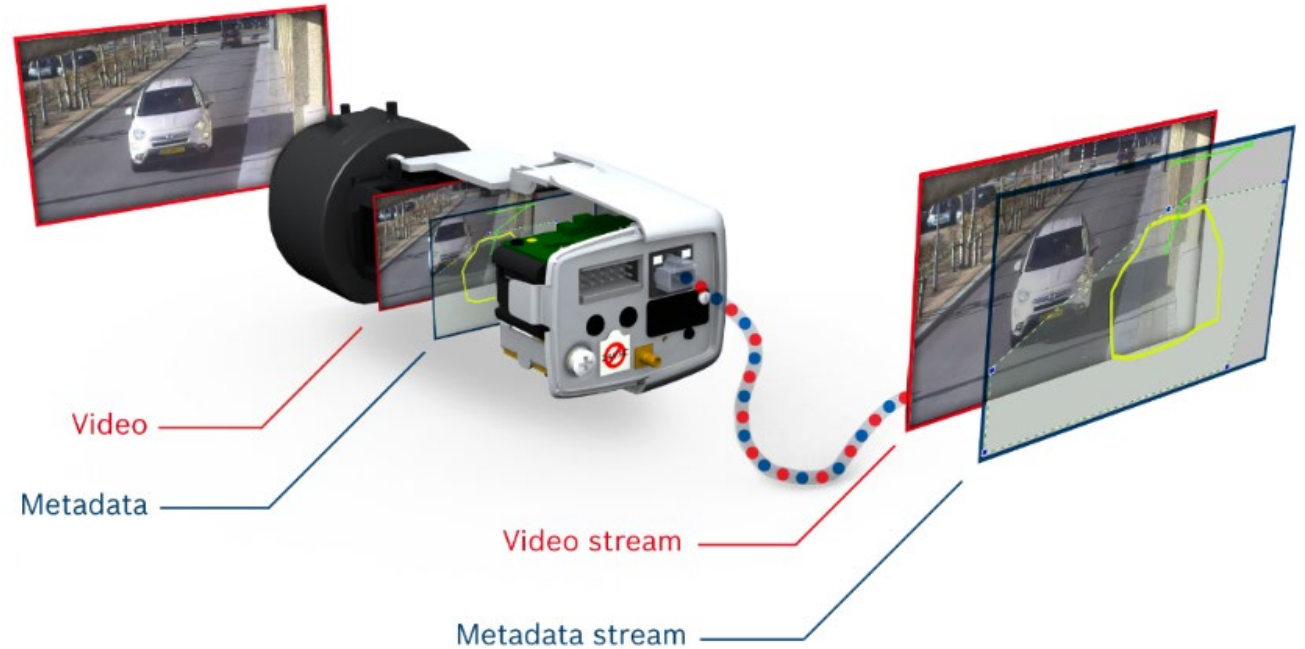
Smart Infrastructure Enabled by Video-as-a-sensor Technology

Detection Accuracy measured at 98%

Highway

Two wheelers   Cars   Truck
Bus   Person Detector (Wide angle view)   Location & speed
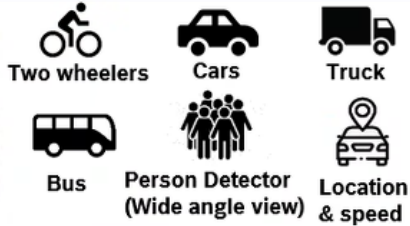
| Use Case	Applicable detector
Highway safety (Person on highway)	• High resolution detectors • Person/Two wheeler detection • Geo-Location & speed
Highway Safety: Stopped Vehicle	• High resolution detectors • Vehicle detector (sub classification) • Vehicle counting
Highway: Traffic Flow (slow traffic, Queue warning)	• AI detector + IVA tracking • Vehicle detector (sub classification) • Vehicle speed
Highway: Wrong way detection	• High resolution detectors • Vehicle detector (sub classification) • Vehicle speed
Highway safety Parking & Rest areas	• AI detector + IVA tracking • Vehicle detector (sub classification) • Vehicle speed

Intersection

Two wheelers   Cars   Truck
Bus   Person Detector (Wide angle view)   Location & speed

Use Case	Applicable detector
Stop bar classification	• High resolution detectors • Vehicle detector (sub classification) • Vehicle counting
Advance traffic	• High resolution detectors • AI detector + IVA tracking • Vehicle detector (sub classification) • Vehicle speed
Intersection: Pedestrian & vulnerable road user safety	• AI detector + IVA tracking • Vehicle detector (sub classification) • Vehicle speed • Two wheeler & person detection
Vehicle count by sub class	• High resolution detectors • Vehicle detector (sub classification) • Vehicle counting

Specialized

School Zone   Transportation   Railroads

| Use Case	Applicable detector
Rail Crossing	• High resolution detectors • Person detection • AI Detector + IVA tracking
School Zone	• High precision detectors • Person & large cluster detection • AI Detector + IVA tracking
Curbside & Sidewalks	• AI detector for vehicle accuracy • Multiple vehicle classes (truck/bus)
Parking & Double Parking	• AI detection for vehicle occupancy

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Applications

Intersections

▶ Detect pedestrians and bicycles

▶ Jaywalking. Alert when traffic lights are illegally crossed

▶ Crowd detection. Instantly alert when thresholds are reached

▶ Enforcement of safety regulations, curb-side management

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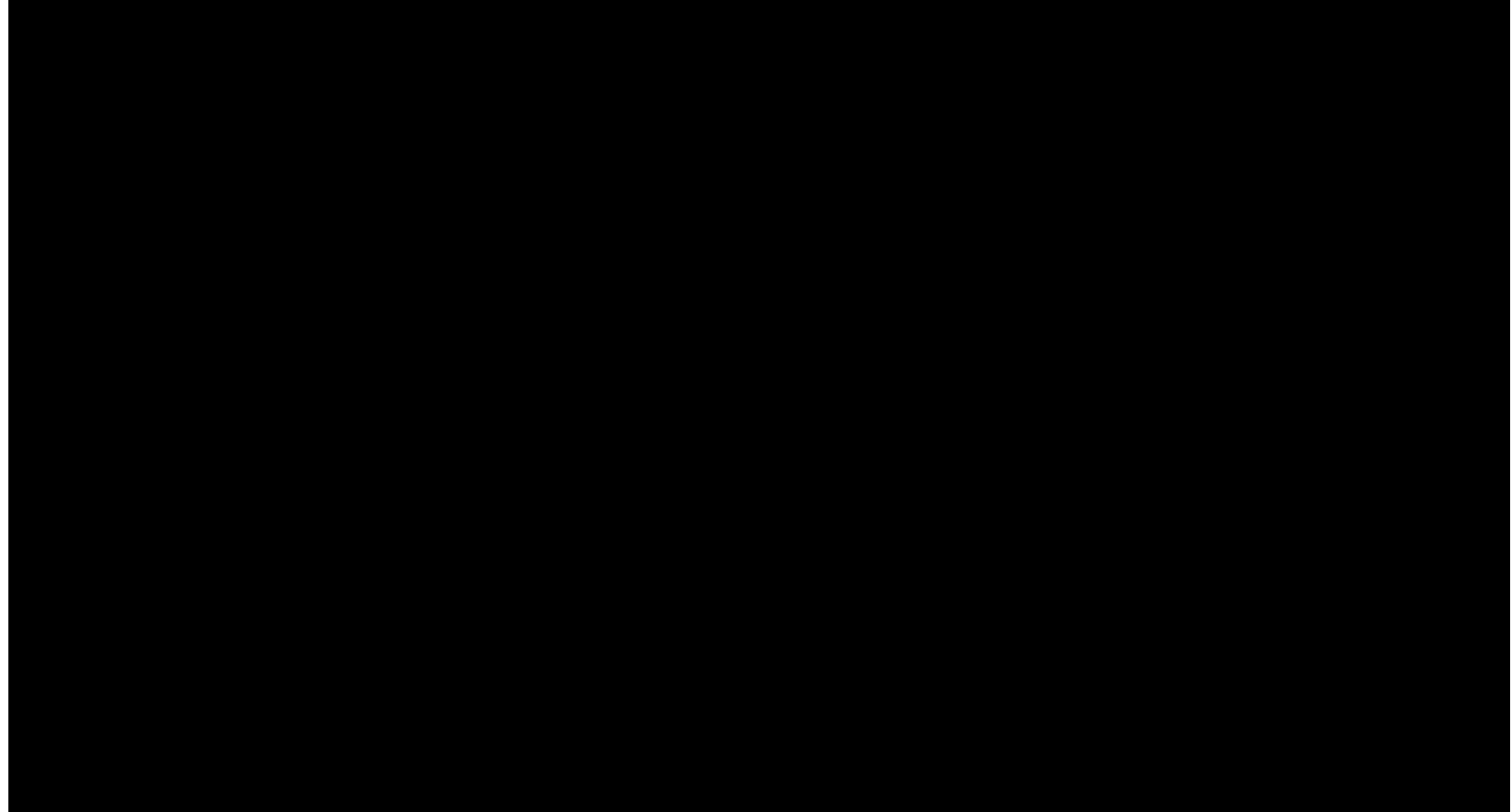
Applications

Accurate detection in difficult situations

▶ Sun glare and high contrast shadows

▶ Headlight beams

▶ Extreme weather

▶ Camera shake

▶ Detect with occlusions, detect with over a 50% overlap

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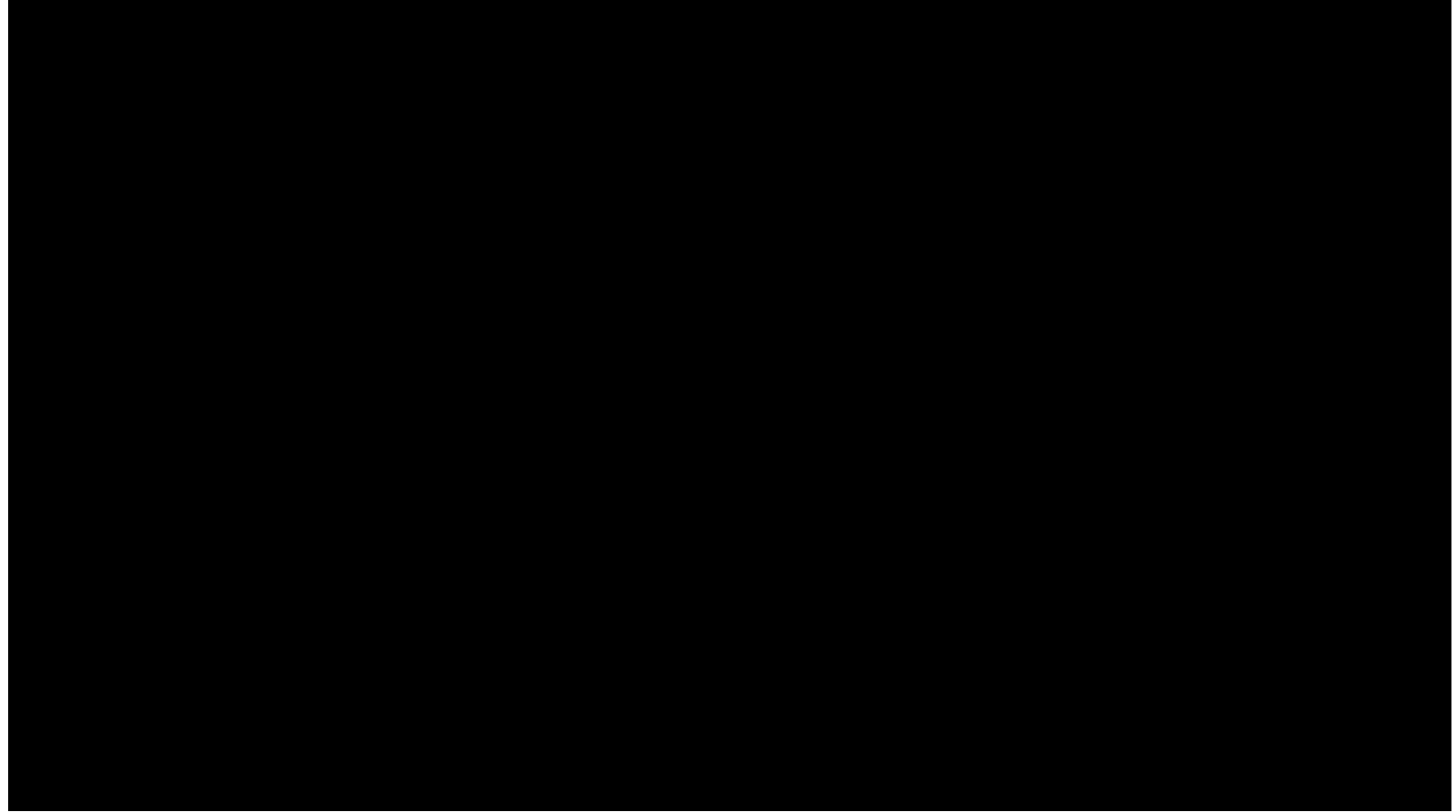
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Applications

- ▶ GPS Tracking
- ▶ R/T positions streamed @15fps
- ▶ Live position tracking across multiple camera datastreams
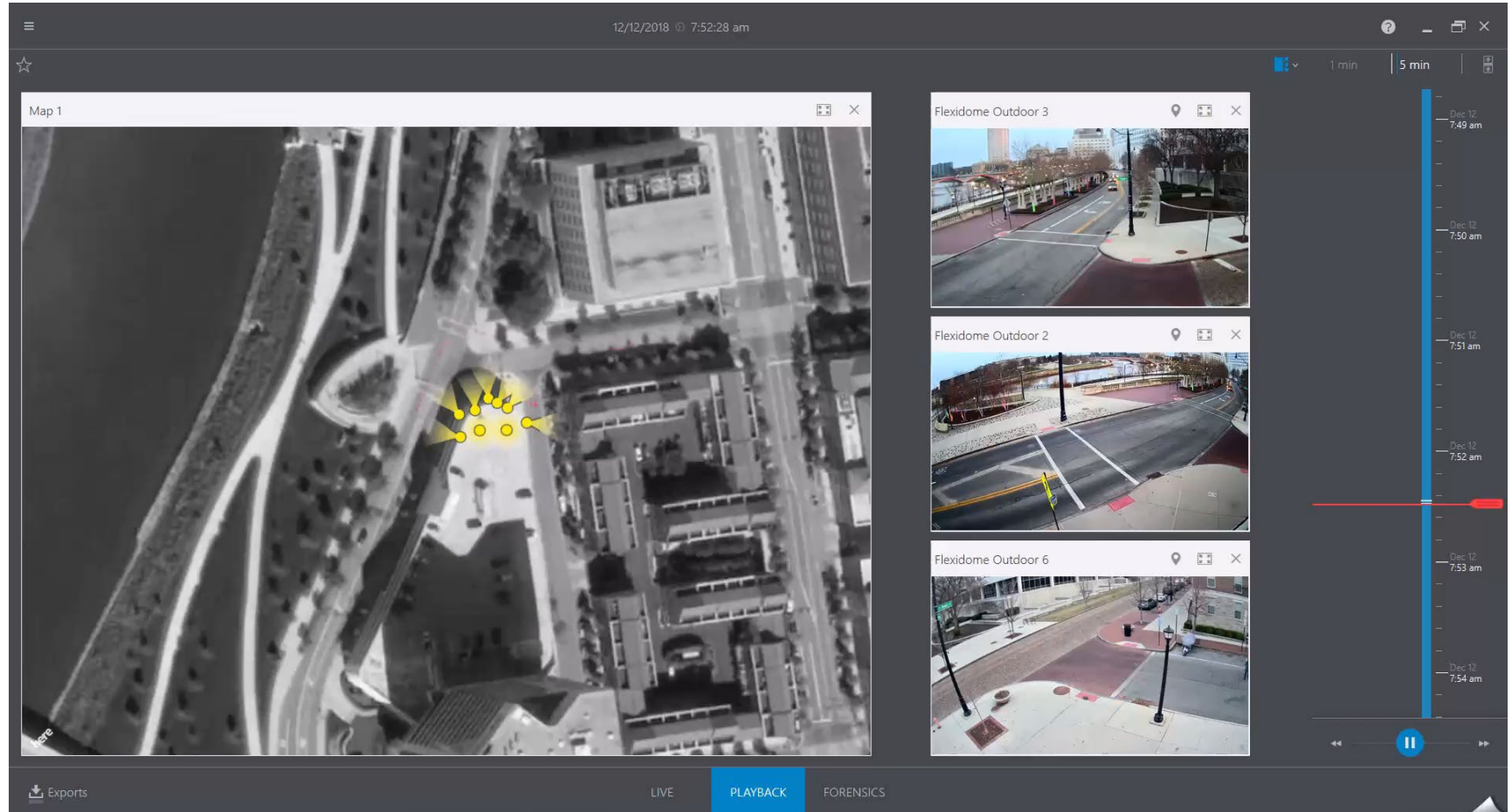
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PROJECT EXAMPLES

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New York City DOT
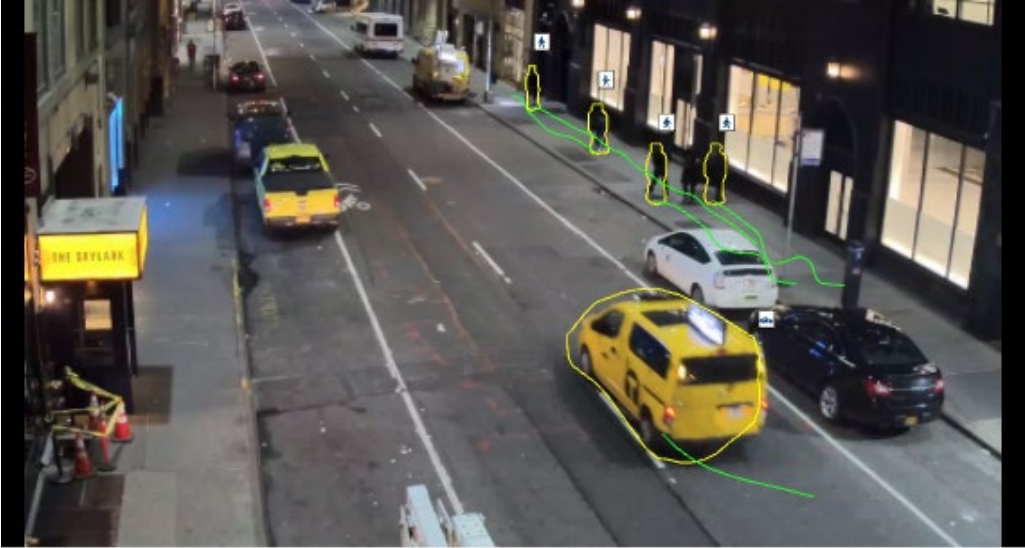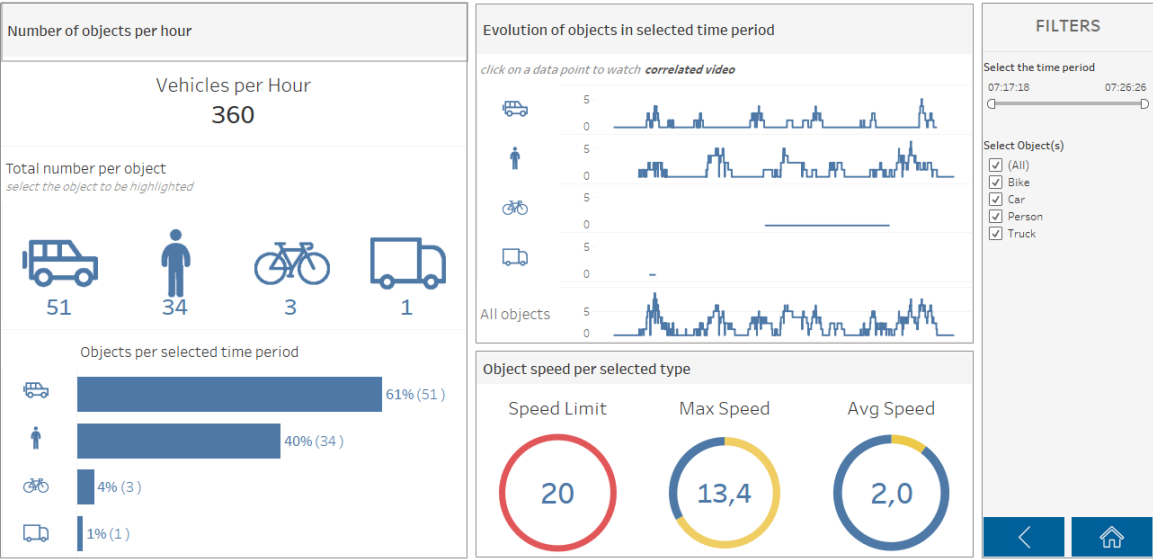
Pilot partners:
New York City DOT, Bosch BT-SC and
Industrial E-net

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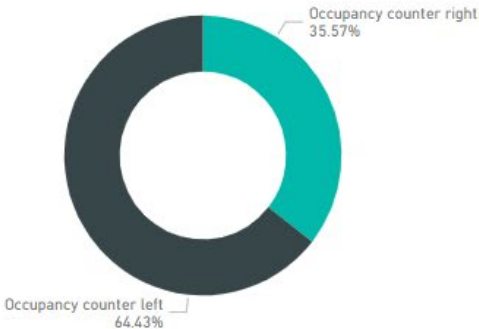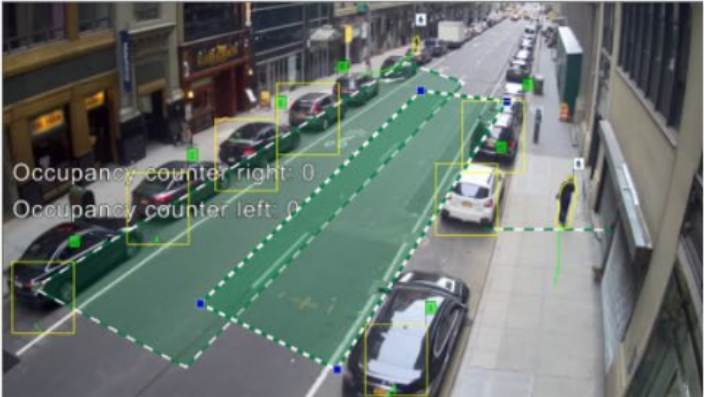
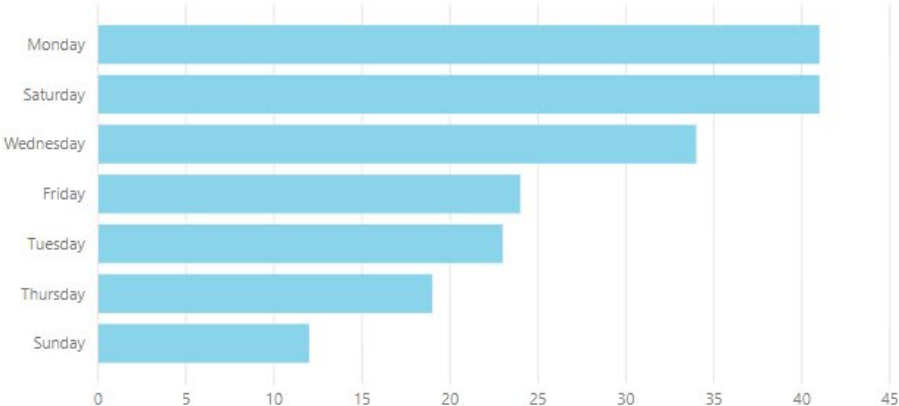# Smart Infrastructure Enabled by Video-as-a-sensor Technology
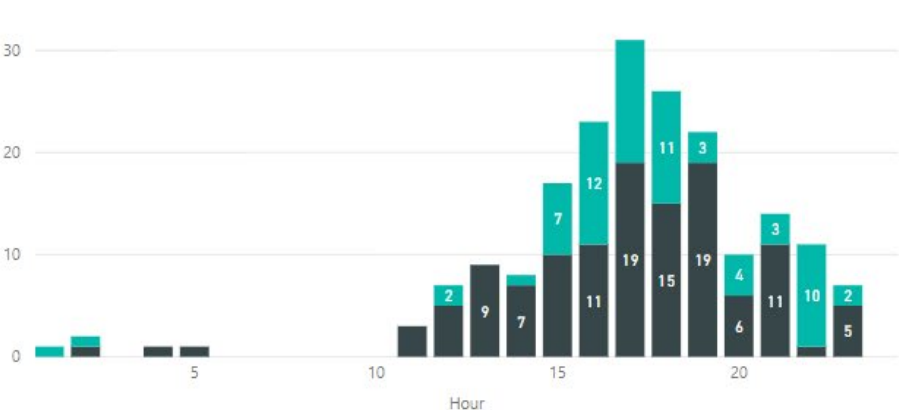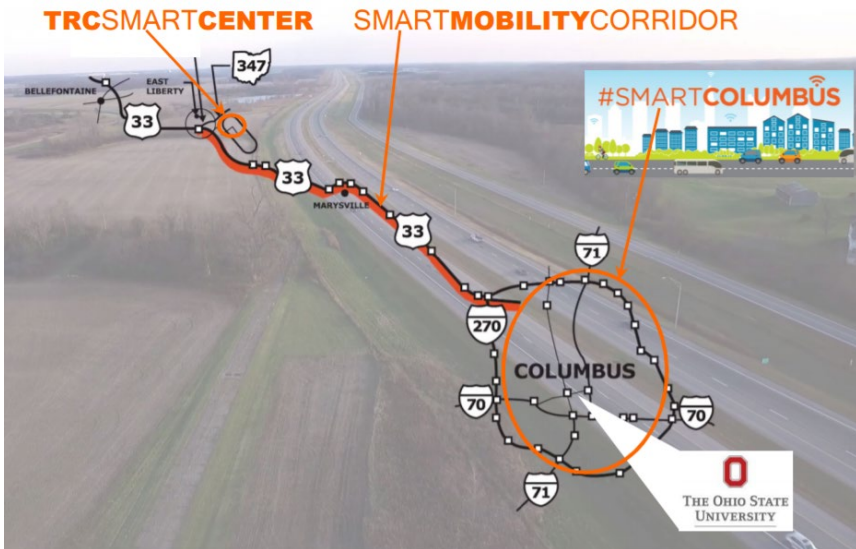
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Smart Columbus

Project Overview - US-33 Smart Mobility Corridor
$15m investment; Finish Fall 2018

- 35 mile premier public CV/AV proving grounds
- Highway between Columbus and E. Liberty OH
- Partnership: ODOT, Honda, TRC, OSU and local Governments

TRCSMARTCENTER   SMARTMOBILITYCORRIDOR

#SMARTCOLUMBUS

ODOT – Ohio Department of Transportation
TRC – Transportation Research Center
OSU – The Ohio State University

**Improving corridor safety by warning drivers of dangers ahead**

| Applications	
Curve Speed Warning	Warn vehicle with dangerous speed in road curve. Speed limit for truck differs from limit for sedan.
Queue Warning	Advance queue warning for upstream traffic in locations with restricted visibility (humps in the road, curves, highway exits).
Pedestrian	Detecting pedestrians on road, hard shoulders.
Signalized Intersections	Detecting pedestrians, car at stop line, advance car detection.
CCTV w. analytics	Automatic Incident Detection: stopped car on hard shoulder, sudden speed change
Wrong Way Driver	Detecting WWD, Warning upstream highway traffic on dynamic message signs of WWD. Tracking WWD with PTZ cameras.
Work Zone Warning	Warning cars driving towards constructions sites at high speeds.

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Marysville Ohio – Pedestrian Safety

▶ City of Marysville Ohio intersection detection -GPS coordinate pedestrian position broadcast via TIM messages to OBU and cloud apps running a Kapsch map interface

▶ Thermal cameras as sensors for ped and vehicle detection

▶ Crosswalk counts, j-walk counts, turning movement counts

▶ Connect:ITS to generate DSRC TIM alerts
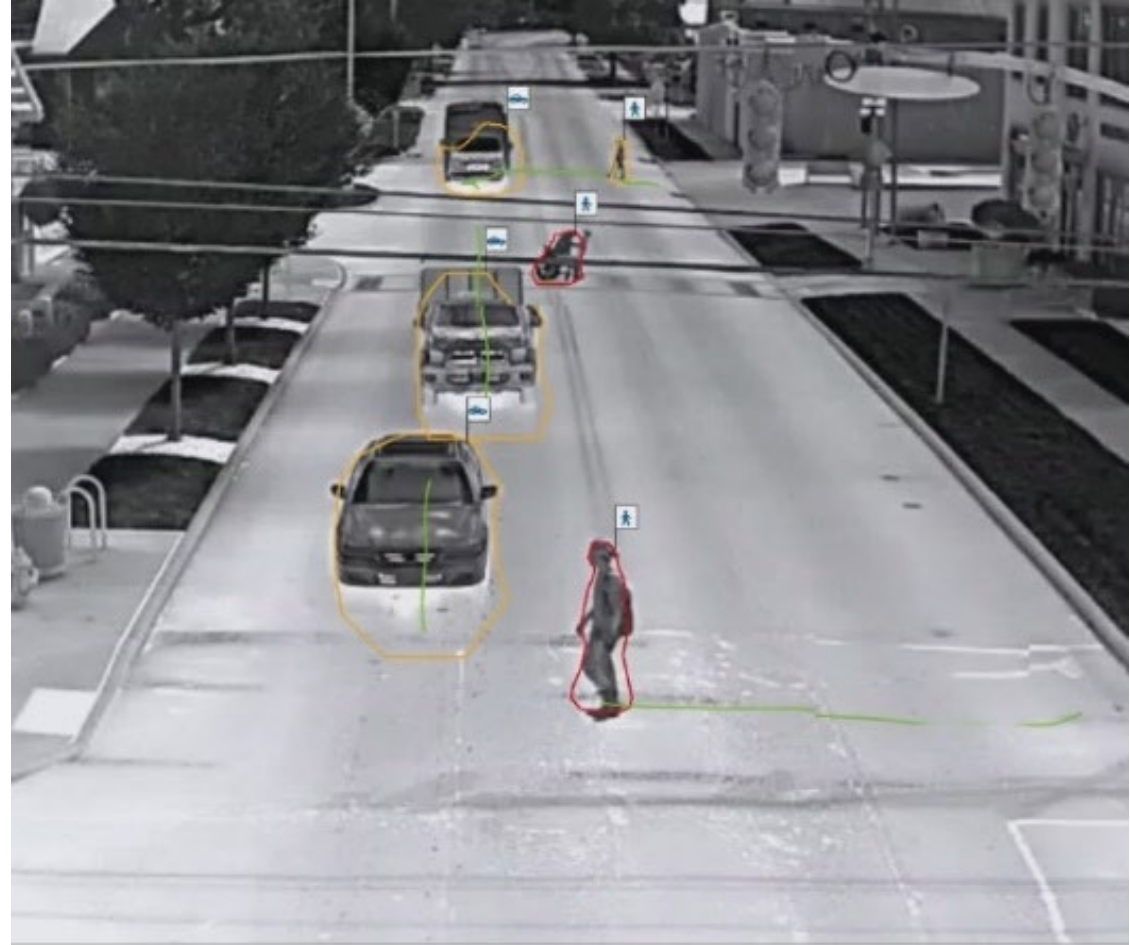
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Marysville Ohio – Pedestrian Safety

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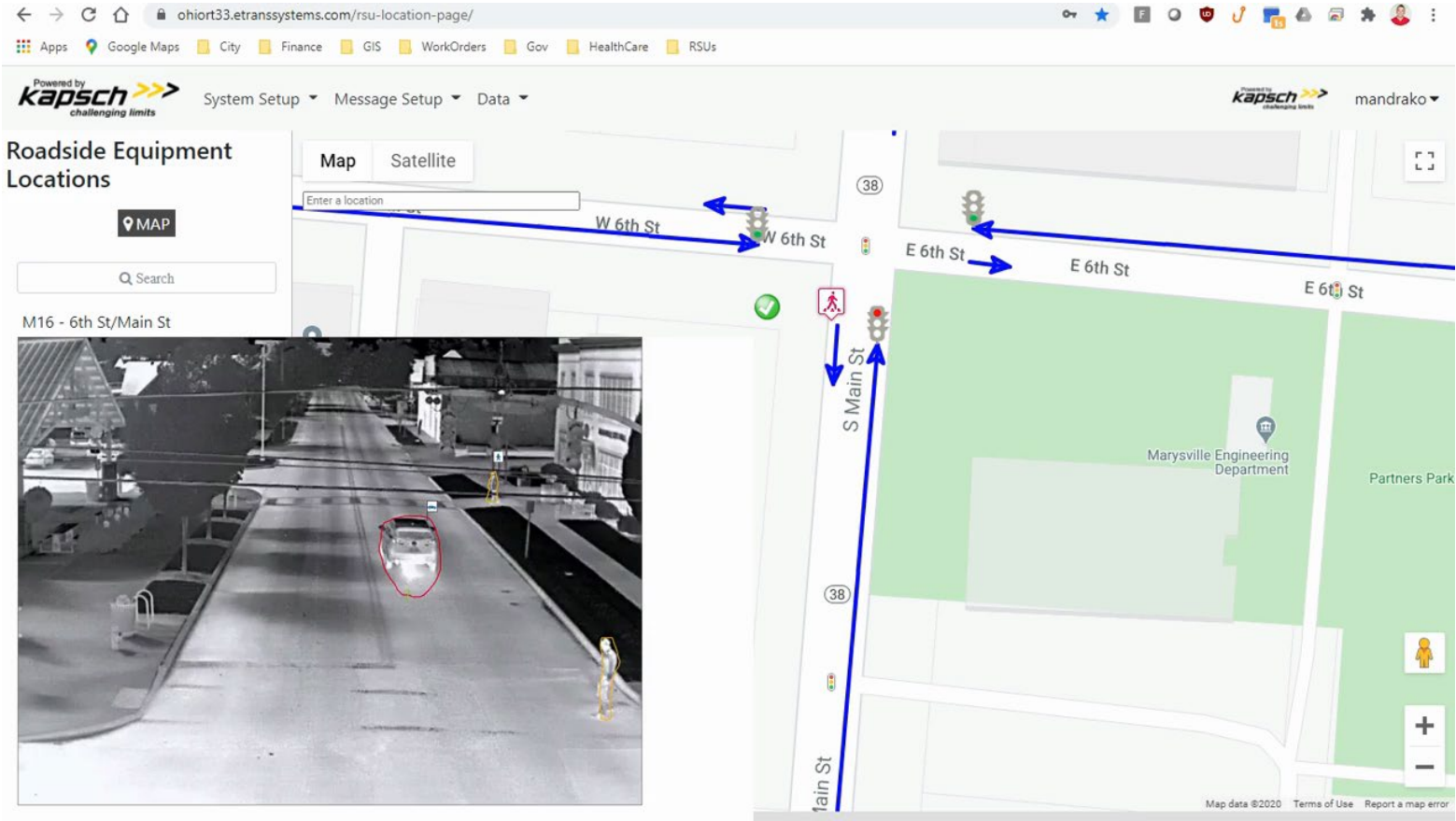
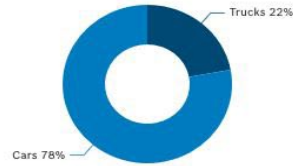# Smart Infrastructure Enabled by Video-as-a-sensor Technology

Marysville Ohio – Pedestrian Safety

▶ Concurrent to the Connect:ITS DSRC pedestrian position broadcast, the cameras all send vehicle and pedestrian data to the cloud enabling historical analysis
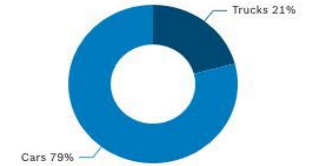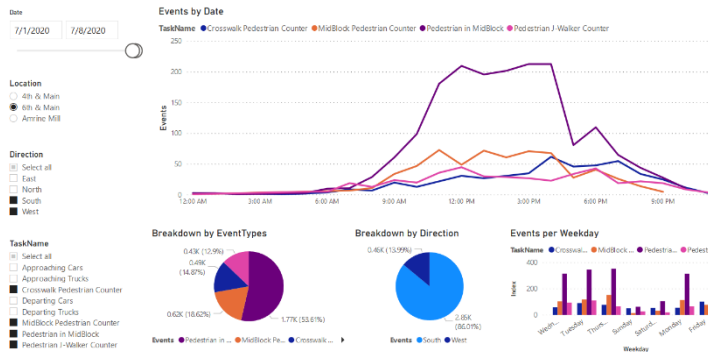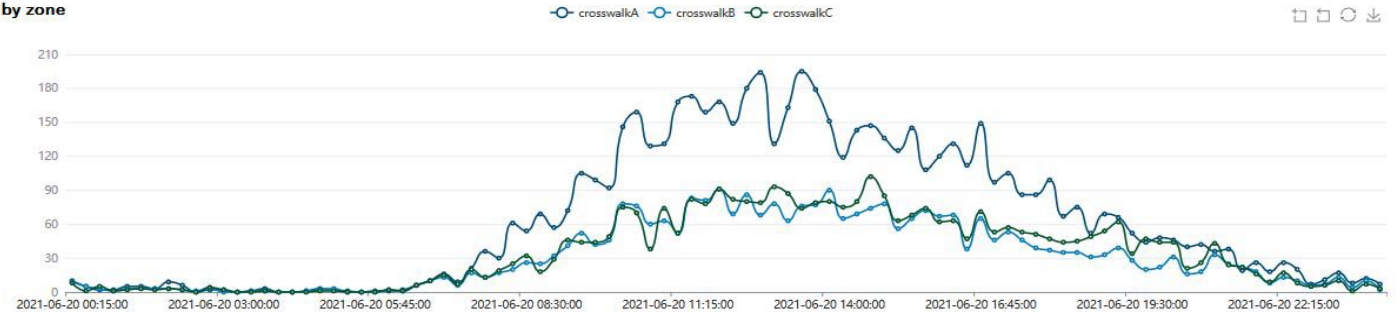
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FUTURE INNOVATIONS

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Fostering synergies by connecting different divisions and projects across Bosch

TOP95 Project, CR activities

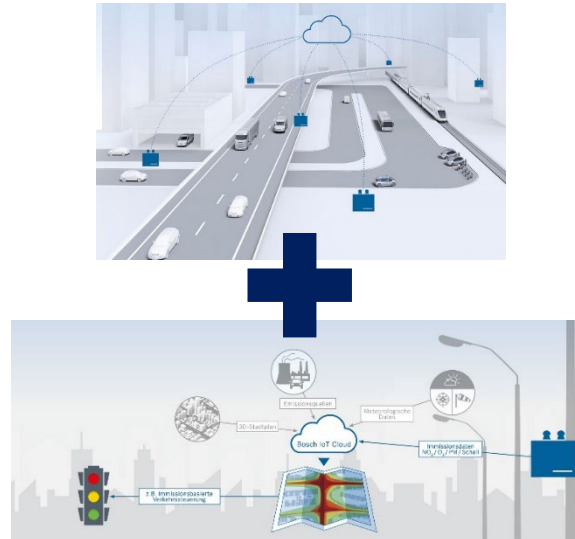**Evaluate and drive pull for infrastructure-supported automated driving**

▶ Initiatives reach from sensor fusion to communication technologies
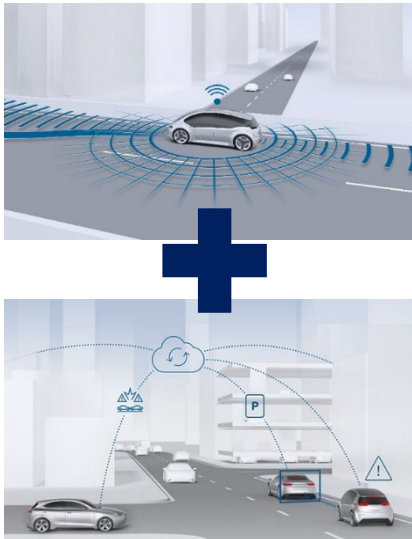
Air Quality Solutions

Emission Monitoring System: Accurate high-quality measurement of air quality

▶ Realistic emission modeling to enable emission-based traffic management

GPS-based WWD

GPS based cloud solution to detect and warn wrong-way drivers and other drivers

▶ Live and field proven service, fastest system to detect and warn drivers

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