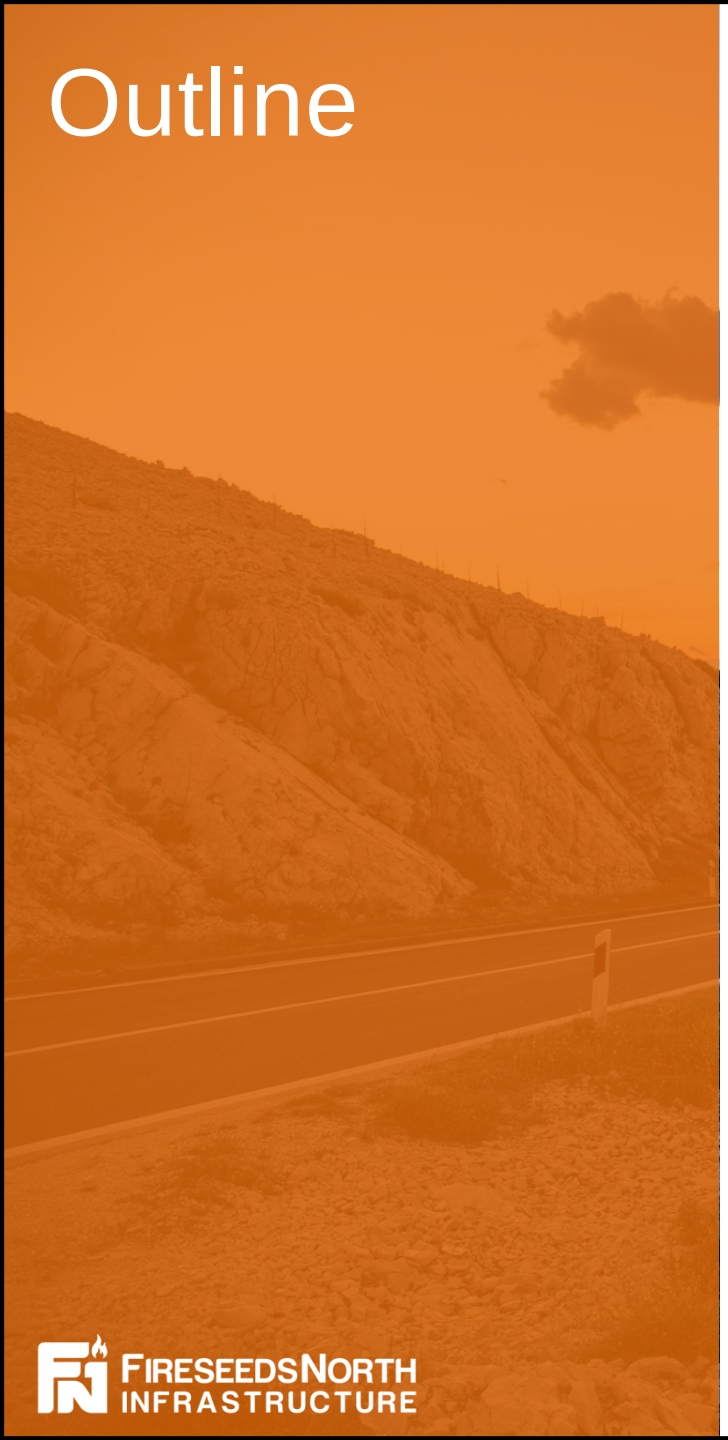
Development of a Safe System Indicator for Video Conflict Analysis Applications

CARSP Conference 2017

Outline



- Video Conflict Analysis
  - Background
  - Process
- The Safe System Approach
  - Key principles
  - Applications
- Safe System Pilot
  - Overview
  - Results

FIRESEEDSNORTH INFRASTRUCTURE

The Problem

Images source: qcostarica.com

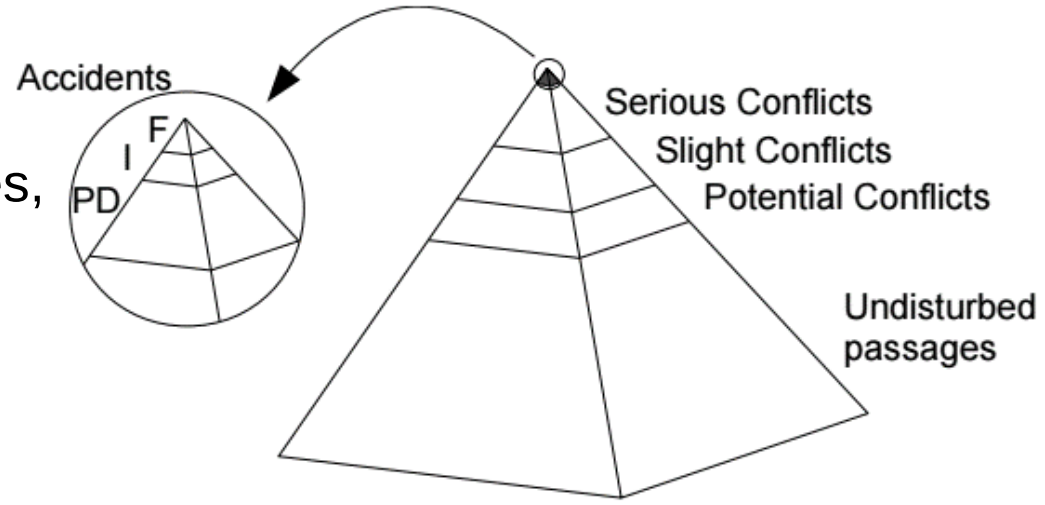
- Collisions are a leading cause of injury and death, and a major contributing factor to traffic congestion, delay and other economic losses.

- Collision data is the primary measure of road safety. However, our ability to make informed road safety decisions is limited by it's reactive and often incomplete nature.
  - Collisions (injuries and deaths) must occur before decisions can be taken
  - Underreporting and inaccurate reporting creates bias
  - Does not adequately capture driver behaviour and contributing factors

Solution: Surrogate safety science

Definition

Safety Surrogate: an event correlated to safety outcomes, which is easier to measure than the outcome.



Fatal crash = safety outcome

Right-angle near miss = safety surrogate

Takeaway

Using safety surrogate allows analysis that is more **rapid**, **proactive**, and **detailed** than conventional collision data analysis.

Solution: Video Conflict Analysis

- Software for automated analysis of conflicts between all road users types (vehicles, pedestrians, cyclists) on roads and intersections using video data.
- In Canada, R&D on VCA is active at several universities and many Canadian cities have applied or are planning to apply VCA.
- Fireseeds North is developing a VCA software that addresses critical gaps in current technology.


Video Conflict Analysis:
How does it work?

Video conflict analysis

Step 1A	Homography: a geometric procedure that uses coordinates to transform pixel space to real space	
Step 1B	Masking: an image overlay to focus the analysis	
Step 2	Feature tracking: frame-by-frame comparisons to identify small groups of pixels that are moving and exhibits some contrast to their surroundings	
Step 3	Object grouping: A heuristic algorithm brings together features based on speed, proximity, and share geometric edges. Objects may then be classified as vehicles, pedestrians, cyclists, etc.	

Video conflict analysis

Feature tracking:

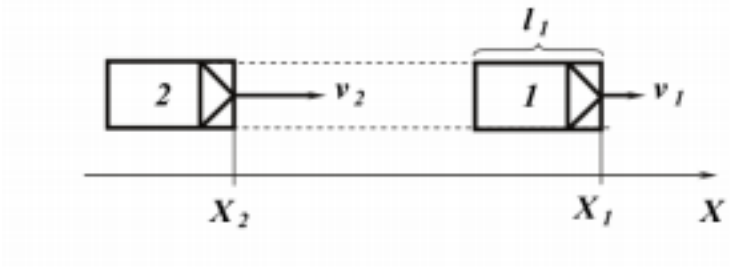
Video conflict analysis

Step 4 Object trajectory database: each object is recorded in the trajectory database for each frame that the object is present (along with the object's coordinates, speed, and orientation)

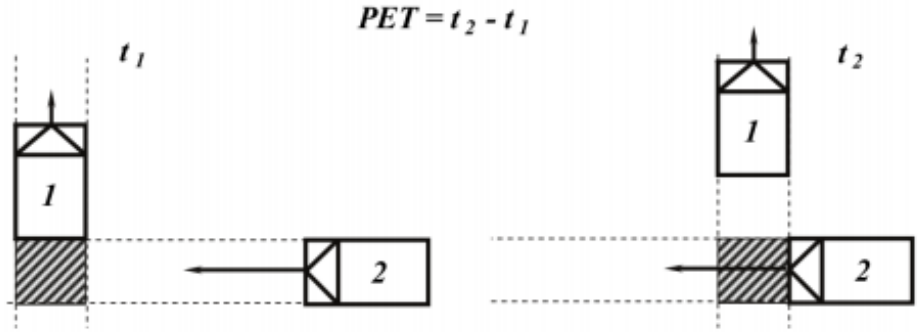
Trajectory ID	Frame Number	X Coordinate	Y Coordinate
5	789	129.940	22.312
5	790	132.829	23.016
5	791	135.011	23.894
5	792	137.467	24.581
5	793	139.506	25.201
5	794	141.627	25.948
6	922	54.192	44.123
6	923	57.492	43.019
6	924	60.801	42.980
6	925	64.023	41.833
6	926	67.756	40.752
6	927	70.201	39.633

Video conflict analysis

Step 5 Analyze database for conflicts: by applying algorithms to the database, we can produce a host of near-miss indicators with endless possibilities.



Time-to-collision (TTC): At current closing speed, how much time remains until a collision occurs?

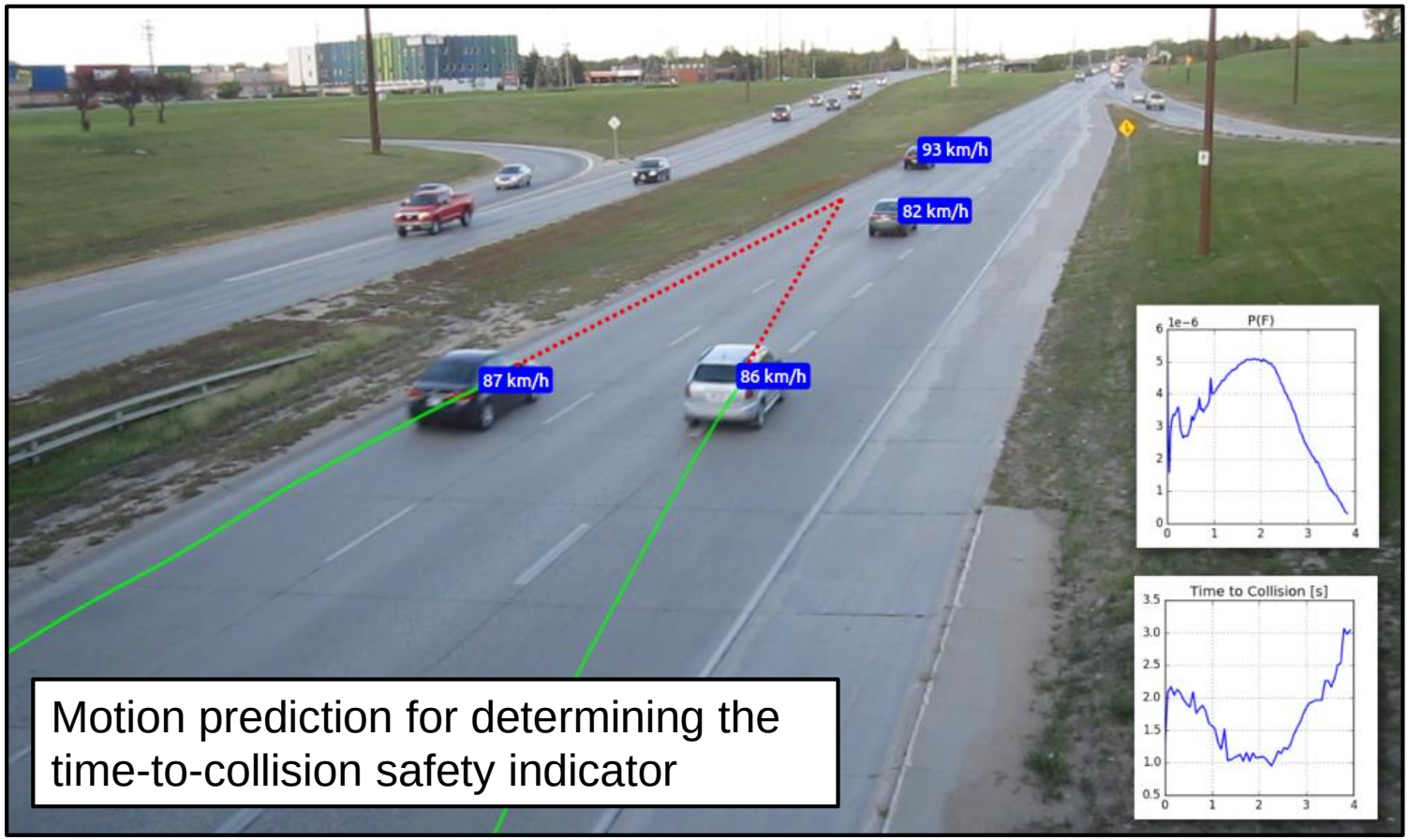


Gap time: how much time elapses after Vehicle 1 leaves the encroachment zone before Vehicle 2 enters the zone?

Other indicators: collision course angle, velocity angle, distance/proximity, speed differential, collision probability

Step 5 Illustration

Time-to-collision (TTC) is calculated for each frame, with the most severe value (shortest time) recorded for each interaction:



Motion prediction for determining the time-to-collision safety indicator


The Safe System
Approach

The Safe System Approach

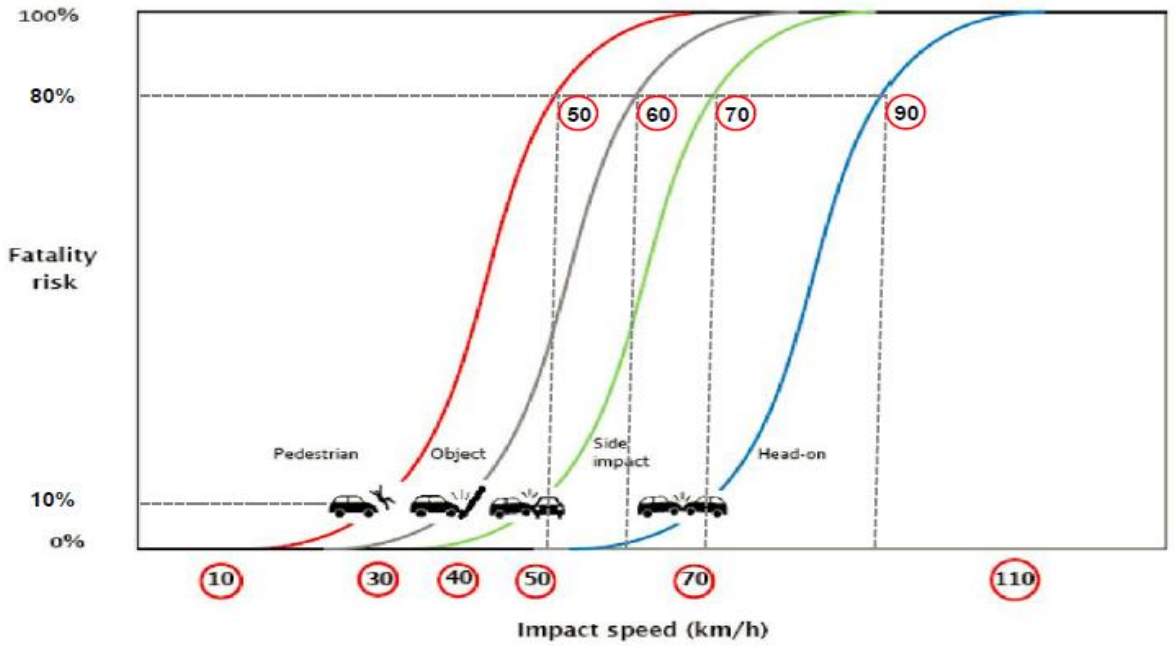
The Safe System approach aims for a more forgiving road network that factors human fallibility and vulnerability into consideration. Under a Safe System the whole transport system is designed to protect people from death and serious injury.

- **We accept that:**
  - **People make mistakes** - We need to consider that humans make mistakes and some crashes are inevitable.
  - **People are vulnerable** - Human bodies have a limited ability to withstand forces from collisions without being seriously injured or killed.
  - **We need to share responsibility** - Those who help create the road system and those who use the roads must both share responsibility for creating a road system in which crash forces don't lead to death or serious injury.
  - **We need to strengthen all parts of the system** - We need to improve the safety of all components of the system - roads and roadsides, speeds, vehicle components, and the use of roads - so that if one part fails, other parts will continue to protect the people within the system.

Under the Safe System approach, all system designers must bear responsibility for road safety outcomes. System designers are made up of engineers, policy makers, enforcement officers, vehicles manufacturers, planners, the media, parents and more.

Safe System - Human Tolerances to Physical Forces

- < 30-50 km/h pedestrians, cyclists
- < 50-70 km/h vehicle occupants in side impact crashes
- < 70-90 km/h vehicle occupants in head on crashes



Source: C06 Road Safety Audit, IRF Certified Road Safety Training, Doha, Qatar, April 3-6, 2017.

Safe System PET indicator

Safe System PET Indicator Applications

Conflict	Gaps < 1.5 s	Gap < 1.5s + Impact > 60km/h	...	Risk Prediction
EBT vs SBT	45 (36%)	45 (36%)	...	High
EBT vs NBT	4 (3%)	0 (0%)	...	Low
WBT vs SBT	14 (20%)	8 (11%)	...	Medium
...	...	...	...	...

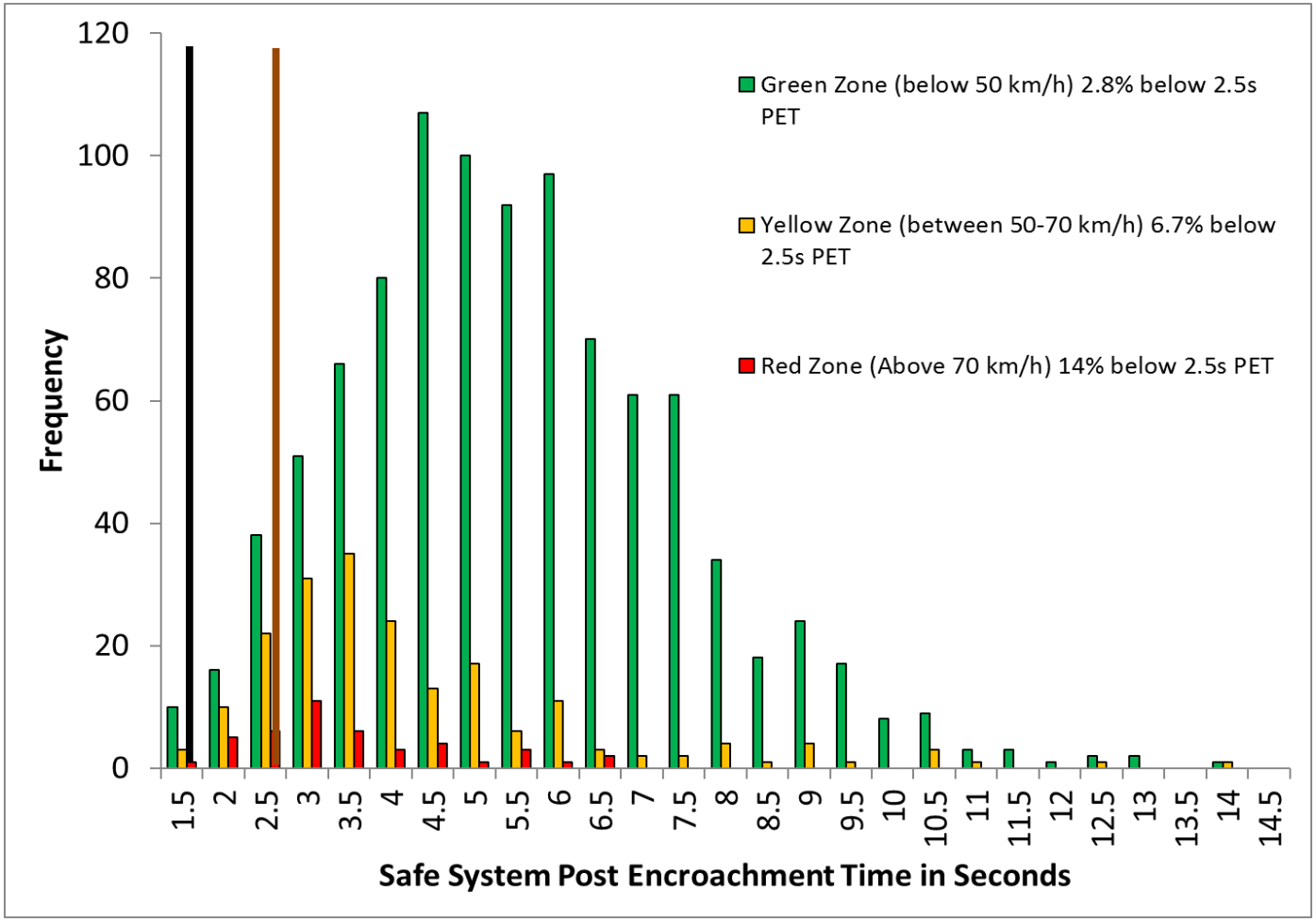

Safe System Pilot
Project

Pilot Overview

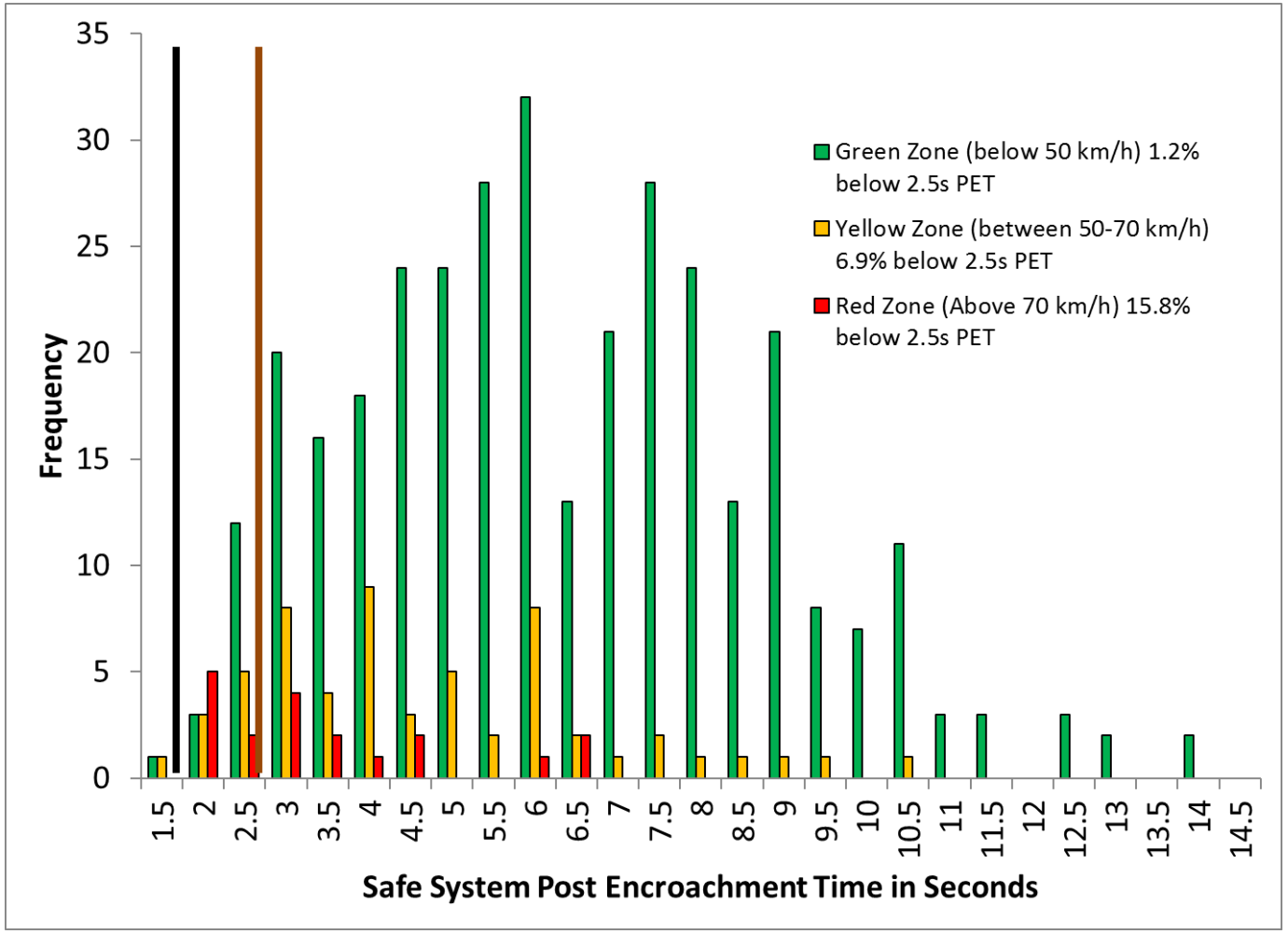
- Focus of the pilot was on Left-turn across path (LTAP) interactions at an urban intersection.
- Approximately 1200 LTAP interactions were tracked over an 8-hour period.
- PETs below 2.5s were considered risky at this intersection.
- 3 speeds zones were evaluated
  - Green Speed Zone : interaction speed below 50km/h
  - Yellow Speed Zone: interaction speed between 50-70km/h
  - Red Speed Zone: interaction speed above 70 km/h

The fatality risk is lower than 10% for the green speed zone and greater than 80% for the red speed zone.

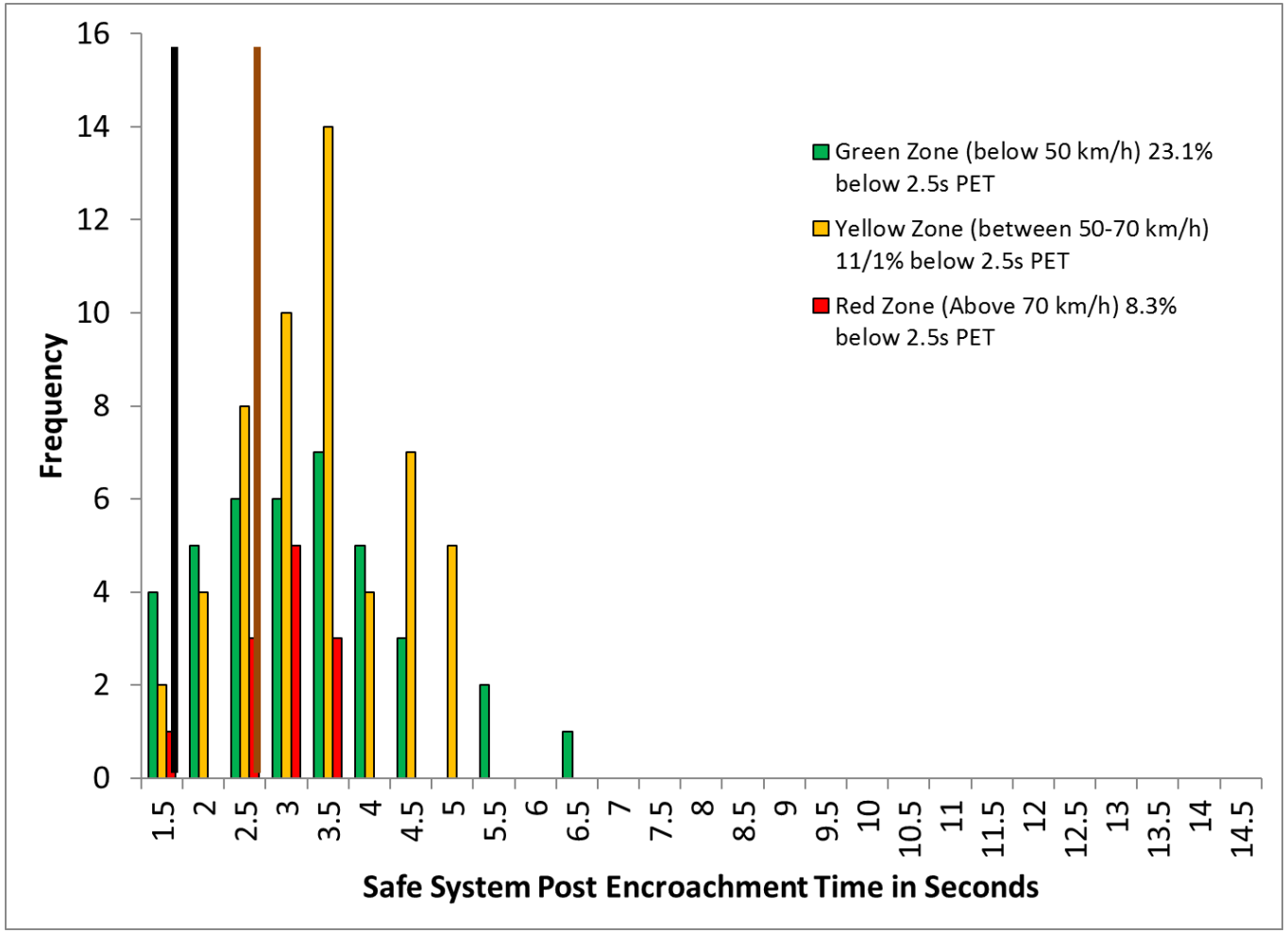
Intersection Left - Safe System PET



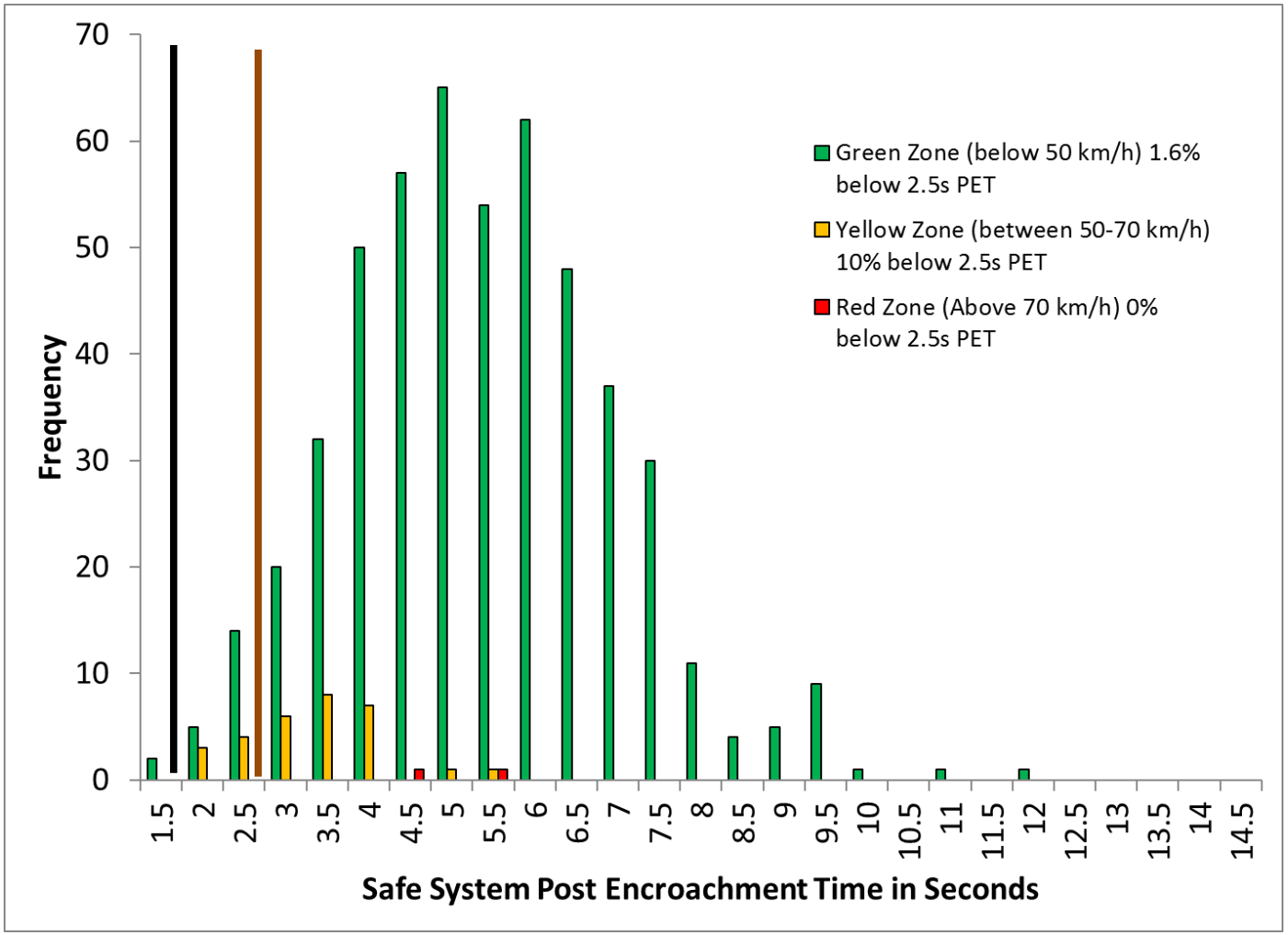
Westbound Left - Safe System PET



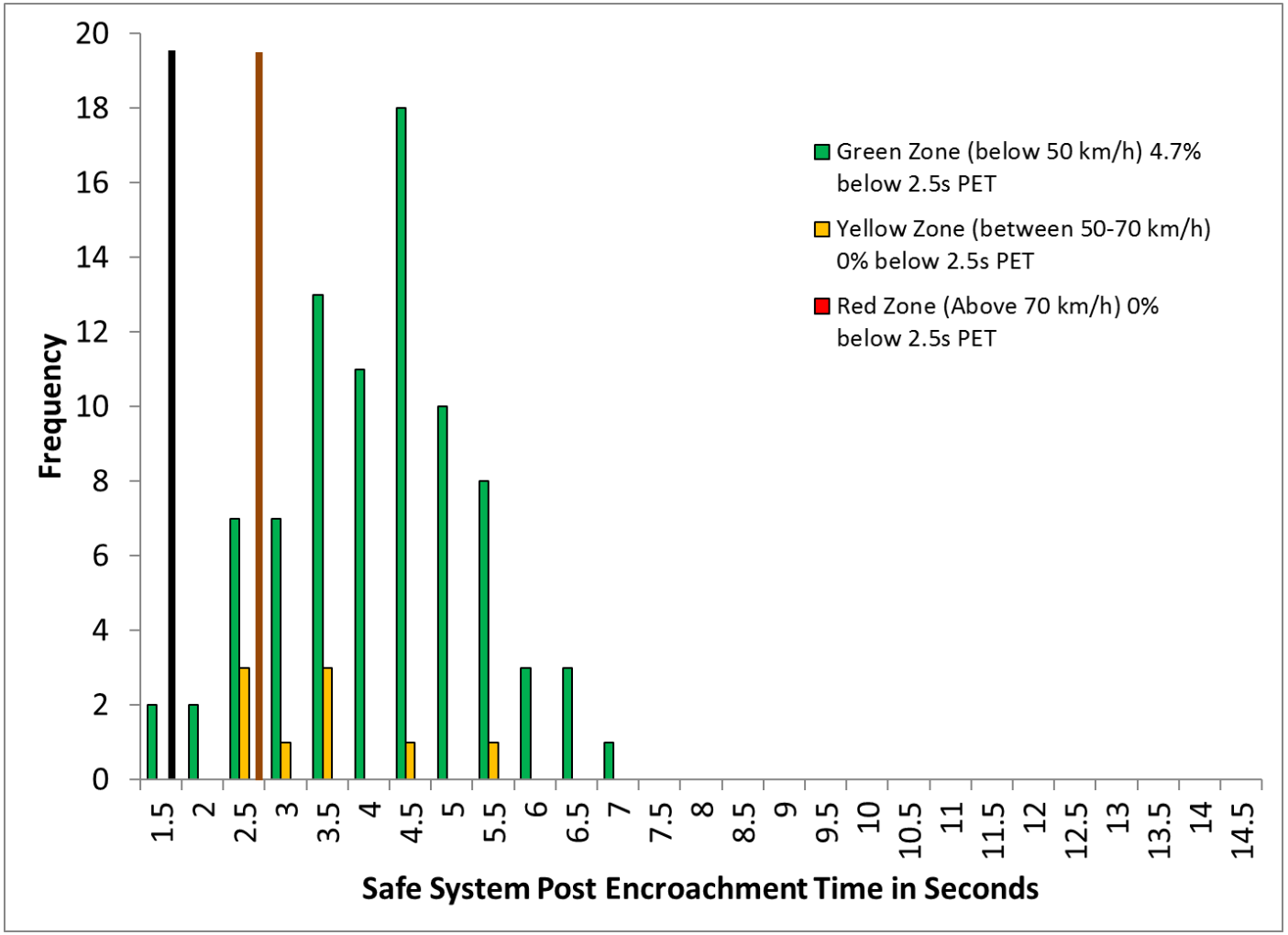
Eastbound Left - Safe System PET



Northbound Left - Safe System PET



Southbound Left - Safe System PET




Conclusions

Long-term vision for sustainable safety: towards zero

- Long term goal is to eliminate deaths and injuries
- Safe System approach is a new way of responding to fatal and serious crashes
- Safe System approach requires strong government leadership at all levels and the inclusion of a broad range of partners and stakeholders
- Video Conflict Analysis is a tool that can play a crucial role in the evaluation of
  - Diagnosing Safety conflicts
  - Developing Safe System countermeasures
  - Evaluating Safe System applications

Thank You!

Questions?

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