

Video Analytics Towards Vision Zero



Bellevue Neighborhood Conference

April 21, 2018

Daniel Lai

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City of Bellevue, WA



Google Cloud Platform Live



ENVELOPVR



Smart City Solutions



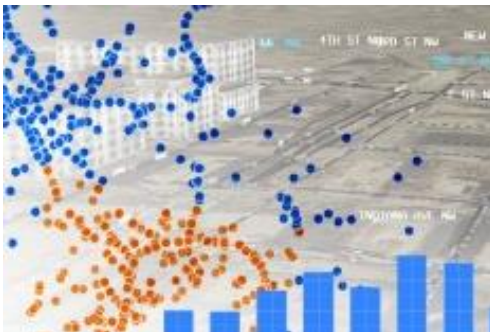
ADAPTIVE SIGNAL SYSTEM



VIDEO ANALYTICS PARTNERSHIP



CONNECTED VEHICLE PILOT



PERFORMANCE MEASURES

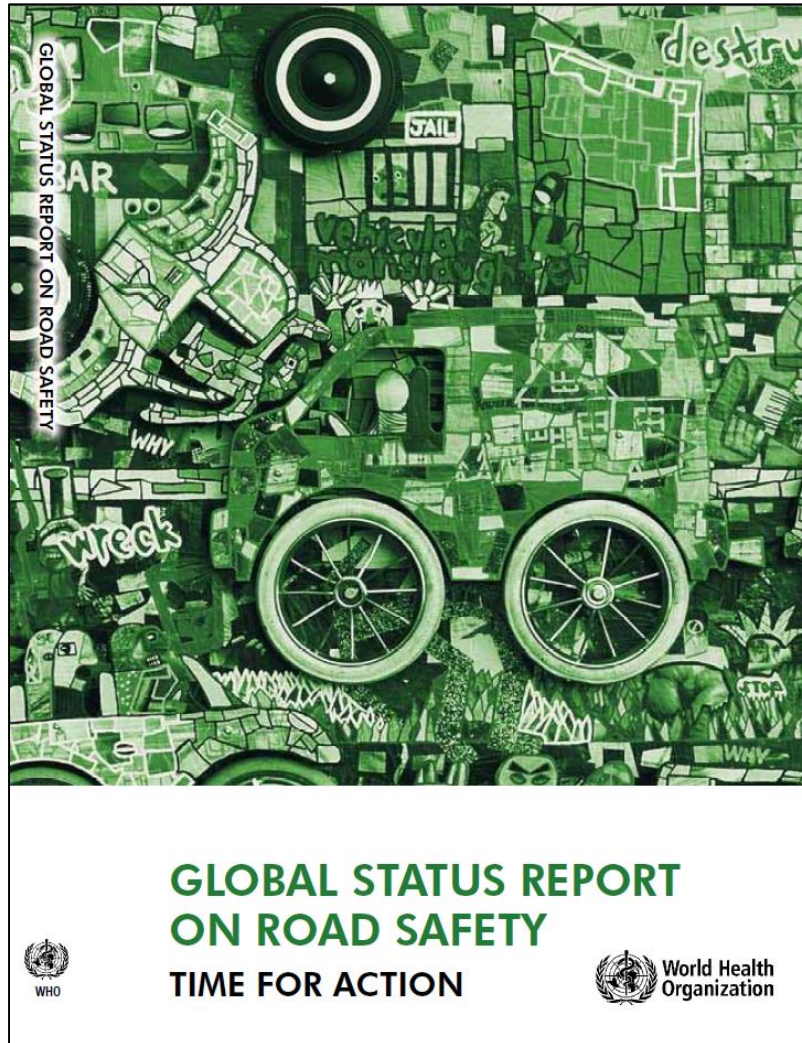


TRANSIT SIGNAL PRIORITY



LIGHTING CONTROLS

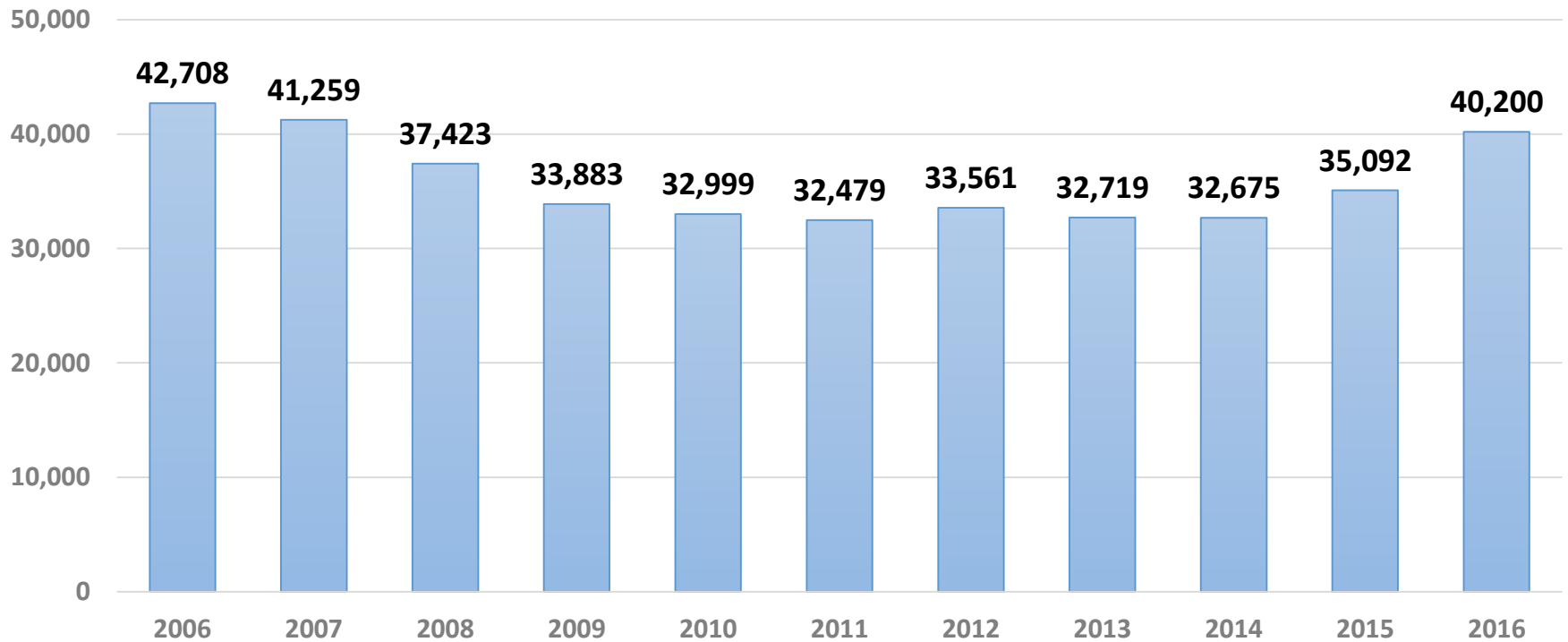
Worldwide: Traffic Fatalities



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

Bellevue Resolution No. 9035



WHEREAS, the worldwide Vision Zero movement is founded on the belief that death and injury on city streets is unacceptable and preventable

- The City of **Bellevue endorses Vision Zero** as part of a comprehensive effort to strive to achieve zero traffic deaths and serious injuries on Bellevue streets by 2030.

Bellevue: A Vision Zero City

Vision Zero Cities

A Vision Zero City meets the following minimum standards:

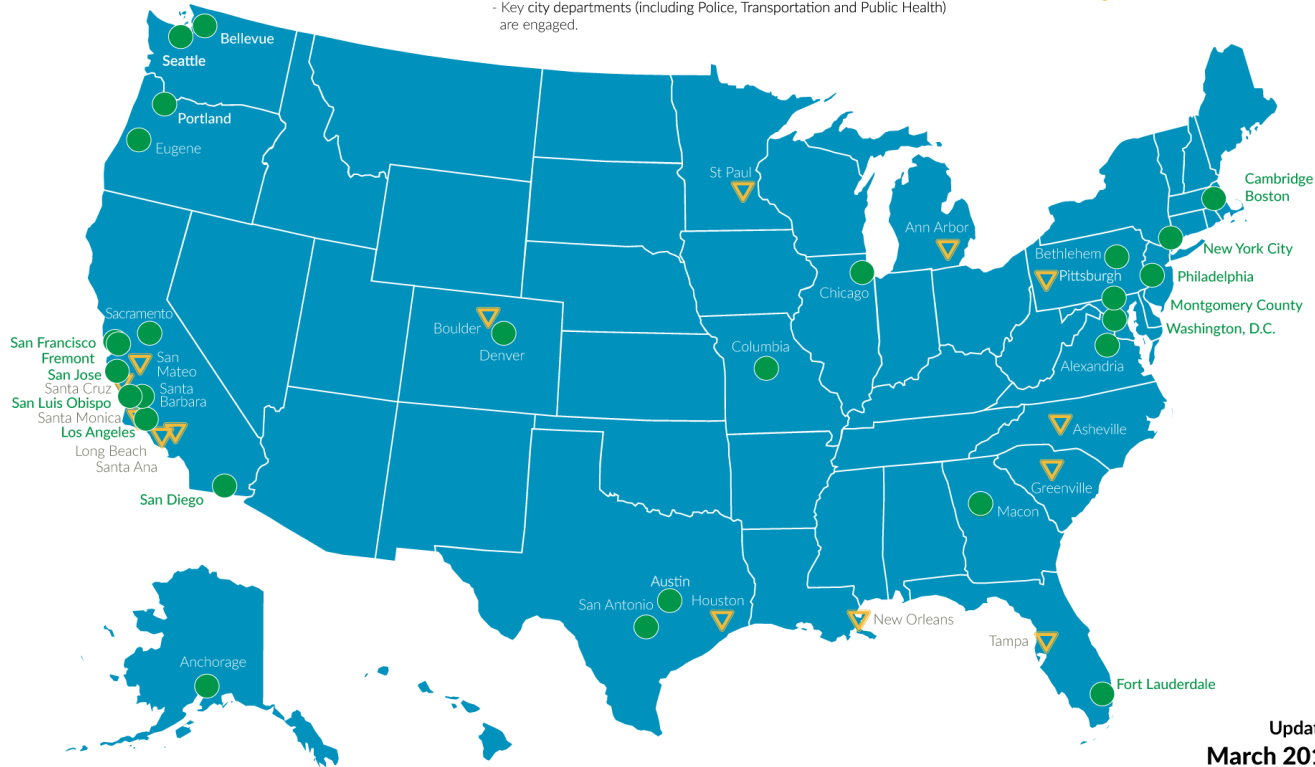
- Sets clear goal of eliminating traffic fatalities and severe injuries
- Mayor has publicly, officially committed to Vision Zero
- Vision Zero plan or strategy is in place, or Mayor has committed to doing so in clear time frame
- Key city departments (including Police, Transportation and Public Health) are engaged.



Vision Zero City



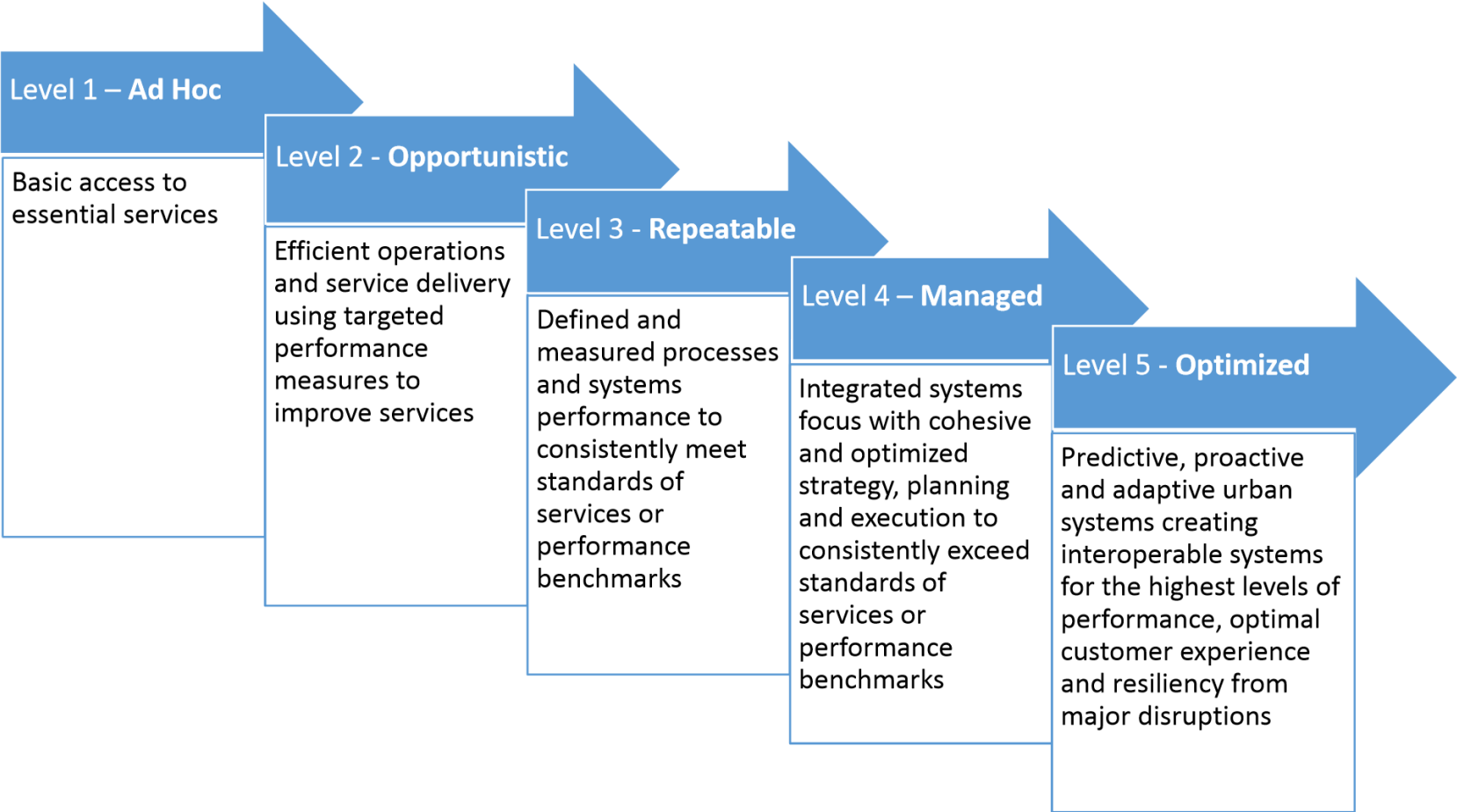
Considering Vision Zero



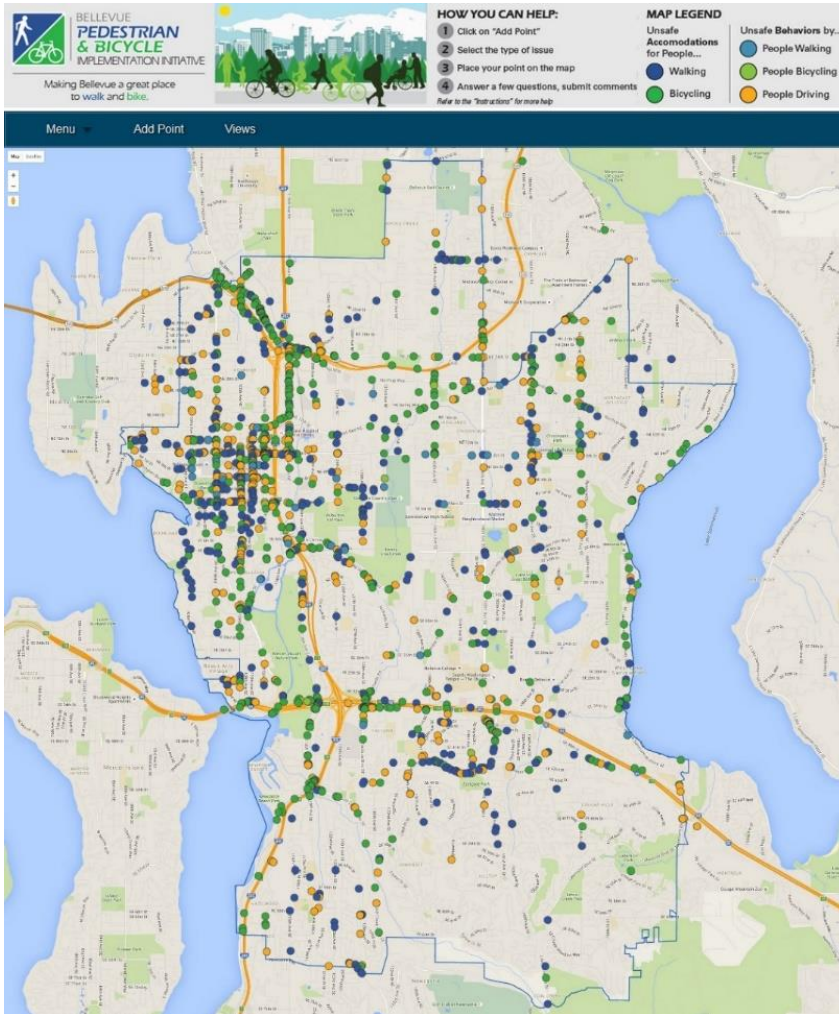
Updated
March 2017

Source: Vision Zero Network

Bellevue: A Smart City

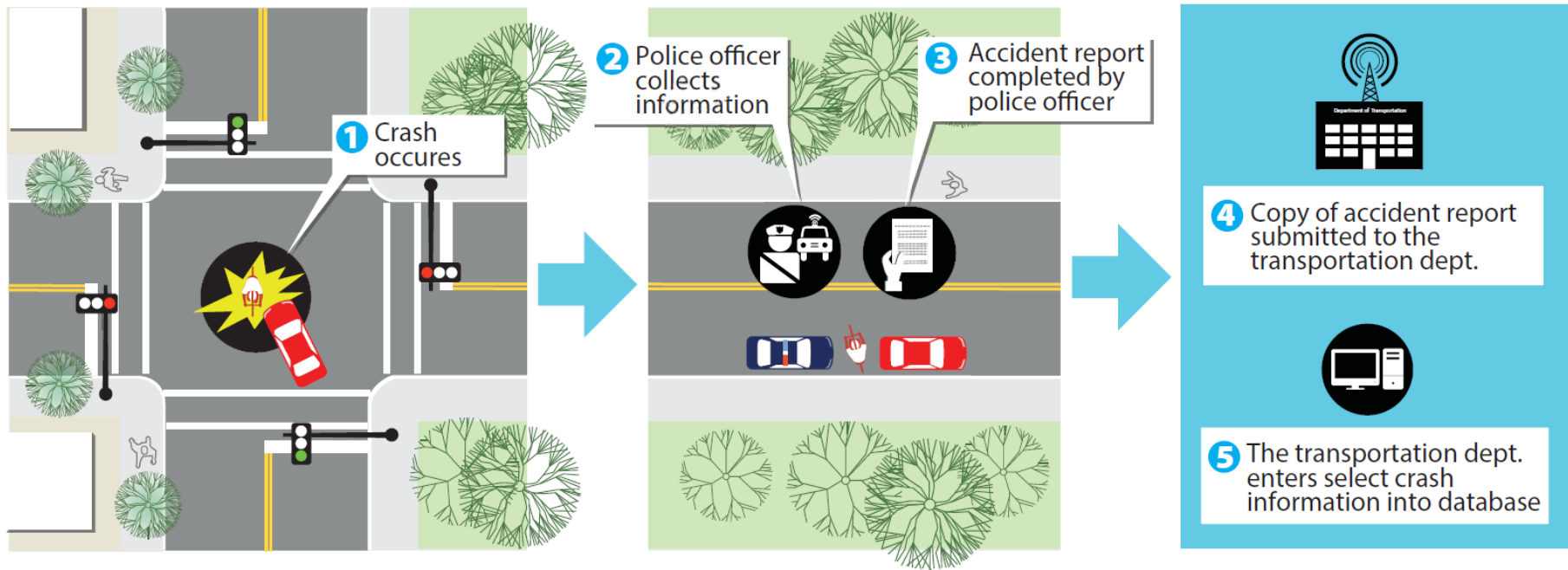


Road Safety Concerns

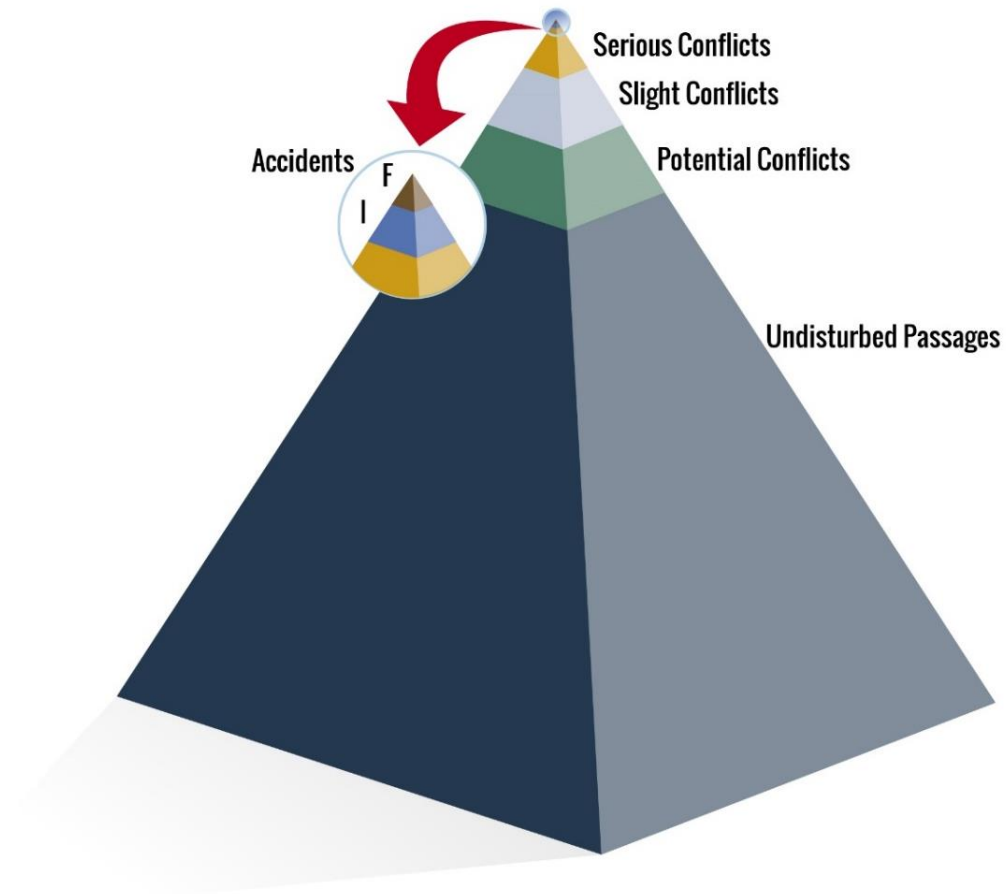


	Total Points Placed	
Ped Facilities	514	32%
Bike Facilities	573	35%
Ped Behaviors	57	4%
Bike Behaviors	22	1%
Car Behaviors	452	28%
Total	1618	

Crash-Based (Ad-Hoc) Approach

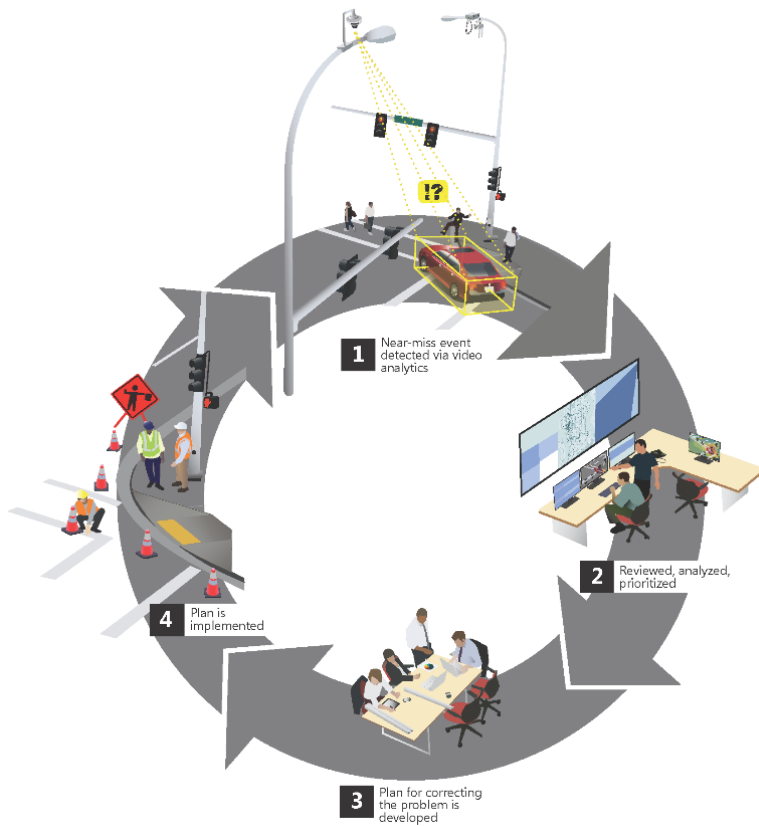


Conflict-Based (Optimized) Approach



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

Video Analytics Platform



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.

DNN Architecture

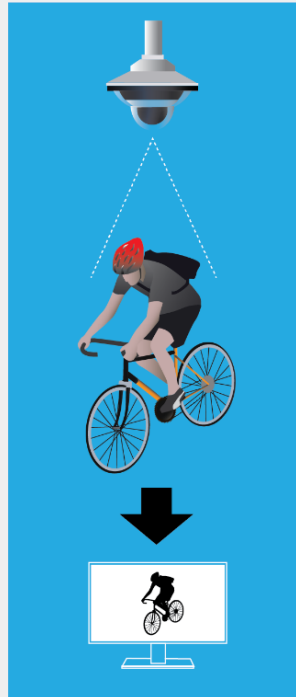
training

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



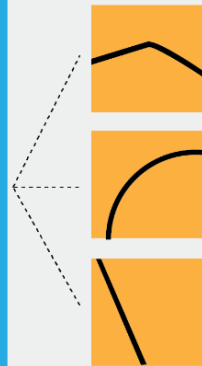
input

new image is shown to the pretrained network



first layer

the neurons respond to simple shapes, like edges



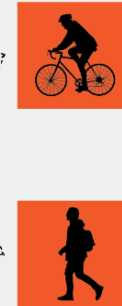
higher layer

the neurons respond to complex shapes



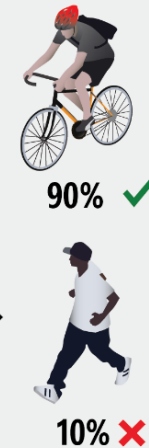
top layer

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

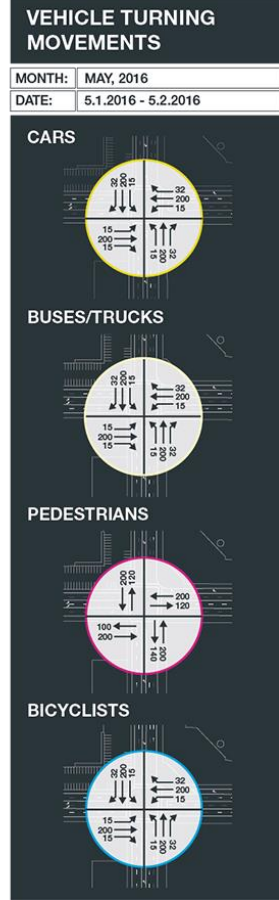
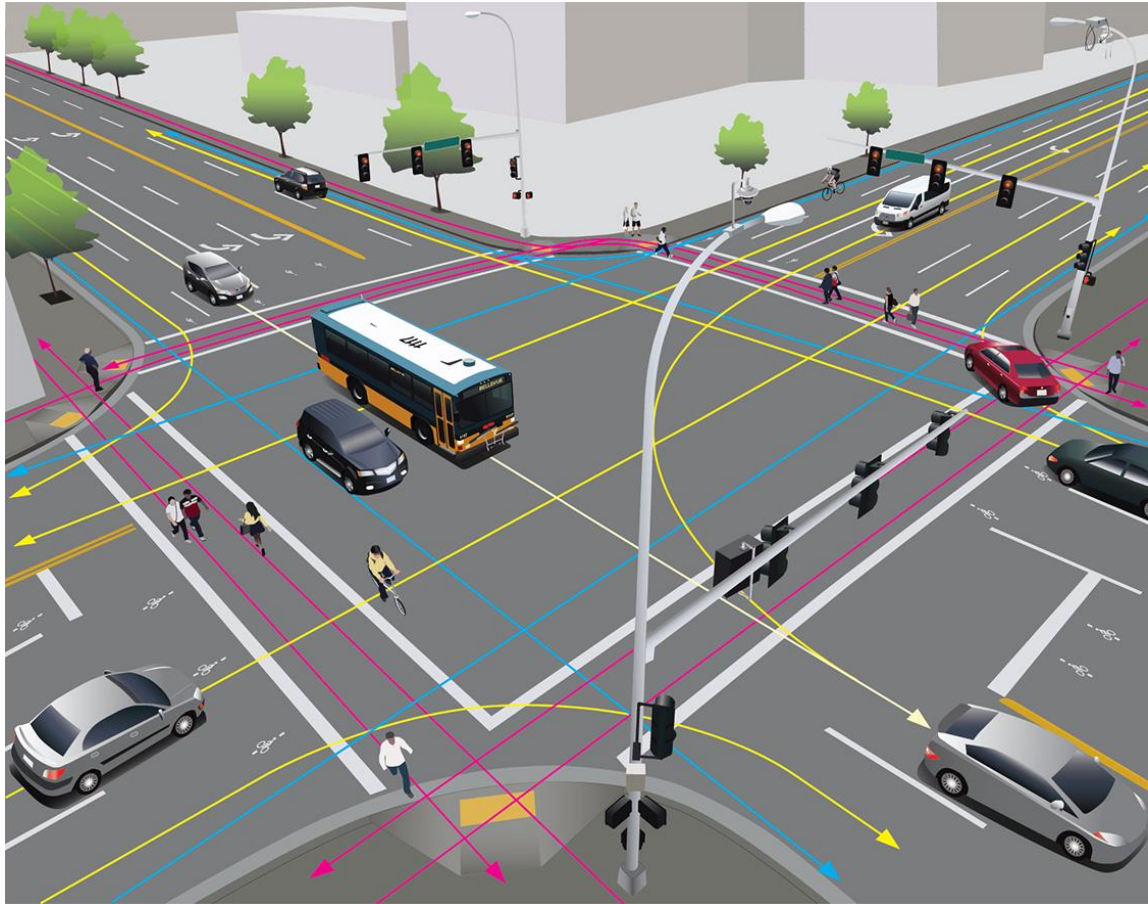


output

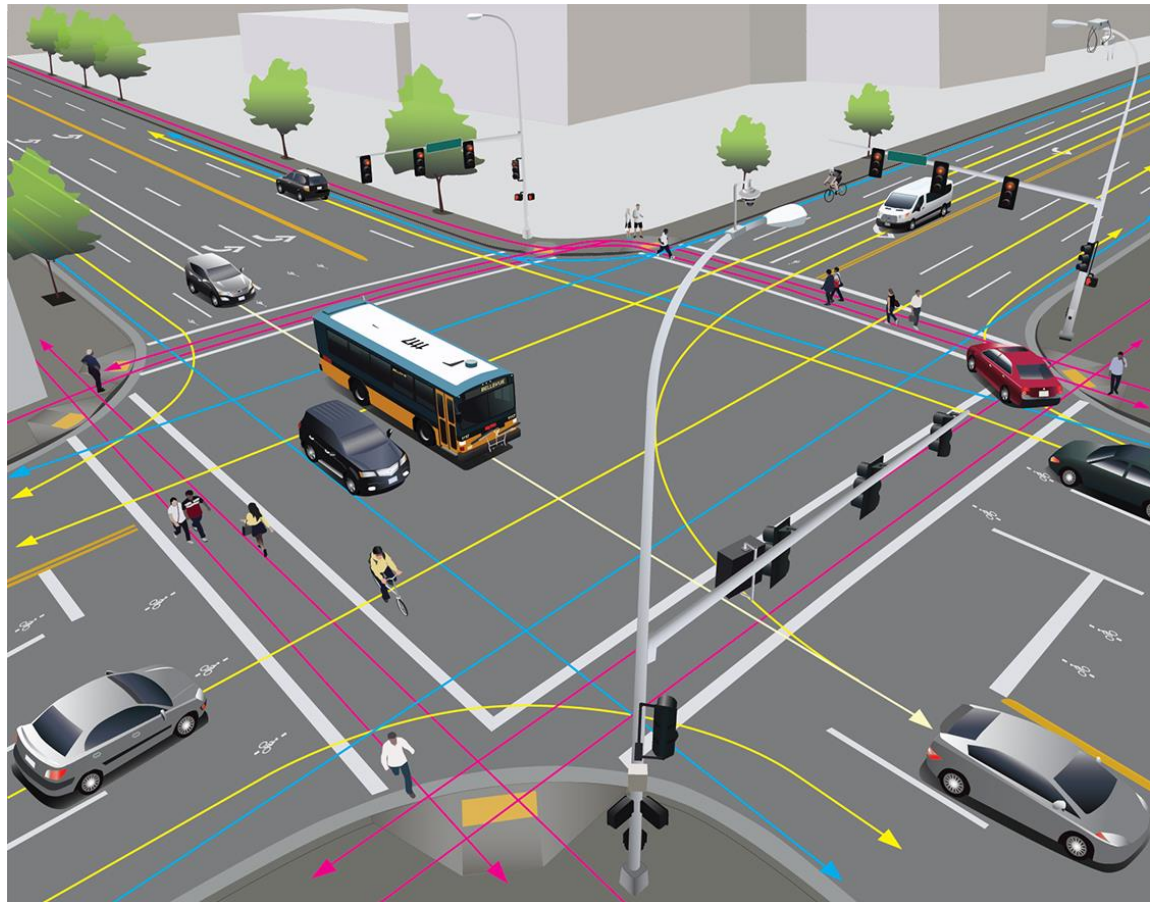
the network predicts what the object most likely is based on its training.



Turning Movements



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



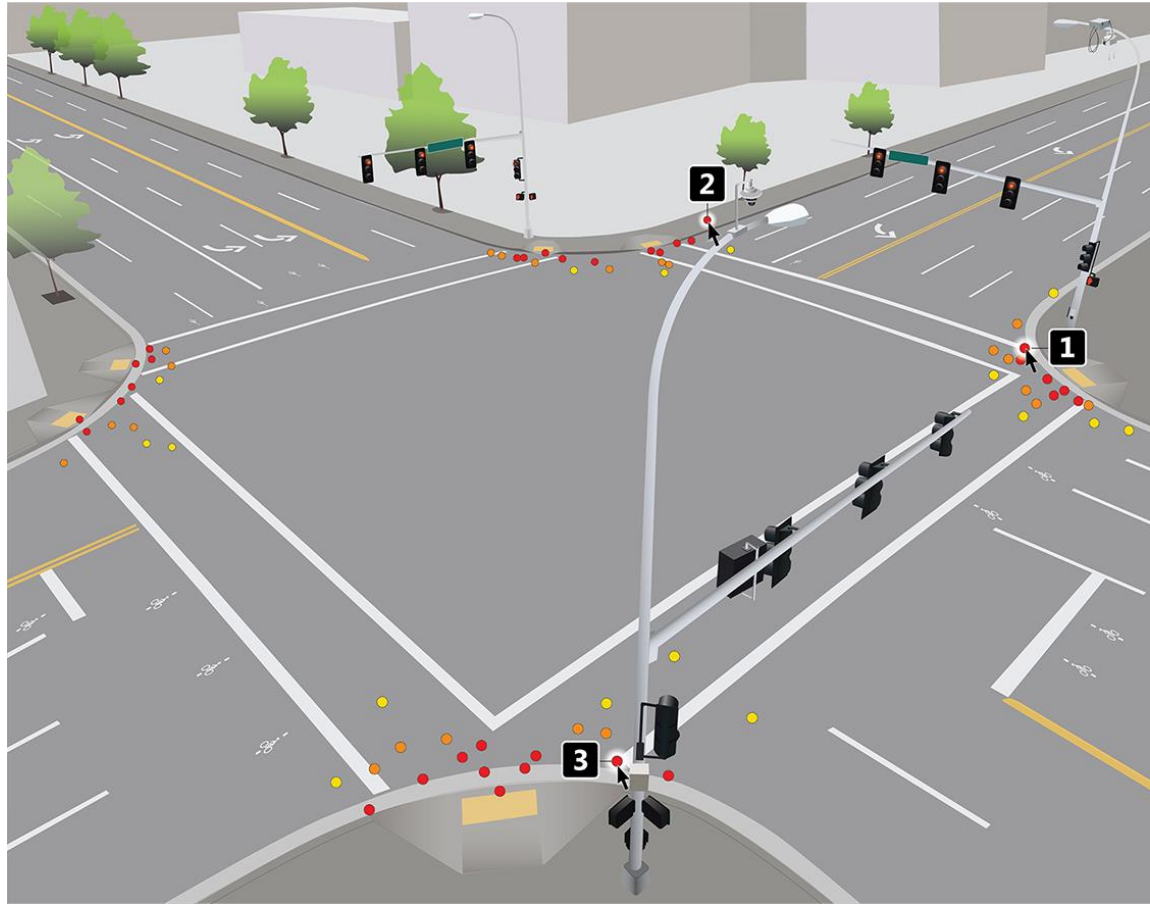
1,000 pedestrians/day

BICYCLISTS



100 bikes/day

Traffic Conflict 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

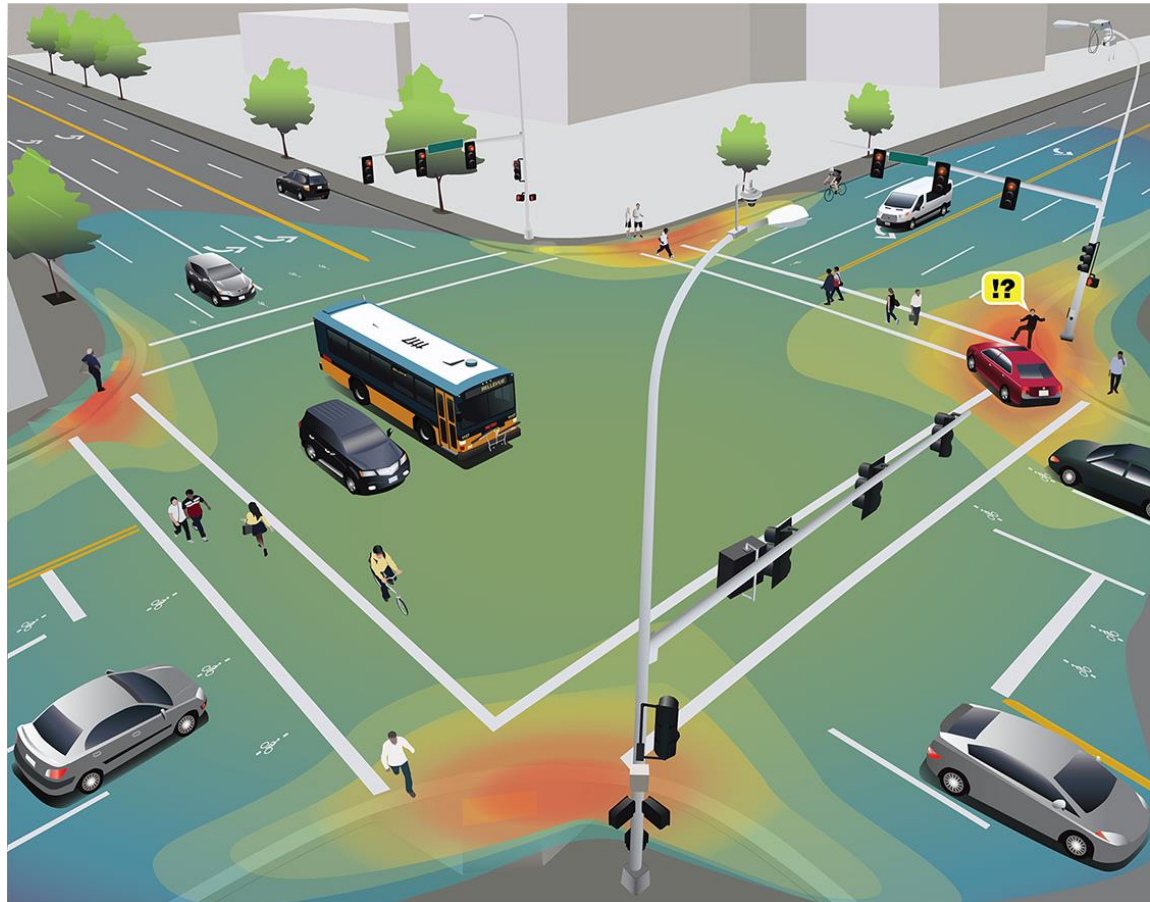
3

05/19/2016
!

01:00/02:00

The right panel contains a summary table and three video thumbnails. The table shows the data for the month of May 2016, from May 1st to May 31st. Below the table are three video thumbnails, each labeled with a number (1, 2, 3) corresponding to the conflict points in the 3D rendering. Each thumbnail shows a specific near-miss event with a yellow speech bubble containing an exclamation mark and a question mark (!?), a dollar sign, hash, asterisk, and percent sign (\$#*%&), or just an exclamation mark (!). The thumbnails also include a date and a video progress bar.

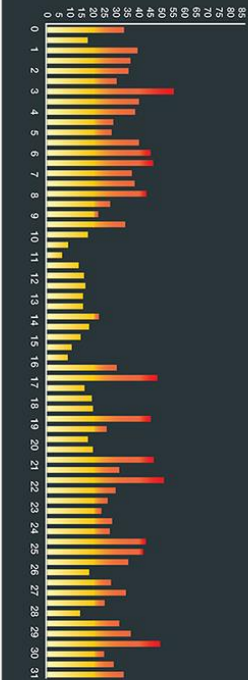
Traffic Conflict Detection



QUANTITY, LOCATION & SEVERITY OF NEAR MISS EVENTS

MONTH: MAY, 2016

DATE: 5.1.2016 - 5.31.2016



Partnership Momentum



Crowdsourcing Initiative

Video Analytics towards Vision Zero

Worldwide problems demands bold action



- 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



- 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 starting June →

<http://www.ite.org/visionzero/videoanalytics/>

Crowdsourcing Initiative

✓ Skip and Get Next Task

✓ Submit and Get Next Task

✓ Submit and Exit

✓ Exit

📄 Instructions

+ New Object

Annotate all objects of interest, moving, stationary, or obstructed, for the entire video.

2015-Sep-10 08:49:30.867 AM (PDT)



What type of object did you just annotate?

- Pedestrian
- BiCycle
- PedestrianWithStroller
- MotorBike
- Car
- Bus
- Truck
- WheelChair

Pedestrian 2

- Outside of view frame
- Temporarily not visible
- Crossing Road

Pedestrian 1

- Outside of view frame
- Temporarily not visible
- Crossing Road

In this video, please track all of these objects:

- Pedestrian
- BiCycle
- PedestrianWithStroller

⏮ Rewind

▶ Play

Disable Resize

Hide Boxes

Hide Labels

Slower

Slow

Normal

Fast


Media Coverage

METROLAB NETWORK

ABOUT MEMBERS PROJECTS PROGRAMS SUMMIT JOIN BLOG

01 Jun Guest Blog: Introducing the Video Analytics Towards Vision Zero Partnership
Posted on 06/03/2019 by Partnership by Metrolab Network

The City of Bellevue, in partnership with Microsoft, the University of Washington (UW) and a number of cities, private sector companies, research universities and nonprofit organizations, is launching a new partnership-Video Analytics Towards Vision Zero-which aims to use footage from traffic cameras across North America to "teach" computers how to recognize near-miss collisions.



Launching today, the partnership is developing a video analytics platform which leverages cloud computing and machine learning systems to convert raw video footage from the City of Bellevue's existing camera network into useful data that can be searched, managed, and used to provide detailed information on traffic flow and allow a more rapid response to non-crash traffic conflicts.

The potential of the project for saving lives is significant. In 2016, road crashes resulted in approximately 40,000 deaths and 4.8 million injuries in the United States alone. For young people under age 18, these collisions were the leading cause of death.

Understanding the root causes for near-collision events could enable local governments to take proactive, corrective actions to reduce the potential for future crashes. Performance dashboards are under development in the Video Analytics Towards Vision Zero Partnership to flag high risk locations that warrant intervention. The dashboards are based on a predetermined, numeric scale of near-miss conditions, and a more granular indicator of a higher risk of collision, adjusted for the number of road users passing through the intersection, in terms of human lives and property damage; near-collision events are zero-cost learning opportunities, compared to learning from actual crashes and their grim consequences.

In order to ensure the success of the program, the project is looking for people to use a crowd-sourcing tool to analyze videos and teach computers to identify a person in a wheelchair, on a bike or in a car, as well as patterns of movement in intersections. The more people who take part, the better computers will learn to recognize near-miss collisions. If you would like to learn more about this partnership, and participate in the crowd-sourcing initiative visit this [website](#) or contact [Frans Loosenbroek](#), for additional information.



LOS ANGELES

VISION ZERO
LOS ANGELES | 2015 - 2025

HOME ABOUT PROJECTS CALENDAR

When the Vision Zero LA team comes to work every day, we know the statistics about traffic collisions. In addition to the national numbers (40,000 deaths and 4.6 million injuries), we know locally: Every year more than 200 people die on the streets of Los Angeles, half of whom are pedestrians or cyclists. Traffic collisions are the leading cause of death for children between the ages of 2 and 14.

Crowdsourced technology has already changed the way many of us get around (Lyft, Uber, Waze, and so on). What if we could also use technology to predict where vehicle collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them? Thanks to a new online platform and partnership called Video Analytics Towards Vision Zero, everyday citizens can play a role in teaching computers how to recognize and prevent potential traffic collisions before they happen.

By using footage from traffic cameras across North America, VAVZ will "teach" computers how to recognize near-miss collisions. Data from these machine learning systems will allow transportation engineers to predict where crashes will occur and take proactive measures to prevent them.

WSDOT BLOG

Friday, June 8, 2017
Help researchers train computers to recognize road users, prevent collisions
by Dr. Ruz

What if we could use technology to predict where vehicle collisions involving people who walk or bike will occur, then take steps to prevent them? Would you want to help? Well, now you can.

Volunteers are needed to help train computers to recognize road users and flag "near misses" at intersections. An example of a near miss is when a driver nearly hits someone on a bicycle.

How? You'll use your task for a few minutes of a pre-recorded traffic camera. Then, you'll track the movement of each person or vehicle within the screen. By doing so, the computer can learn to distinguish a person walking, biking, using a wheelchair, etc. or an object in a car. The computer will then be able to flag near misses. Using data from the video analysis, engineers could then take corrective actions to prevent future crashes.



Technology that will help predict where the greatest risk for an injury or fatality is.



Global News National TV News Programs

Hamilton partners with Microsoft on Vision Zero traffic initiative

Hamilton, Ontario, is partnering with Microsoft to launch a new initiative to use video analytics to predict where collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them.

The City of Hamilton is partnering with tech giant Microsoft to test a new initiative to use video analytics to predict where collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them.

TREC Portland State University

Video analytics help train computers to recognize road users, prevent collisions

In 2016, road crashes resulted in 40,000 deaths and 4.8 million injuries in the United States. For young people under age 18, these collisions were the leading cause of death.

What if we could use technology to predict where vehicle collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them? Thanks to a new online platform and partnership called Video Analytics Towards Vision Zero, everyday citizens can play a role in teaching computers how to recognize and prevent potential traffic collisions before they happen.

The partnership involves public participation in the most prominent, using technology to analyze video from traffic cameras to identify a person in a wheelchair, on a bike or in a car, as well as patterns of movement in intersections. The more volunteers who take part, the better computers will learn to recognize near-miss collisions.

Hamilton

News Releases

City of Hamilton partnering with Microsoft on Vision Zero Video Analytics project

Hamilton, Ontario, is partnering with Microsoft to launch a new initiative to use video analytics to predict where collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them.

SmartCitiesCouncil

How analyzing "near-miss" traffic collisions could help save lives

The project, which "teaches" computers to recognize road users and flag "near misses" at intersections, is a key step in a larger effort to use video analytics to predict where collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them.

GREATER GREATER WASHINGTON

We can use data to achieve Vision Zero by spotting dangerous places before crashes happen

Hamilton, Ontario, is partnering with Microsoft to launch a new initiative to use video analytics to predict where collisions involving pedestrians and bicyclists will occur, and then take steps to prevent them.



Traffic Analytics Dashboard

<https://vavz.azurewebsites.net/>

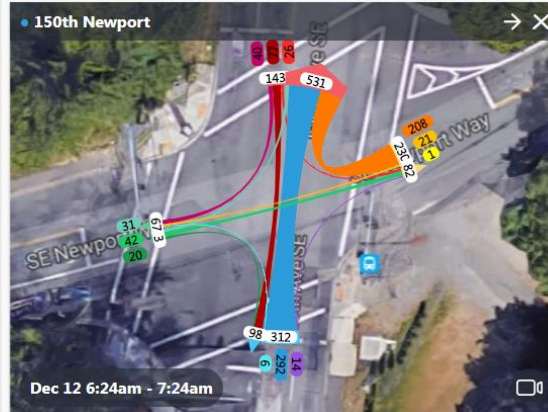
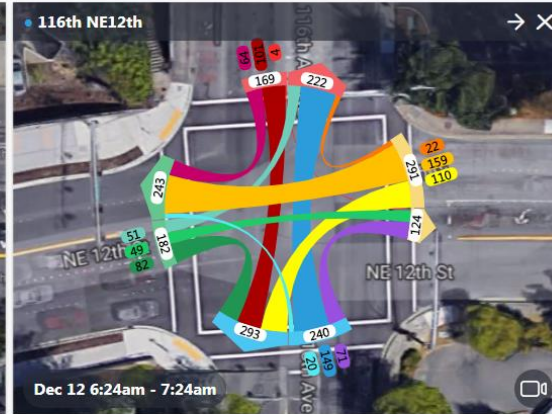
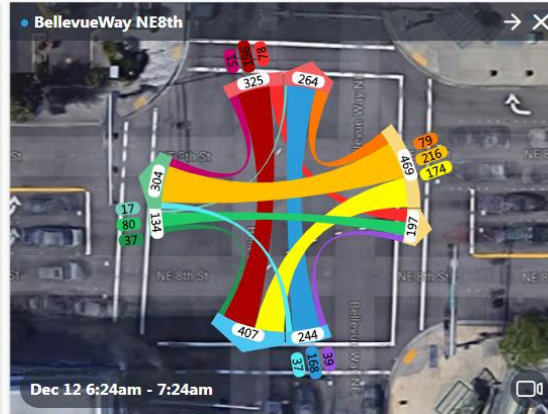
Traffic Analytics Dashboard (Overview)

Busiest Intersections

Location	Last Hr Total	Week ADT
150th SE38th	1949	40062
BellevueWay NE8th	1172	48201
150th Eastgate	1047	34215
116th NE12th	882	30960
150th Newport	778	19068

Alerts

Alert	Last 15min	Mean 15min	Deviation
150th SE38th 38thE WBL	45	19.4	132.0%
150th SE38th 38thE WBR	63	29	117.2%
150th SE38th 38thE WBT	37	12.8	189.1%
150th SE38th 150thS NBR	23	10.6	117.0%

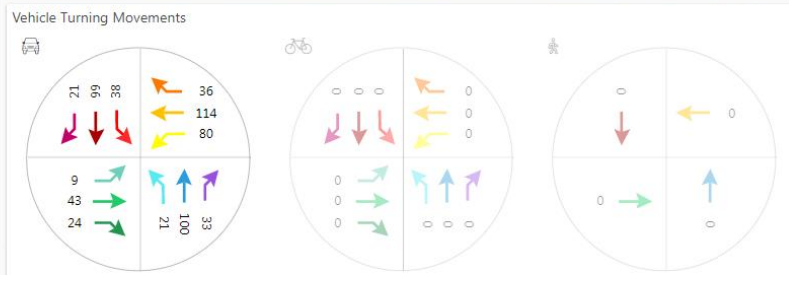
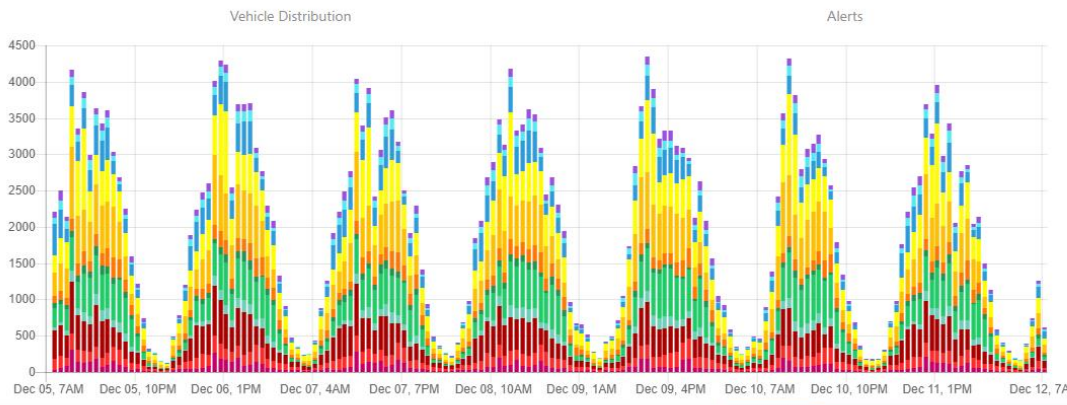
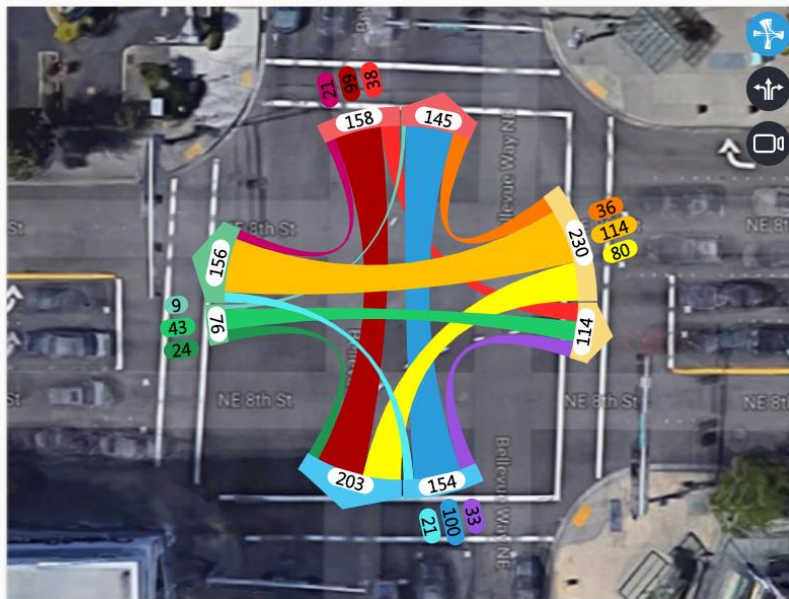
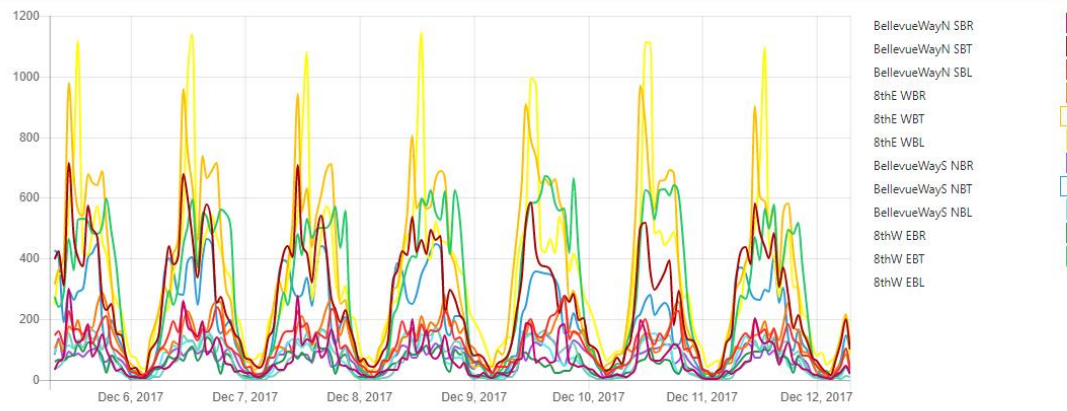


Traffic Analytics Dashboard (Bellevue Way & NE 8th)

Microsoft Traffic Analytics Dashboard Search Alert History

← BellevueWay NE8th 12/05/2017 12/12/2017

1hr: Dec 12 7:00am - 8:00am



Export Reset to 12/05/2017 - 12/12/2017

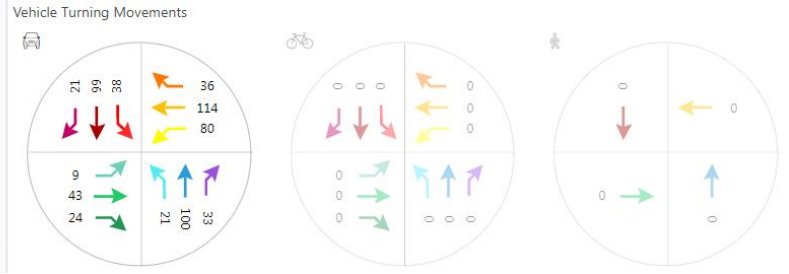
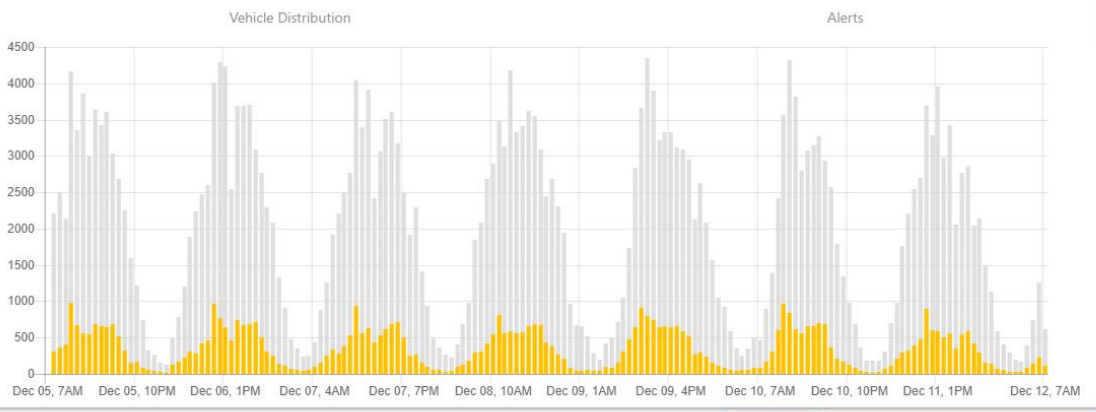
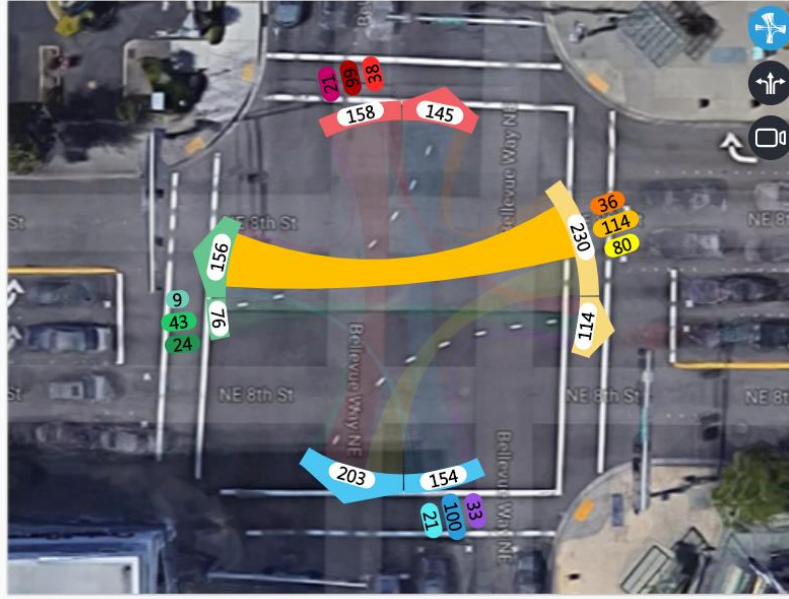
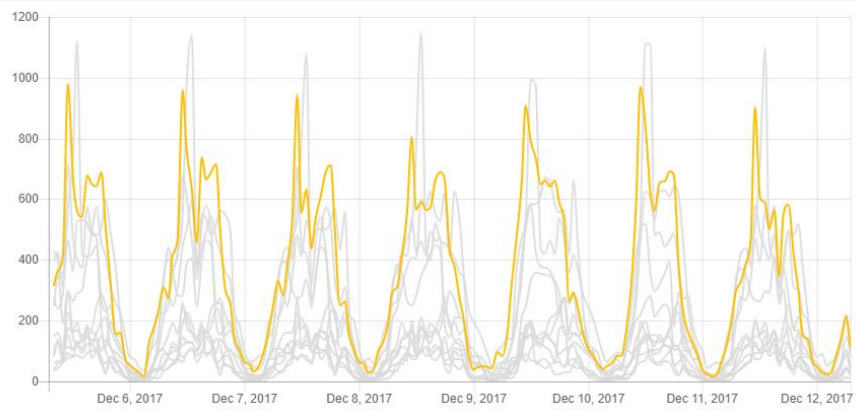
Traffic Analytics Dashboard (Bellevue Way & NE 8th)

Microsoft Traffic Analytics Dashboard Search Alert History

← BellevueWay NE8th ▾ 12/05/2017 12/12/2017

🚗 🚲 🚶

1hr: Dec 12 7:00am - 8:00am



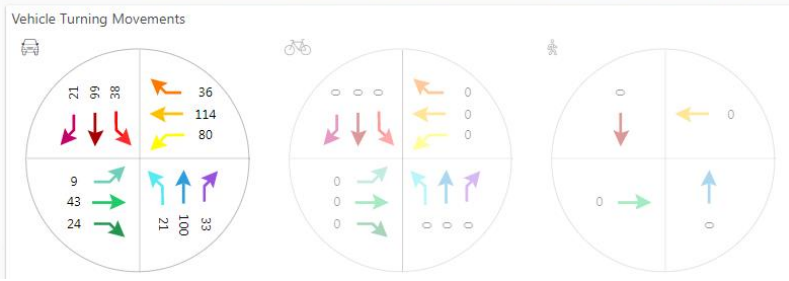
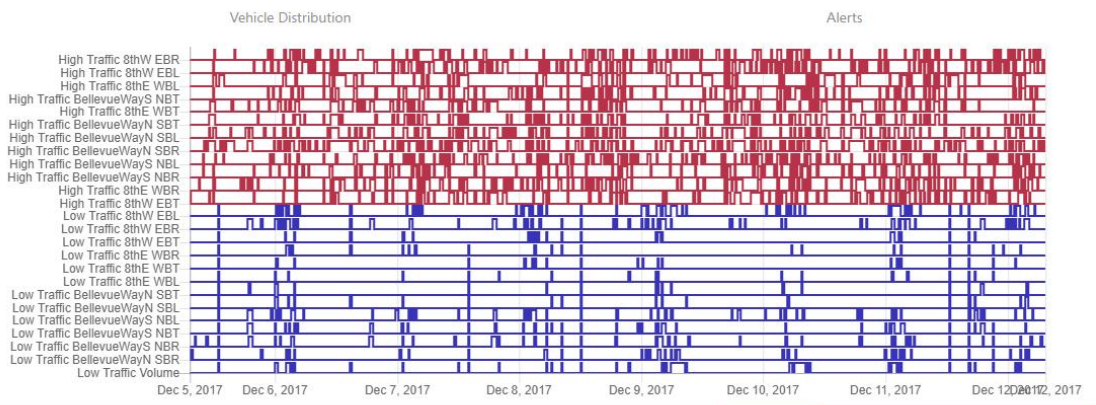
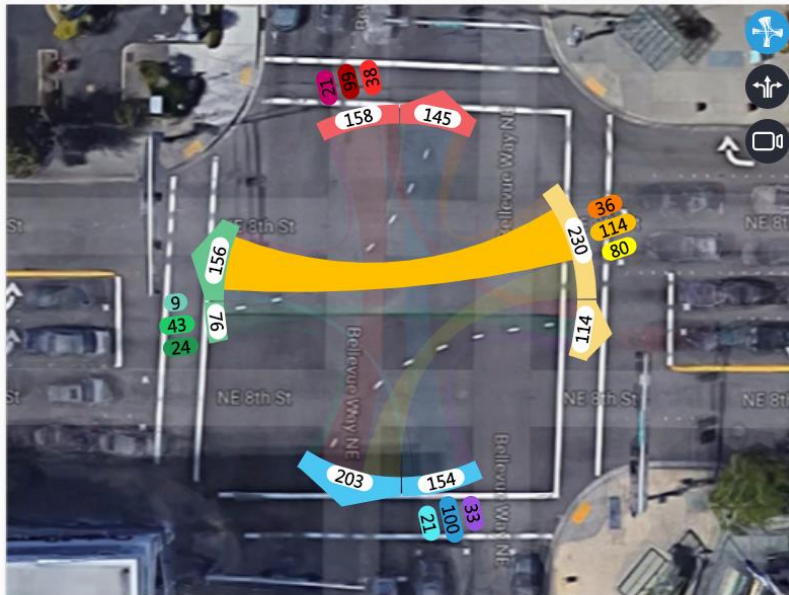
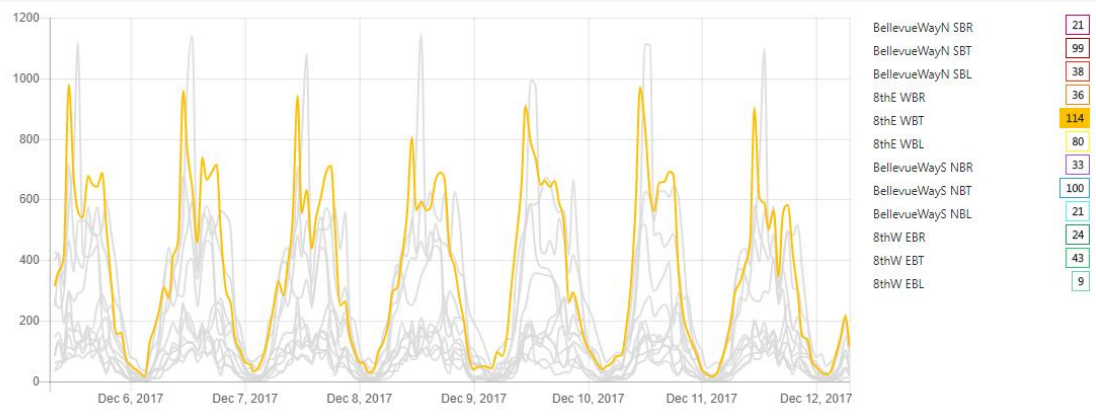
Export Reset to 12/05/2017 - 12/12/2017

Traffic Analytics Dashboard (Bellevue Way & NE 8th)

Microsoft Traffic Analytics | Dashboard | Search | Alert History

← BellevueWay NE8th ▾ | 12/05/2017 | 12/12/2017 | [Calendar] [Car] [Bike] [Pedestrian]

1hr: Dec 12 7:00am - 8:00am



Export | Reset to 12/05/2017 - 12/12/2017

Traffic Analytics Dashboard (Overview)

Microsoft Traffic Analytics									
Dashboard									
Search									
Alert History									
12/05/2017		12/12/2017		Intersection		Alert type		All	
Alert	Alert Type	Intersection	Direction	Period					
High Traffic	Traffic Anomaly	116th NE12th	12thE WBR	12/05/2017 08:00 - 08:30					
Low Traffic	Traffic Anomaly	150th Newport	150thS NBL	12/05/2017 08:00 - 08:30					
Low Traffic	Traffic Anomaly	BellevueWay NE8th	BellevueWayS NBR	12/05/2017 08:15 - 08:30	8	28.3	71.7%		
Low Traffic	Traffic Anomaly	150th Newport	NewportW EBT	12/05/2017 08:15 - 08:30	5	19.4	74.2%		
High Traffic	Traffic Anomaly	150th Newport	NewportE WBL	12/05/2017 08:15 - 08:30	1	0	0.0%		
Low Traffic	Traffic Anomaly	150th Newport	150thS NBR	12/05/2017 08:15 - 08:30	2	9.2	78.3%		
Low Traffic	Traffic Anomaly	150th Newport	150thS NBL	12/05/2017 08:15 - 08:30	0	0.4	100.0%		
Low Traffic	Traffic Anomaly	116th NE12th	12thE WBR	12/05/2017 08:15 - 08:30	6	21.8	72.5%		
High Traffic	Traffic Anomaly	150th SE38th	150thS NBR	12/05/2017 08:15 - 08:30	8	4.8	66.7%		
Low Traffic	Traffic Anomaly	150th Newport	150thS NBR	12/05/2017 08:30 - 08:45	1	8.6	88.4%		
High Traffic	Traffic Anomaly	150th Newport	150thS NBL	12/05/2017 08:30 - 08:45	2	1	100.0%		
Low Traffic	Traffic Anomaly	150th Newport	150thS NBL	12/05/2017 08:45 - 09:00	0	1.8	100.0%		
Low Traffic Volume	Traffic Anomaly	150th SE38th		12/05/2017 09:00 - 09:15	305	761.5	59.9%		
Low Traffic	Traffic Anomaly	150th SE38th	38thW EBT	12/05/2017 09:00 - 09:15	7	24	70.8%		
Low Traffic	Traffic Anomaly	150th SE38th	38thE WBR	12/05/2017 09:00 - 09:15	6	23.8	74.8%		
Low Traffic	Traffic Anomaly	150th SE38th	38thE WBT	12/05/2017 09:00 - 09:15	2	7.2	72.2%		
Low Traffic	Traffic Anomaly	150th SE38th	38thE WBL	12/05/2017 09:00 - 09:15	7	27.2	74.3%		
Low Traffic	Traffic Anomaly	150th SE38th	150thN SBL	12/05/2017 09:00 - 09:15	7	31.2	77.6%		
High Traffic	Traffic Anomaly	BellevueWay NE8th	8thE WBR	12/05/2017 09:00 - 09:15	32	20.6	55.3%		

Information

Name	High Traffic
Type	Traffic Anomaly
Traffic type	Car
Threshold	0.5
Historical value options	Average of 15mins intervals, over previous 6 Weeks
Comparison method	Relative difference between latest and mean traffic
Directions aggregation	No aggregation - directions are handled independently

Enhancing Pedestrian & Bicycle Accuracy



Enhancing Pedestrian & Bicycle Accuracy

Synthia meets Physically-Based Rendering (Preliminary Results: Work in Progress)



November 2017

2017 Transportation Achievement Award for Safety



ite Institute of Transportation Engineers Inc.
1627 Eye Street, NW, Suite 600, Washington, DC 20008 USA | Tel: 202.785.0060 | Fax: 202.785.0609 | www.ite.org

Marianne Saglam
Communications and Media Senior Director
202.785.0060 ext. 123

NEWS

VIDEO ANALYTICS TOWARDS VISION ZERO PARTNERSHIP RECEIVES THE TRANSPORTATION ACHIEVEMENT AWARD FOR SAFETY FROM THE INSTITUTE OF TRANSPORTATION ENGINEERS

Toronto, ON, Canada— Video Analytics Towards Vision Zero Partnership, City of Bellevue, Washington USA received the Transportation Achievement Award for Safety at the Institute of Transportation Engineers (ITE) 2017 Annual Meeting & Exhibit, held July 30 – August 2, in Toronto, ON, Canada.

Consistent with its Vision Zero policies, the City of Bellevue, Washington is committed to generating better data on travel behavior, patterns, crashes, and conflicts and developing collaborations with others in the public and private sector to make our intersections smarter and safer. In recognition of the opportunities to enhance traffic operations and public safety, the City of Bellevue entered into a technology development partnership with Microsoft and the University of Washington.

The video analytics platform that was developed leverages cloud computing and machine learning systems to convert raw video footage from the City of Bellevue's existing camera network into useful data that can be searched, managed, and used to provide detailed information on traffic flow and allow a more rapid response to non-crash traffic conflicts.

The Transportation Achievement Awards are awarded annually for excellence in the advancement of transportation to meet human needs, by entities concerned with transportation such as governmental agencies, legislative bodies, consulting firms, industry, and other organizations. Awards are presented in the categories of planning, design, operations, and safety.

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