ITS TIME

Viability of Real Time Prediction and Prevention of Traffic Crashes: How can we prevent traffic crashes in real-time?

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Freeway Traffic Management

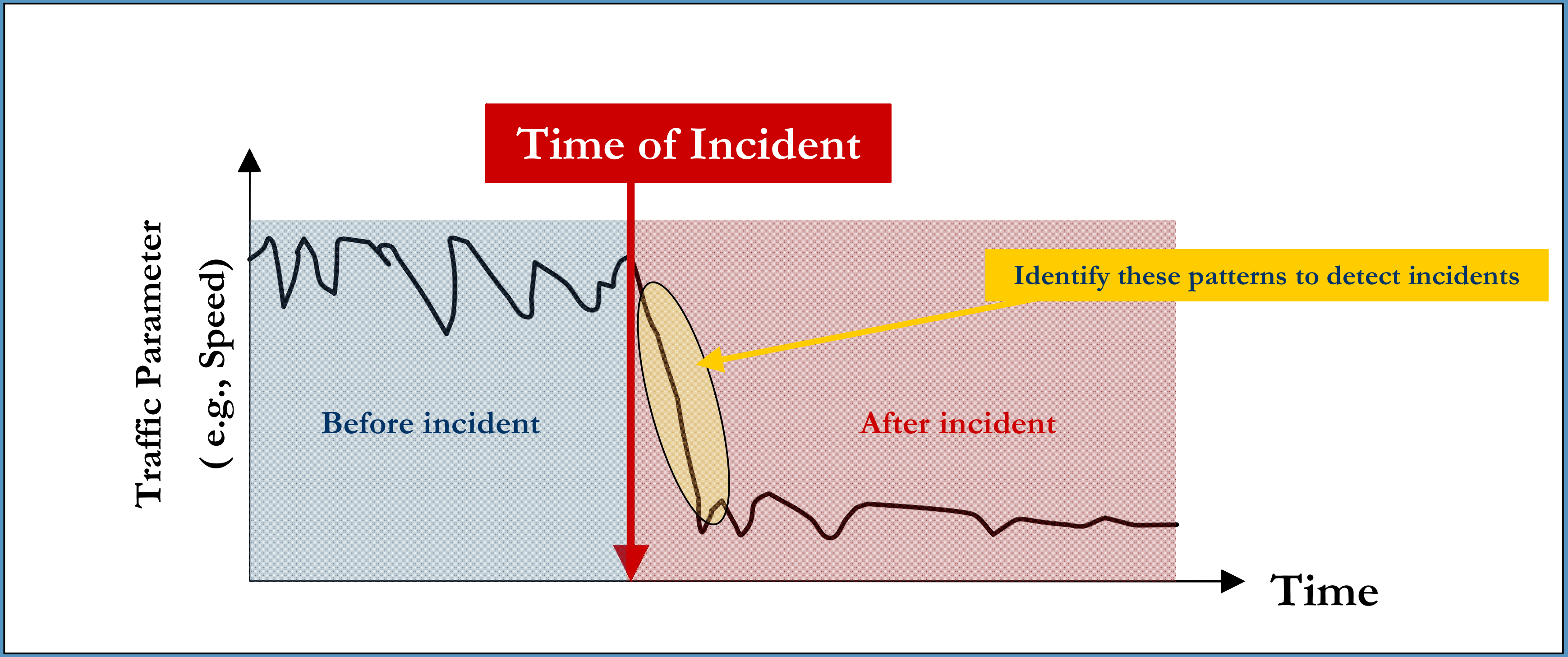
- Objective of freeway traffic management is to monitor and mitigate ***recurring*** (during peak hours) and ***non-recurring*** congestion (from incidents, weather etc.)

- Traffic management authorities rely on traffic surveillance apparatus (e.g., *loop detectors*, video cameras) to monitor freeway traffic conditions

- Loop detectors provide speed, volume, and lane-occupancy for very short durations

- Incident detection algorithms have been one of the most investigated research areas

The idea of Incident Detection



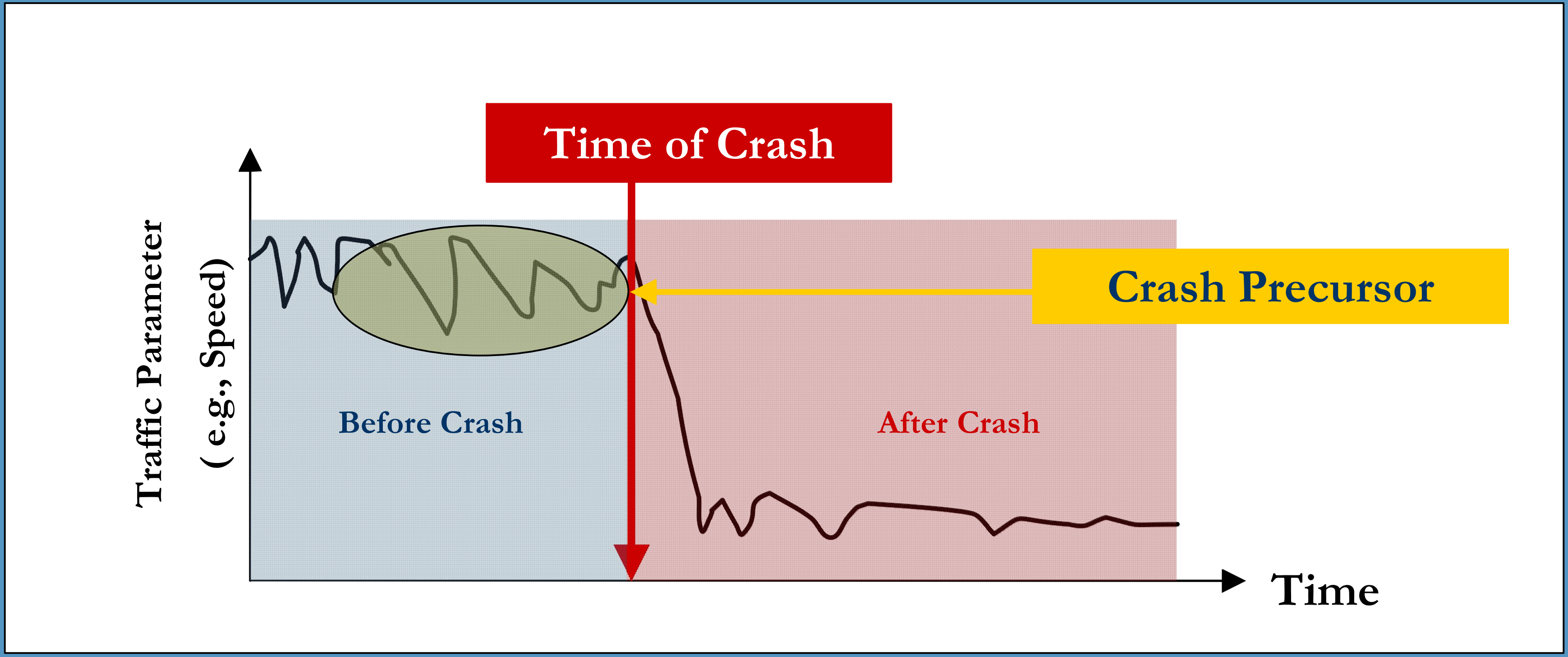
Drop in speed at upstream detector following an incident

Incident Detection Algorithms and Cell Phone Usage

- Cellular phone based incident reporting, combined with CCTV based verification, is generally the most efficient method for detection (FHWA, 2000)
- Automated incident detection algorithms are available but not widely used; Even back in the year 1999, close to 80% of the incidents in Seattle metropolitan area were being detected using cell phones
- Hence, some of the more recent research has been directed towards assessing the likelihood of incidents ***before*** they occur instead of ***detecting them after*** they occur

Traffic Patterns of Interest

Traffic flow parameters observed before the crash



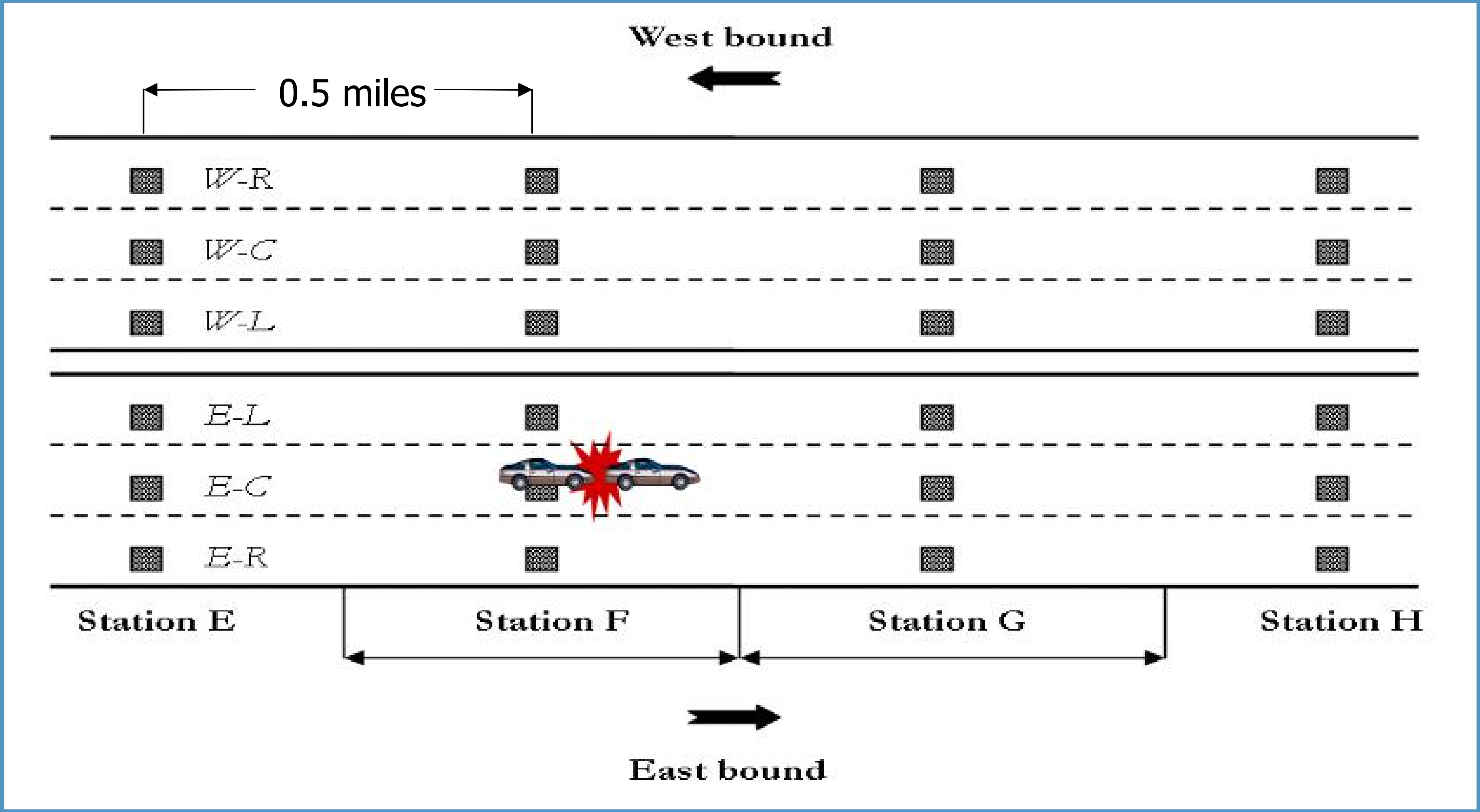
Proactive Approach

- **Our approach is comparative in nature by comparing crashes with a sample of non-crash cases**

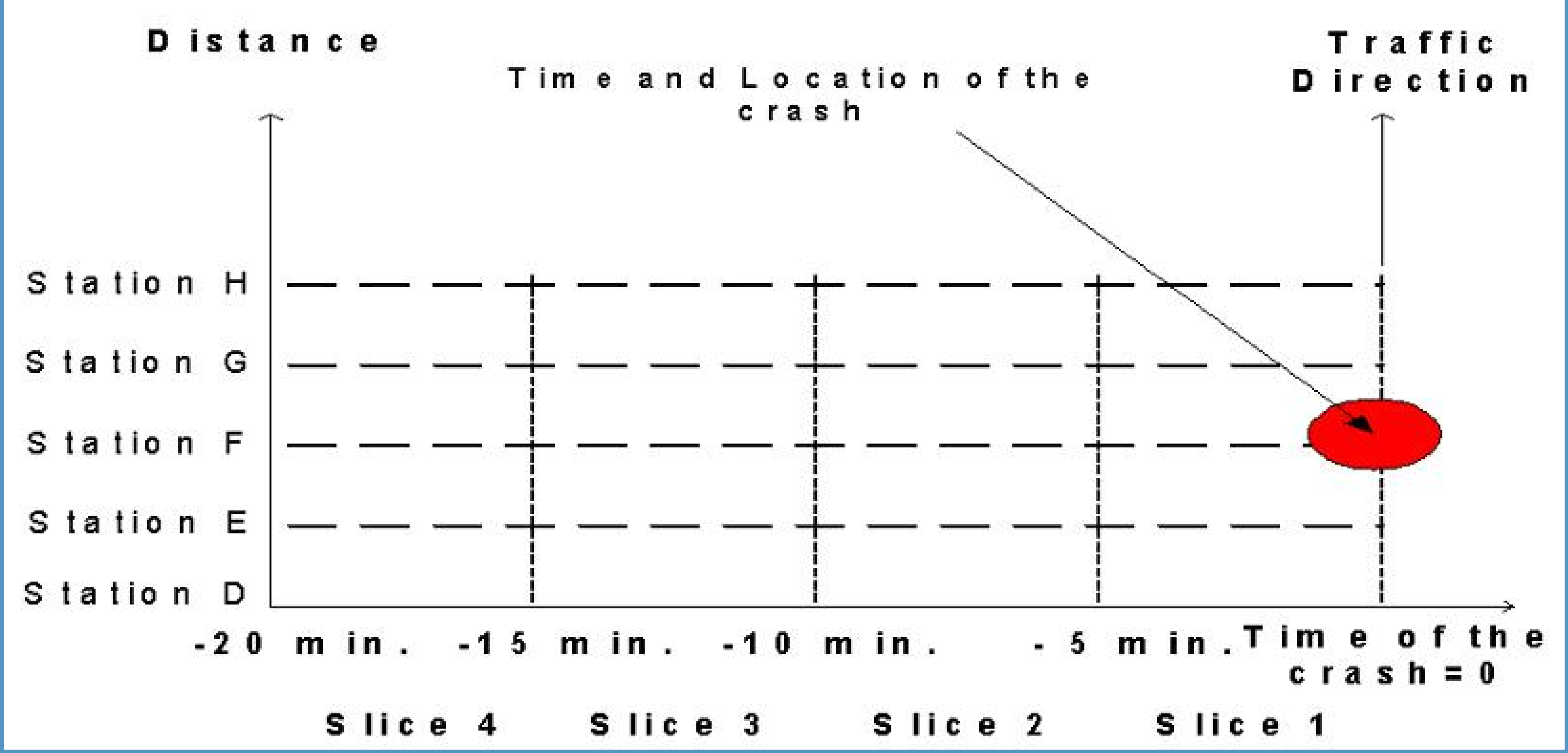
- **Are Crash Prone Traffic Conditions Discernible from “Normal” Traffic?**

Data Sources

Loop detectors on the Interstate-4 corridor



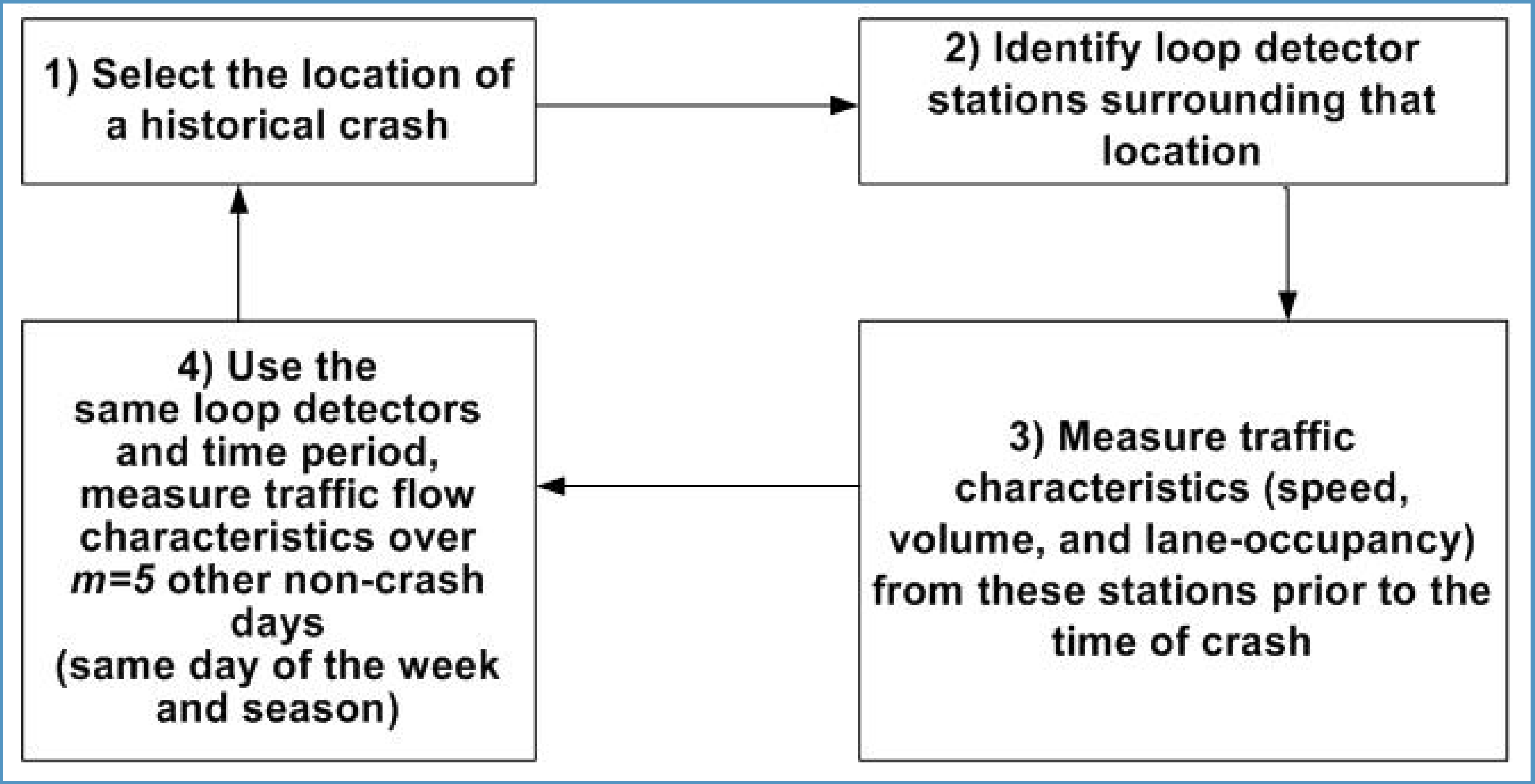
Input Traffic Parameters



Calculate 5-minute average, standard deviation, and coefficient of variation from 30-second raw speed, volume, and lane-occupancy values

Sampling Non-crash Conditions: Matched Sampling Procedure

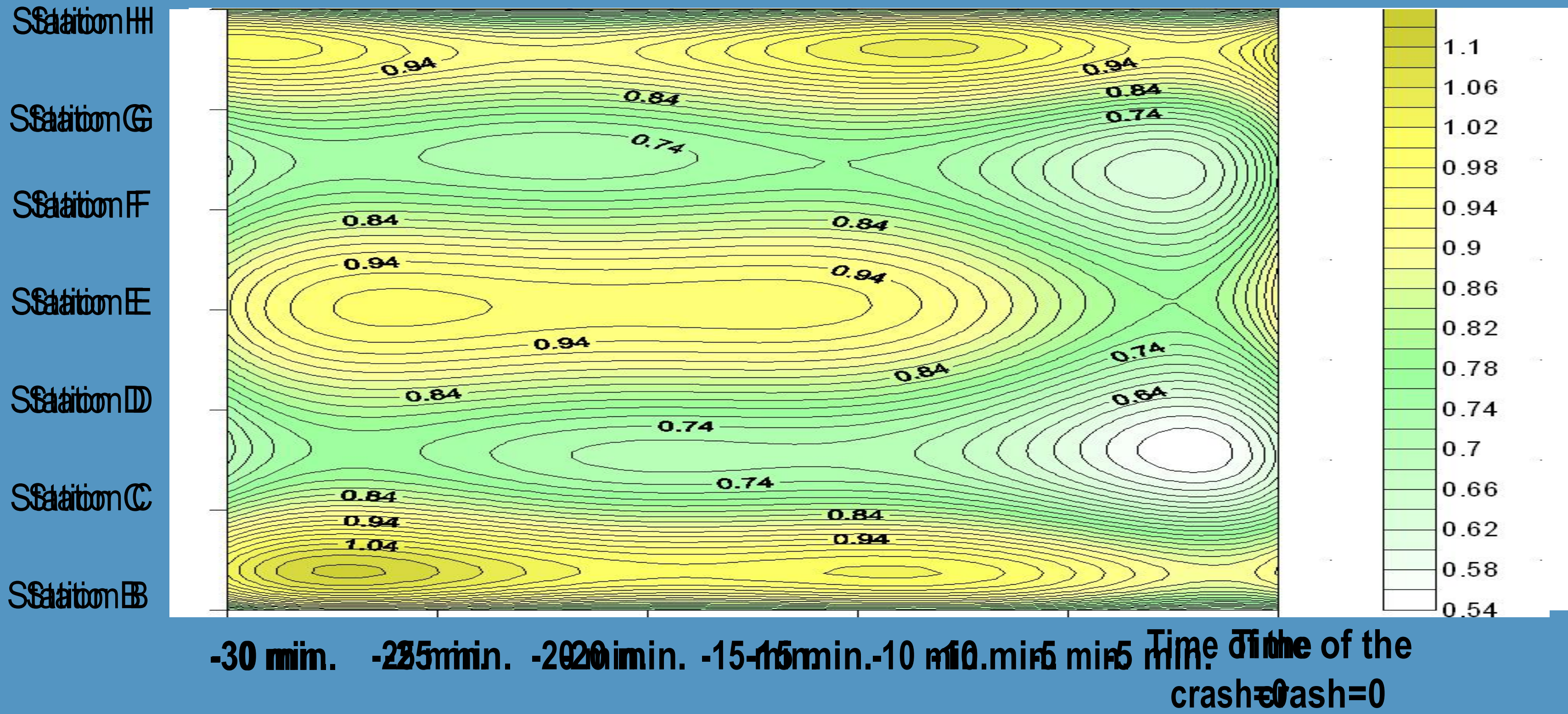
Four-step procedure (Epidemiological Studies)



Simple logistic regression models

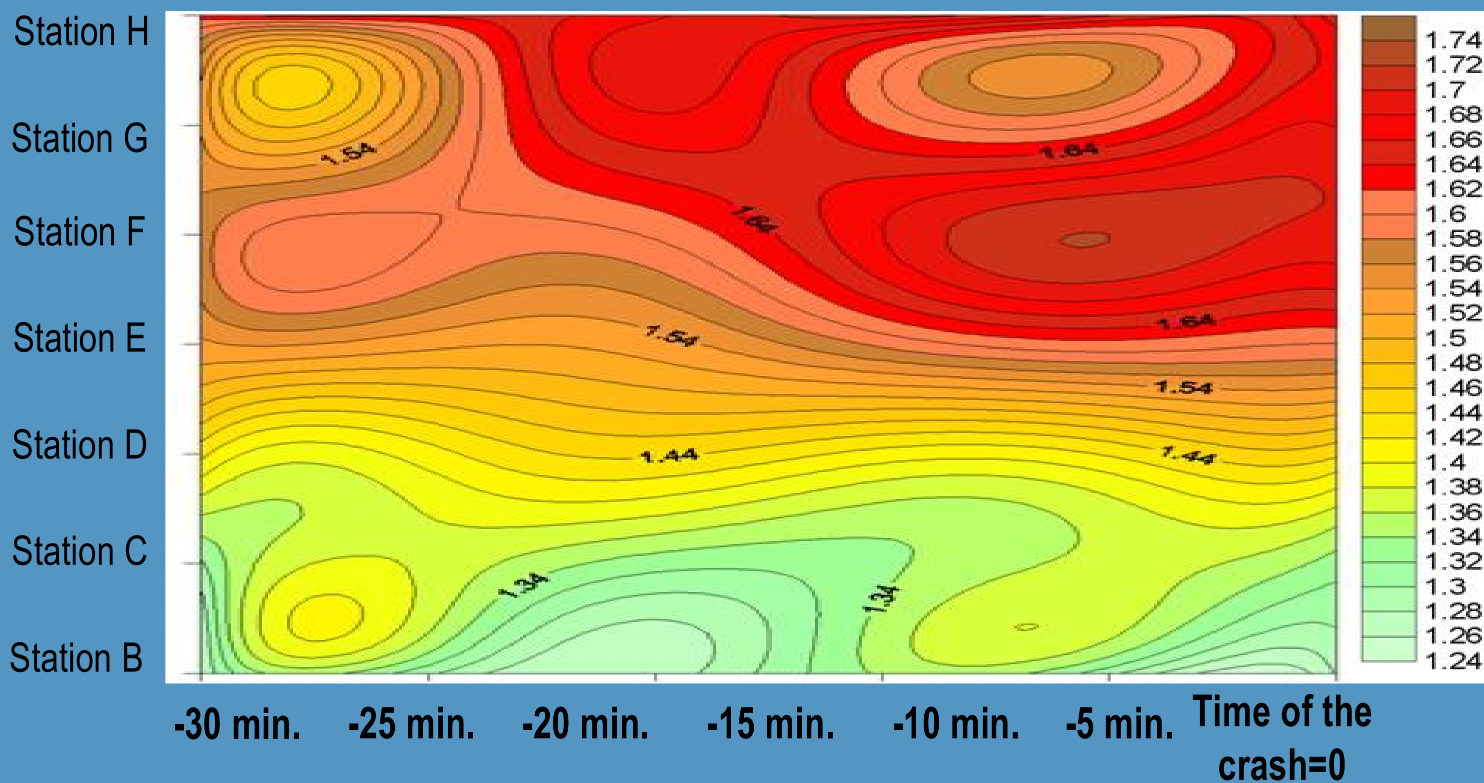
- Estimate a series of simple (one covariate) models for all different parameters
- Average, standard deviation, and coefficient of variation for speed, volume, and occupancy from all surrounding stations
- 7 stations (B through H) and 6 time-slices(1/2 hour period)
- Coefficient of Variation of Speed was one of the most significant parameters
- Models for 7*6=42 coefficients of variation of speed had the most significant impact on crash risk

Hazard Ratio Contour Plot (Coefficient of variation in Speed)



Contour plots of hazard ratios corresponding to coefficient of variation in speed (42 model outputs)

Hazard Ratio Contour Plot (Average Occupancy)



Contour plots of hazard ratios corresponding to average occupancy (42 model outputs)

Disaggregate Analysis of Crashes by Type

- The next step was to compare following specific groups of crashes with the non-crash cases:
    - Low-speed rear-end crashes
    - Medium-to-high speed rear-end crashes
    - Lane-change related crashes

- These specific groups of crashes were separately compared to a random sample of non-crash cases

- The output of the models was a continuous measure of crash risk (different for each of the three groups), namely, posterior probability; 0<Posterior Probability<1

Significant Parameters Associated with Crashes

- Presence of a ***downstream on-ramp*** and ***high temporal variation in speed*** are significantly associated with **low-speed rear-end crashes**
- Presence of a ***downstream on-ramp*** and ***speed differential between upstream and downstream stations*** was critical for **medium-to-high speed rear-end crashes**
- ***Lane-occupancy differential across adjacent lanes*** was a significant parameter for **lane-change related crashes**

Classification Accuracy

- Rear-end Crash Models
  - The implementation strategy can identify about *75% of the rear-end crashes*
- Lane change related Crashes
  - Similarly, about *57% of the lane-change related crashes* could be identified with this approach
- The output can also be used to compare freeway locations in real-time for their crash potential

Applications of the Framework

- Issue warnings to the motorists through Dynamic Message Signs (DMS) based on a observed measure of risk

- Application of existing traffic management strategies with objective of reduction in real-time crash risk, e.g., *Variable Speed Limits* (VSL), *Ramp Metering* (RM), and *Route Diversion (RD) using DMS*

- These strategies may be evaluated by building and validating the Interstate-4 corridor in a micro-simulation package (e.g., PARAMICS) and comparing the risk estimates for the base case (No ITS strategies) with risk estimates for the cases with ITS strategies

Evaluation Results

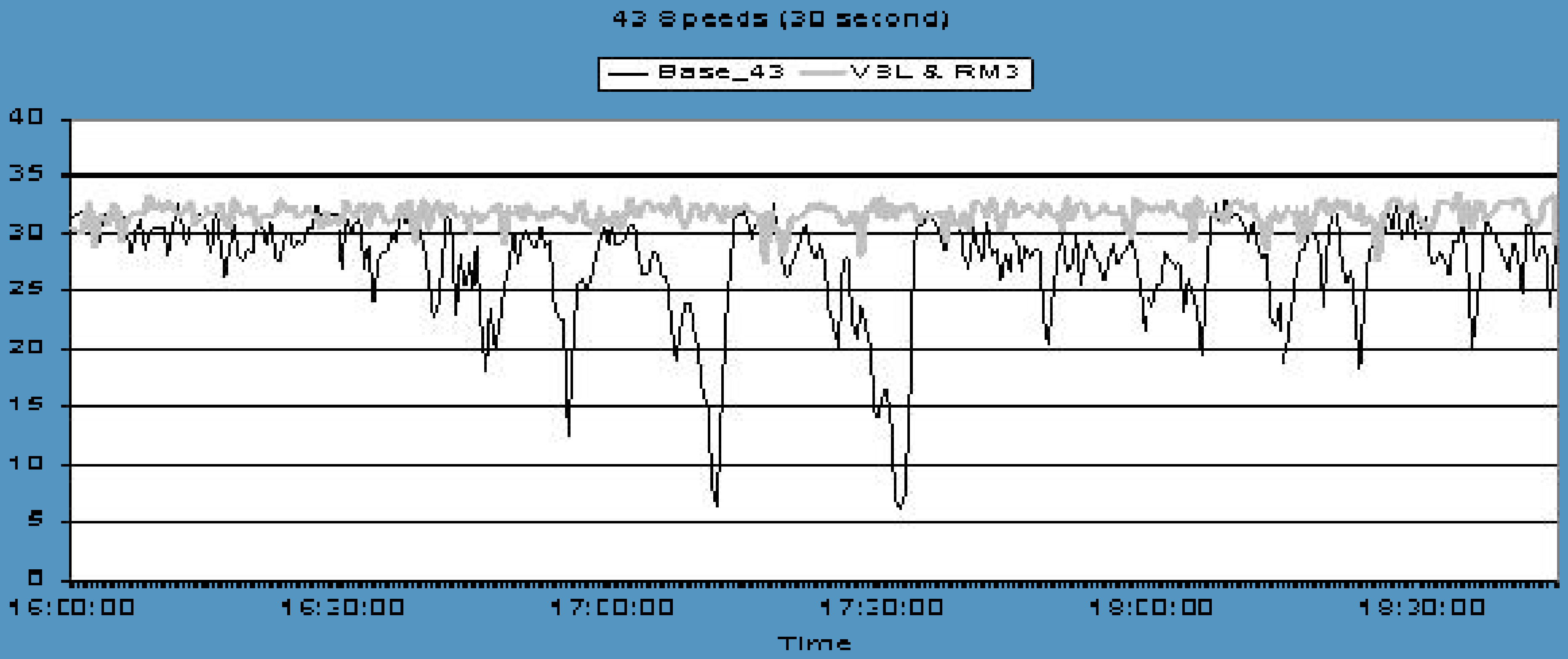
- Under low-speed conditions Ramp Metering is more effective while at medium-to-high speeds Variable Speed Limit was found to more effective in reducing the measure of crash risk

- Route Diversion should be applied under medium to high speed conditions

- Route Diversion at high network loading scenarios (low-speed conditions) causes increased travel times, over-saturation of on-ramps, and increased crash risk

- Crash risk migration phenomenon

Evaluation Results: Sample Speed Profiles



Stabilization in 30-second speeds following ITS strategies implementation

Micro-simulation Application

Video

Conclusions

- The research indicates that traffic safety may be related with the operational conditions on the uninterrupted flow facilities and that *inconsistency in traffic flow* may be considered as a factor for crash causation

- *Drivers' response* to the crash prevention strategies; Is it too much information?

- *Transferability issues* were recently investigated with data from five freeways in the Netherlands

Conclusions from Preliminary Analysis of Dutch Data

- Factors such as speed variation were significantly related with real-time crash risk indicating that traffic flow “inconsistency” may be a factor for crash causation on the Dutch Freeways as well

- In the Netherlands en-route information delivery system is quite advanced compared to the freeways in FL. Therefore, the implementation of proactive traffic management strategies may be easier to achieve

- Human factors relevant to drivers’ reaction to these strategies still need to be considered