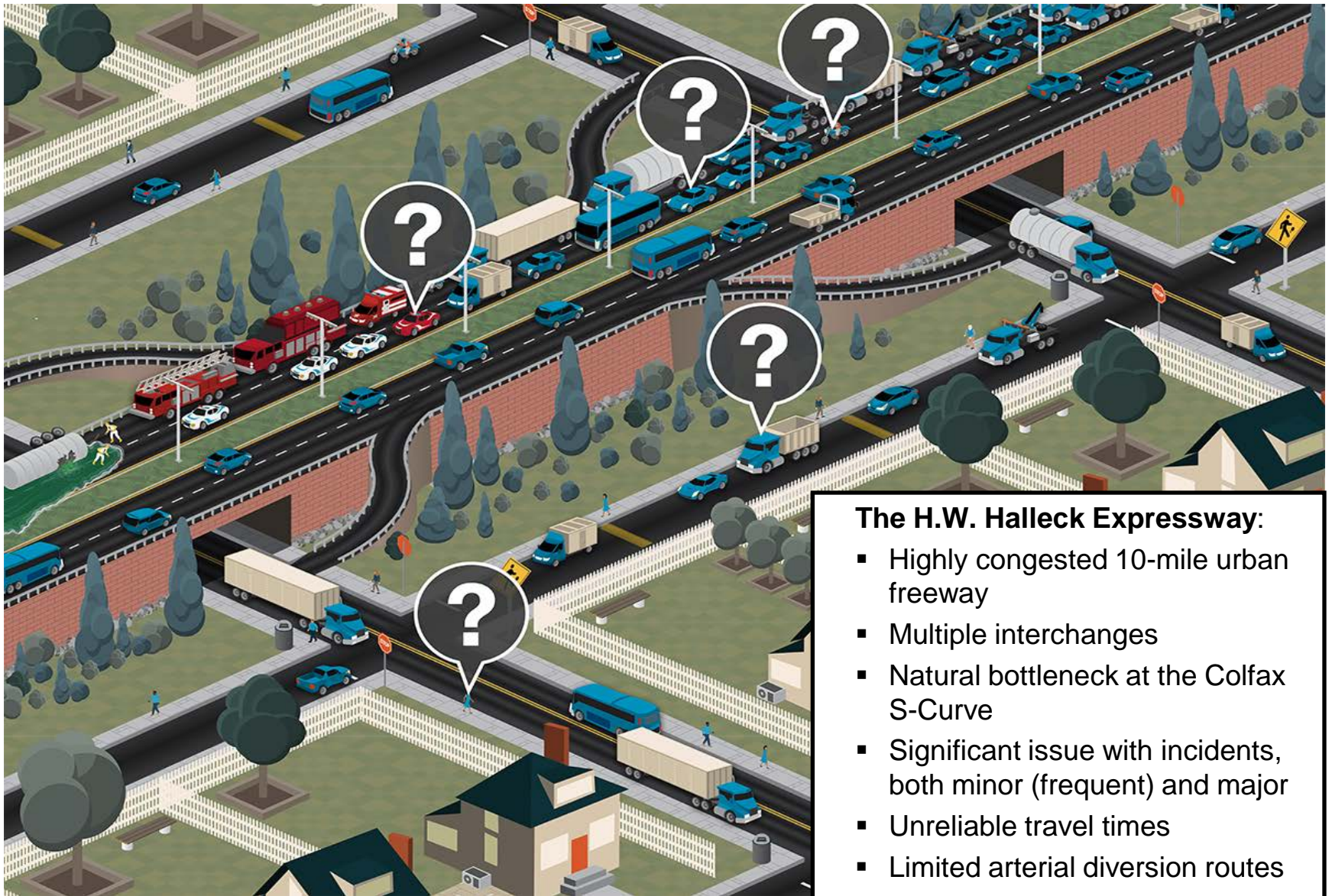




Example CV Pilot Deployment Concepts: H.W. Halleck Expressway

Bob Rupert (FHWA)

H.W. Halleck Expressway



The H.W. Halleck Expressway:

- Highly congested 10-mile urban freeway
- Multiple interchanges
- Natural bottleneck at the Colfax S-Curve
- Significant issue with incidents, both minor (frequent) and major
- Unreliable travel times
- Limited arterial diversion routes

Stakeholders Convene and Identify Key Transportation Challenges

- **Recurrent Congestion**

- Colfax S-curve is a natural bottleneck
- Multiple interchanges leads to merge/weave delays

- **Incidents**

- Response to major incidents lack coordination among agencies
- Frequent minor incidents makes travel times unpredictable

- **Diversion Management**

- Arterial diversion routes have limited capacity, easily overwhelmed
- Mass diversions lead to gridlock on local arterials



Stakeholder Set Three Key Improvement Targets

Goal	Performance Measure	Performance Target
Improve Colfax S-Curve throughput	Peak period throughput	Increase peak period throughput by 8%
Reduce major incident delays	Delays due to major incidents	Cut delay from major incidents by 25%
Manage diversions better	Number of gridlock events	“Zero tolerance” for arterial gridlock during freeway incidents



Applications Considered to Improve Bottleneck Throughput

V2I Safety

Red Light Violation Warning
 Curve Speed Warning
 Stop Sign Gap Assist
 Spot Weather Impact Warning
 Reduced Speed/Work Zone Warning
 Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety

Emergency Electronic Brake Lights (EEBL)

Forward Collision Warning (FCW)

Intersection Movement Assist (IMA)
 Left Turn Assist (LTA)
 Blind Spot/Lane Change Warning (BSW/LCW)
 Do Not Pass Warning (DNPW)
 Vehicle Turning Right in Front of Bus Warning (Transit)

Road Weather

Motorist Advisories and Warnings (MAW)
 Enhanced MDSS
 Vehicle Data Translator (VDT)
 Weather Response Traffic Information (WxTINFO)

Environment

Eco-Approach and Departure at Signalized Intersections
 Eco-Traffic Signal Timing
 Eco-Traffic Signal Priority
 Connected Eco-Driving
 Wireless Inductive/Resonance Charging
 Eco-Lanes Management
 Eco-Speed Harmonization
 Eco-Cooperative Adaptive Cruise Control
 Eco-Traveler Information
 Eco-Ramp Metering
 Low Emissions Zone Management
 AFV Charging / Fueling Information
 Eco-Driving
 Dynamic Traffic
 Eco-Driving

Improve Colfax S-Curve Throughput

Probe-based Pavement Maintenance
 Probe-enabled Traffic Monitoring
 Vehicle Classification-based Traffic Studies
 CV-enabled Turning Movement & Intersection Analysis
 CV-enabled Origin-Destination Studies
 Work Zone Traveler Information

Mobility

Advanced Traveler Information System
 Intelligent Traffic Signal System (I-SIG)
 Signal Priority (transit, freight)
 Mobile Accessible Pedestrian Signal System (PED-SIG)
 Emergency Vehicle Preemption (PREEMPT)
Dynamic Speed Harmonization (SPD-HARM)
Queue Warning (Q-WARN)
 Cooperative Adaptive Cruise Control (CACC)
 Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
 Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
 Emergency Communications and Evacuation (EVAC)
 Connection Protection (T-CONNECT)
 Dynamic Transit Operations (T-DISP)
 Dynamic Ridesharing (D-RIDE)
 Freight-Specific Dynamic Travel Planning and Performance

Smart Roadside

Wireless Inspection
 Smart Truck Parking



Applications Considered to Reduce Incident Delay

V2I Safety

Red Light Violation Warning
 Curve Speed Warning
 Stop Sign Gap Assist
 Spot Weather Impact Warning
 Reduced Speed/Work Zone Warning
 Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety

Emergency Electronic Brake Lights (EEBL)
 Forward Collision Warning (FCW)
 Intersection Movement Assist (IMA)
 Left Turn Assist (LTA)
 Blind Spot/Lane Change Warning (BSW/LCW)
 Do Not Pass Warning (DNPW)
 Vehicle Turning Right in Front of Bus Warning (Transit)

Road Weather

Motorist Advisories and Warnings (MAW)
 Enhanced MDSS
 Vehicle Data Translator (VDT)
 Weather Response Traffic Information (WxTINFO)

Environment

Eco-Approach and Departure at Signalized Intersections
 Eco-Traffic Signal Timing
 Eco-Traffic Signal Priority
 Connected Eco-Driving
 Wireless Inductive/Resonance Charging

Reduce Incident Delay

AFV Charging / Fueling Information
 Eco-Smart Parking
 Dynamic Eco-Routing (light vehicle, transit, freight)
 Eco-ICM Decision Support System

Agency Data

Probe-based Pavement Maintenance
 Probe-enabled Traffic Monitoring
 Vehicle Classification-based Traffic Studies
 CV-enabled Turning Movement & Intersection Analysis
 CV-enabled Origin-Destination Studies
 Work Zone Traveler Information

Mobility

Advanced Traveler Information System
 Intelligent Traffic Signal System (I-SIG)
 Signal Priority (transit, freight)
 Mobile Accessible Pedestrian Signal System (PED-SIG)
 Emergency Vehicle Preemption (PREEMPT)
 Dynamic Speed Harmonization (SPD-HARM)
 Queue Warning (Q-WARN)
 Cooperative Adaptive Cruise Control (CACC)

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)

Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)

Emergency Communications and Evacuation (EVAC)
 Connection Protection (T-CONNECT)
 Dynamic Transit Operations (T-DISP)
 Dynamic Ridesharing (D-RIDE)
 Freight-Specific Dynamic Travel Planning and Performance

Smart Roadside

Wireless Inspection
 Smart Truck Parking



Applications Considered to Manage Diversions Better

V2I Safety

Red Light Violation Warning
 Curve Speed Warning
 Stop Sign Gap Assist
 Spot Weather Impact Warning
 Reduced Speed/Work Zone Warning
 Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety

Emergency Electronic Brake Lights (EEBL)
 Forward Collision Warning (FCW)
 Intersection Movement Assist (IMA)
 Left Turn Assist (LTA)
 Blind Spot/Lane Change Warning (BSW/LCW)
 Do Not Pass Warning (DNPW)
 Vehicle Turning Right in Front of Bus Warning (Transit)

Road Weather

Motorist Advisories and Warnings (MAW)
 Enhanced MDSS
 Vehicle Data Translator (VDT)
 Weather Response Traffic Information (WxTINFO)

Environment

Eco-Approach and Departure at Signalized Intersections
 Eco-Traffic Signal Timing
 Eco-Traffic Signal Priority
 Connected Eco-Driving
 Wireless Inductive/Resonance Charging

Zero Tolerance for Arterial Gridlock Under Incident Conditions

AFV Charging / Fueling Information
 Eco-Smart Parking
 Dynamic Eco-Routing (light vehicle, transit, freight)
 Eco-ICM Decision Support System

Agency Data

Probe-based Pavement Maintenance
 Probe-enabled Traffic Monitoring
 Vehicle Classification-based Traffic Studies
 CV-enabled Turning Movement & Intersection Analysis
 CV-enabled Origin-Destination Studies
 Work Zone Traveler Information

Mobility

**Advanced Traveler Information System
 Intelligent Traffic Signal System (I-SIG)**

Signal Priority (transit, freight)
 Mobile Accessible Pedestrian Signal System (PED-SIG)
 Emergency Vehicle Preemption (PREEMPT)
 Dynamic Speed Harmonization (SPD-HARM)
 Queue Warning (Q-WARN)
 Cooperative Adaptive Cruise Control (CACC)
 Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
 Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
 Emergency Communications and Evacuation (EVAC)
 Connection Protection (T-CONNECT)
 Dynamic Transit Operations (T-DISP)
 Dynamic Ridesharing (D-RIDE)
 Freight-Specific Dynamic Travel Planning and Performance
 Drayage Optimization

Smart Roadside

Wireless Inspection
 Smart Truck Parking



Connected Vehicle Applications Selected in Performance-Driven Approach

Improve Bottleneck Throughput

- Speed Harmonization and Queue Warning
- Emergency Electronic Brake Lights and Forward Collision Warning

Reduce Incident Delay

- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
- Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)

Manage Diversions Better

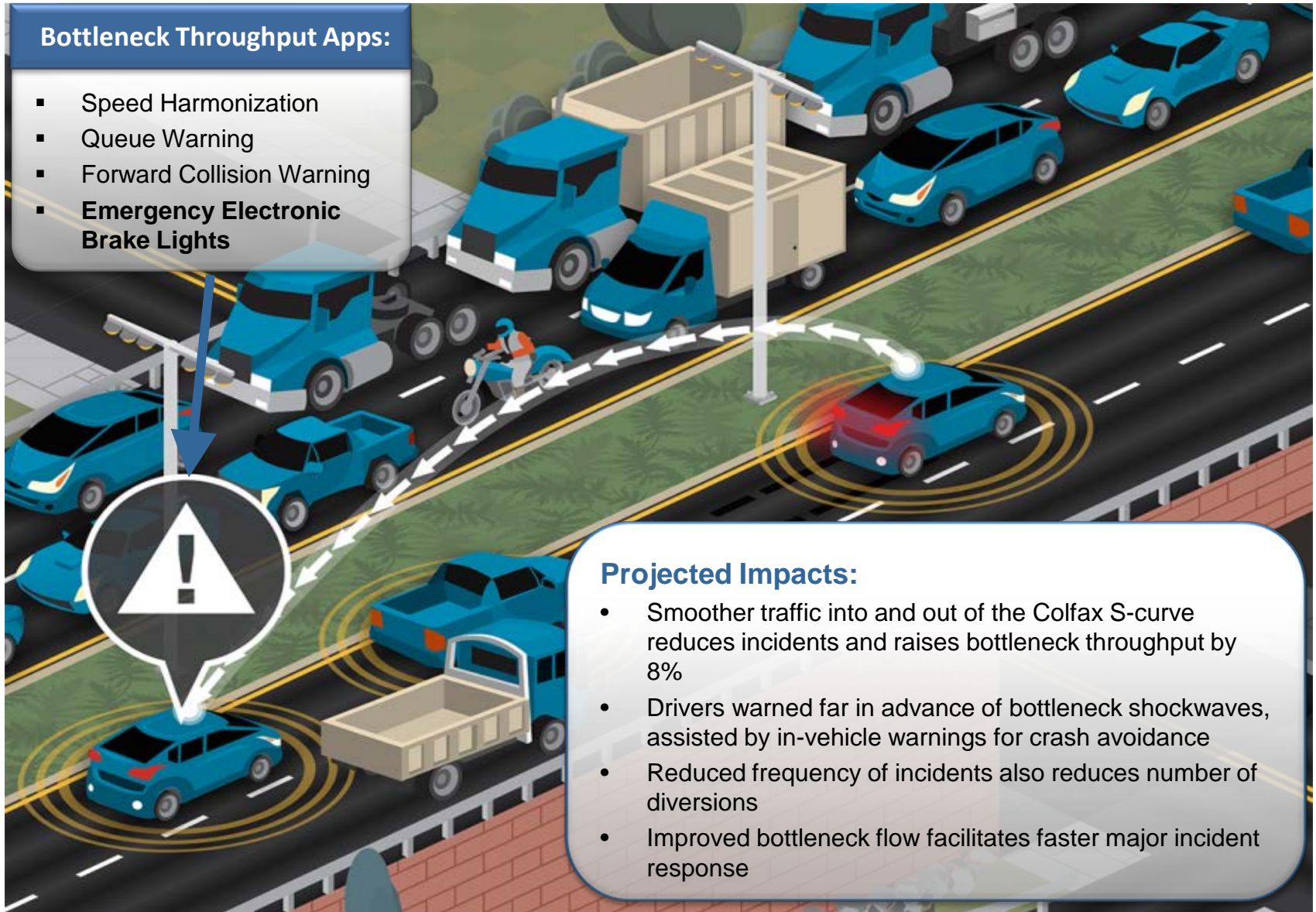
- EnableATIS
- Intelligent Signal Control (I-SIG)



Projected Synergies and Impacts from Bottleneck Throughput Applications in the Deployment Concept

Bottleneck Throughput Apps:

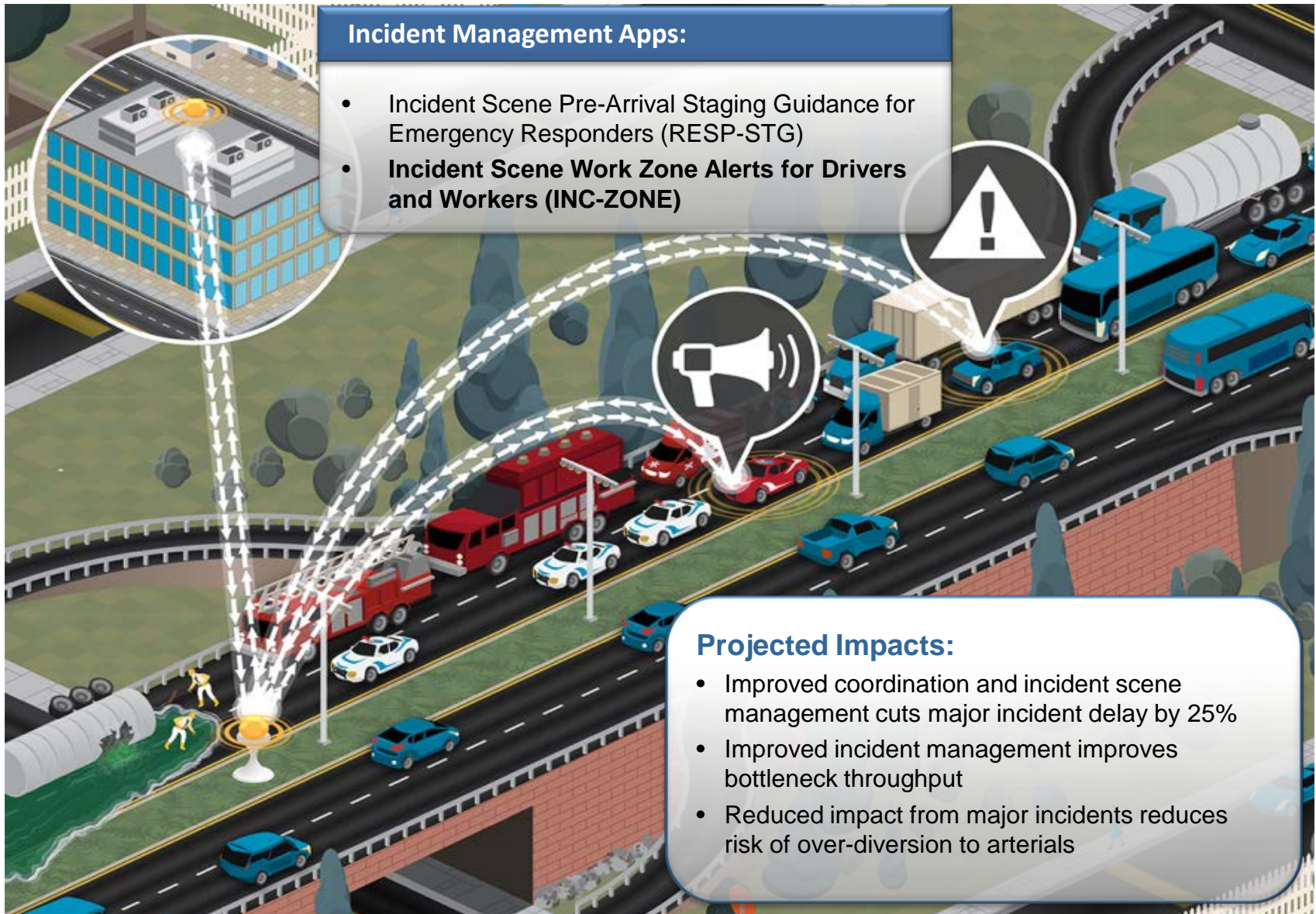
- Speed Harmonization
- Queue Warning
- Forward Collision Warning
- **Emergency Electronic Brake Lights**



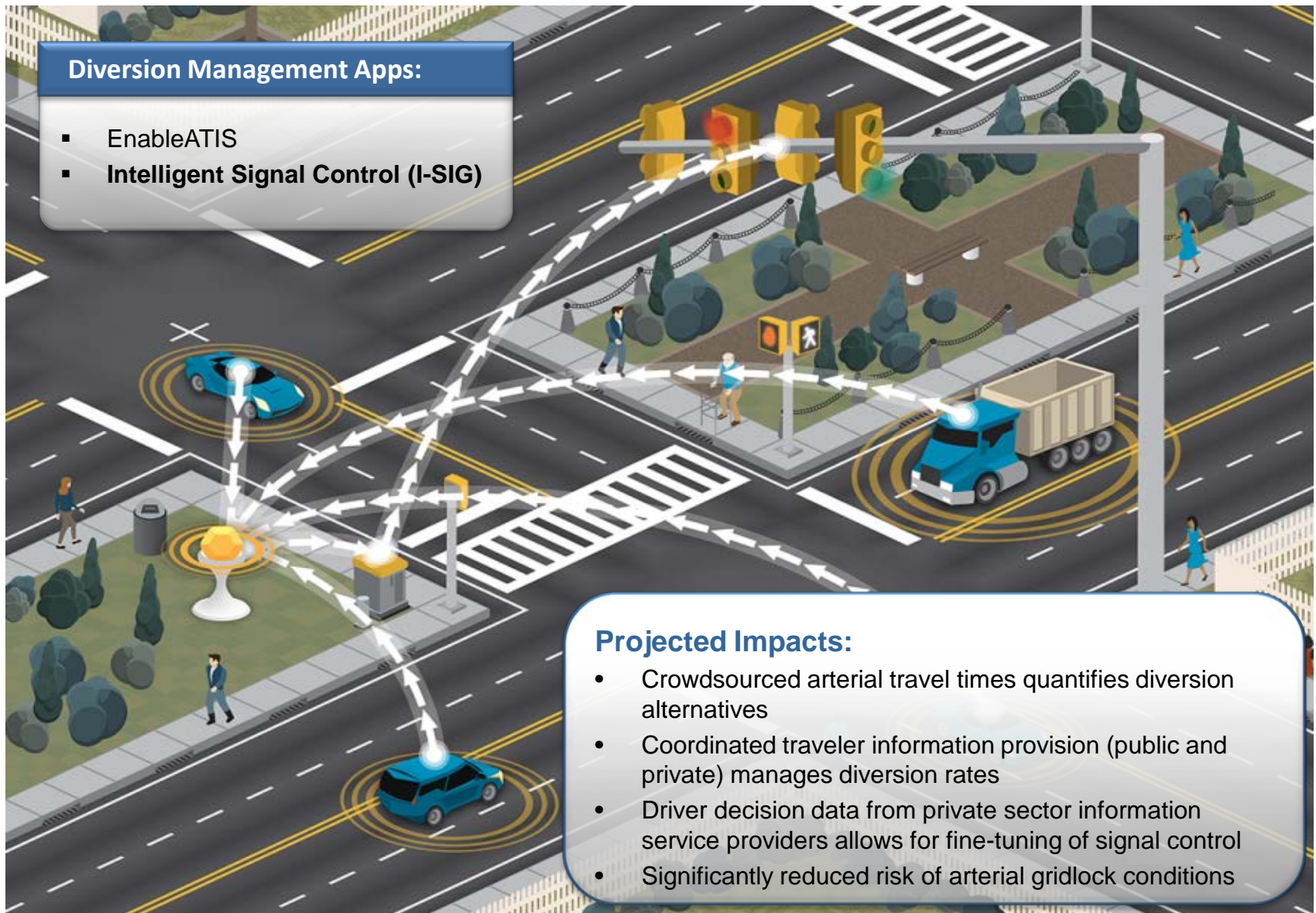
Projected Impacts:

- Smoother traffic into and out of the Colfax S-curve reduces incidents and raises bottleneck throughput by 8%
- Drivers warned far in advance of bottleneck shockwaves, assisted by in-vehicle warnings for crash avoidance
- Reduced frequency of incidents also reduces number of diversions
- Improved bottleneck flow facilitates faster major incident response

Projected Synergies and Impacts from Incident Management Applications in the Deployment Concept



Projected Synergies and Impacts from Diversion Management Applications in the Deployment Concept



Diversion Management Apps:

- EnableATIS
- Intelligent Signal Control (I-SIG)

Projected Impacts:

- Crowdsourced arterial travel times quantifies diversion alternatives
- Coordinated traveler information provision (public and private) manages diversion rates
- Driver decision data from private sector information service providers allows for fine-tuning of signal control
- Significantly reduced risk of arterial gridlock conditions

Integrated Concept for H. W. Halleck Expressway

