FLIR

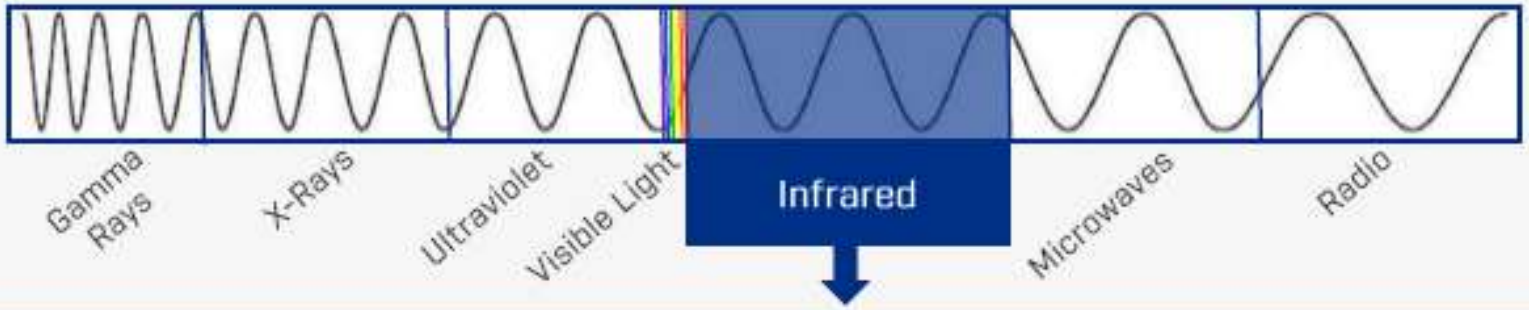
Michael Deruytter

DIRECTOR INNOVATION

NOV 1, 2018

What We Do: Thermal Sensing

Leveraging an Area of the Electromagnetic Energy Spectrum Beyond Our Eyesight

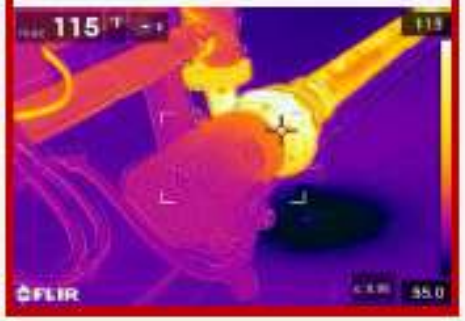


To Develop Imaging Solutions That Enhance Peoples' Perception and Awareness

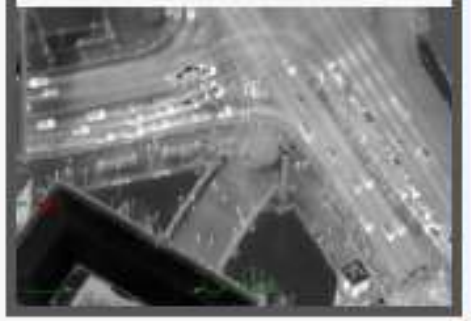
See in Total Darkness

See Through Obscurants

Measure Temperature



Enhanced Long Range Imaging



Accurately Detect People & Animals

Operating Portfolio

$1.8B
Revenue
LTM Q1'18

3,500
EMPLOYEES
WORLDWIDE

FLIR

Industrial

- Building / electrical / mechanical inspection cameras
- Thermal camera cores
- Machine vision cameras
- Lab / R&D cameras
- Firefighting cameras
- Commercial UAS

LTM Q1'18 Revenue	LTM Q1'18 Operating Margin
$688M	29%

Government & Defense

- Airborne systems
- Maritime systems
- Border surveillance
- Radiation detectors
- Explosives detectors
- Chemical-biological threat detectors

LTM Q1'18 Revenue	LTM Q1'18 Operating Margin
$650M	30%

Commercial

- Security cameras
- Video management software
- Boating electronics
- Outdoor and tactical sights
- Intelligent transportation systems

LTM Q1'18 Revenue	LTM Q1'18 Operating Margin
$495M	12%

Intelligent Transportation Systems

Detection and Monitoring Solutions for Traffic Applications

FLIR Intelligent Transportation Systems (ITS) is revolutionizing how traffic flows on roadways throughout the world. Our unique, field-proven solutions help keep vehicles, pedestrians, and bicycles moving safely and smoothly.

Smart City Sensors

Traffic Signal Control

Data collection

Automatic Incident Detection

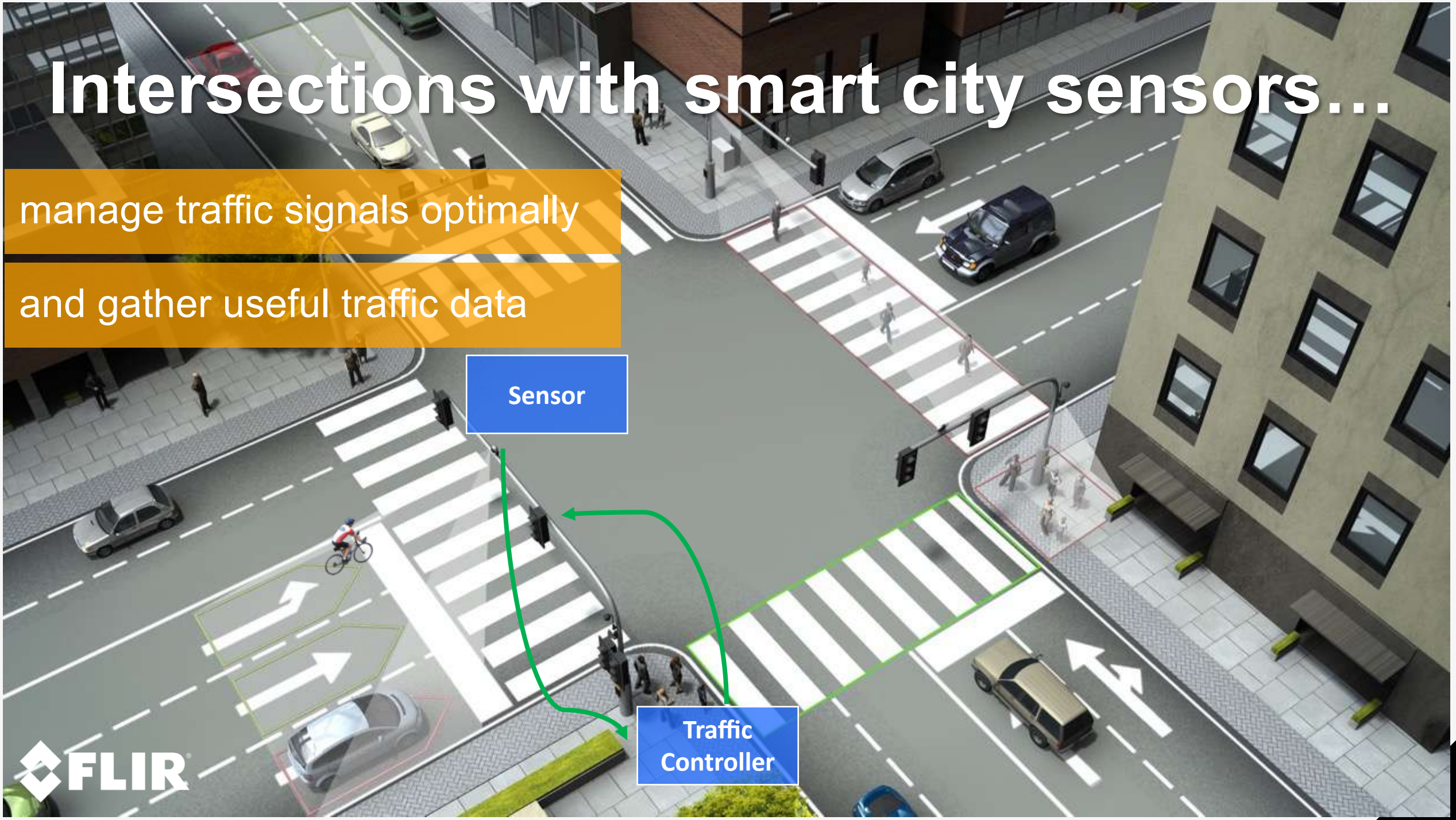
Fire Detection

Pedestrian & Bicycle Safety

Traffic Management

Public Transport Safety

FLIR


Intersections with smart city sensors…
manage traffic signals optimally
and gather useful traffic data
Sensor
Traffic Controller
FLIR

Pedestrian & Bicycle detection

PUSH BUTTON CANCEL

DYNAMIC CLEARANCE TIME

WARNING SIGNALS

LEADING PEDESTRIAN / BICYCLE INTERVAL

PEDESTRIAN PRIORITY

Why Pushbuttons fail

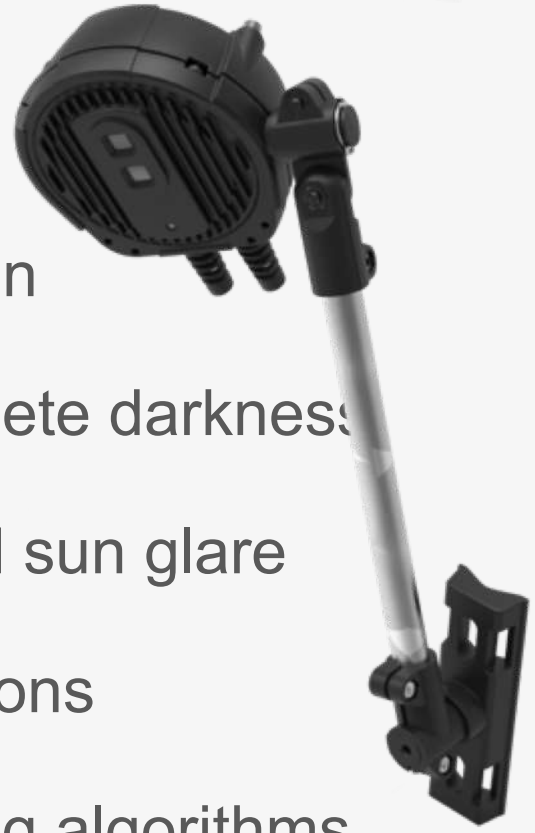
Sometimes hard to know what crossing it is for

People and cyclists don’t use it

People don’t wait for it

How thermal succeeds

- 24/7 reliable detection
- at night and in complete darkness
- through shafows and sun glare
- in all weather conditions
- using thermal tracking algorithms



Pedestrian Counting

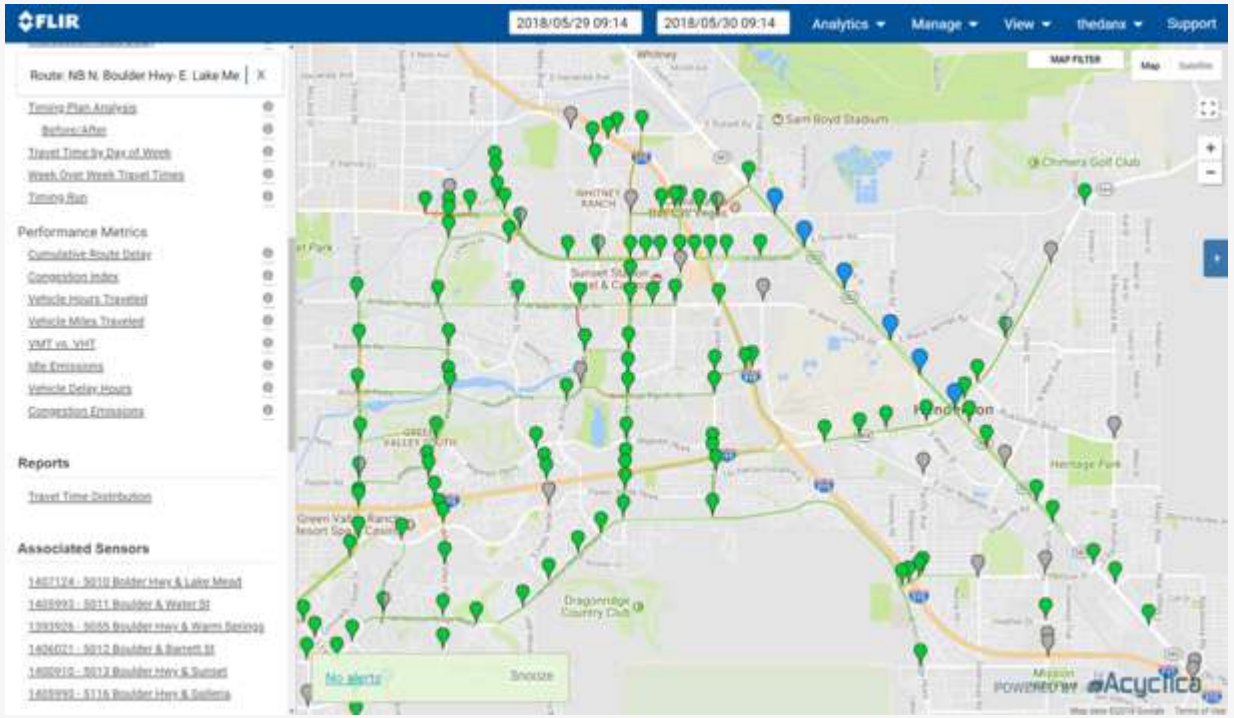
- Optimize traffic signal control in real time
- Safety analyses
- Before and after studies
- Monitor seasonal variations
- Deploy staff appropriately
- Securing funding, justifying expenditures

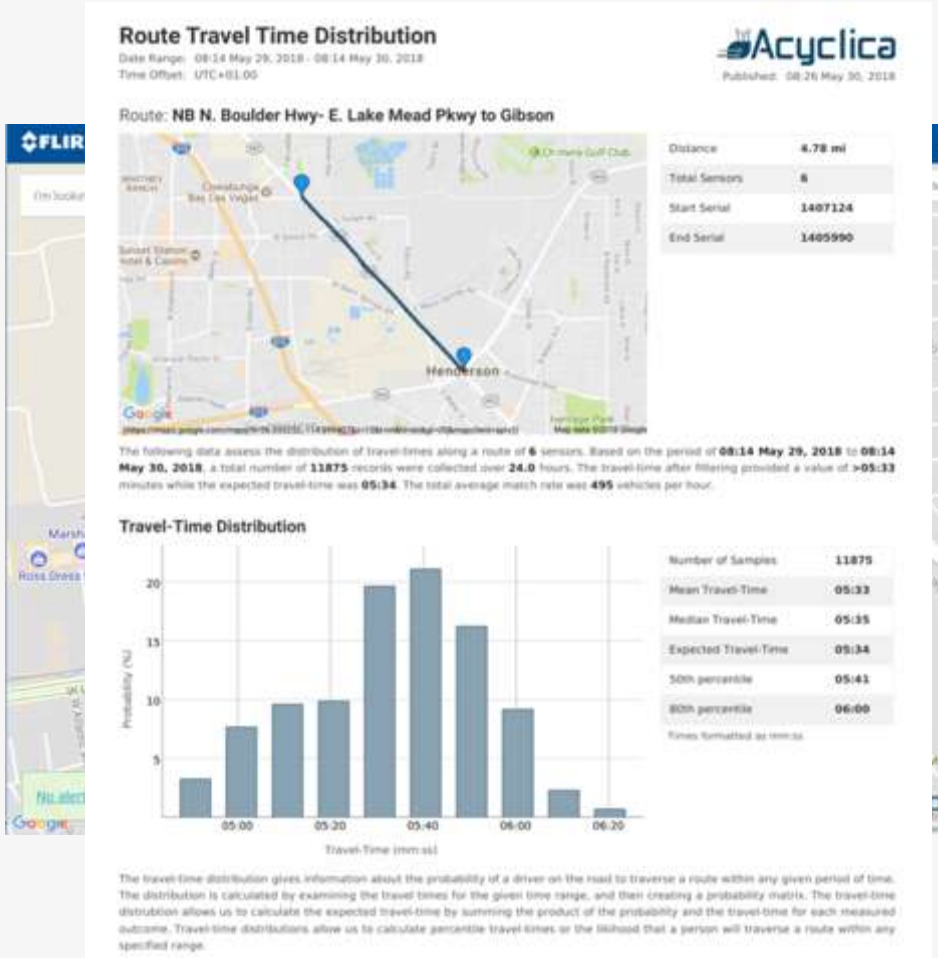
The cloud layer for infrastructure

Wi-Fi Travel & delay time

FLIR Acyclica

ITS-IQ Smart City platform





ITS-IQ:

- Wi-Fi Travel Time & Delay at intersections
- ITS Data Analytics: Volume / Speed / Occupancy / Turning Movement Count / congestion map
- Images / camera configuration / dashboards / custom reports

https://flir.acyclica.com/#

FLIR | 2018/10/15 15:36 | 2018/10/22 15:36 | Analytics | Manage | View | michaelder... | Support

Available Analytics

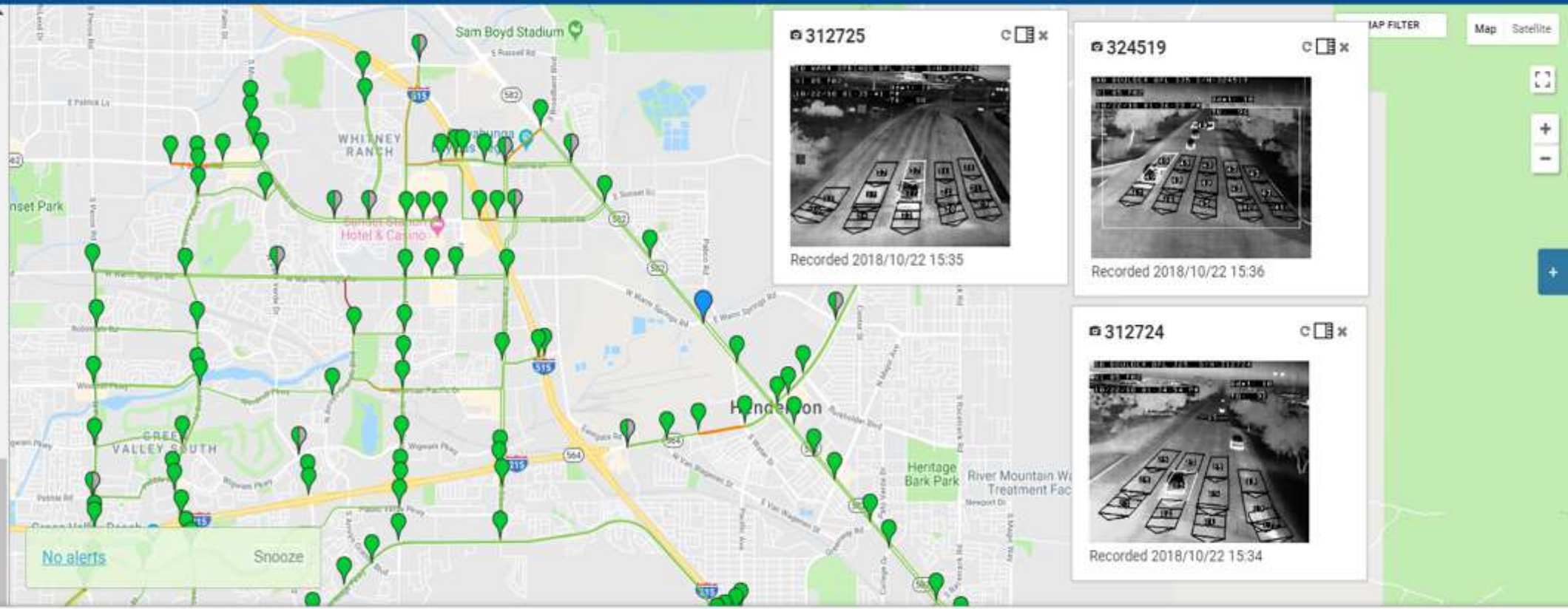
I'm looking for... X

Delay by Movement
Delay by Approach

Performance Metrics
Arrivals on Red / Green
Purdue Coordination
Pedestrian Delay
Vehicle Delay
Arrival and Departure Delay

Device Tools
Data Availability
Records per Hour
Distinct Records per Day
Delay

VSO Analytics
Data Availability
Time of Day Distribution
Volume
Speed
Occupancy



312725

Recorded 2018/10/22 15:35

324519

Recorded 2018/10/22 15:36

312724

Recorded 2018/10/22 15:34

5055 Boulder Hwy & Warm Springs

Configured Data

Heater	Off (1 V)
Cabinet Door	Open (1 V)
Flash Sense	Off (0.03 V)
BBS Battery	Normal (6.47 V)
CAB DC	Critical (0.03 V)

RYG Channels (8)

Smart City Sensors

Functionality

TrafiSense Dual 6xx
ThermiCam Dual 6xx

Vehicle/bike/ped
TrafficData
Inverse Direction
Pedestrian Presence
Thermal Video
HD Video

TrafiRadar

Vehicle Presence
Dilemma zone
Advance Detection
Video

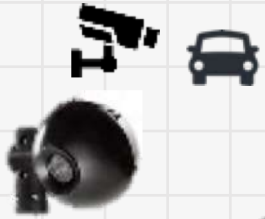
TrafiSense 6xx / 3xx
ThermiCam 6xx / 3xx

Vehicle/bike/ped
TrafficData
Stopbar classification
Inverse Direction
Pedestrian Presence
Thermal Video

HIGH END

TrafiCam x-stream

Vehicle Presence
TrafficData
HD Video



TrafiOne

Pedestrian counting
Vehicle presence
HD video
Wi-Fi monitoring

MID END

TrafiOne

Pedestrian Presence

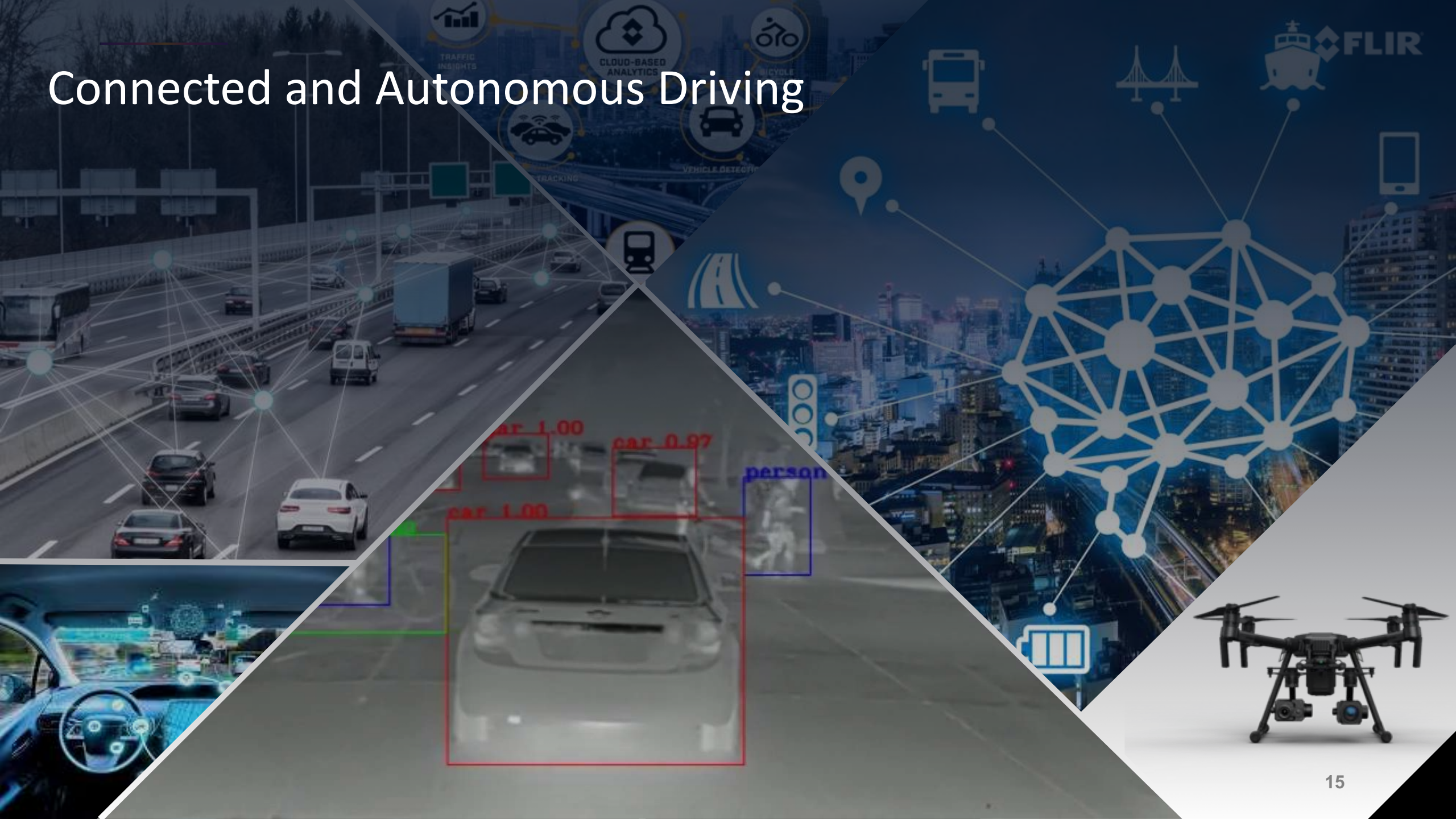
TrafiCam 2

Vehicle Presence

LOW END

ITS-IQ Wi-Fi travel & delay time
Data Fusion

Connected and Autonomous Driving



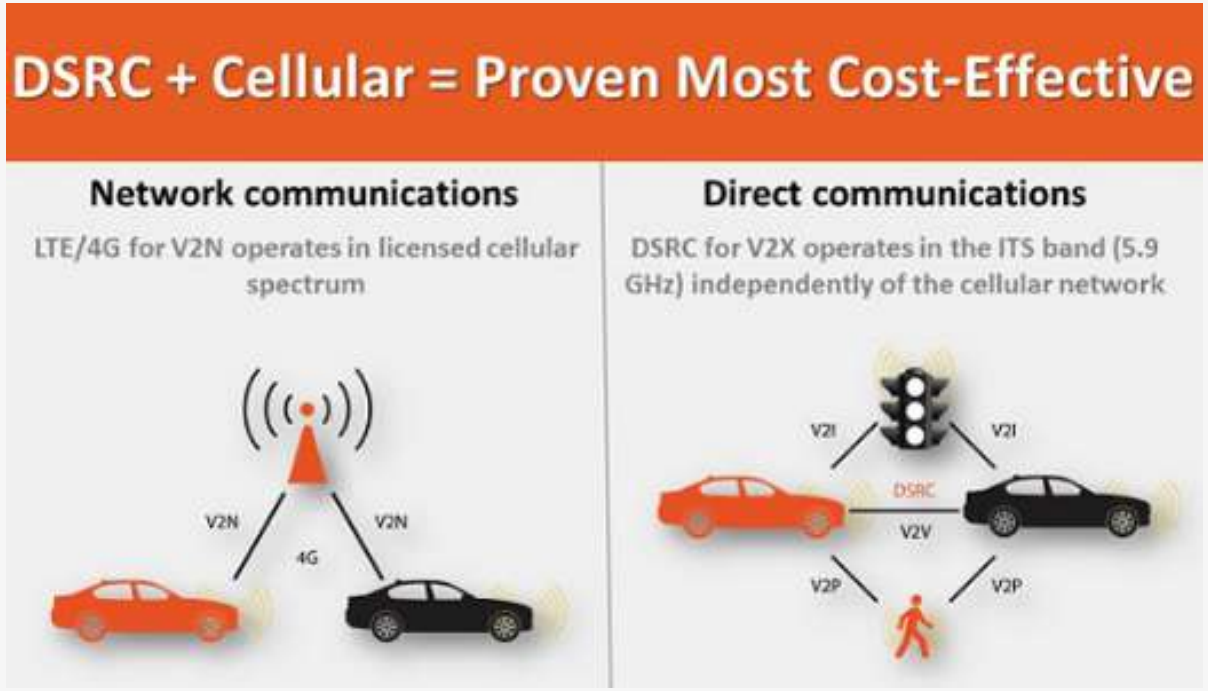
C-ITS

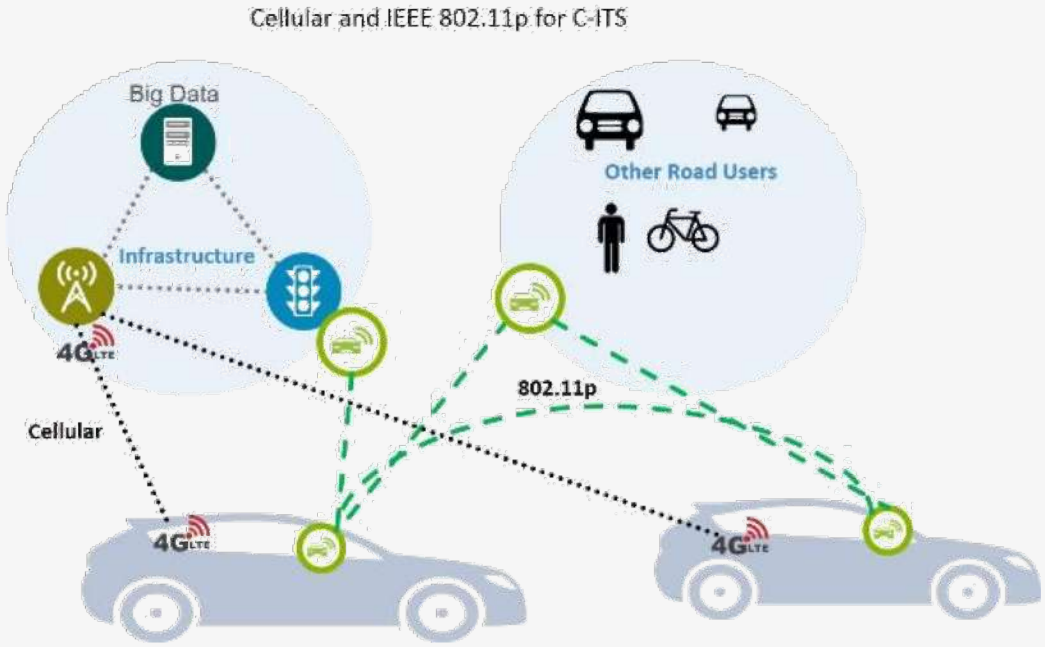
Cooperative ITS

V2X

V2X Technology

ABIresearch
technology market intelligence





V2X Technology

Dedicated Short Range Communications

- Range – 300m – 500m – 2 km
- US: 75 MHz in the 5.9 GHz band – IEEE 802.11p
- EU: 30 MHz in the 5.89 GHz band – ITS G5
- Low Latency, high reliability
- Prioritization
- Interoperability
- Security & Privacy (no personal info, anonymous)

V2X standards

Application layer Definition of message schemes	SAE J2735 (US) CAM, DENM (EU)
Network layer IP stack IPV6, security, applications	IEEE 1609.1-4 (US) Geo Networking (EU)
MAC / FI layer	IEEE 802.11p (US) ITS G5 (EU)

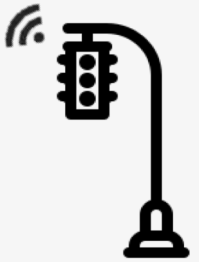
OBU

On Board Unit

- GPS position
- Speed
- Acceleration
- Heading
- Transmission state
- Brake status
- Steering wheel angle
- Path history
- Path prediction

RSU

Road Side Unit



- Receive Basic Safety Messages from vehicles
- Receive Signal Request Messages from emergency vehicles and priority vehicles
- Broadcast intersection MAP and SPaT (Signal Phase and Timing)

V2X Technology

With the aim of increasing safety in road traffic, Volkswagen will enable vehicles to communicate with each other as from 2019

- From 2019 on, Volkswagen will start fitting the first models with pWLAN technology
- Information on traffic risks arising at short notice will be sent to other vehicles and the local environment within a few milliseconds

Wolfsburg – Connectivity between different vehicles as well as between vehicles and transport infrastructure in the vicinity is another important step towards connected motoring that aims to reduce road accidents or minimise their consequences. As from 2019, Volkswagen will therefore start fitting its first models with pWLAN as standard in order to serve as an additional communication technology for the exchange selected information relevant to traffic between cars made by different manufacturers. This will involve information being exchanged both between vehicles (car-to-car), as well as between vehicles and the transport infrastructure (car-to-X)*. This will, for example, enable information about the current traffic situation, accidents and other situations relating to traffic conditions to be shared with the local environment, within a radius of approx. 500 m, even faster than has been possible in the past.

V2V Safety Technology Now Standard on Cadillac CTS Sedans

10,000 NYC Vehicles Are Going To Test the Government's Connected Car Tech

The US Department of Transportation analysis of two potential applications, “intersection movement assist” (IMA) and “left turn assist” (LTA), indicated there could be an average **50-percent reduction in crashes**, injuries, and fatalities just through these two applications.

V2X Adoption Rate

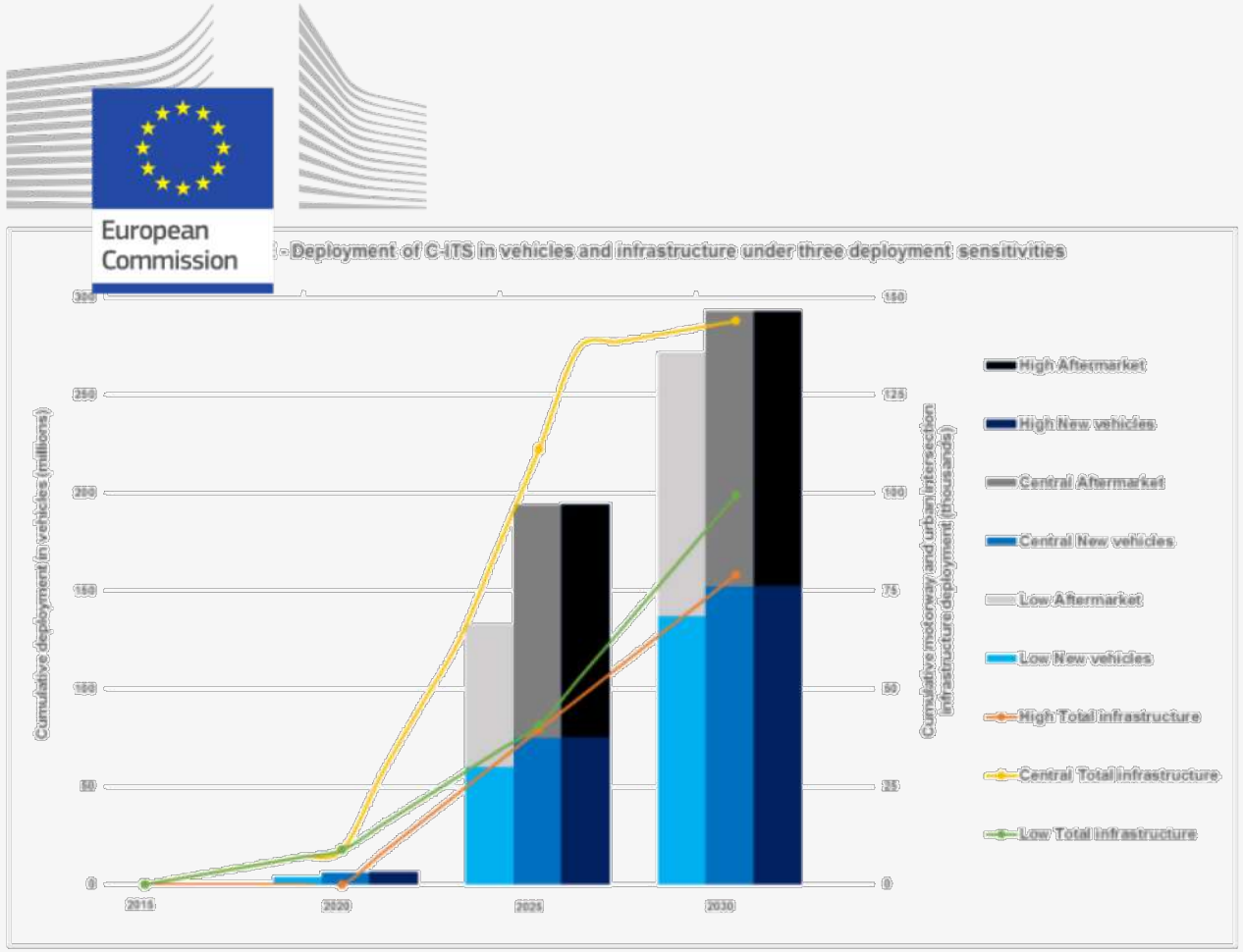
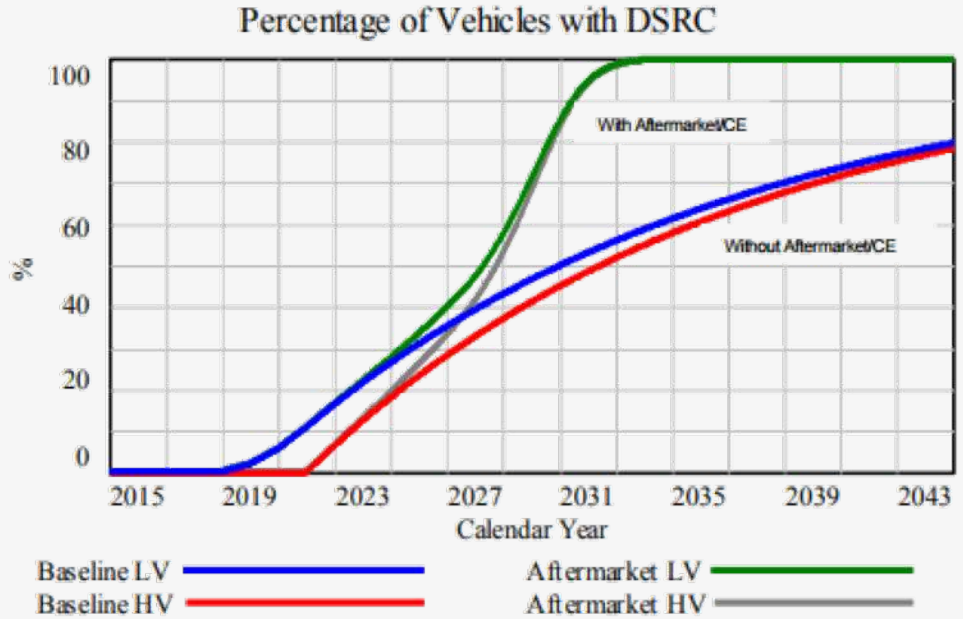


Figure 2: Cumulative deployment of C-ITS equipment in vehicles and infrastructure

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

U.S. Department of Transportation
Federal Highway Administration



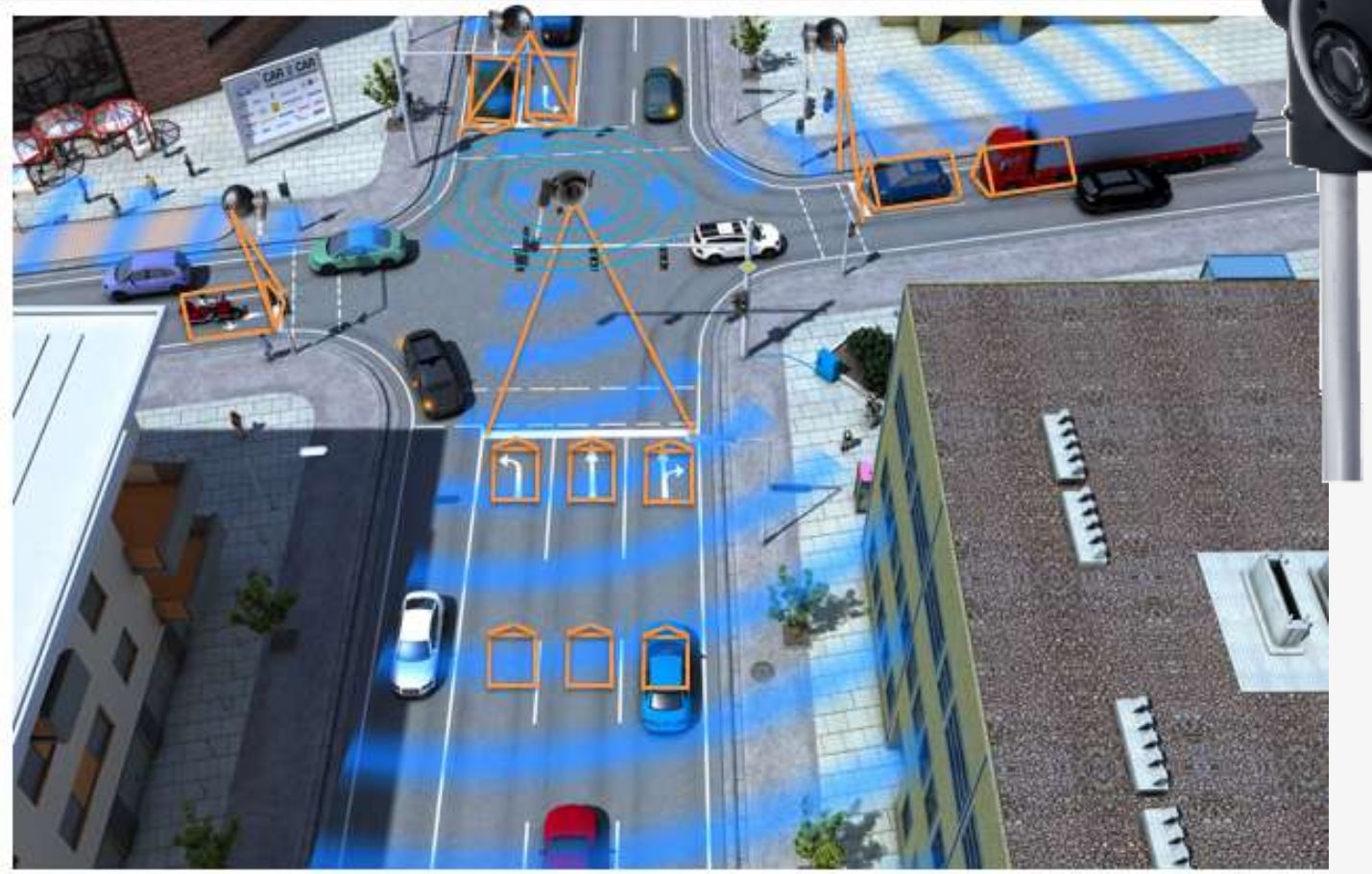
Forecast Percentage of Road Users (All Light [LV] and Heavy [HV] Vehicles) Equipped with DSRC 2015-2045 (Source: ITS America)

V2I

V2V technology is expected to speed-up the deployment of various V2I applications

- Red Light Violation Warning
- Curve Speed Warning
- Stop Sign Gap Assist
- Reduced Speed Zone Warning
- Spot Weather Information Warning
- Stop Sign Violation Warning
- RailRoad Crossing Violation Warning
- Oversize Vehicle Warning
- Electronic Toll Collection
- Pedestrian in Signalized Crosswalk Warning (PSWC)
- Public tranposrt priority
- Traffic signal preemption for emergency vehicles

ThermiCam V2X

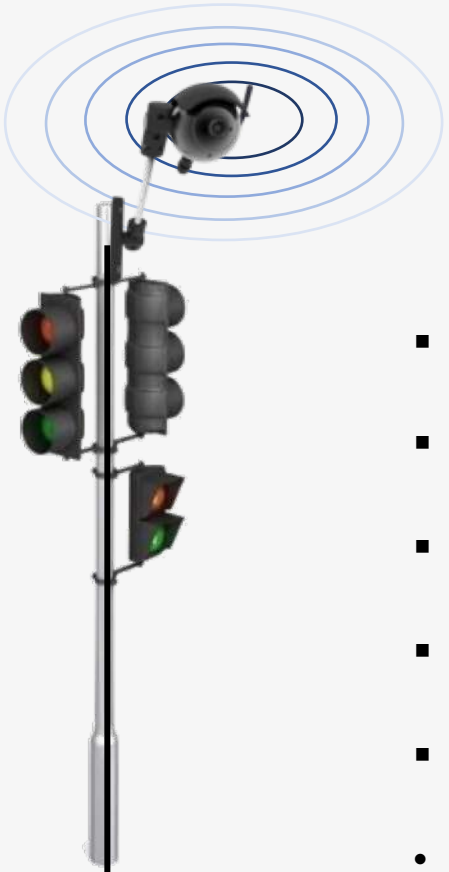


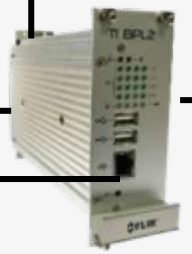
- Local processing of V2X messages
- Camera is in ideal position for antenna
- Thermal and virtual detection in 1 device
- Transition period till 2025 and way beyond
- Reduces complexity, ensure interoperabilty
- BPL communication for easy installation

ThermiCam V2X

FLUX (Local) or
ITS-IQ (cloud)
V2X managment

16 x Outputs





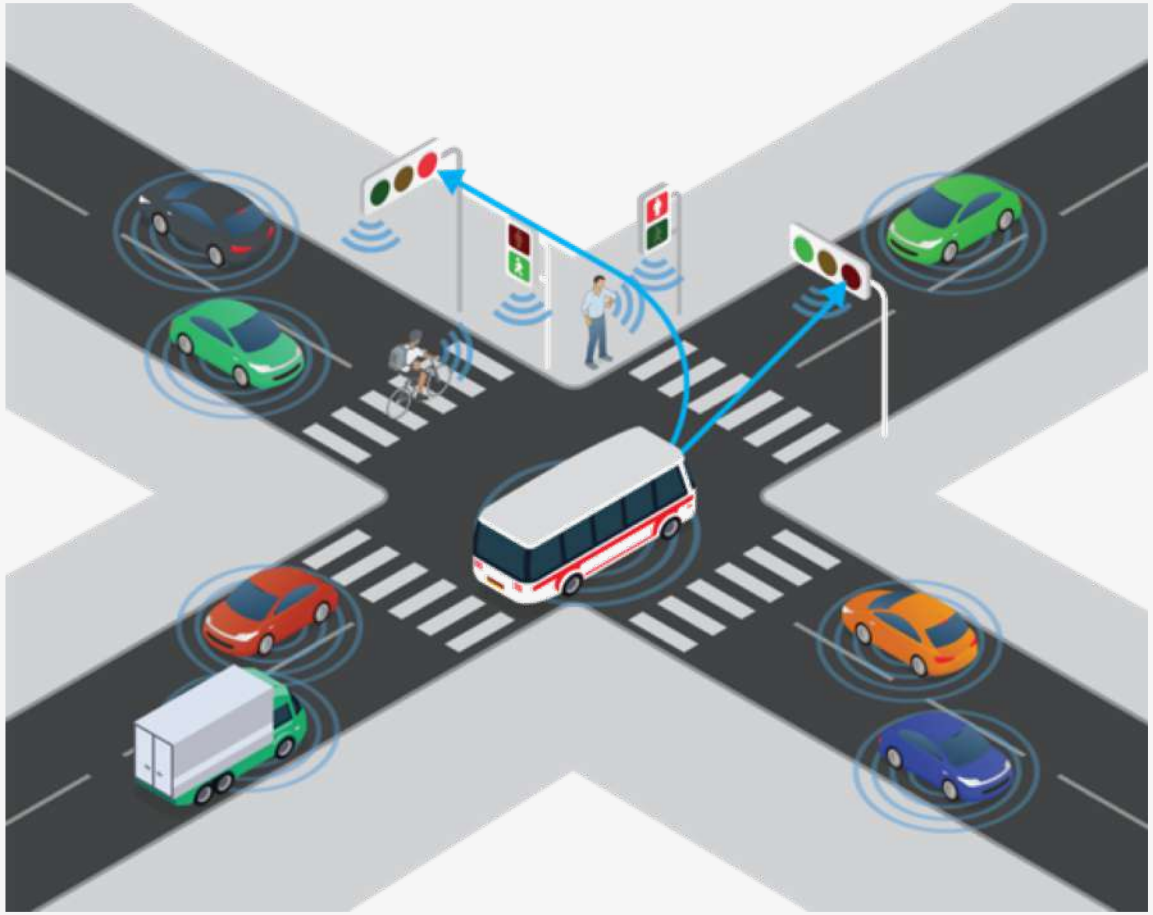
Power

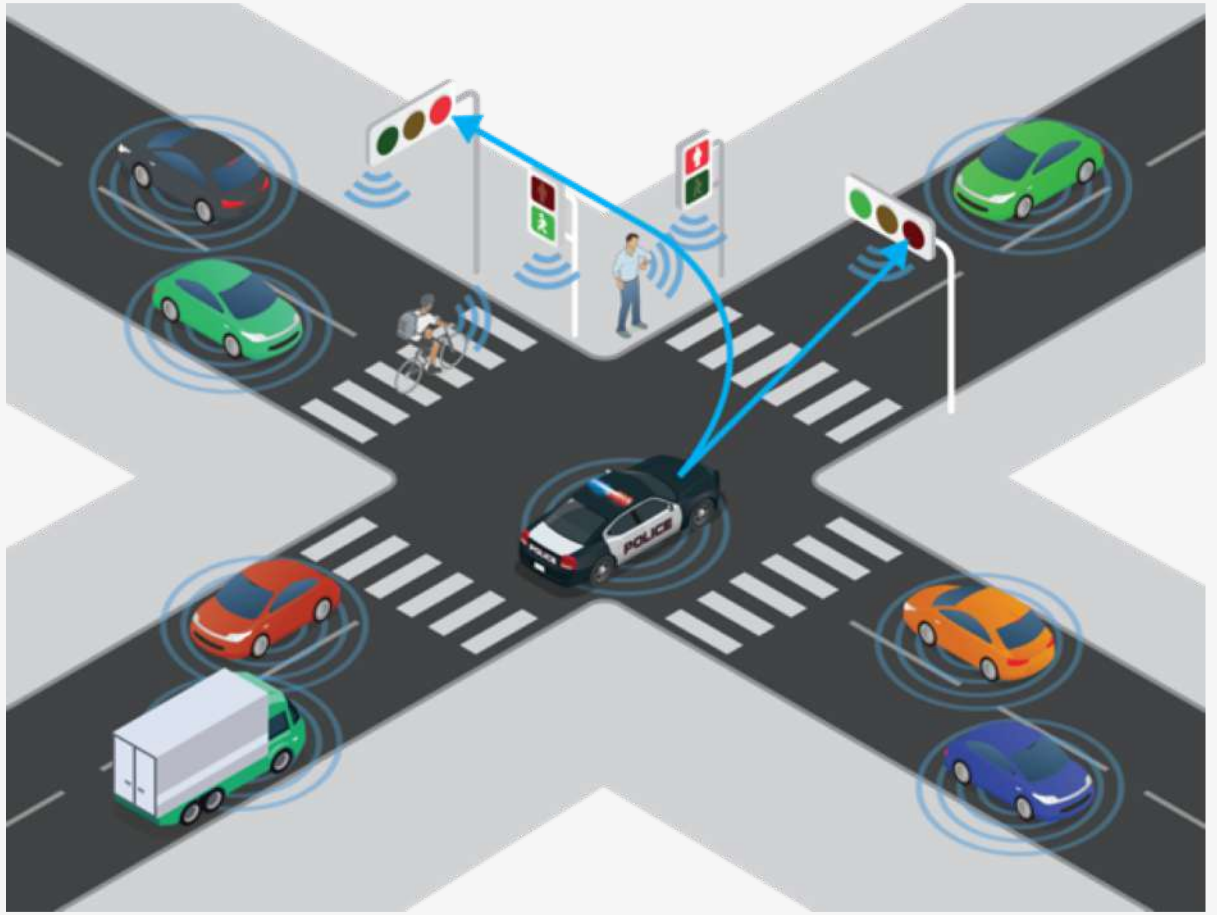
Power cable
Broadband over powerline communication

TCP/IP Ethernet
communication

- Virtual detector
- SPaT / MAP
- Dilemma zone protection / queue warning
- Data collection & analytics (VSO & traffic flow data)
- Pedestrian/bicyclist warning
- Pre-emption, signal priority

V2X: Traffic Signal priority

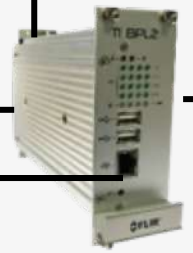




ThermiCam V2X

FLUX (Local) or
ITS-IQ (cloud)
V2X managment

16 x Outputs



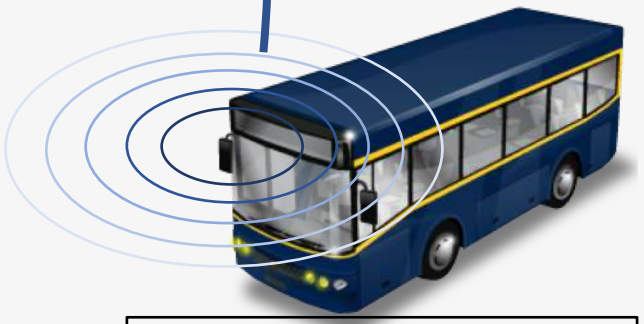
Power

Power cable
Broadband over powerline communication

TCP/IP Ethernet
communication

DE_StationType = {6} (bus)
DE_VehicleRole = {1} (PublicTransport)
DE_Latitude = {50.92536666}
DE_Longitude = {3.121452777}

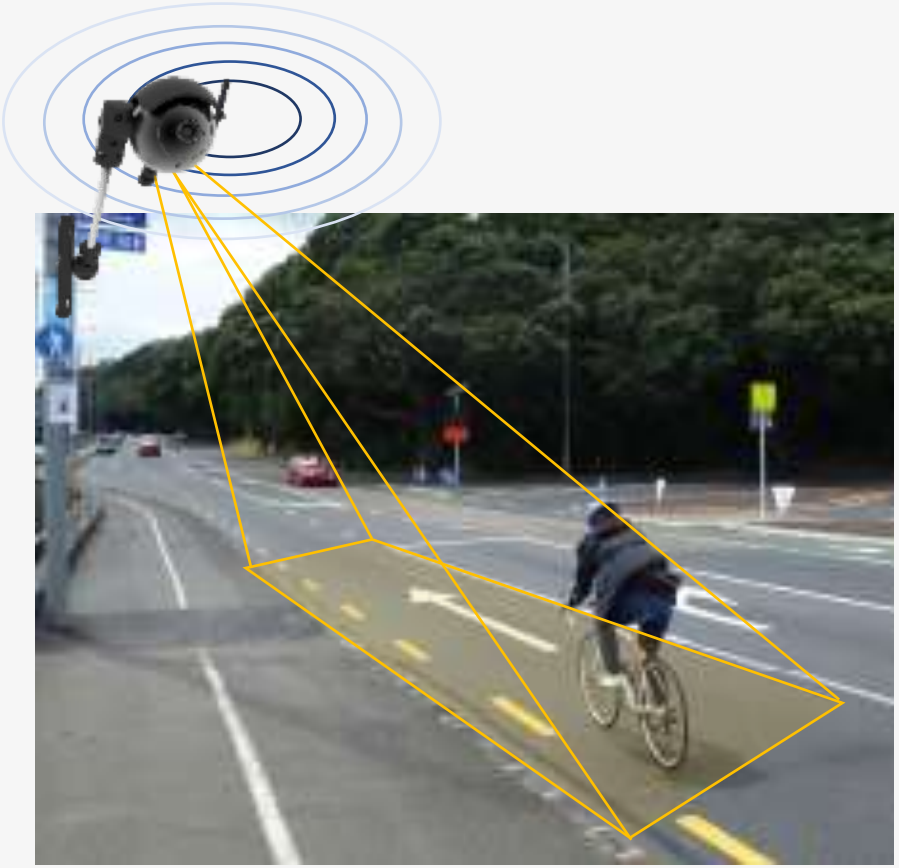
ETSI TS 102 894-2 CAM
Cooperative Awareness Message



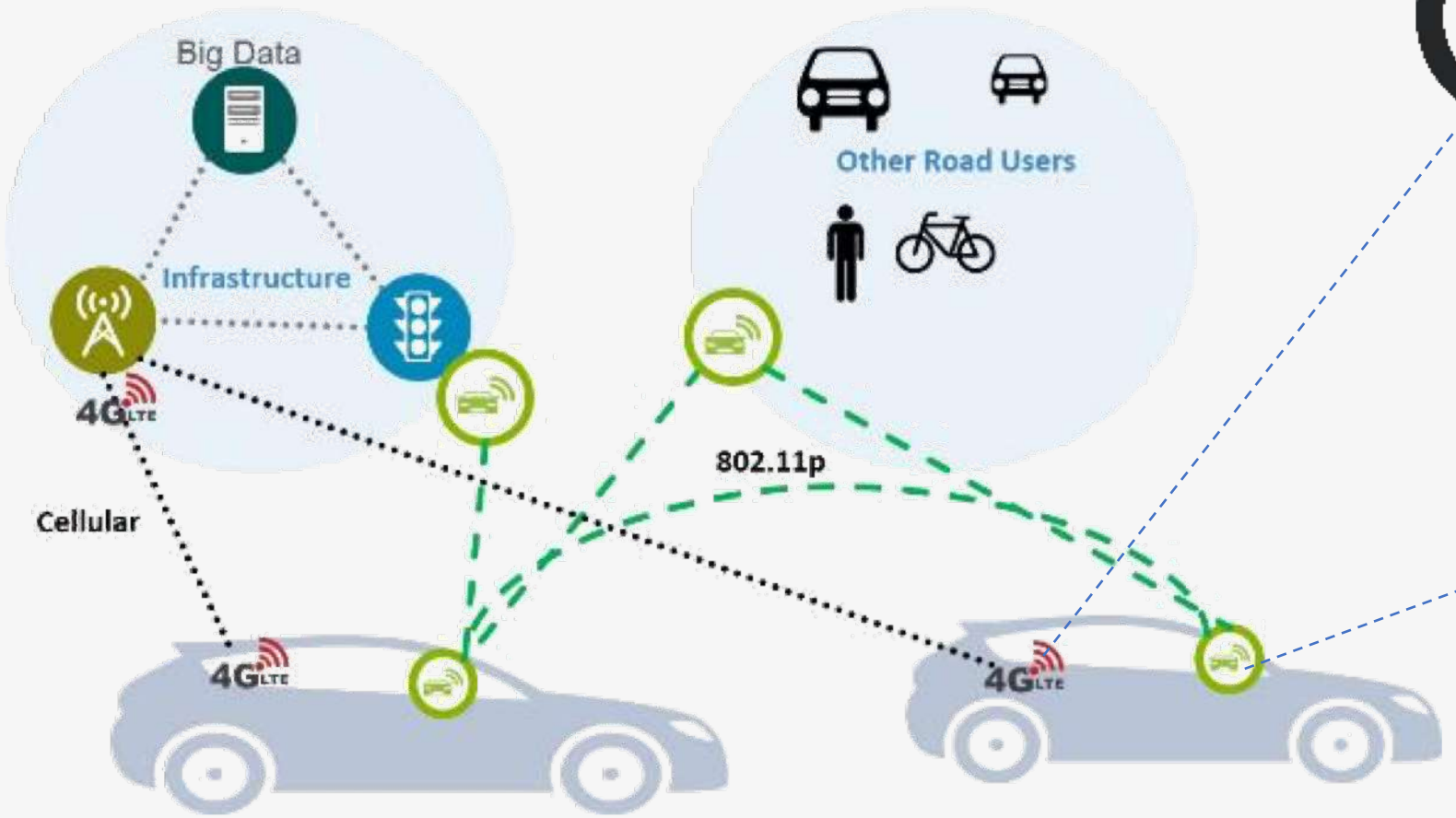
Public Transport vehicle
with V2X OBU

V2X: Traffic Signal priority

TrafiSense V2X: Ped & Bike warning



Cellular and IEEE 802.11p for C-ITS



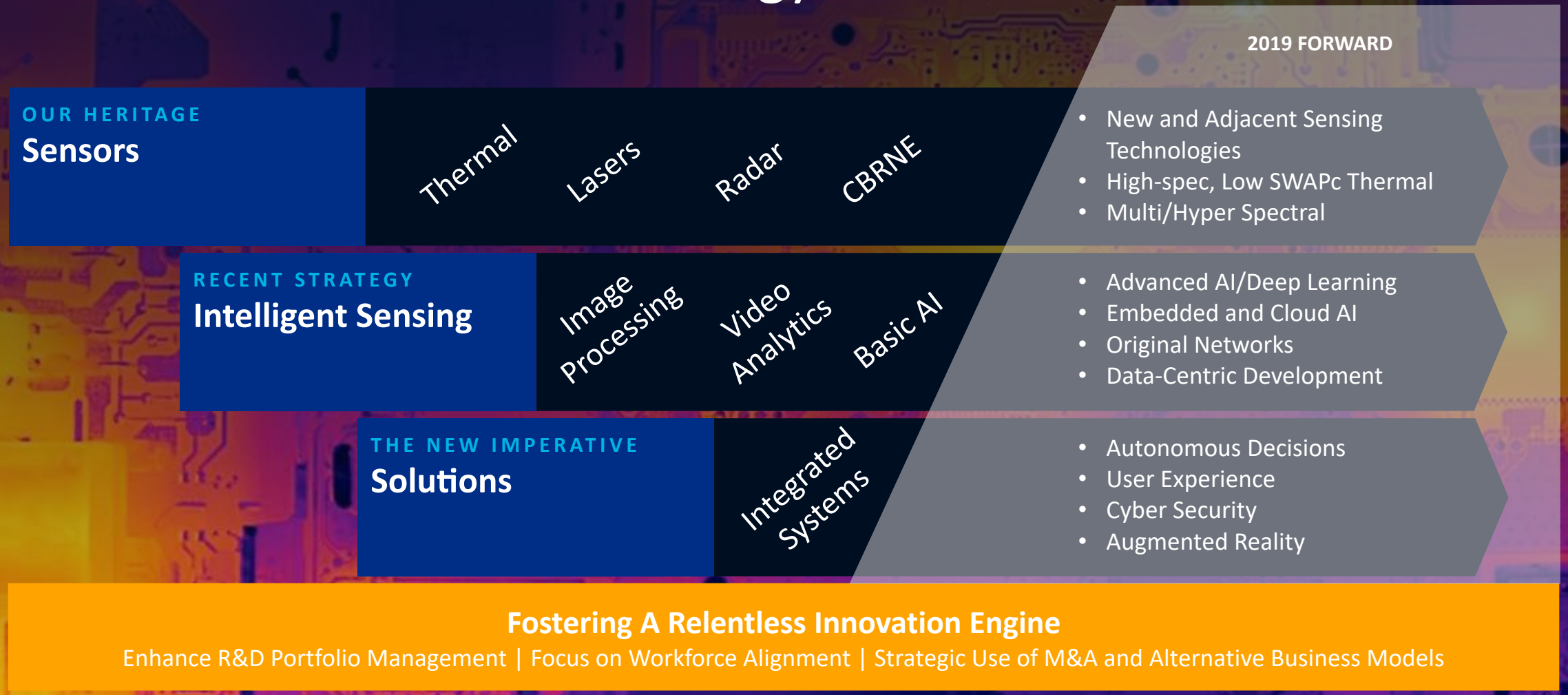
ITS-IQ

ThermiCam V2X


TRAFFIC INSIGHTS
CLOUD-BASED ANALYTICS
BICYCLE DETECTION
PEDESTRIAN DETECTION
VEHICLE TRACKING
VEHICLE DETECTION
TUNNEL SAFETY
ROAD MONITORING
RAIL MONITORING
TRAFFIC CONTROL
TRAFFIC SAFETY

FEED

Further Evolution of Technology



Fostering A Relentless Innovation Engine

Enhance R&D Portfolio Management | Focus on Workforce Alignment | Strategic Use of M&A and Alternative Business Models