



Design and Testing of a Decision Support System for Deploying Weather Responsive Traffic Signal Operations in Texas

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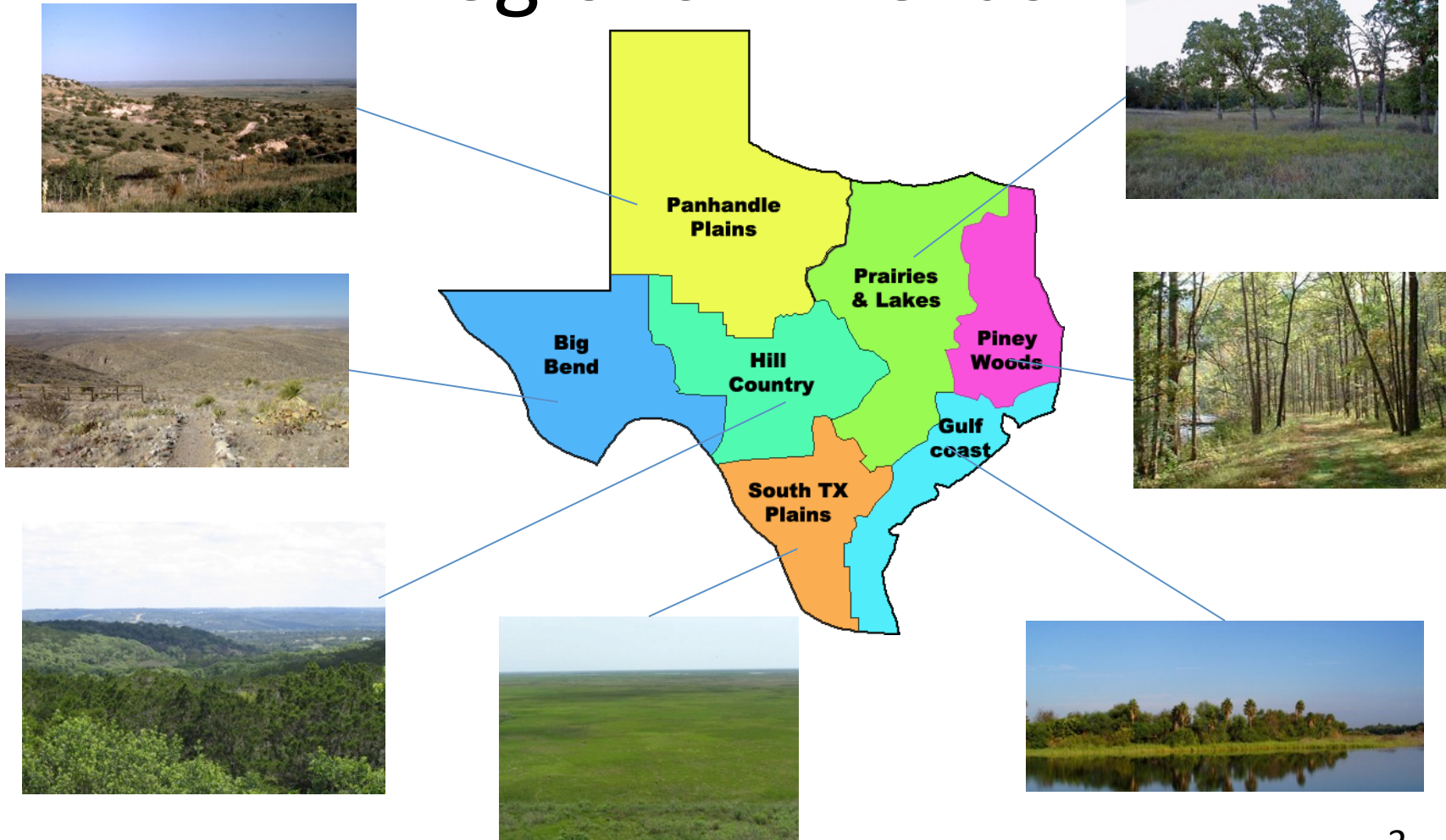
Fort Collins, CO
April 30th, 2016



Your Image of Texas?

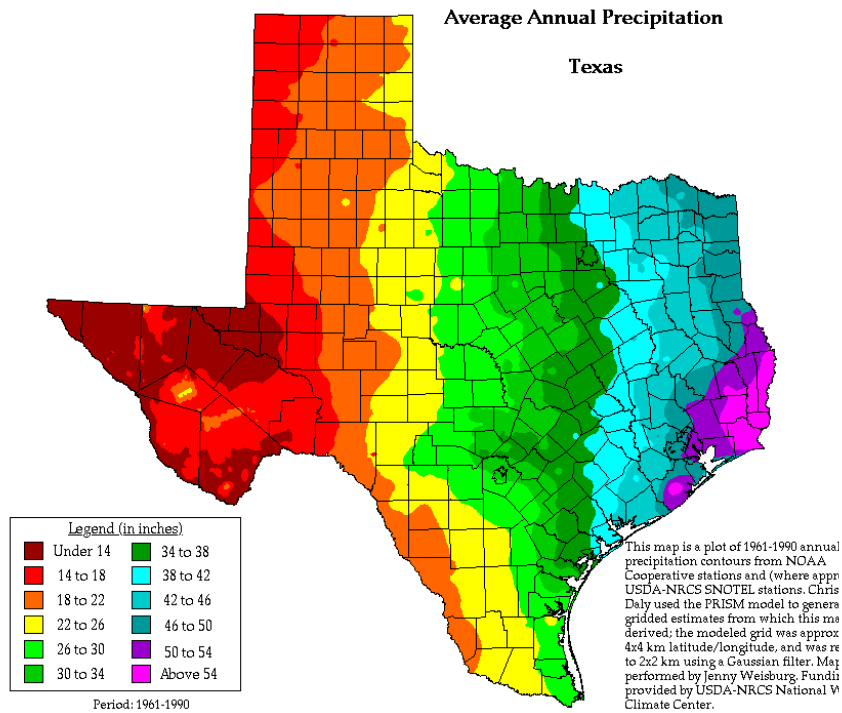


Regions in Texas

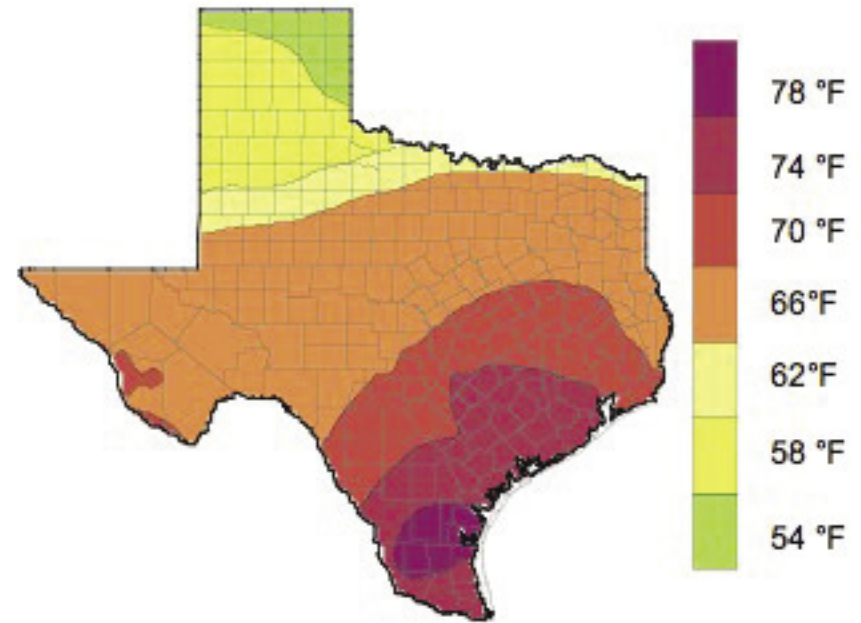




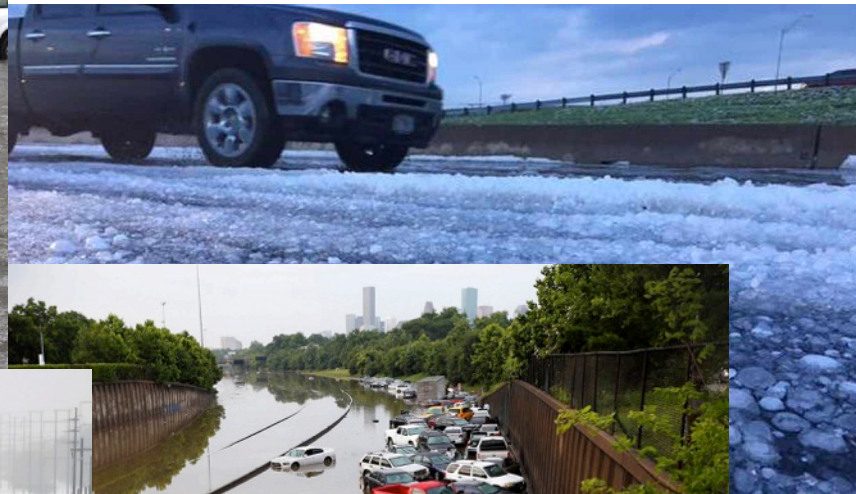
Average Annual Precipitation



Mean Annual Temperature



Recent Texas Weather Events



“If you don’t like the weather in Texas, wait a few hours – it’ll change!”



Motivation for Project

- US Crashes*
 - 22% of all vehicle crashes are weather-related
 - 73% of weather-related collisions occur on wet pavement, 46% during rainfall
- Crashes on Texas Highways**
 - 9% of all fatalities and 10% of all crashes occurred during inclement weather conditions
 - 11% of fatalities and 15% of all crashes occurred when pavement conditions “poor” due to weather

*Source: Ten-year averages from 2004 to 2013 analyzed by Booz Allen Hamilton, based on NHTSA data

**Texas Motor Vehicle Crash Statistics 2014, Texas Department of Transportation (<http://www.txdot.gov/government/enforcement/annual-summary.html>)

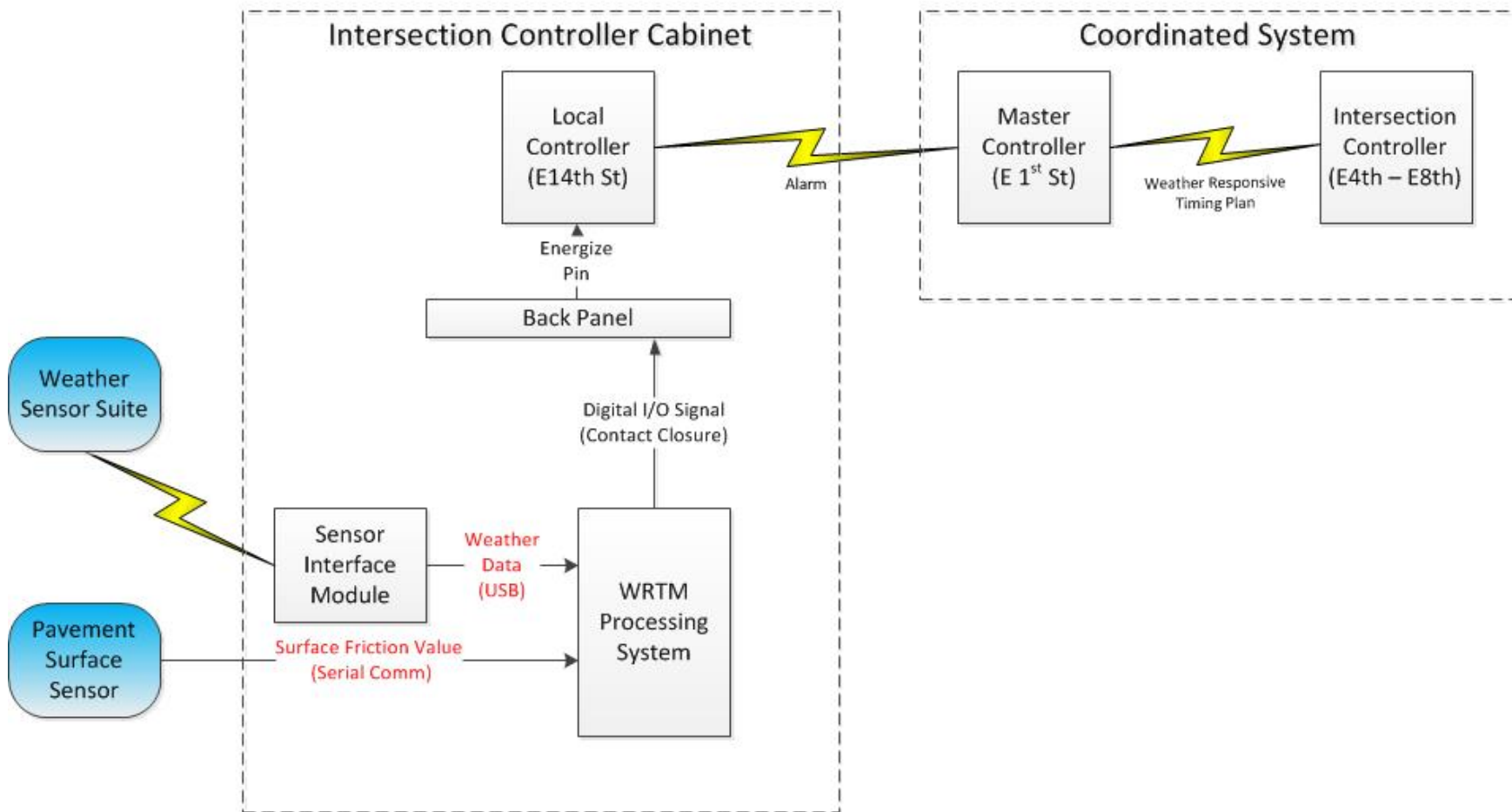


Project Goals and Objectives

- Quantify impacts of weather on traffic signal operations
- Identify appropriate weather responsive traffic management (WRTM) strategies for signals
- Establish criteria and architecture for deploying WRTM
- Update *Traffic Signal Operations Handbook*
- Develop and pilot test training course



General System Architecture



Weather Station

- Davis Instruments
- Wireless Integrated Sensor Suite
 - Rain collector
 - Temperature/humidity sensor
 - Anemometer
 - Wind vane
 - Solar panel/battery backup
- Sensor Interface Module
- Data Logger
- Costs: \$1,000



Pavement Surface Sensor

- Non-intrusive pavement sensor
- Detects
 - Surface ice, snow, and water
 - Surface states
 - Surface Grip – relative scale of “grip” state from 100 (best) to 0 (worst)
- Wired or wireless applications
- Cost: \$15,000



Visibility Sensor

- Detects
 - Visibility Distance
 - Visibility “State”
- Classify visibility as “acceptable” or “poor”
- Costs: \$7,000



WRTM Processing Unit

- Industrial computer
- 10" x 6.0" x 2.7"
- Functions
 - Collects weather data
 - Monitors pavement and visibility sensor inputs
 - Recommend plan change
 - Stores evaluation data
 - Issues weather alerts
- Cellular communications
- Cost: \$2,000





Decision Support System

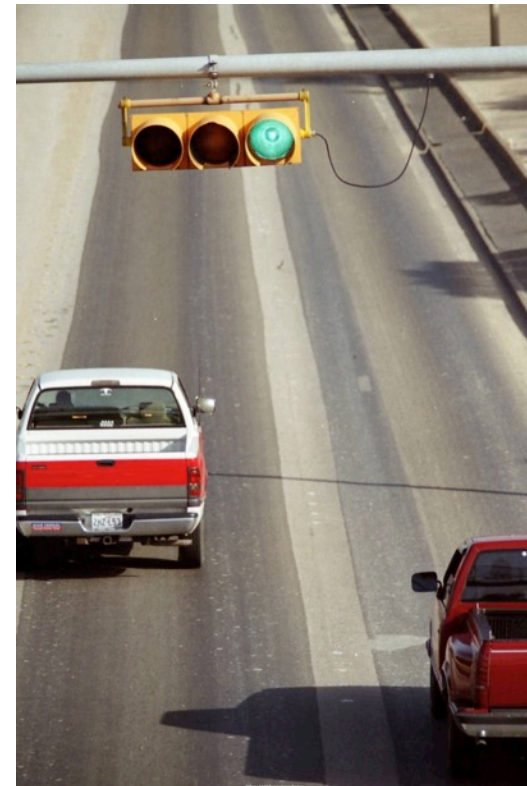
- Implement strategies stored in plan library
- Use special function
- New plans based on reduced speeds

Visibility	Surface Condition		
	Good	Marginal	Poor
Acceptable	Normal	Normal	Plan 1
Poor	Plan 1	Plan 2	Plan 3

Plan 1	Plan 2	Plan 3
<ul style="list-style-type: none"> • Coordination Plan • Phase Recalls • Min Green Increases 	<ul style="list-style-type: none"> • Coordination Plan • Red Extension • Phase Recalls 	<ul style="list-style-type: none"> • Red Extension • Phase Recalls • Truck Extension

Weather Responsive Traffic Signal Timing Strategies

- Adjustments to signal change intervals
 - Red Extension
- Changes in phase durations
 - Increase Minimum Greens
 - Phase Recalls
- New coordination plans
- Special operations plans



Red Extension

- Extend red clearance interval by 1 to 2 second
- Provide additional margin of clearance during poor pavement conditions
- Depending upon approach speed
- May require additional detection zones
- Already supported by some controllers



Increase Minimum Green Times

- Increase minimum greens
 - due to reduction in start-up loss times
 - slower accelerations
- Possible only with some NTCIP controller



Implement Phase Recalls

- Max and/or Min recalls
- Guarantees phases are serviced
- Provides consistency in operations
- Example: Fog





Coordination Plan Changes

- New coordination plans during weather event
- Used Synchro to investigate different Cycle/Split/Offset combinations
- Existing Cycle Length/Existing Splits
 - Existing offset
 - Optimized offset
 - Existing Cycle Length/"Max" Recall on cross-streets
- Optimized Cycle Length
 - Offsets for slower speeds





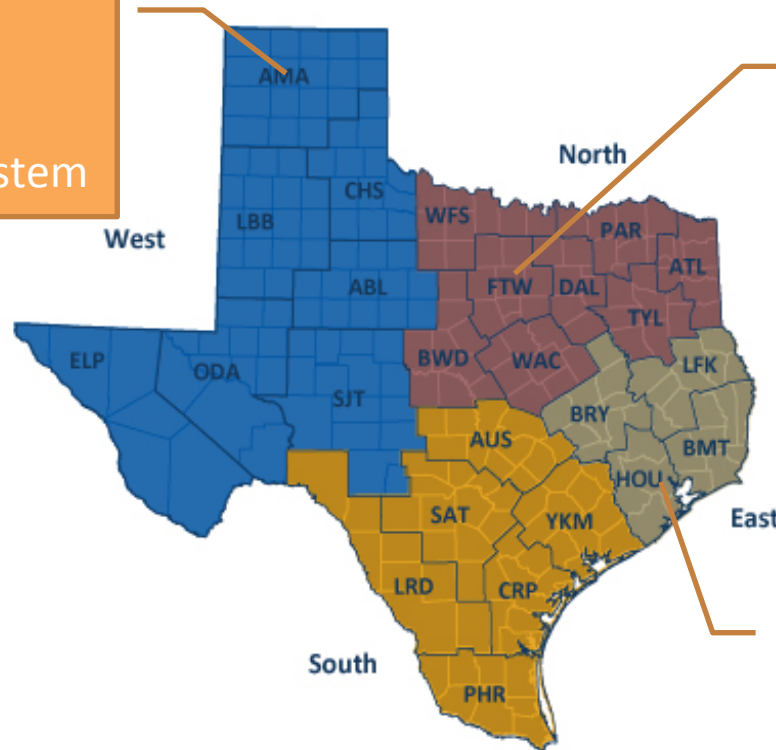
Truck “Extension” During Bad Weather

- Add truck detector
- Place “Hold” on main-street green, if
 - Detected vehicle is truck
 - Pavement conditions “bad”
 - Limit number of Holds per cycle
- Allows truck to travel through indecision zone (2 secs from intersection)
- May require additional equipment to be installed



Evaluation Test Sites

Roadway: US 287
Location: Dumas
Weather: Ice, Snow
Signals: Isolated/System



Roadway: SH 174
Location: Burleson
Weather: Rain, Ice
Signals: System

Roadway: SH 146
Location: Clear Lake City
Weather: Rain, Fog
Signals: System



Performance Evaluation

- Operational Objective – provide similar level of performance during inclement weather as in normal conditions
- Output
 - Number of weather activations
 - Duration of activations
- Outcome
 - Travel times / travel speeds
 - Number of stops
 - Throughput
 - Weather-related collisions



Issues and Lessons Learned

- Sensor Placement
 - Where do you “look”?
- Calibrating of sensors
 - How do I know sensor is working for all conditions?
 - Different pavement types
- Calibrating thresholds
- Sensor costs





Questions

