Video Analytics towards Vision Zero

Northwest Institute for Advanced Computing:

Workshop on Data Sciences – Smart Mobility

May 3, 2017

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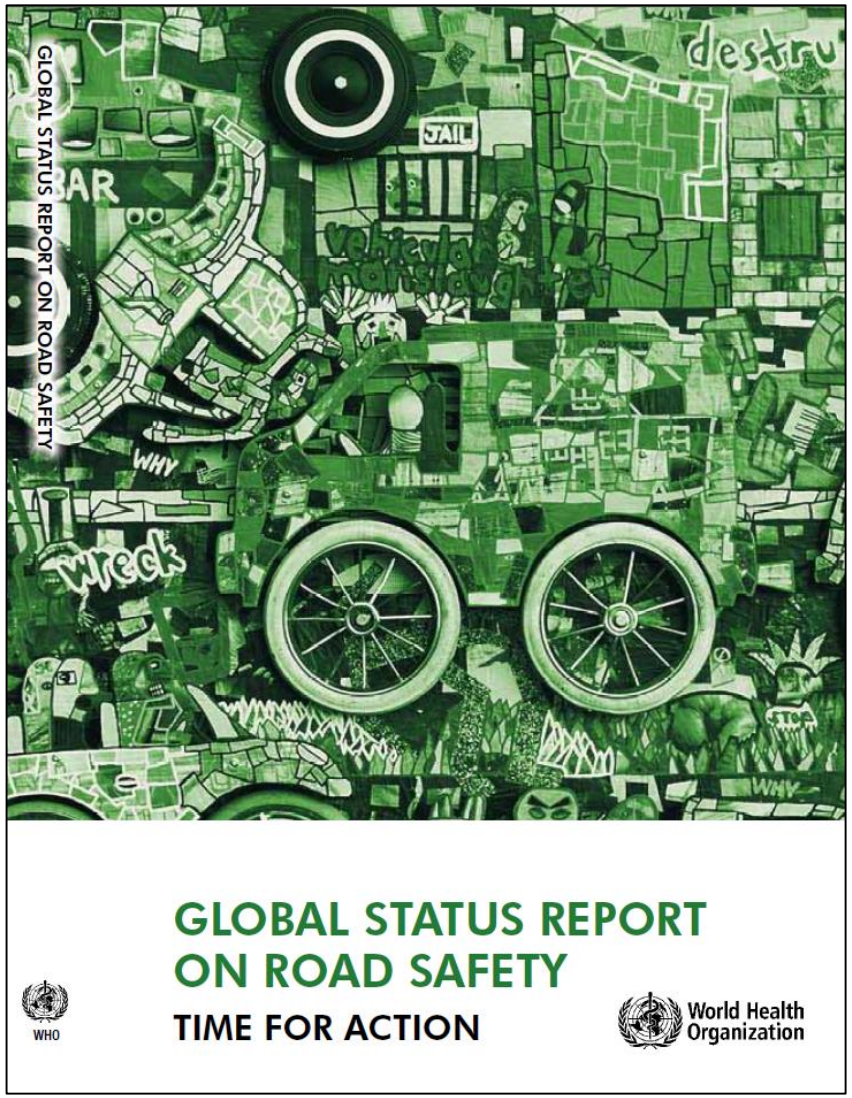
City of Bellevue, WA

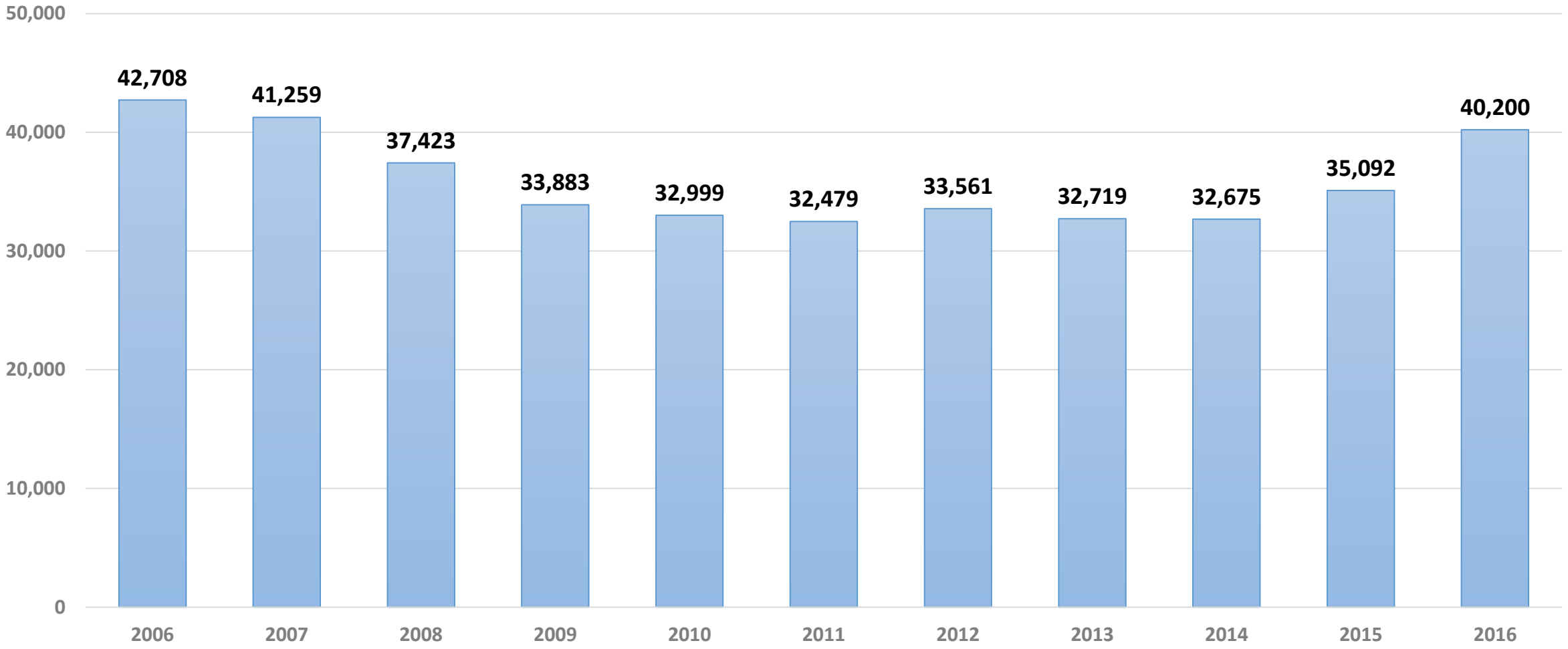
Worldwide: Traffic Fatalities



Leading Causes of Death (2004)

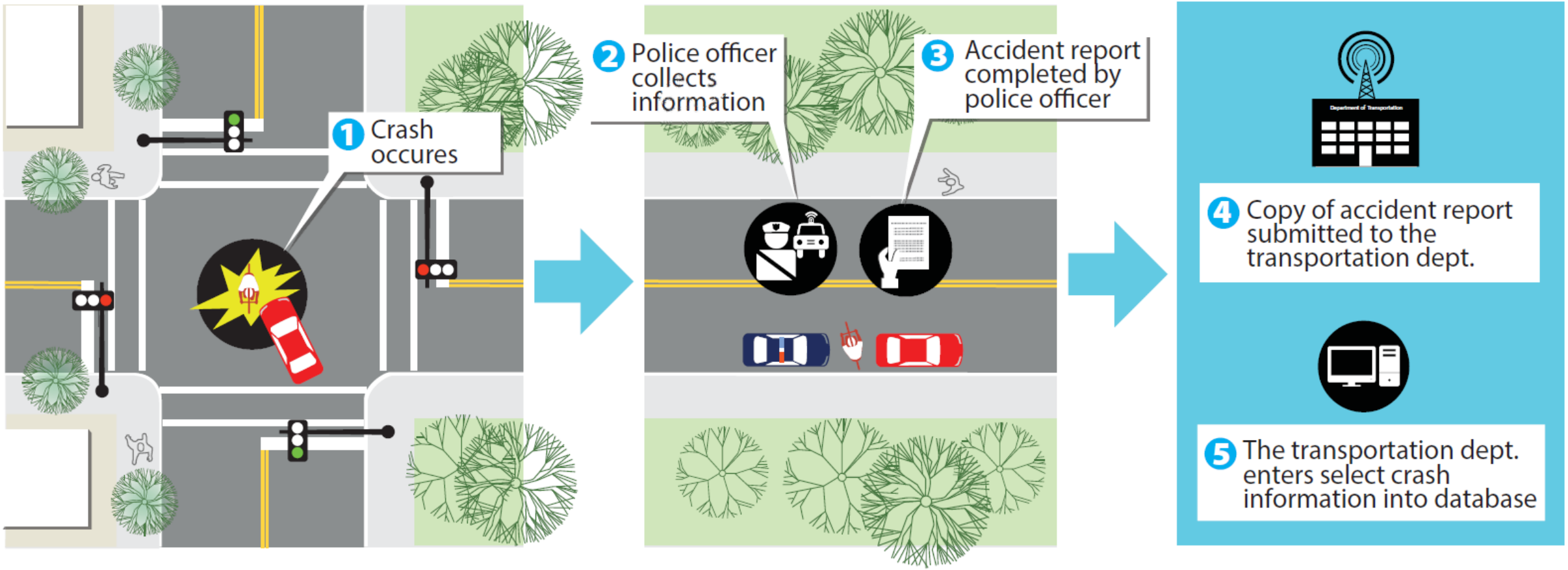
RANK	LEADING CAUSE	%
1	Ischaemic heart disease	12.2
2	Cerebrovascular disease	9.7
3	Lower respiratory infections	7.0
4	Chronic obstructive pulmonary disease	5.1
5	Diarrhoeal diseases	3.6
6	HIV/AIDS	3.5
7	Tuberculosis	2.5
8	Trachea, bronchus, lung cancers	2.3
9	Road traffic injuries	2.2
10	Prematurity and low birth weight	2.0
11	Neonatal infections and other	1.9
12	Diabetes mellitus	1.9
13	Malaria	1.7
14	Hypertensive heart disease	1.7
15	Birth asphyxia and birth trauma	1.5
16	Self-inflicted injuries	1.4
17	Stomach cancer	1.4
18	Cirrhosis of the liver	1.3
19	Nephritis and nephrosis	1.3
20	Colon and rectum cancers	1.1

USA: Traffic Fatalities



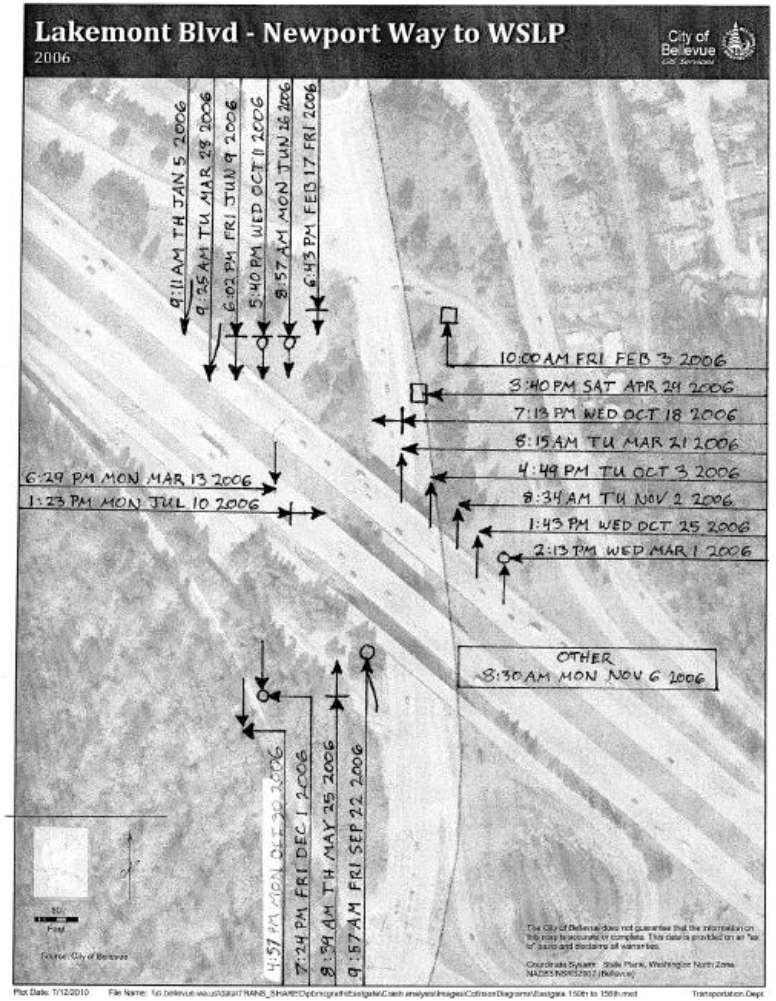
NHTSA, Impact of Crashes (2010): Economic Cost: $242B; Societal Harm: $836B

Traditional Crash Reporting Process



Crash Based Approach: Lakemont Interchange Case Study

From 2005 through 2010 there were 60 collisions recorded by the Bellevue Police Department and the WSP at this location.

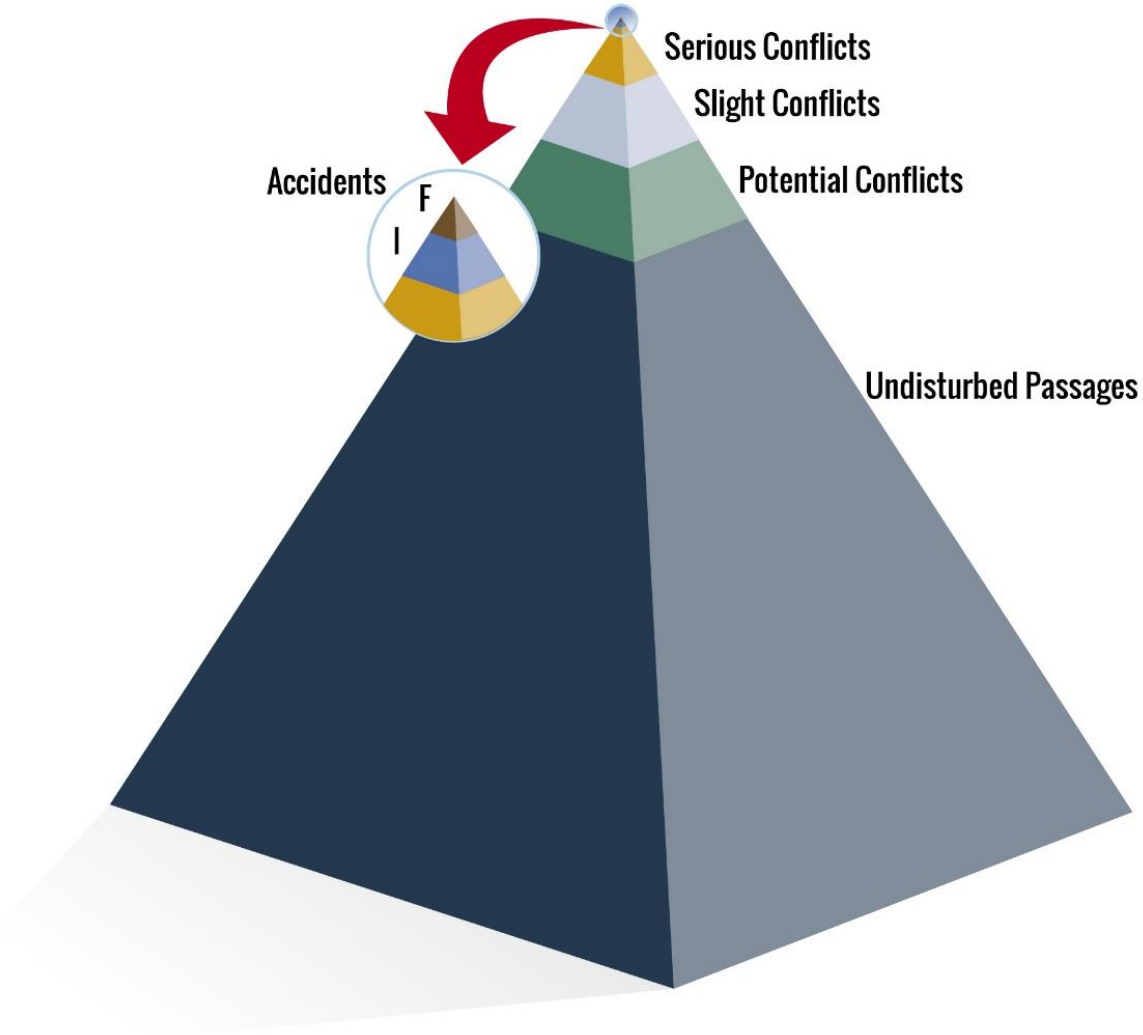


In 2013, WSDOT built a new roundabout at the intersection of the WB I-90 on- and off-ramps and WLSP SE/180 Ave SE.

Vision Zero: Reframing Traffic Deaths & Injuries as Preventable

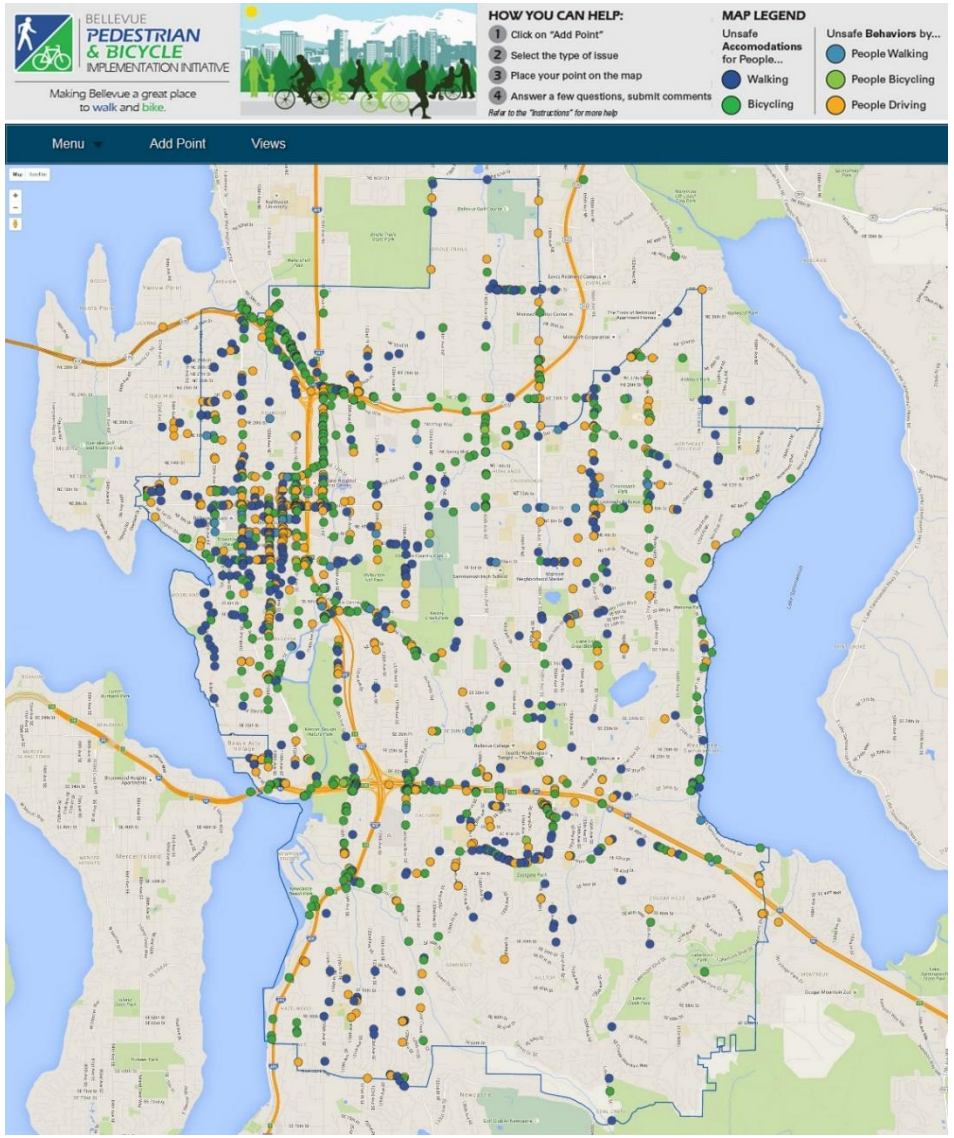
Amy Carlson, Vice President, CH2M HILL

Conflict-Based Approach: Don’t Wait For Crashes to Happen



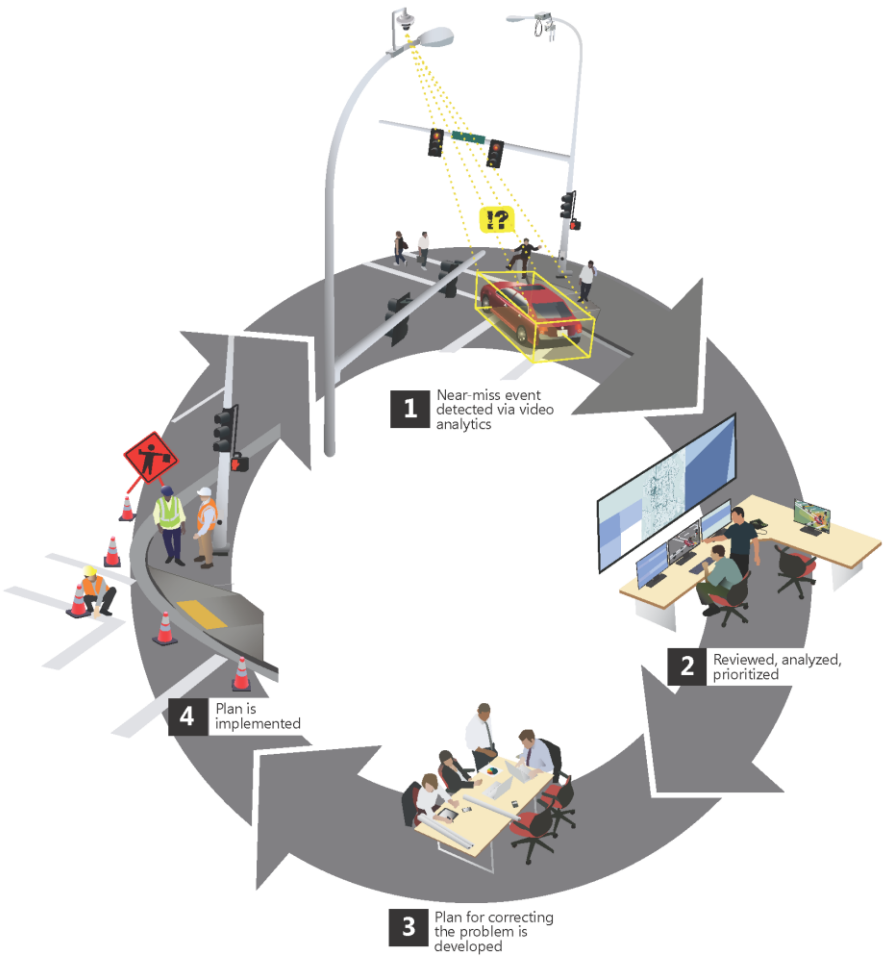
Hyden’s Safety Pyramid (adapted from Hyden, 1987)

Conflict-Based Approach: Public Involvement Strategy



	Total Points Placed	
Ped Facilities	514	32%
Bike Facilities	573	35%
Ped Behaviors	57	4%
Bike Behaviors	22	1%
Car Behaviors	452	28%
Total	1618	

Conflict-Based Approach: Video Analytics Strategy

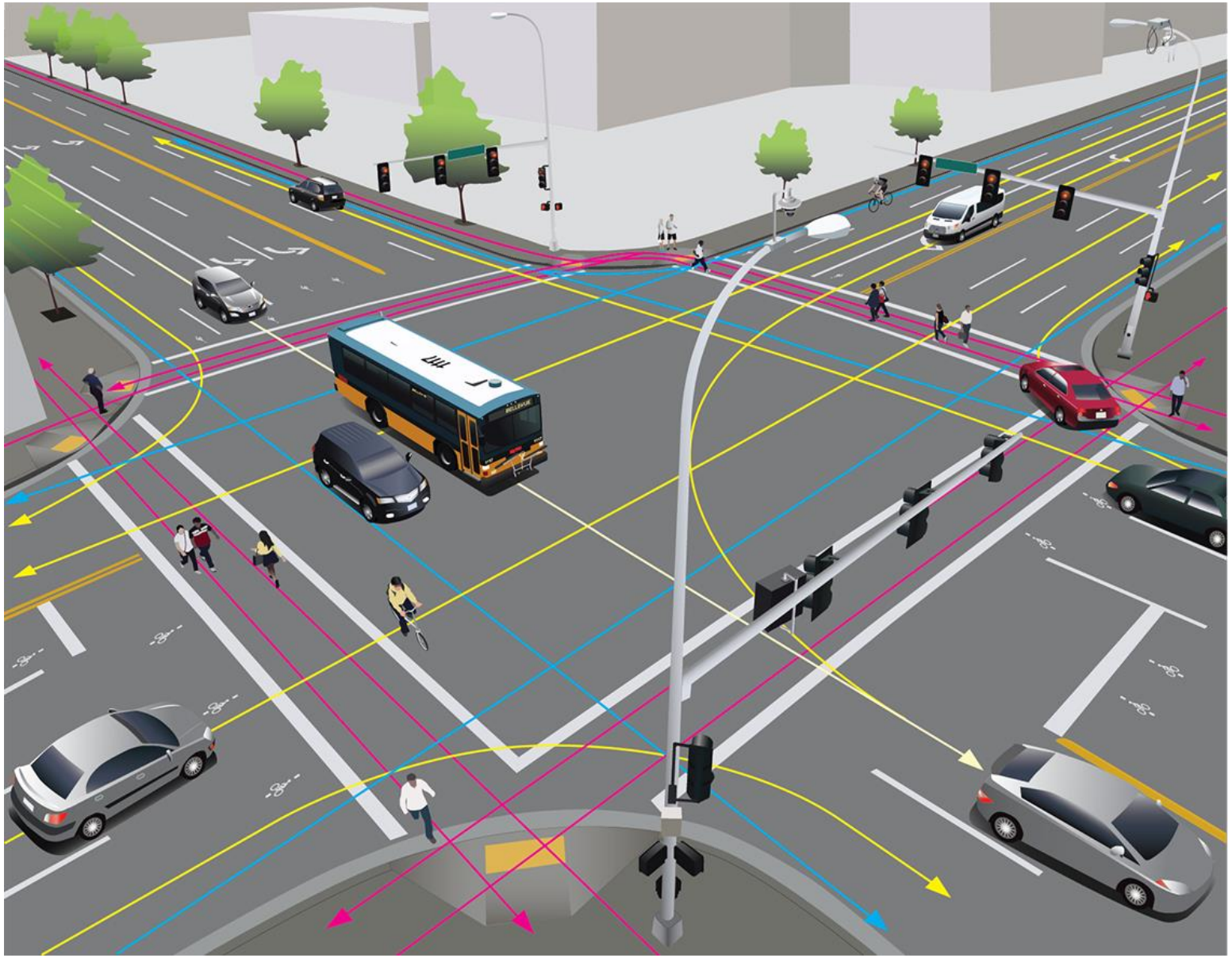


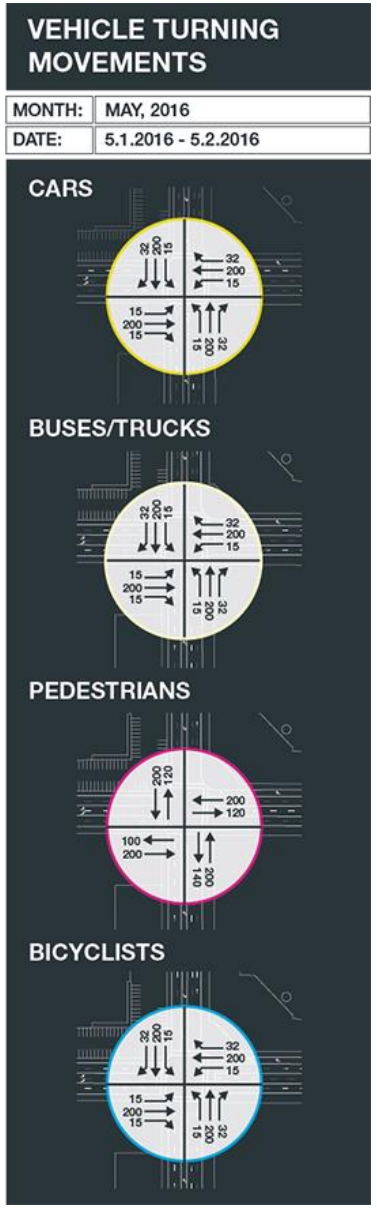
Leverage a city's existing traffic camera system to simultaneously:

- **monitor counts and travel speed of all road user groups (vehicle, pedestrian, and bicycle);**
- **document the directional volume of all road user groups as they move through an intersection; and,**
- **assess unsafe "near-miss" trajectories and interactions between all road user groups.**

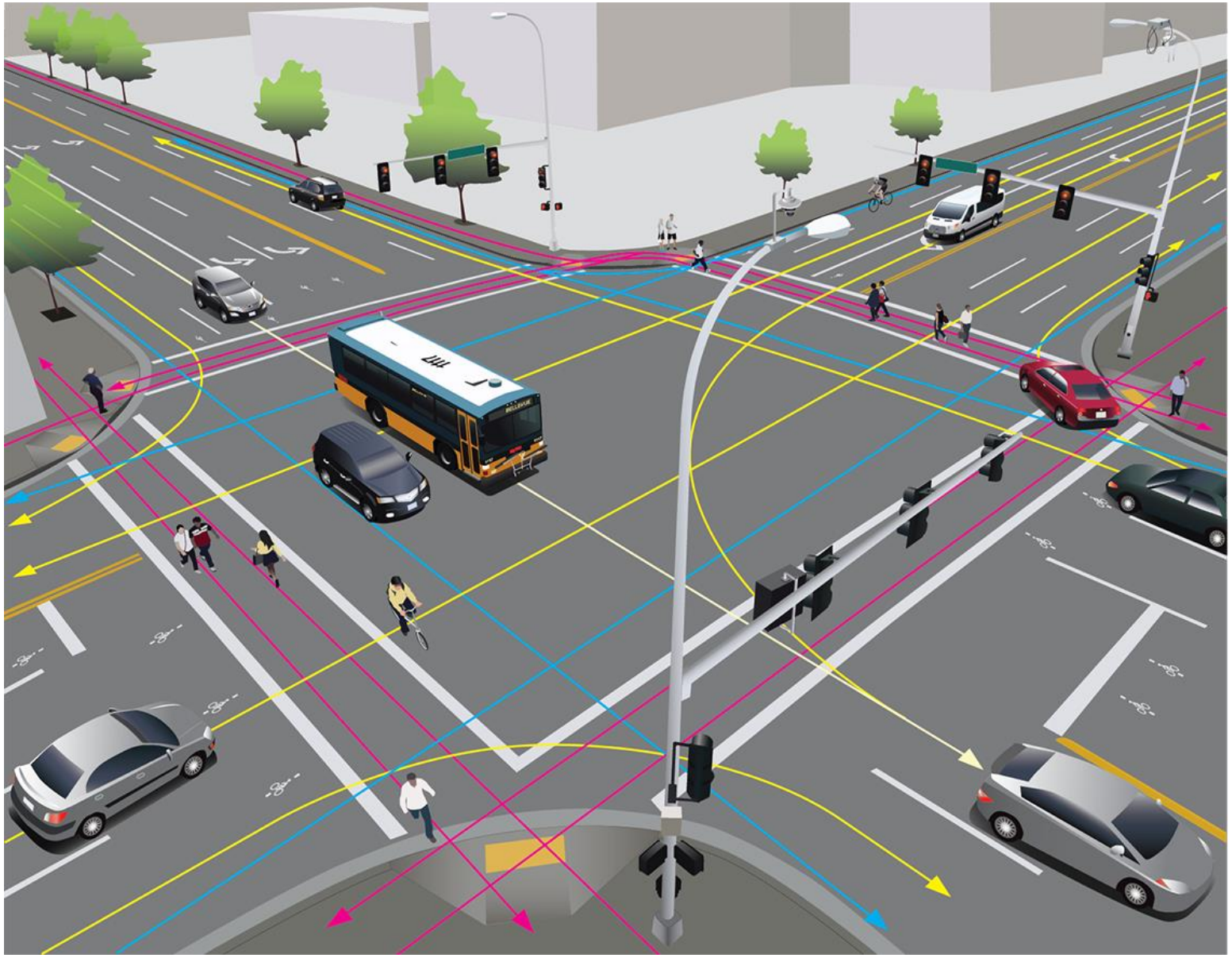
Partnership Momentum

Trajectory Detection & Turning Movement Counts





Volume Charts



VEHICLE DISTRIBUTION CHARTS BY TIME OF DAY

MONTH:	MAY, 2016
DATE:	5.1.2016 - 5.1.2016

CARS

30,000 cars/day

BUSES/TRUCKS

400 buses & trucks/day

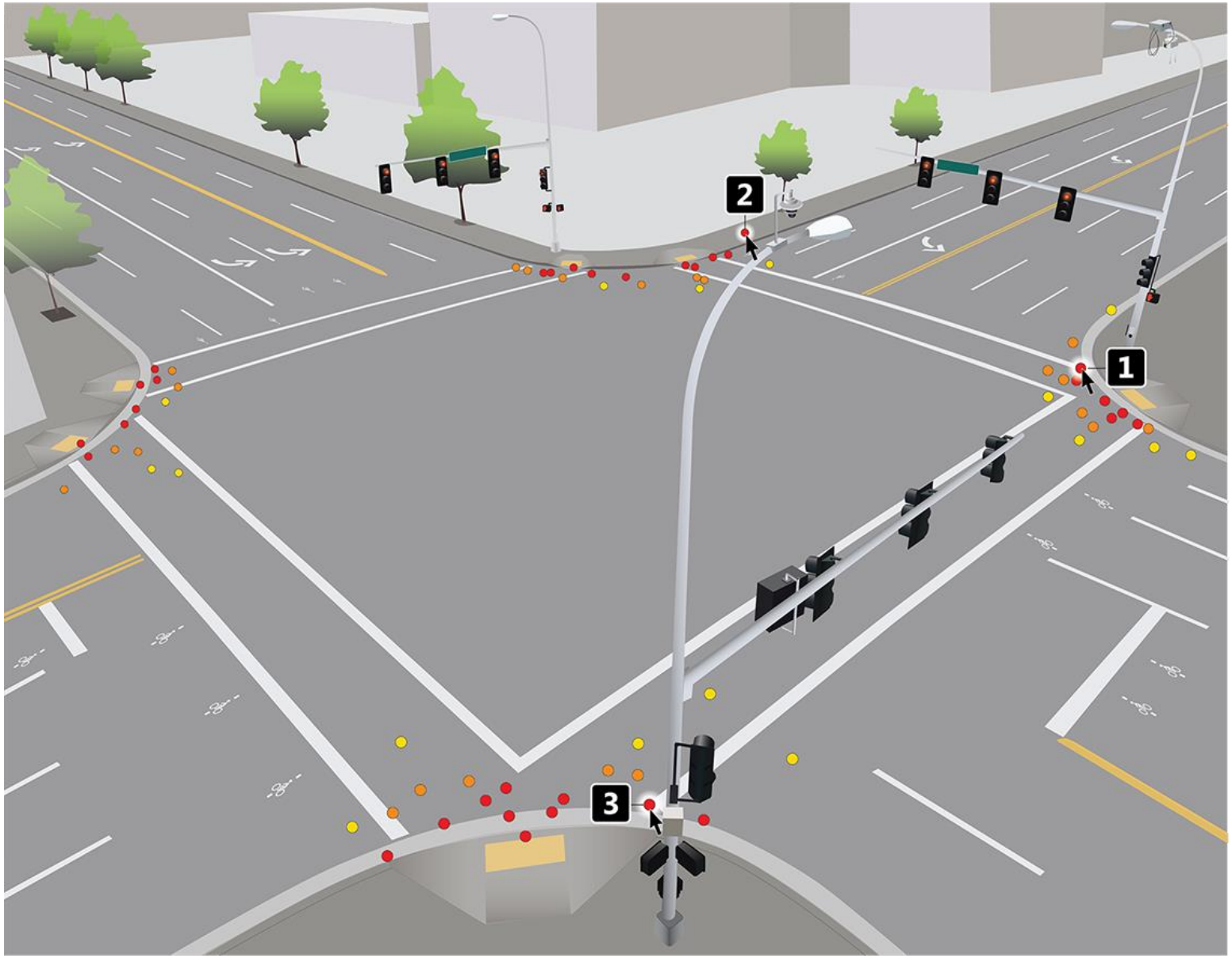
PEDESTRIANS

1,000 pedestrians/day

BICYCLISTS

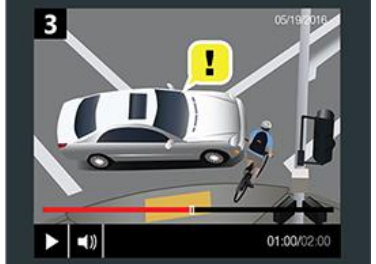
100 bikes/day

Near-Miss Detection

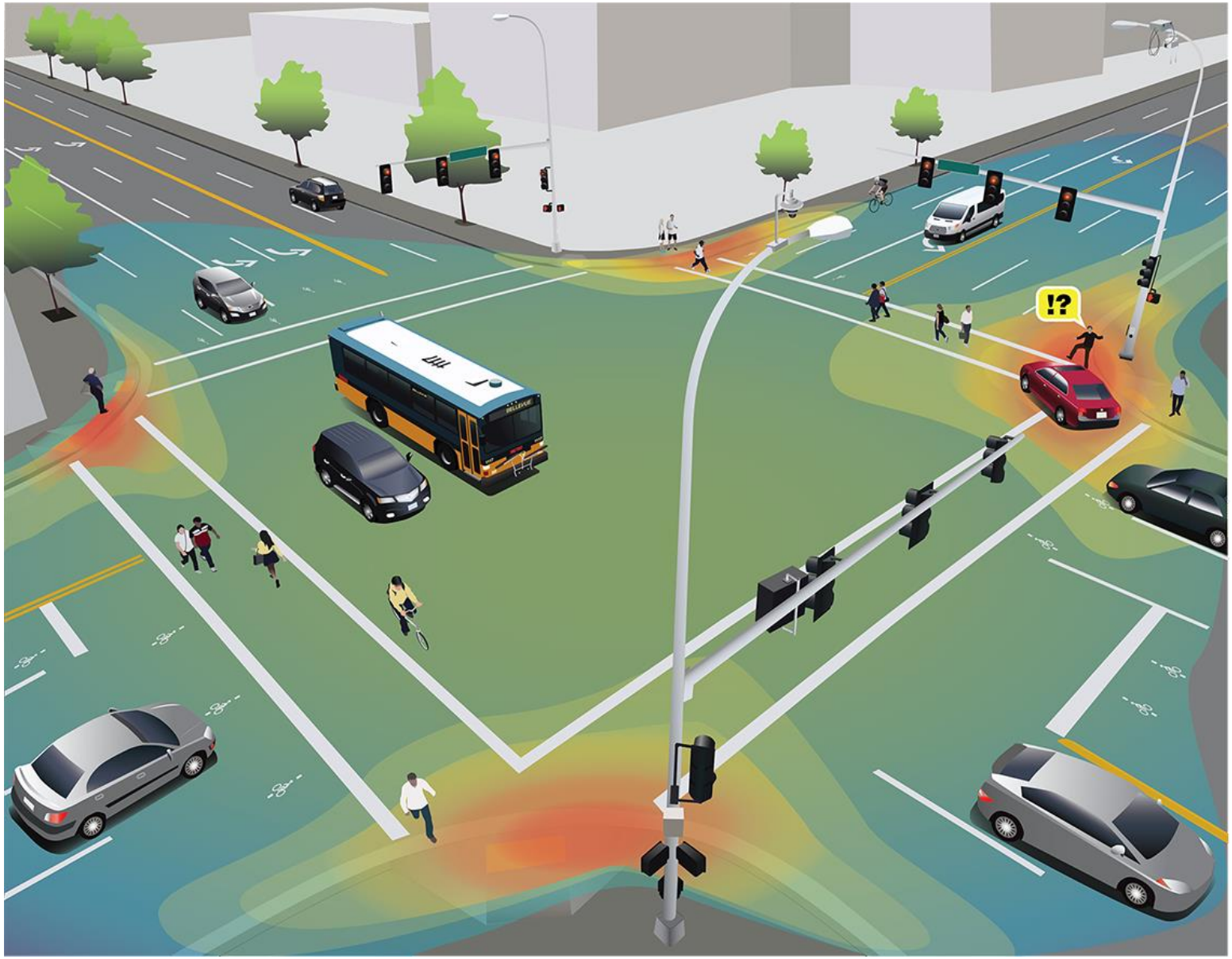


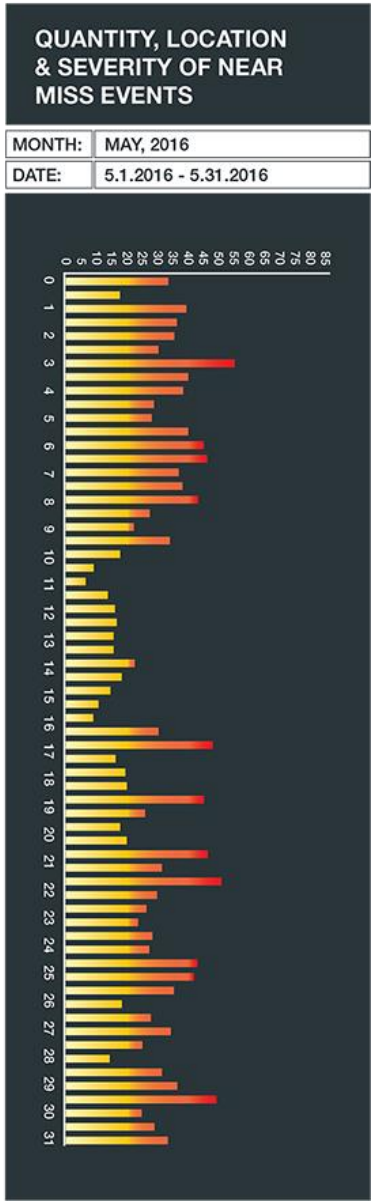
QUANTITY, LOCATION & SEVERITY OF NEAR MISS EVENTS

MONTH:	MAY, 2016
DATE:	5.1.2016 - 5.31.2016



Near-Miss Detection





Partnership Approach

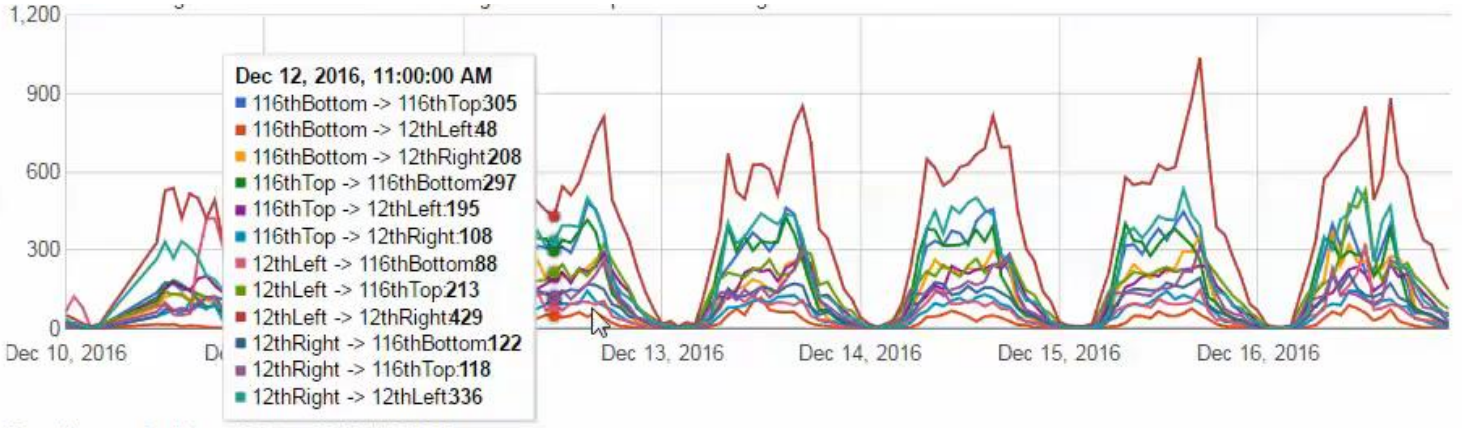
Milestone 1: Demonstrate the capability of vision technologies by detecting relevant events in the sample traffic videos (e.g., detecting cars, pedestrians, and bikes and tracking their movements).

Milestone 2: Demonstrate an end-to-end system that will, continuously in real-time, detect and store the events, and present aggregated information.

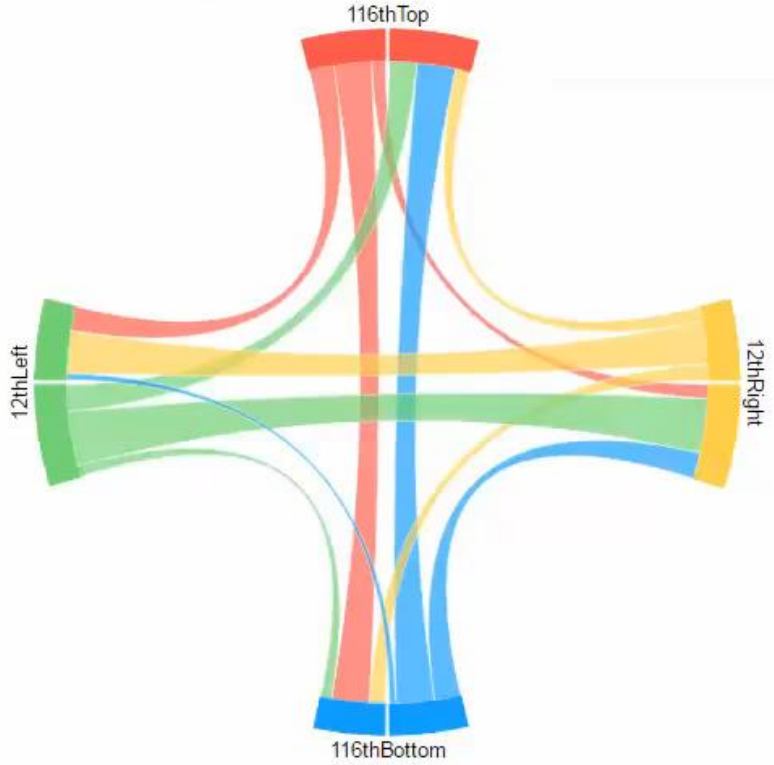
Milestone 3: Pilot deployment of end-to-end system (running on servers provided by Microsoft) in the City of Bellevue traffic control center. The system will run off of a live feed.

Milestone 4: Support additional scenarios (e.g., near-collisions of cars with pedestrians and bikes or patterns of bikers crossing a busy intersection).

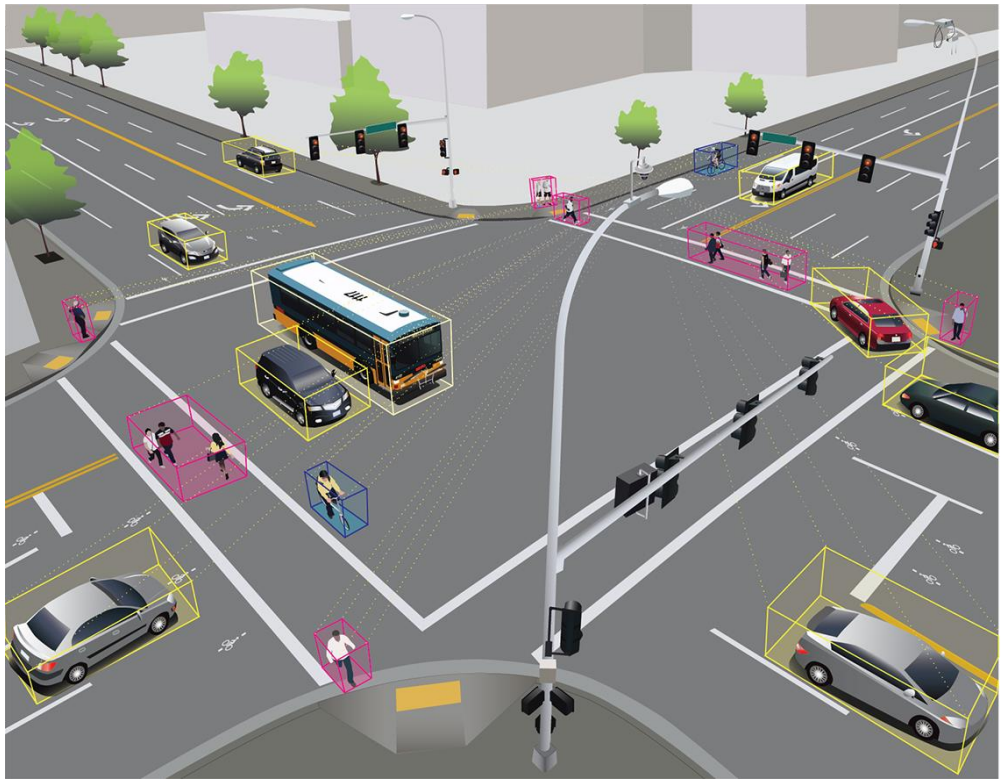
Turning Movement Counts Sample: 116th NE & NE 12th



flow diagram for Mon, 12 Dec 2016 11:00:00



Object Classification Accuracy



We recognized it as…

When it really is…

Classified-as → / Truth ↓	*Vehicles*	*Bikes*	*Peds*	*None*
Vehicles	**0.95**	0.01	0.02	0.02
Bikes	0.08	**0.67**	0.16	0.08
Peds	0.15	0.15	**0.73**	0.05
None	0.09	0.03	0.11	**0.81**

How Neural Networks Work

training

during the training phase, a neural network is fed thousands of labeled images of various objects, learning to classify them

input

new image is shown to the pretrained network

first layer

the neurons respond to simple shapes, like edges

higher layer

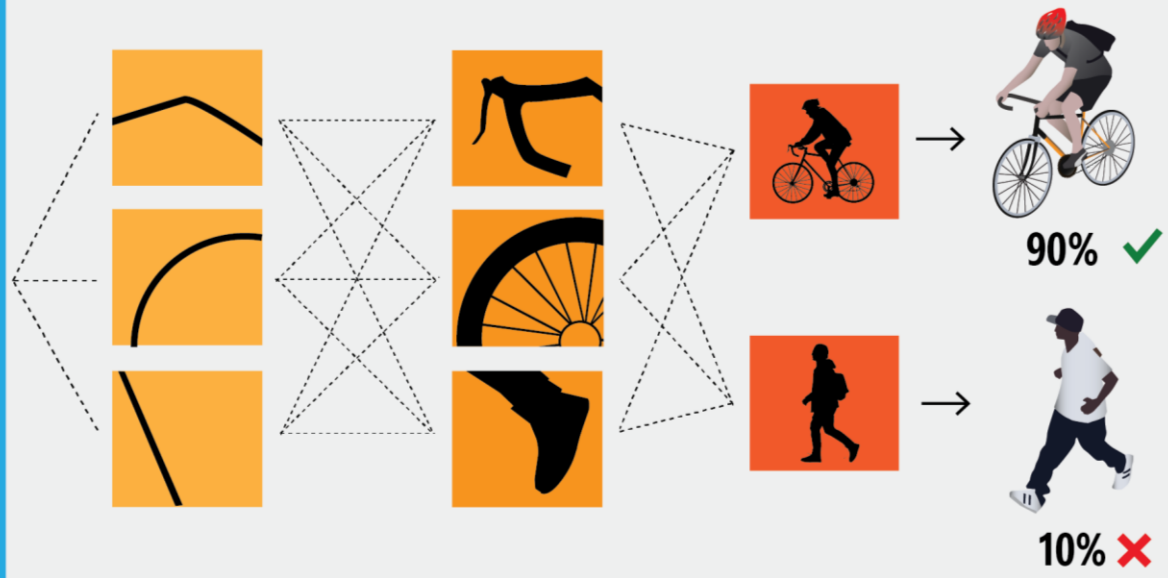
the neurons respond to complex shapes

top layer

neurons respond to highly complex abstract concepts that we would identify as different objects

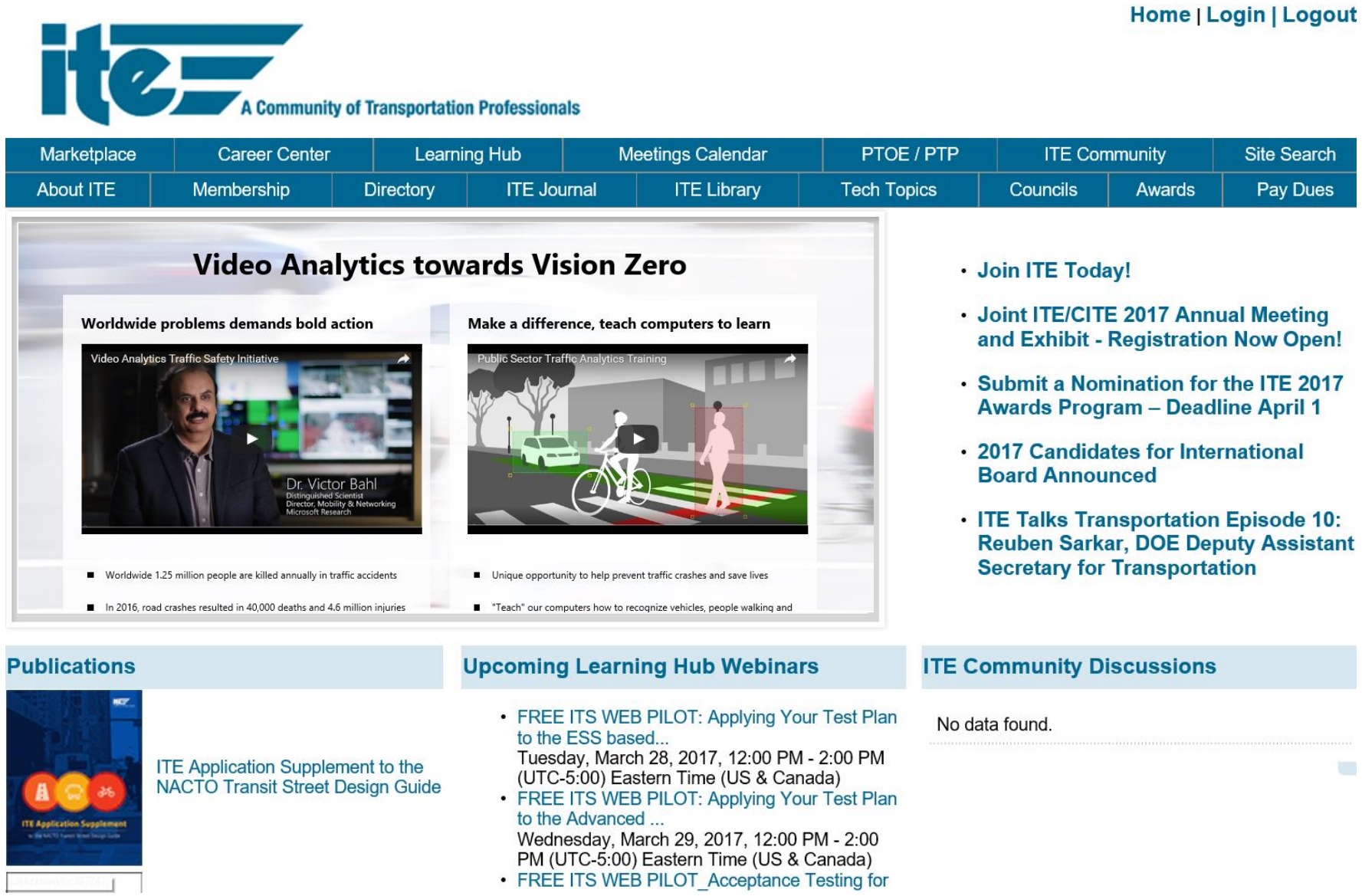
output

the network predicts what the object most likely is based on its training.

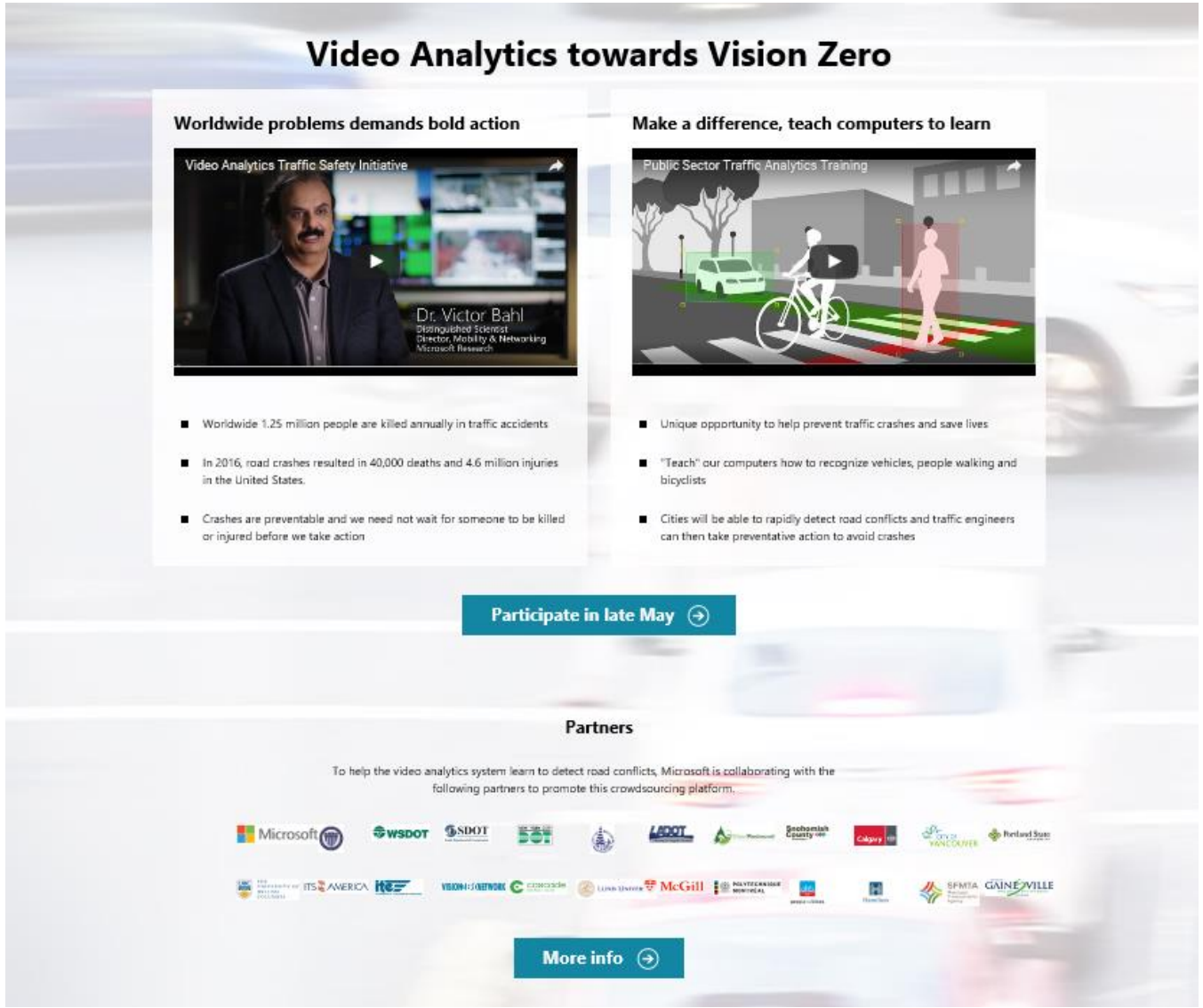


Summer 2017: Crowdsourcing Initiative

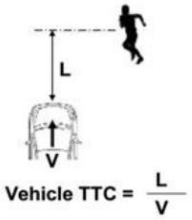
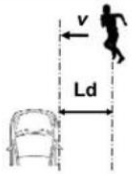
Summer 2017: ITE Website



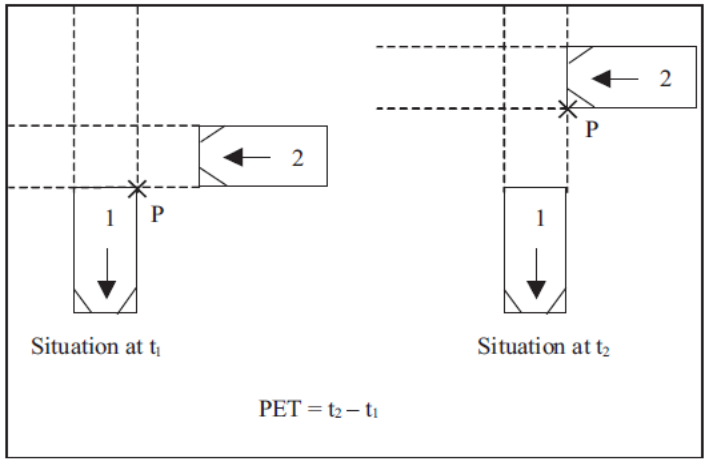
Summer 2017: Crowdsourcing Webpage



Summer 2017: Classify Near-Miss Events

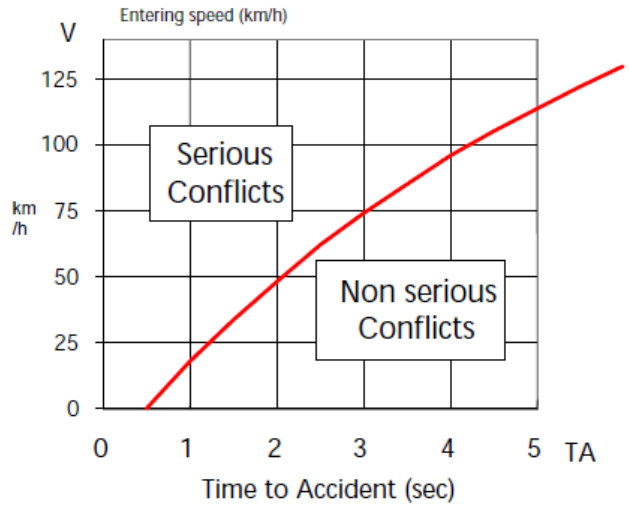
Focused object	Vehicle	Pedestrian
Time	Vehicle time to collision (Vehicle TTC)	Pedestrian time to vehicle (Pedestrian TTV)
Definition	 Vehicle TTC = $\frac{L}{V}$	 Pedestrian TTV = $\frac{Ld}{v}$
Study	Previous study (Matsui et al. 2011b)	Present study

Time to Collision (Matsui et al., 2013)



Post Encroachment Time (Van der Horst et. al., 2014)

The border between Serious and Non-serious Conflict



Definition of a Serious Conflict

TA = Time to Accident
The time that is remaining from when the evasive action is taken until the collision would have occurred *if* the road users had continued with unchanged speeds and directions.
The TA value can be calculated based on the estimates of distances **d** and speed **v**.

d = Distance to the potential point of collision

v = Speed when the evasive action is taken

Swedish Conflict Technique (Hyden et. al., 1987)

Deployment Strategy: Trusted Data Platform

TRUST FRAMEWORKS, PRACTICES & STANDARDS

RESEARCH-ALIGNED INNOVATION LABS

PILOTS AND PROOF OF CONCEPTS

For More Information

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