

# Video Analytics towards Vision Zero

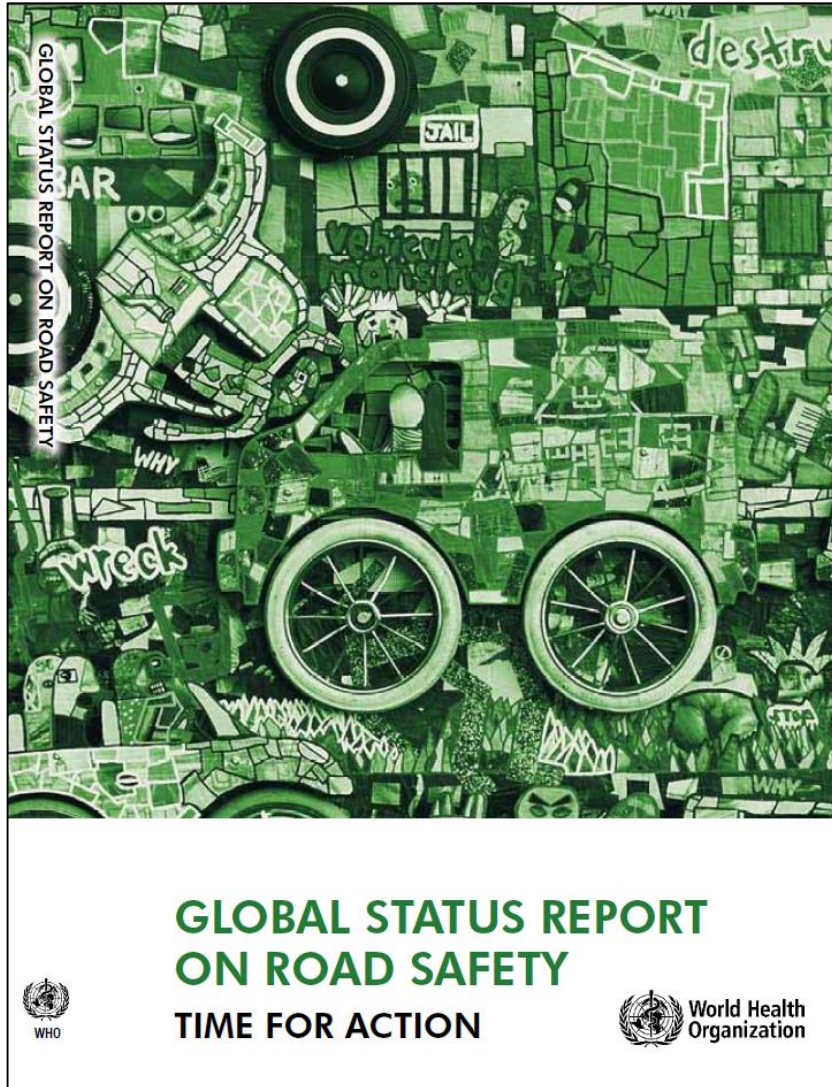


## **Northwest Institute for Advanced Computing:** *Workshop on Data Sciences – Smart Mobility*

May 3, 2017

*Franz Loewenherz  
Principal Planner  
City of Bellevue, WA*

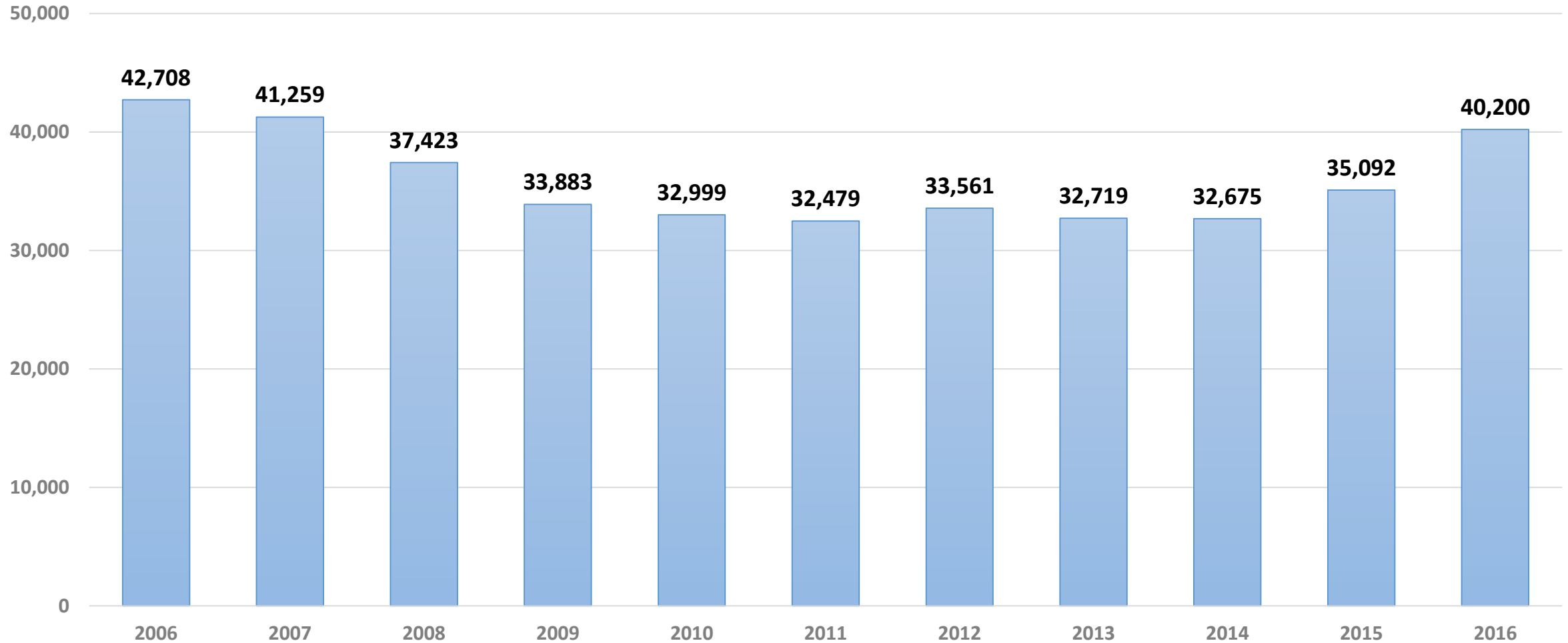
# Worldwide: Traffic Fatalities



## Leading Causes of Death (2004)

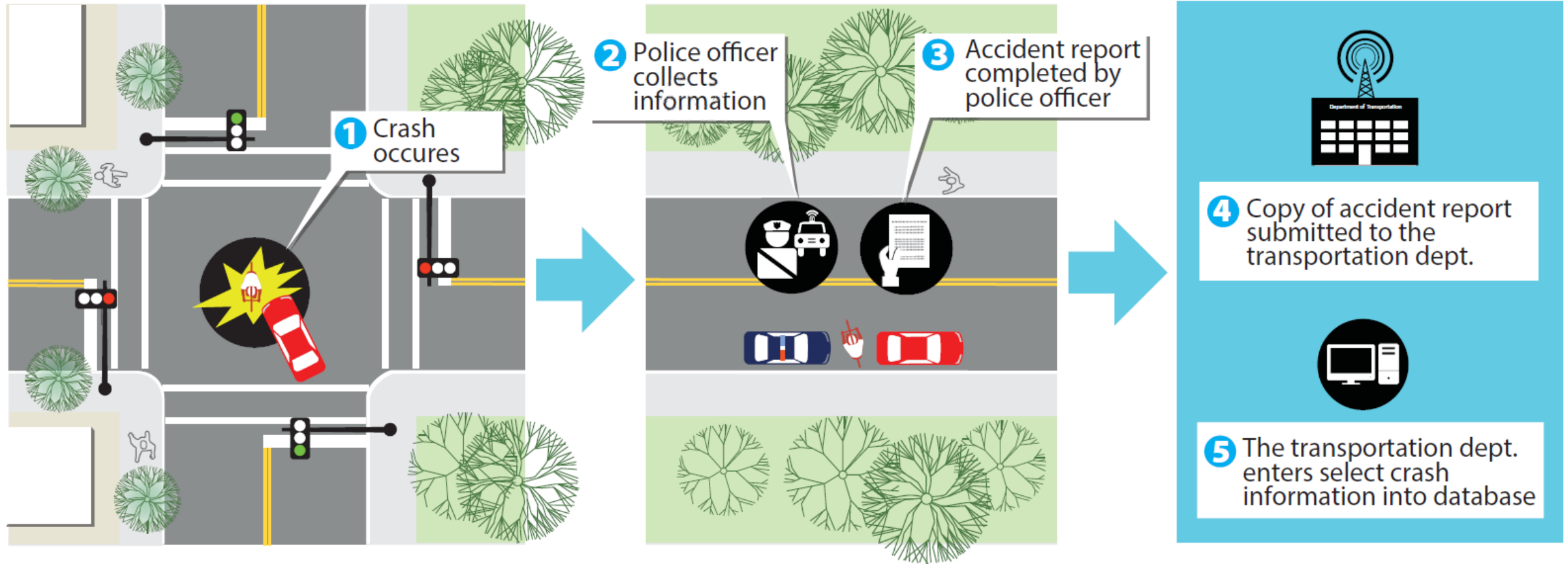
RANK	LEADING CAUSE	%
1	Ischaemic heart disease	12.2
2	Cerebrovascular disease	9.7
3	Lower respiratory infections	7.0
4	Chronic obstructive pulmonary disease	5.1
5	Diarrhoeal diseases	3.6
6	HIV/AIDS	3.5
7	Tuberculosis	2.5
8	Trachea, bronchus, lung cancers	2.3
9	Road traffic injuries	2.2
10	Prematurity 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**

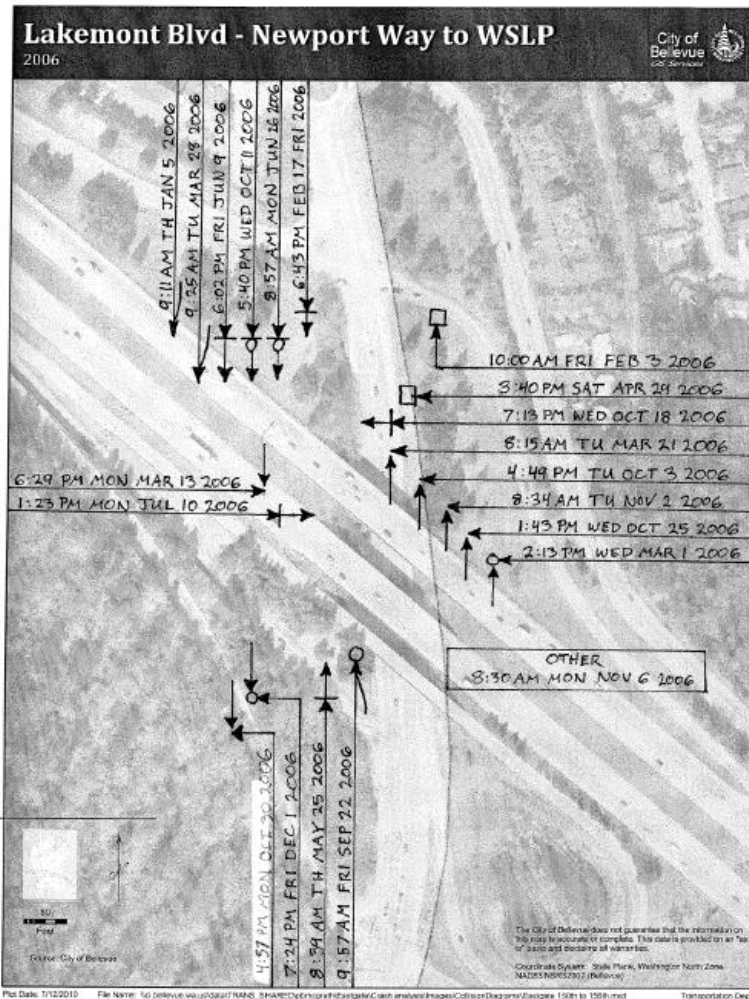
# Traditional Crash Reporting Process



# 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.

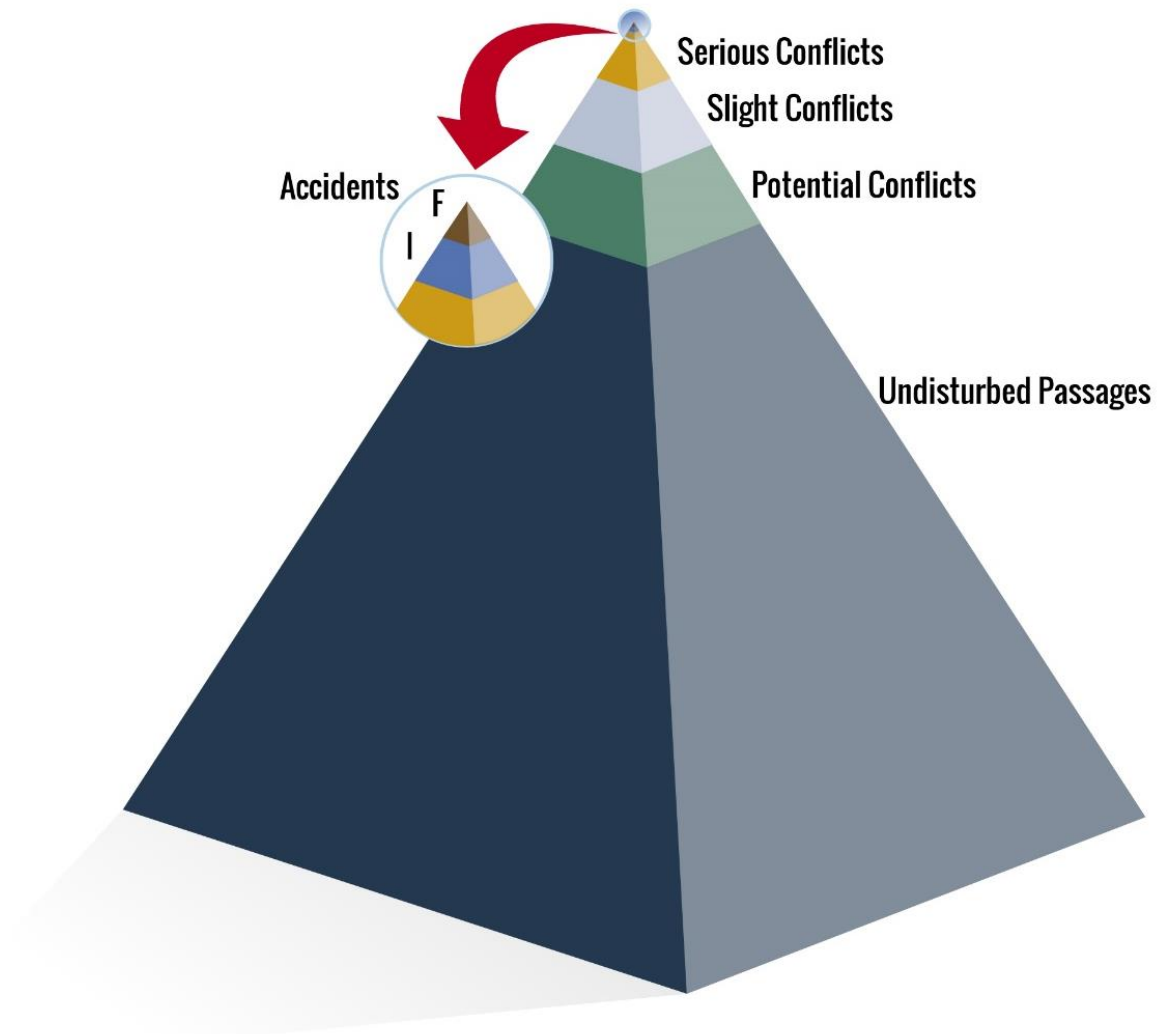


# Vision Zero: Reframing Traffic Deaths & Injuries as Preventable



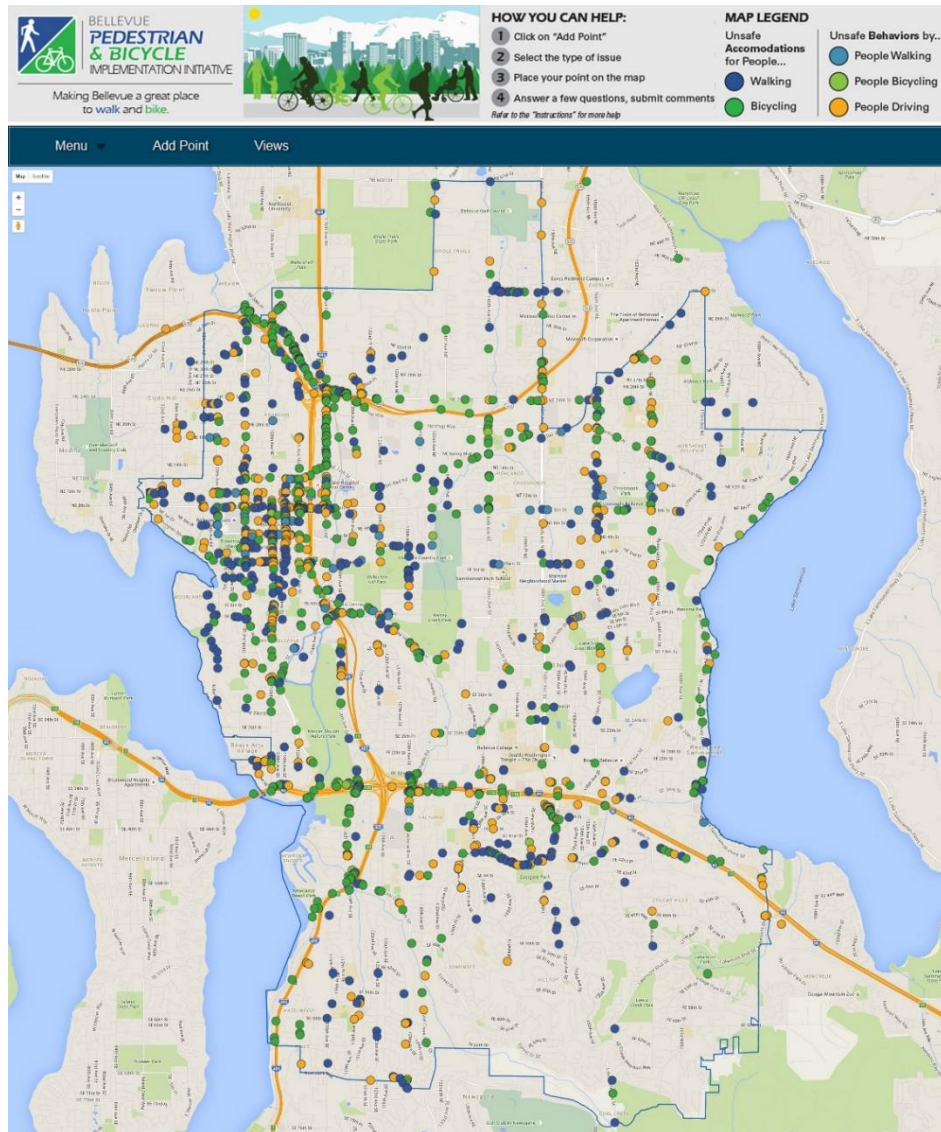
**Amy Carlson, Vice President, CH2M HILL**

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



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

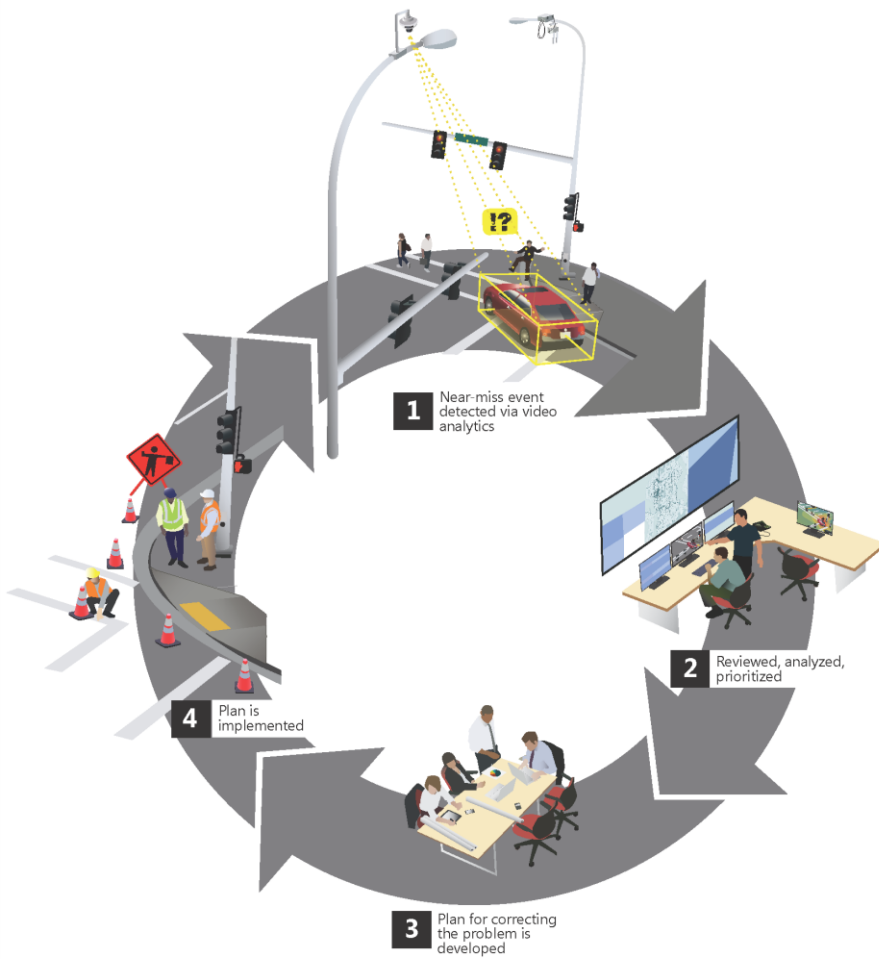
# Conflict-Based Approach: Public Involvement Strategy



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



# Conflict-Based Approach: Video Analytics Strategy



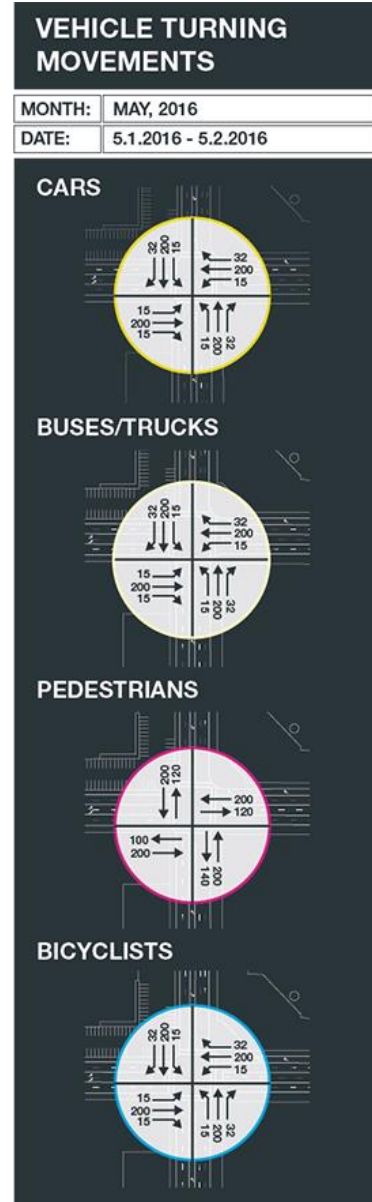
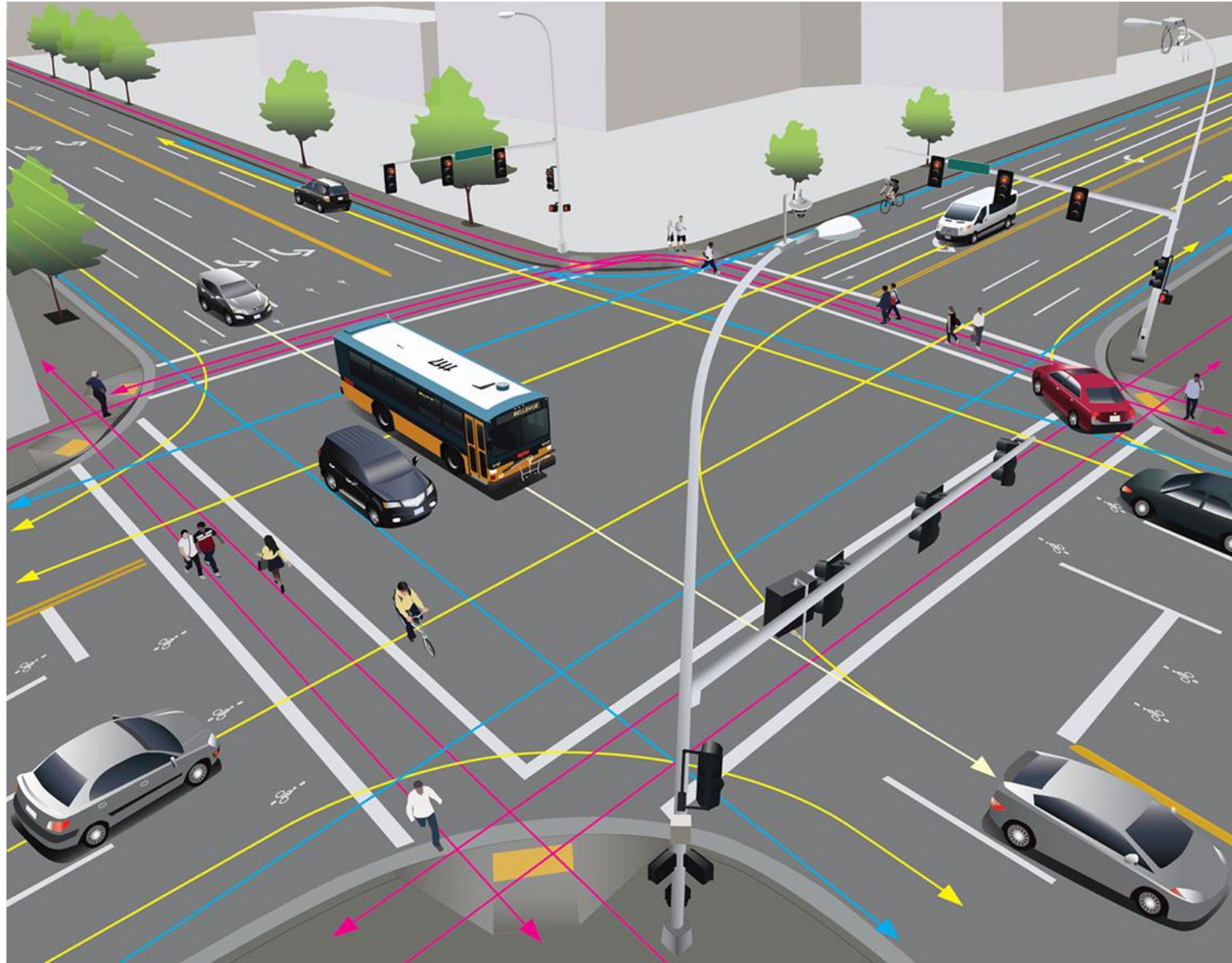
**Leverage a city's existing traffic camera system to simultaneously:**

- **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.**

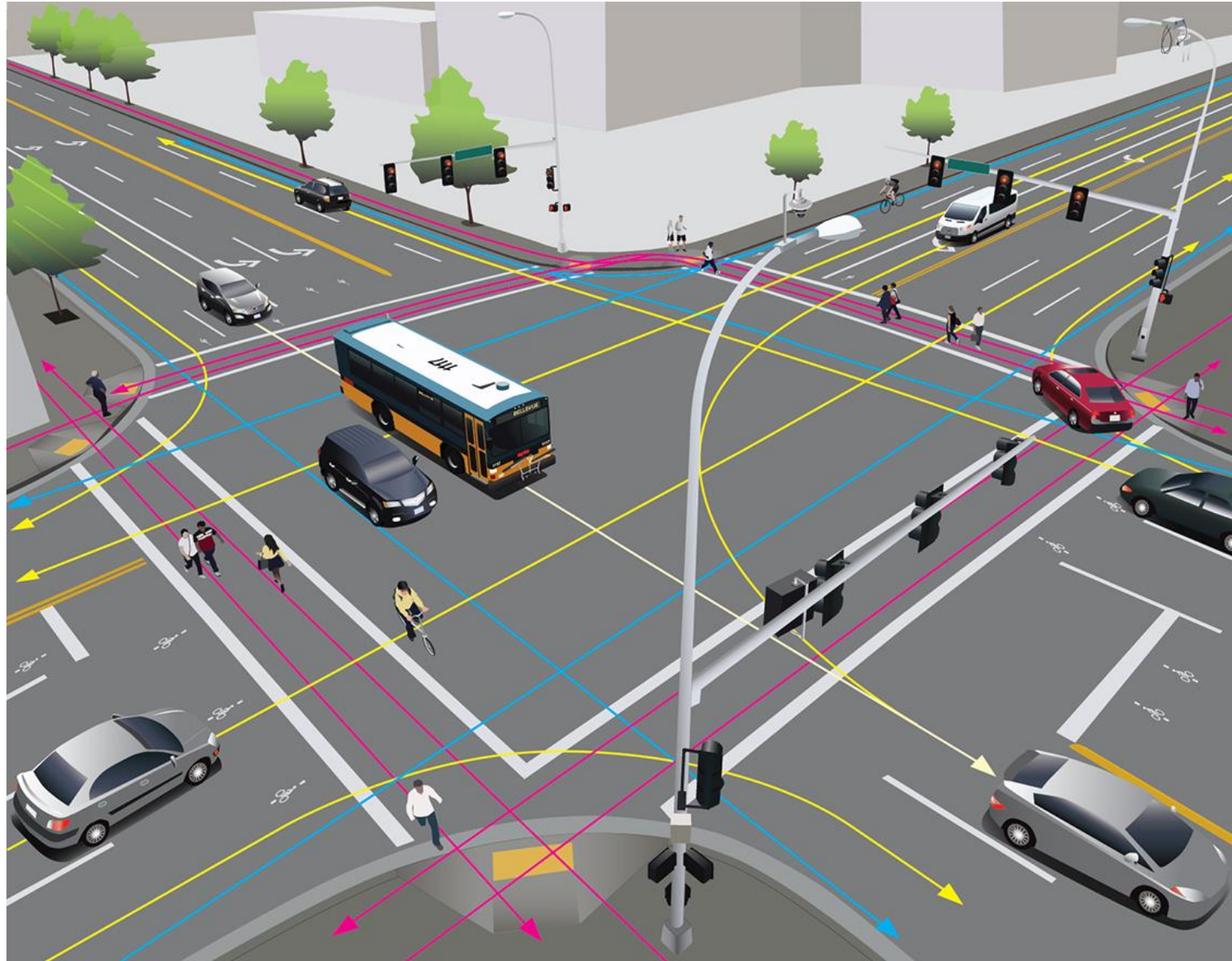
# Partnership Momentum

OVERSIGHT	  
GOVERNMENT	          
RESEARCH	    
NON-PROFIT	     

# Trajectory Detection & Turning Movement Counts



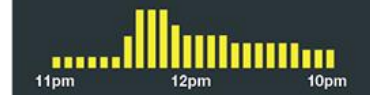
# Volume Charts



## VEHICLE DISTRIBUTION CHARTS BY TIME OF DAY

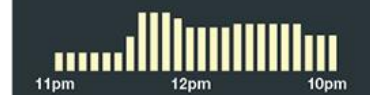
MONTH: MAY, 2016  
DATE: 5.1.2016 - 5.1.2016

### CARS



30,000 cars/day

### BUSES/TRUCKS



400 buses & trucks/day

### PEDESTRIANS



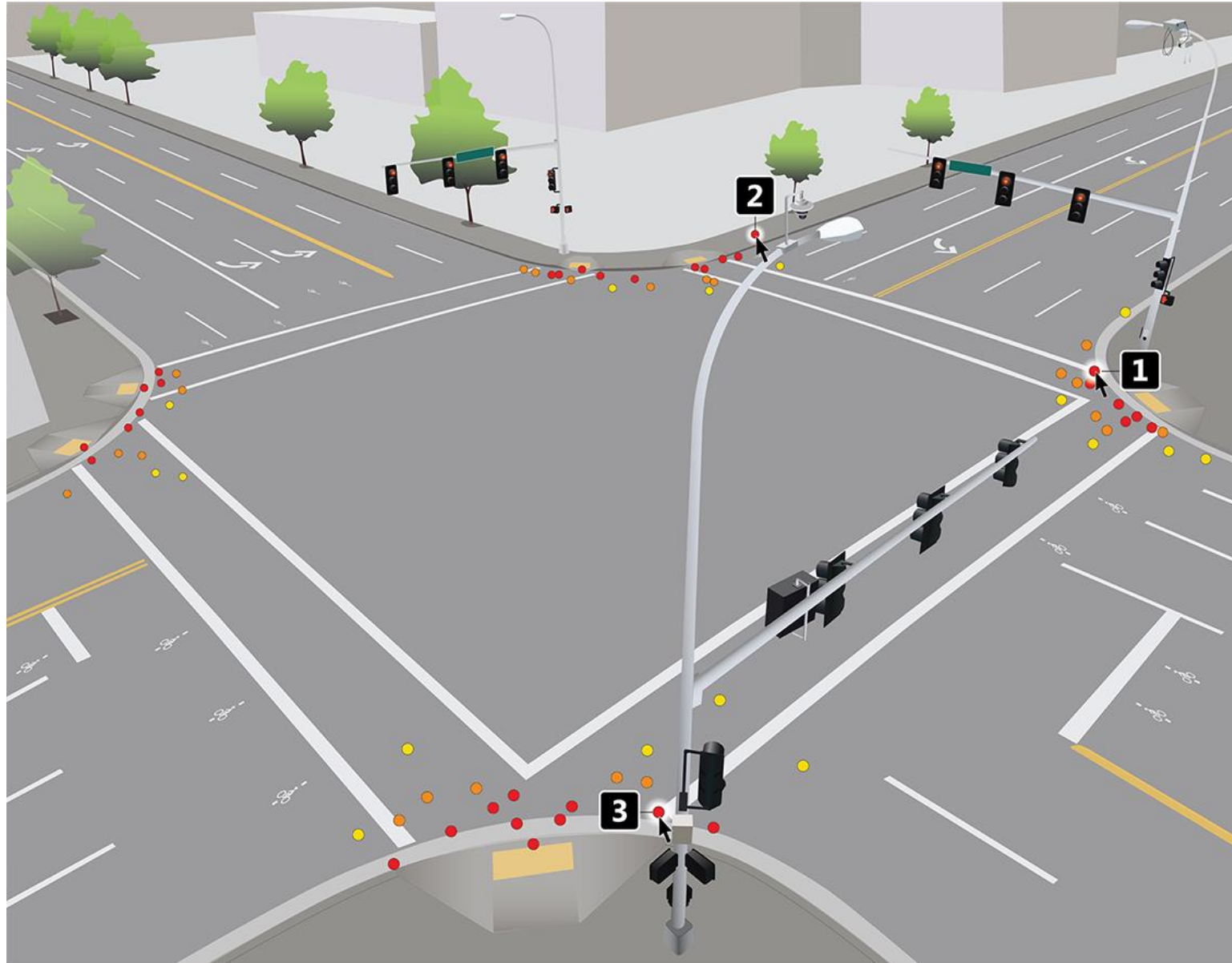
1,000 pedestrians/day

### BICYCLISTS



100 bikes/day

# Near-Miss Detection



**QUANTITY, LOCATION & SEVERITY OF NEAR MISS EVENTS**

MONTH:	MAY, 2016
DATE:	5.1.2016 - 5.31.2016

**1**

05/02/2016  
!?

00:20/02:40

**2**

05/12/2016  
\$#\*%&

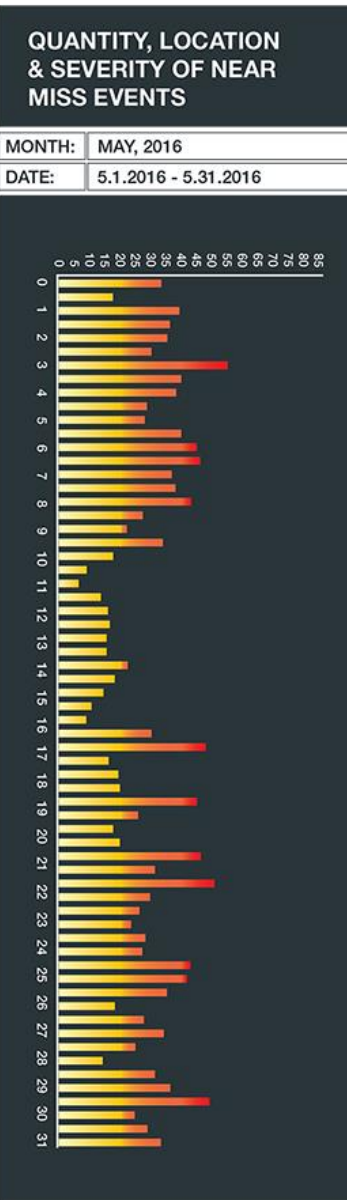
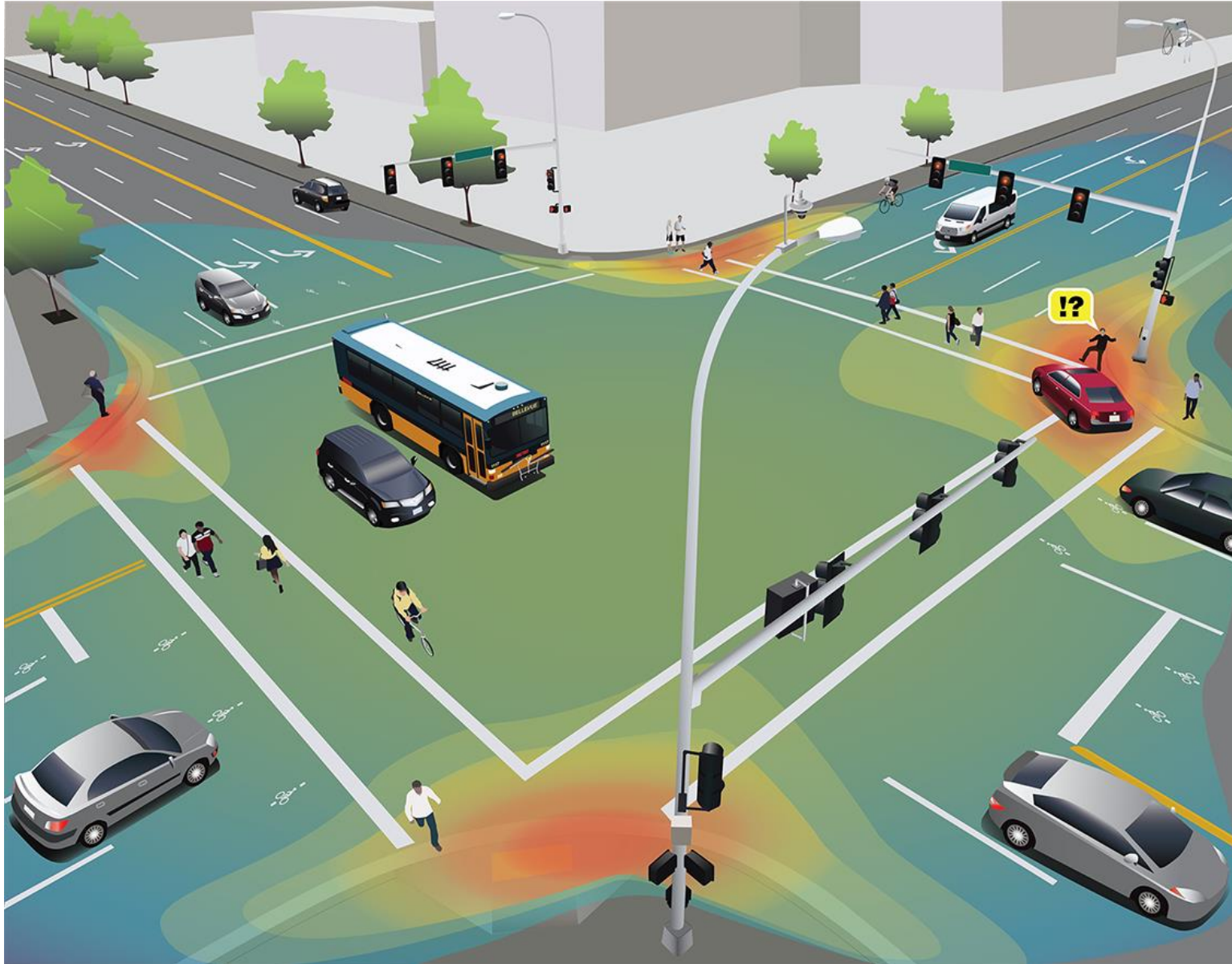
00:07/02:40

**3**


05/19/2016  
!


01:00/02:00

# Near-Miss Detection



# Partnership Approach

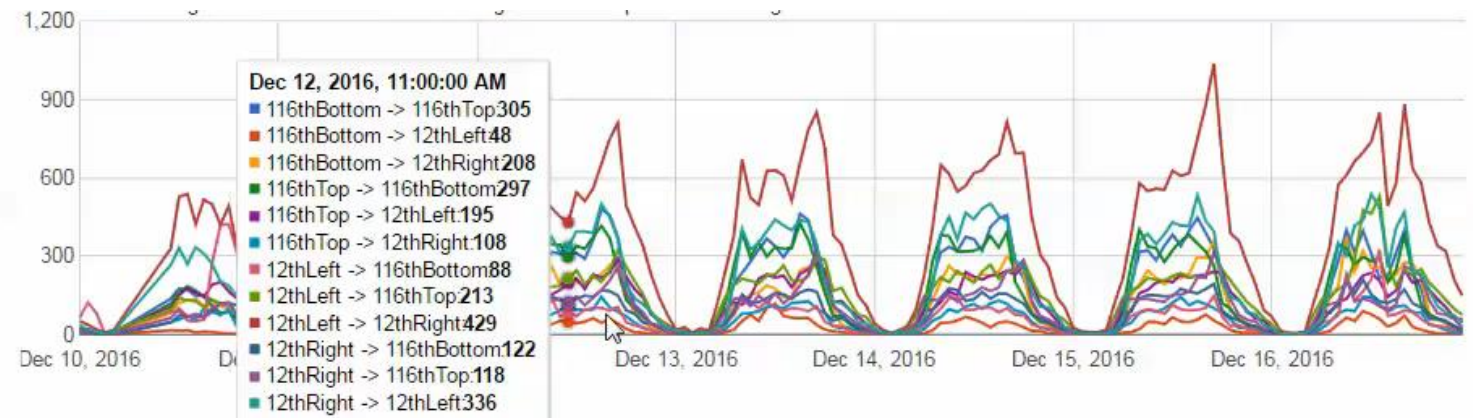
 **Milestone 1:** Demonstrate the capability of vision technologies by detecting relevant events in the sample traffic videos (e.g., detecting cars, pedestrians, and bikes and tracking their movements).

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

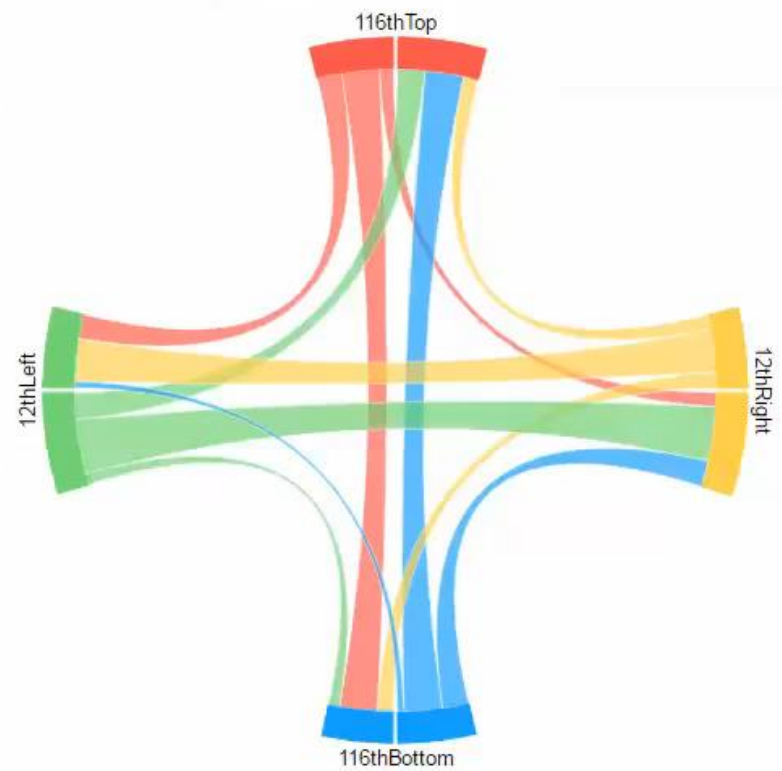
**Milestone 3:** Pilot deployment of end-to-end system (running on servers provided by Microsoft) in the City of Bellevue traffic control center. The system will run off of a live feed.

**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

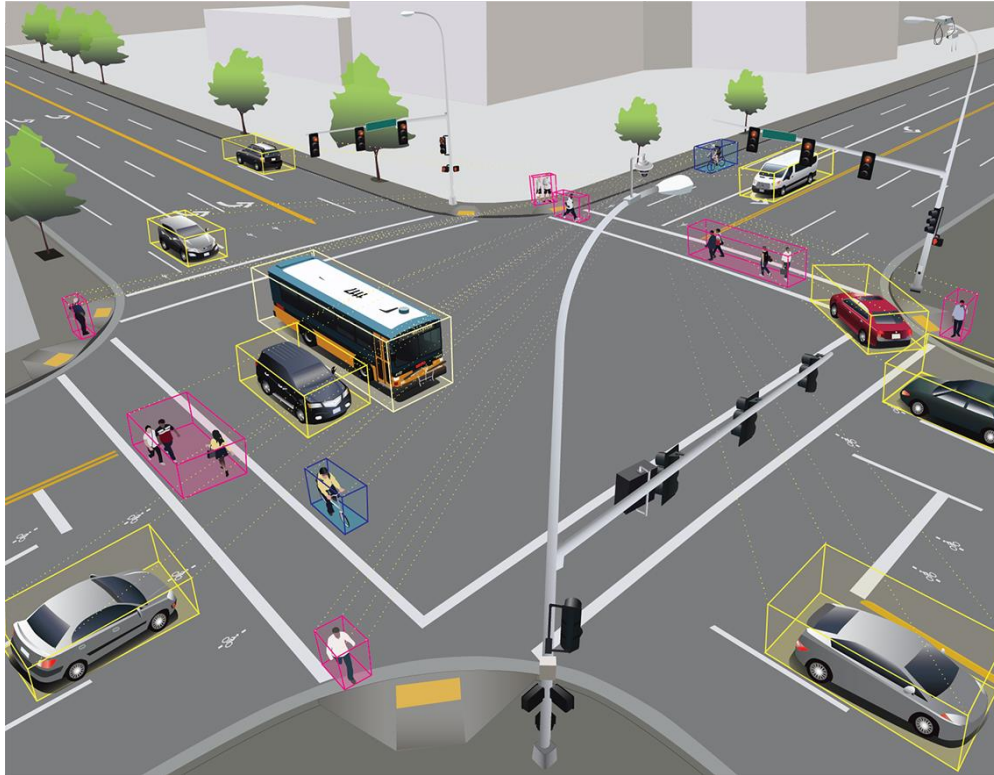


flow diagram for Mon, 12 Dec 2016 11:00:00





# Object Classification Accuracy



When it really is...

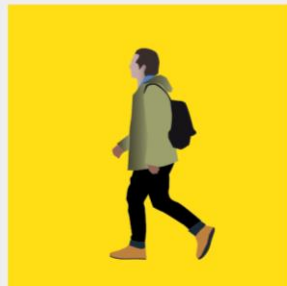
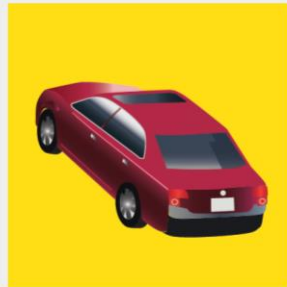
We recognized it as...

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

# How Neural Networks Work

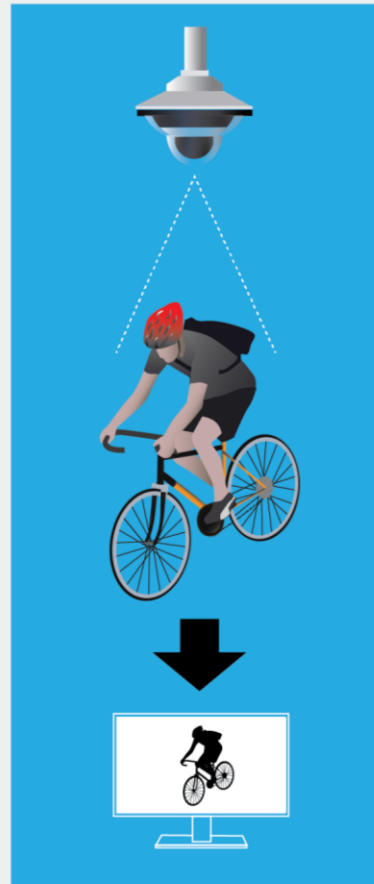
## training

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



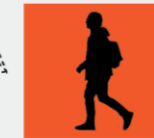
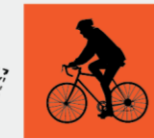
## higher layer

the neurons respond to complex shapes



## top layer

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



90% ✓

10% ✗



# Summer 2017: ITE Website

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## Video Analytics towards Vision Zero

### Worldwide problems demands bold action

Video Analytics Traffic Safety Initiative

**Dr. Victor Bahl**  
Distinguished Scientist  
Director, Mobility & Networking  
Microsoft Research

- Worldwide 1.25 million people are killed annually in traffic accidents
- In 2016, road crashes resulted in 40,000 deaths and 4.6 million injuries

### Make a difference, teach computers to learn

Public Sector Traffic Analytics Training

- Unique opportunity to help prevent traffic crashes and save lives
- "Teach" our computers how to recognize vehicles, people walking and

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- [ITE Talks Transportation Episode 10: Reuben Sarkar, DOE Deputy Assistant Secretary for Transportation](#)

## Publications



[ITE Application Supplement to the NACTO Transit Street Design Guide](#)

## Upcoming Learning Hub Webinars

- [FREE ITS WEB PILOT: Applying Your Test Plan to the ESS based...](#)  
Tuesday, March 28, 2017, 12:00 PM - 2:00 PM (UTC-5:00) Eastern Time (US & Canada)
- [FREE ITS WEB PILOT: Applying Your Test Plan to the Advanced ...](#)  
Wednesday, March 29, 2017, 12:00 PM - 2:00 PM (UTC-5:00) Eastern Time (US & Canada)
- [FREE ITS WEB PILOT\\_Acceptance Testing for](#)

## ITE Community Discussions


No data found.

# Summer 2017: Crowdsourcing Webpage

## Video Analytics towards Vision Zero

### Worldwide problems demands bold action

Video Analytics Traffic Safety Initiative




**Dr. Victor Bahl**  
Distinguished Scientist  
Director, Mobility & Networking  
Microsoft Research

- Worldwide 1.25 million people are killed annually in traffic accidents
- In 2016, road crashes resulted in 40,000 deaths and 4.6 million injuries in the United States.
- Crashes are preventable and we need not wait for someone to be killed or injured before we take action

### Make a difference, teach computers to learn

Public Sector Traffic Analytics Training




- Unique opportunity to help prevent traffic crashes and save lives
- "Teach" our computers how to recognize vehicles, people walking and bicyclists
- Cities will be able to rapidly detect road conflicts and traffic engineers can then take preventative action to avoid crashes

[Participate in late May](#)

### Partners

To help the video analytics system learn to detect road conflicts, Microsoft is collaborating with the following partners to promote this crowdsourcing platform.



[More info](#)

# Summer 2017: Classify Near-Miss Events

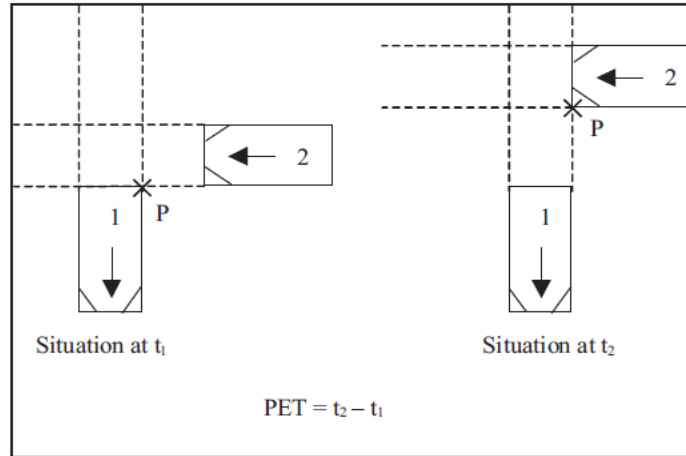


LUND  
UNIVERSITY



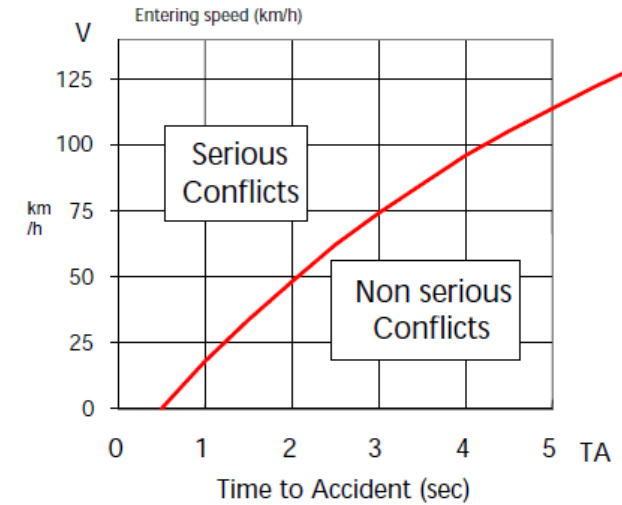
Focused object	Vehicle	Pedestrian
Time	Vehicle time to collision (Vehicle TTC)	Pedestrian time to vehicle (Pedestrian TTV)
Definition	 $\text{Vehicle TTC} = \frac{L}{v}$	 $\text{Pedestrian TTV} = \frac{Ld}{v}$
Study	Previous study (Matsui et al. 2011b)	Present study

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



**Franz Loewenherz**

Transportation Department

[floewenherz@bellevuewa.gov](mailto:floewenherz@bellevuewa.gov)

**425-452-4077**