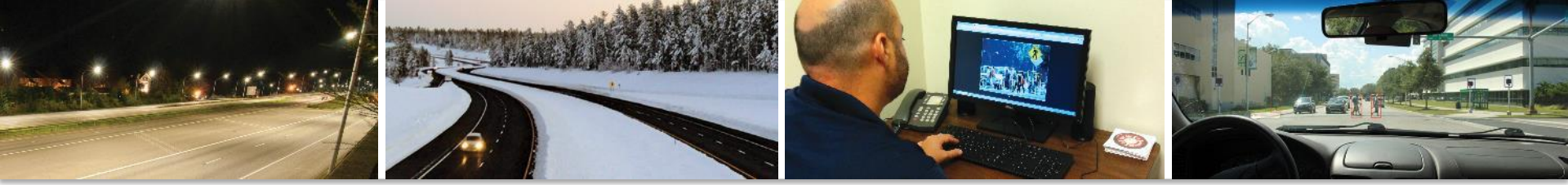


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Overview of SHRP2 Safety Program

Standing Committee on Highway Traffic Safety (SCOHTS)

Rudy Malfabon, Nevada Department of Transportation

April 28, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Presenters

- Moderator – Rudy Malfabon, Director, Nevada Department of Transportation

- Brad Estochen, State Traffic Safety Engineer, Minnesota Department of Transportation

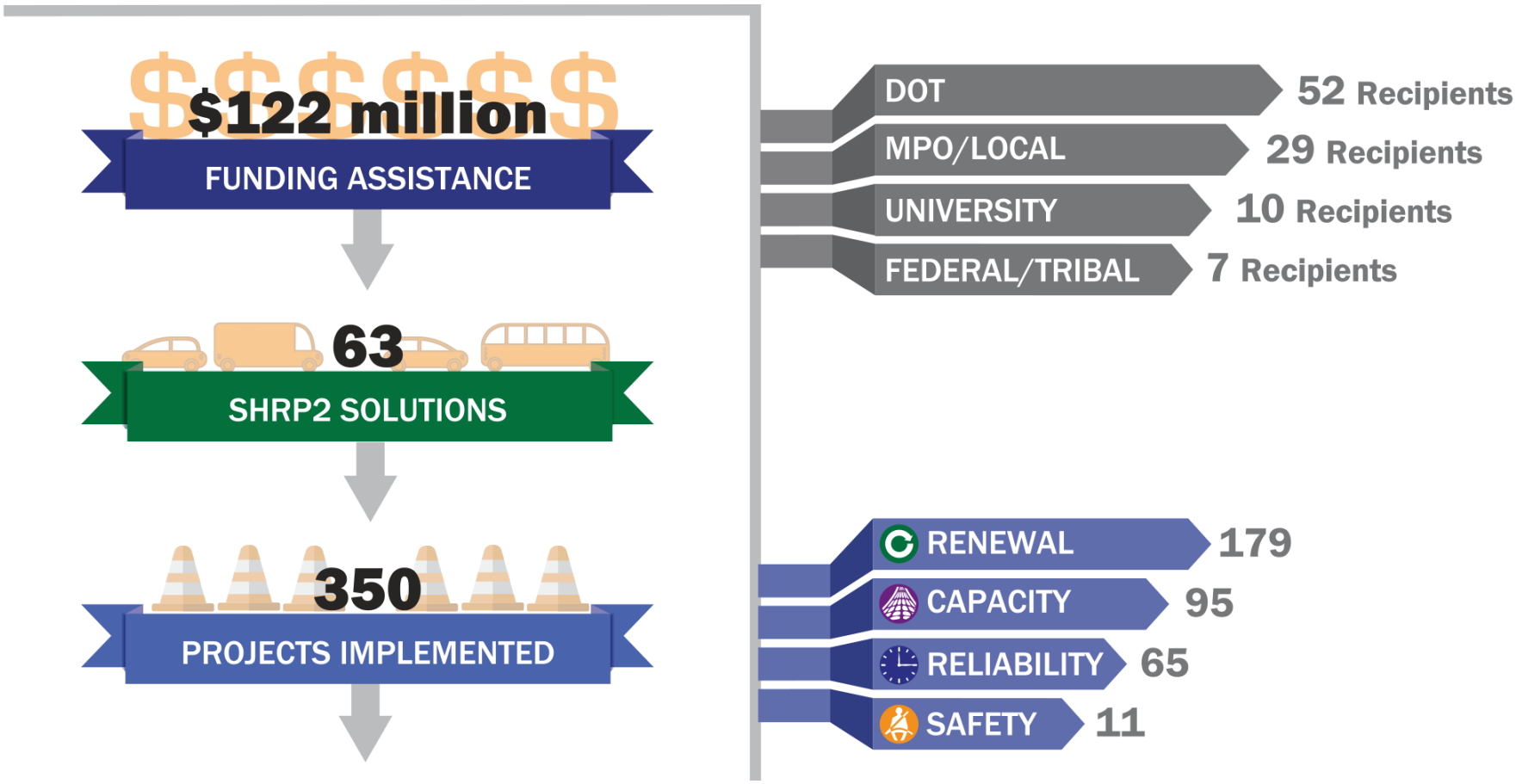
- Mike Griffith, Director, Federal Highway Administration's Office of Safety Integration

- Sandra Larson, Systems Operations Bureau Director, Iowa Department of Transportation

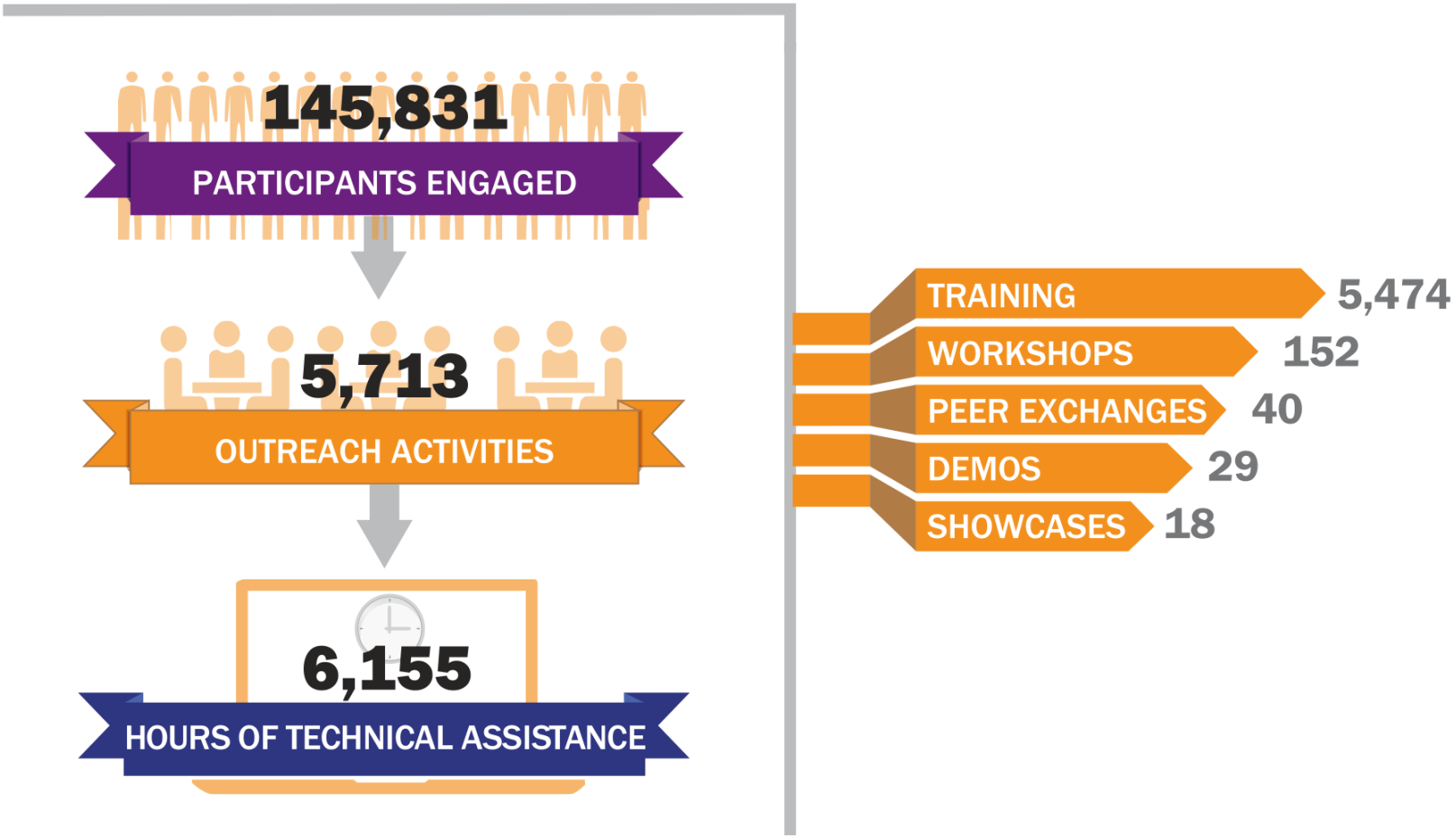
SHRP2 at a Glance

- **SHRP2 Solutions** –63 products
- **Solution Development** – processes, software, testing procedures, and specifications
- **Field Testing** – refined in the field
- **Implementation** – 350 transportation projects; adopt as standard practice
- **SHRP2 Education Connection** – connecting next generation professionals with next-generation innovations

SHRP2 Implementation: Moving Us Forward



SHRP2 Implementation: Moving Us Forward



SHRP2 Safety Program

Consists of Two Large Databases:

- Naturalistic driving study (NDS) database; and
- Roadway Information Database (RID)

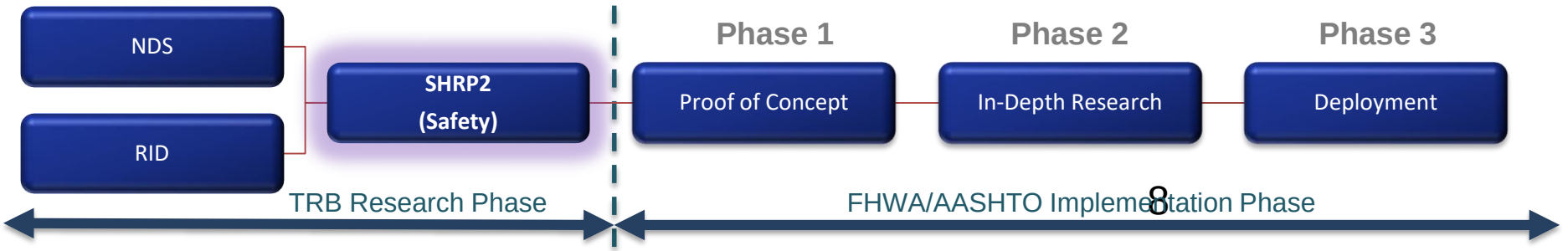
Naturalistic Driving Study (NDS):

- Crash, pre-crash, near-crash, and “normal” driving data
- 3,500+ drivers, 6 sites, all ages

Roadway Information Database (RID):

- NDS trip data can be linked to roadway data from the RID, such as the roadway location, curvature, grade, lane widths, and intersection characteristics.
- These two databases will support innovative research leading to new insights into crash causation.

SHRP2 Safety Program



Implementation Assistance Program (IAP)

Main Objectives

- Utilize IAP to demonstrate the use of the NDS Safety Data
- Increase states' understanding of the potential uses of the data
- Identify safety countermeasures based on research projects
- **Reduce crashes and save lives !**

IAP Safety Process

Phase I – Proof of concept with a sample reduced data set

Phase II – full data set and in-depth research analysis with countermeasure identification

Phase III – deployment to adopt, champion or implement countermeasure nationally

Role of Safety Task Force (STF)

- Collaborate with FHWA, Transportation Research Board (TRB), and research teams
- Oversee Safety Implementation Assistance Program for AASHTO
- Review research proposals and research findings
- Provide and promote opportunities for State DOTs and their research partners to use the NDS/RID
- Provide a customer/user perspective to SDOC

Activities

- Monthly conference calls
- Monitoring progress of teams through series of two interviews – focus on program support, not team evaluation
- Reporting findings to STF, FHWA, and TRB

Phase 1 – Proof of Concept

- 9 months
- Reduced set of NDS and RID data
- 10 states/11 projects
- Teams presented to STF – October 19th and 20th
- FHWA to selected Phase 2 projects with input from STF

Proof of Concept	
Pedestrian Safety	Florida DOT Nevada DOT New York State DOT
Roadway Departure	Iowa DOT
Speeding	Michigan DOT Washington DOT
Work Zones	Minnesota DOT
Horizontal and Vertical Curves	North Carolina DOT
Interchange Ramps	Utah DOT
Adverse Conditions	Wyoming DOT
Roadway Lighting	Washington DOT

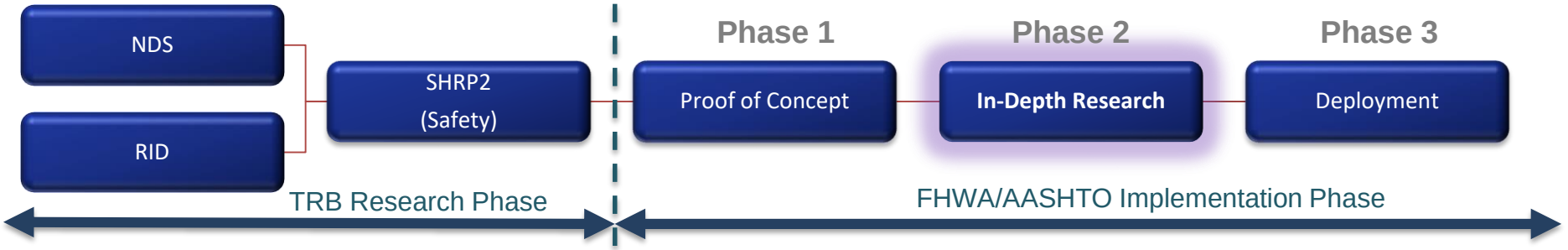
Phase 1 Results - Summary

- All teams excited with potential research findings
- No fatal flaws in research or ability to use NDS data
- Sample of potential outcomes through POC:
  - New data processing tools
  - New highway lighting standards
  - New crash modification factors
  - New methods for establishing speed limits and advisory speeds
  - New understanding about effectiveness of work zone devices/messaging/campaigns
- 2-year, in-depth research proposals
- Lower-than-expected Phase 2 cost proposals

Phase 2 – In-Depth Analysis

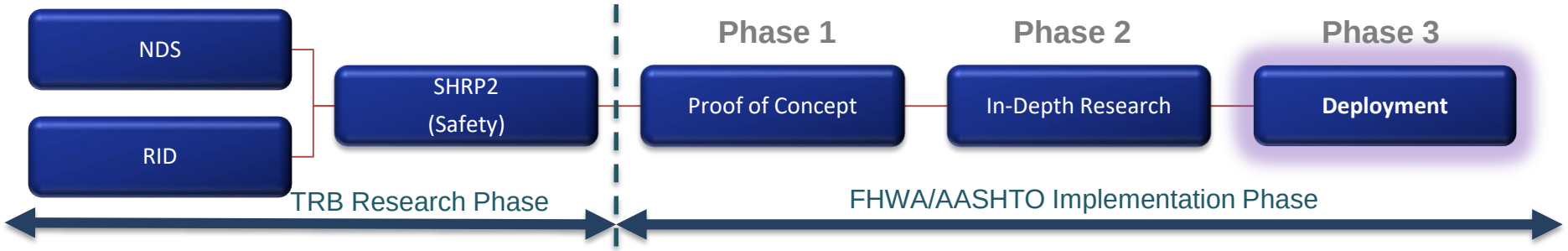
- Selections were announced in December 2015
- Phase 2 to begin January 2016
- Conduct in-depth research and analysis
- Countermeasure identification and refinement

Please see the new Safety Brochure for additional information.



Phase 3 - Implementation

- Adopt, champion, and implement countermeasures nationally
- Integrate findings into Manuals, Guidelines, Policies
- Conduct pilot testing



Minnesota IAP

Evaluation of Work Zone Safety Using the SHRP2 Naturalistic Driving Study Data

Iowa State University and the Minnesota DOT

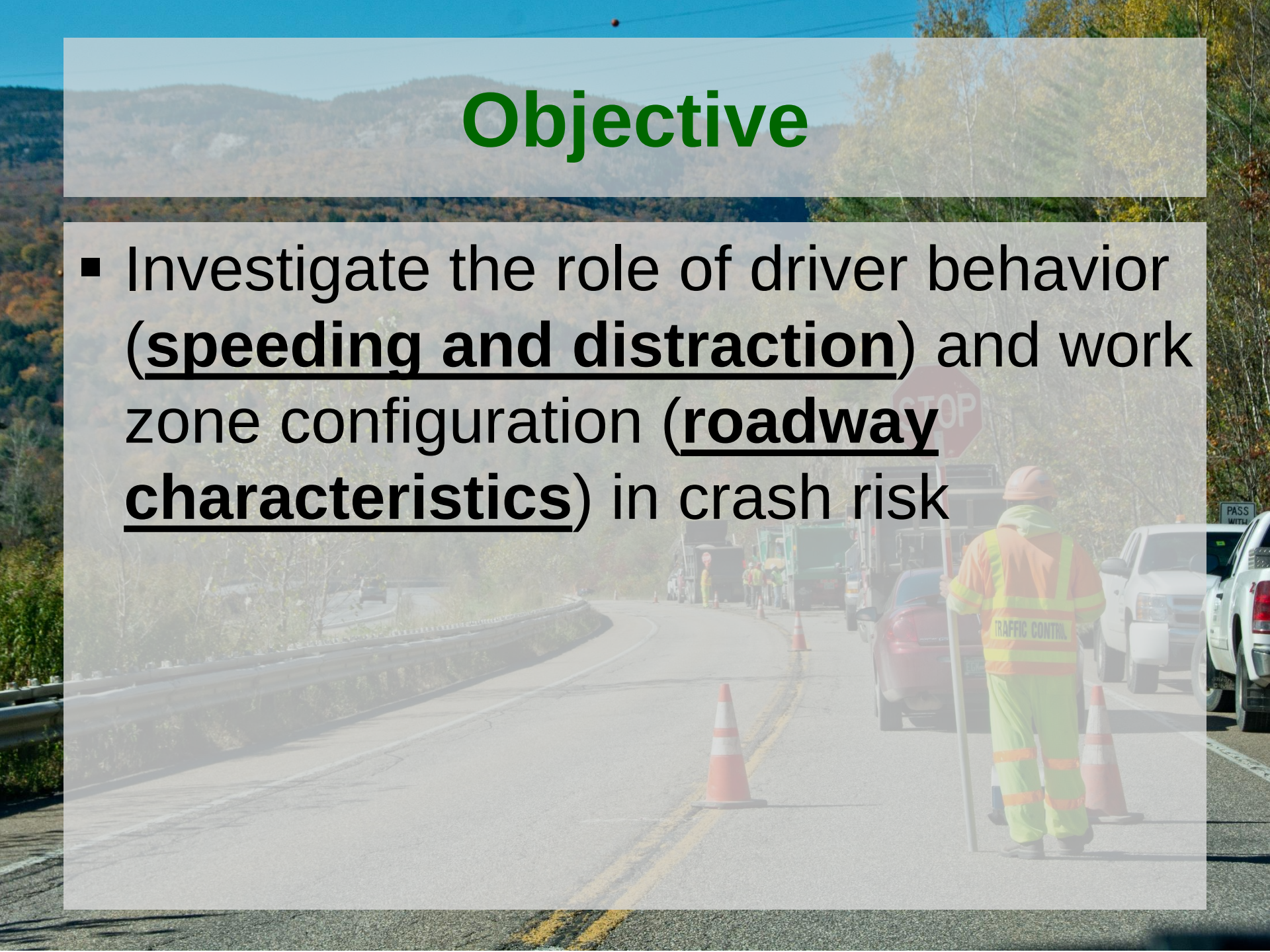
ctre
Center for Transportation Research and Education
IOWA STATE UNIVERSITY

Rationale

- > 1,000 fatalities and 40,000 injuries
- Difficult to understand underlying causes of work zone crashes (**driver behavior**)
- Difficult to isolate work zone related crashes
- SHRP2 data offers unique opportunity:
  - study 1st hand account of activities leading to safety critical events and normal driving
  - identify whether safety critical events were work zone related

Objective

- Investigate the role of driver behavior (**speeding and distraction**) and work zone configuration (**roadway characteristics**) in crash risk



Overview

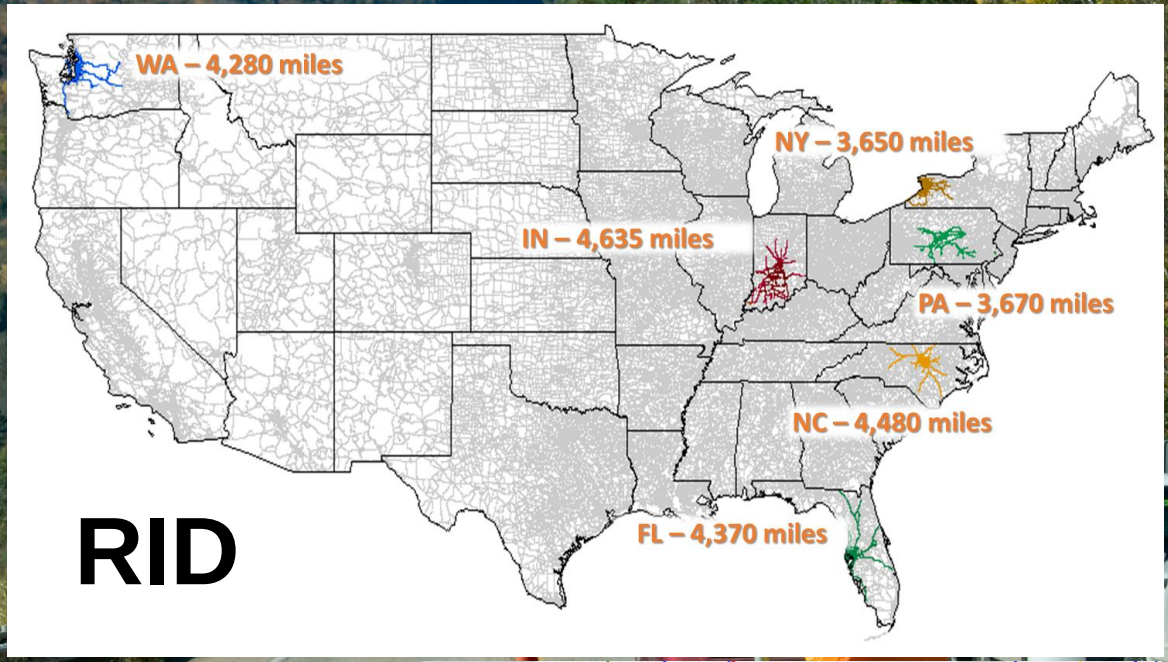
- Developed 3 different models to evaluate data from different perspective
- Investigated multiple crash surrogates
  - Lane position not feasible due to lane and pavement marking discontinuities
  - GPS not sufficiently accurate for TTC and small number of near-crashes
  - Speed was most feasible crash surrogate (**31% of crashes are speeding related**)

Data

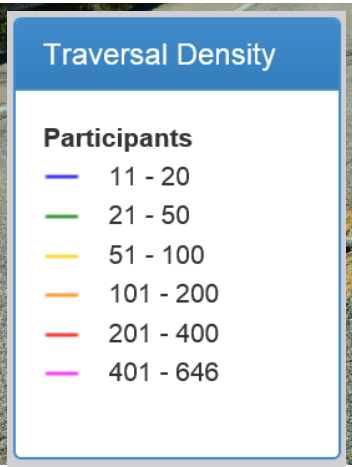
- **Event Detail Table**
  - **256** crashes/near crashes noted as “construction”
  - Reviewed events and determined whether work zone related
    - ✓ *Evidence of active work zone*
    - ✓ *Work zone configuration contributed to event*
    - ✓ *148 events*
  - Identified **1171** baseline events indicated as “construction”
    - ✓ *Requested 420 due to resources*
  - >70 driver, roadway, environmental variables (i.e. driver distraction)
  - Requested & received forward video & time series (except for crashes and some near crashes)
  - Time series data at 0.1 second intervals (speed, acceleration, pedal position, etc.)

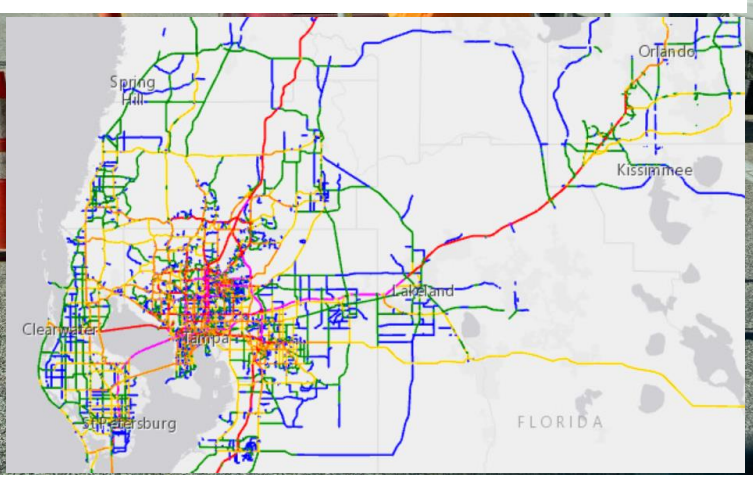
Data

- **RID**
  - Detailed roadway data – 12,500 centerline miles
  - Supplemental roadway data



- **Trip Density Maps**
  - Links showing trips and drivers
  - Utilized to identify potential locations for Phase II





Reduction of Data

- Roadway
  - Geocoded and linked time series data with RID, aerial imagery
  - Used forward view to extract work zone configuration
    - ✓ *Lanes closed, location cones/barrier, traffic control*

- Driver
  - Static (i.e. age, gender, violations) from VTTI
  - Kinematic (i.e. distraction, sleepy) from Event Detail Table for crash/near-crash/baseline
- Environmental
  - TOD, pavement condition (i.e. wet), etc. available from Event Detail Table for crash/near-crash/baseline

Modeling Safety Risk

Phase I analysis

- Focused on rural multi-lane
- Conducted logistic regression using 110 crash/near-crash and 89 baseline events
- Preliminary results indicated
  - **10 mph over speed limit** **11.7** times more likely to be involved in a safety critical work zone event than baseline
  - **3.3** times higher if **distracted**
  - **3.4** times more likely to be **female**
  - Higher when speed deviation is higher
  - Model showed relationship between driver & work zone characteristics and safety risk can be developed
  - Baseline not well correlated to crashes

Modeling Safety Risk

Phase I analysis

- **Limitations**
  - Glance location and duration not consistently coded
    - ✓ *visually distracting tasks and longer glances away from roadway tasks are riskier*
  - Secondary tasks coded only for short segments in safety critical and baseline events
  - Sample size
  - Baseline events not necessarily for comparable work zone configurations
  - Events did not include full traversal of work zone
    - ✓ *Could not determine full work zone configuration/length*

Modeling Safety Risk

Phase II proposed task

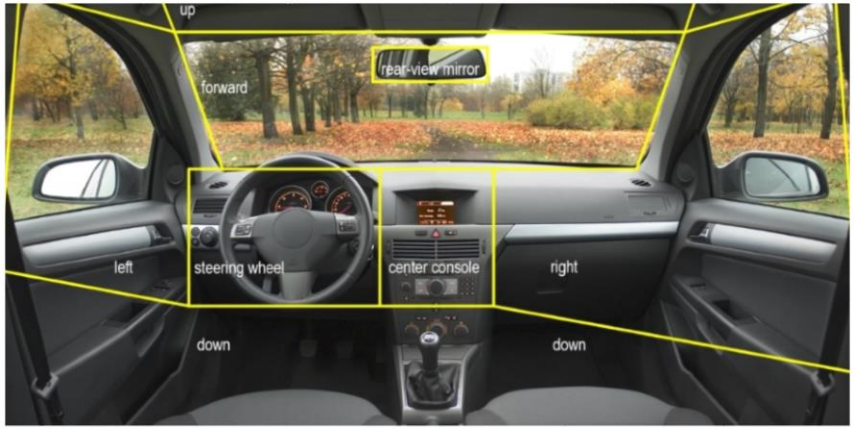
- Methodology
  - Expand to include all roadway types
  - Logistic regression which provides odds ratios
    - ✓ *dependent variable: P\probability of safety critical event*
    - ✓ *co-variates: driver, roadway, work zone characteristics*
- Data Needs
  - Have location of work zone for near-crash, obtain location for crashes (need to work with VTTI)
  - Request time series data for 10 – 15 normal driving events for each safety critical work zone location
  - Reduce roadway/work zone configuration from RID, aerial imagery, forward view, 511 data
  - Reduce driver speed from time series data
  - Reduce glance location and duration at secure data enclave
  - Coordinate data needs across tasks

Modeling Safety Risk

Phase II proposed task

- Data Needs/Reduction
  - Reduce roadway/work zone configuration from RID, aerial imagery, forward view, 511 data
  - Reduce driver speed from time series data
  - Age, gender, # of violations from VTTI
  - Reduce glance location and duration at secure data enclave
    - ✓ *in conjunction with other tasks*

static driver	age	gender	number of violations	number of crashes
	miles driven/yr	years driving		
dynamic driver	glance location and duration	secondary tasks	hands on wheel	impairment (i.e. sleepy)
	seat belt use	num. of passengers		
roadway	speed limit	num. of lanes	shoulder type	lane width
	median type	alignment (tangent, curve)	grade	
environmental	time of day (i.e. daytime, night/no lights)	ambient (i.e. raining)	surface condition (i.e. wet)	LOS
work zone	number of closed/open lanes	DMS	other ITS	type and location of barriers
	equipment/workers	advance signing	length	lane shift



Modeling Safety Risk

Phase II proposed task

- **Outcome**
  - Odds of a safety critical work zone event given a specific roadway, driver, or environmental factor
    - ✓ *(i.e. drivers 10+ mph over speed limit 12 times more likely)*
  - Easily understood by stakeholders
  - Results can be applied in cost/benefit analyses

Modeling Safety Risk

Phase II proposed task

- Methodology
  - Expand to include all roadway types
  - Improve correlation between safety critical and baseline events
  - Logistic regression which provides odds ratios
    - ✓ *dependent variable: P\probability of safety critical event*
    - ✓ *co-variates: driver, roadway, work zone characteristics*
- **Outcome**
  - Odds of a safety critical work zone event given a specific roadway, driver, or environmental factor
    - ✓ *(i.e. drivers 10+ mph over speed limit 12 times more likely)*
  - Easily understood by stakeholders
  - Results can be applied in cost/benefit analyses

Speed Prediction Model

Phase I analysis

- Objective: develop relationship between speed and driver/work zone characteristics
- Data: utilized baseline time series data for rural multilane work zones
  - 87 baseline events included driving within work zone
  - full trace through work zone not available
  - Sampled speed (∑over 1.5 sec) at various points within work zone — dependent variable
  - 226 observations over 87 work zones
  - Extracted work zone configuration from forward video
  - Driver characteristics from Event Detail Table

Speed Prediction Model

Phase I analysis

- Methodology
  - Linear mixed effects model (LME)
  - Accounted for repeated sampling within same work zone
  - Developed best fit model, used AIC and other metrics
- Results
  - Presence of **curve** speed **7.2 mph lower**
  - **Lower speeds** with **more lanes closed**
  - **1.6 mph** lower when **DMS** is present
  - **2.9 mph** lower when **workers present** (90%CI)
  - Result demonstrated feasibility of approach
- Limitations
  - Similar as for safety critical events
  - Complete traces not available in baseline data
  - Secondary tasks only coded for last 6 seconds of baseline

Speed Prediction Model

Phase II proposed task

- **Data**
  - Around 21 co-variates to be included (driver, work zone, roadway)
  - Identify work zones of interest
    - ✓ *Locations of crash/near-crash and baseline*
    - ✓ *Query 511 data for keywords of interest (i.e. lane closure)*
    - ✓ *Work zones and data requested for safety critical event analysis*

Strategies	multi-lane	rural 2-lane with flagger
DMS	X	X
Other ITS	X	X
1-lane closure	X	NA
2-lane closure	X	NA
2+ lanes closed	X	NA
head to head	X	NA
left merge (vs right)	X	NA
barrels/ cones	X	X
jersey barrier	X	X
free-flow	X	X
queuing	X	X

NY Work Zones by Type

lane closure	45
alternating direction	13
reduced to 1 lane	70
reduced to 2 lanes	38
right lane closed	85
left lane closed	55
right shoulder closed	41
left shoulder closed	7

Speed Prediction Model

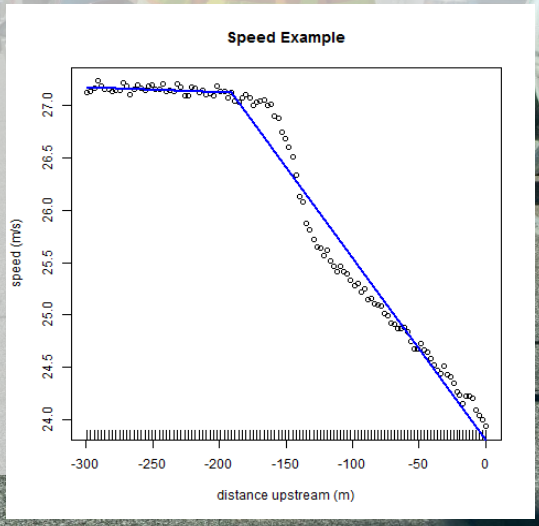
Phase II proposed task

- **Outcome**
  - Prediction of speed given roadway, work zone, and driver characteristic
  - Impact of specific work zone countermeasures on speed
    - ✓ *i.e. different work zone configurations*
  - Output can be used to select configurations/ countermeasures which improve speed compliance and safety

Work Zone Reaction Point

Phase I analysis

- Addressed question of how to get drivers attention in advance of work zone
- Data
  - Utilized baseline events with data in advance of work zone (13 traces)
  - Correlated time series data to location upstream of work zone
  - Correlated position of work zone signs to time series
  - Used driver characteristics (i.e. distraction from Event Detail Table)
- Methodology
  - change point models developed for each work zone



Work Zone Reaction Point

Phase I analysis

- Results
  - Models were reasonably consistent
  - Reaction 128 to 151 m in advance of work zone
  - Data and model adequate for Phase II
- Limitations
  - Sample size
  - Could not include driver or work zone characteristics
  - Steering wheel position less available in full dataset
  - Noise in data

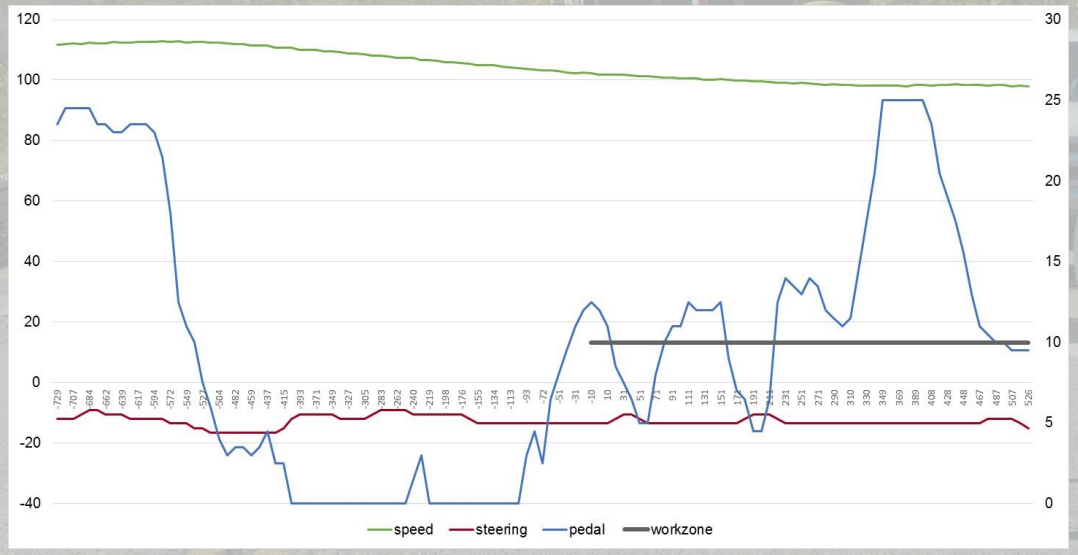
Change point model results (meters)

	average distance	minimum distance	maximum distance	standard deviation	sample size
speed (m/s)	140.8	76.8	200.6	42.1	13
gas pedal position	151.4	100.6	273.6	70.7	5
steering wheel position	128.1	250.2	59.3	76.1	6

Work Zone Reaction Point

Phase II Proposal

- **Data**
  - Time series data (subset of data for previous task with suitable speed, pedal position, steering wheel)
  - Code location of upstream signing, work zone start
  - Address variability in data
    - ✓ *False reaction point*
    - ✓ *Smoothing filter to address data "noise"*



Work Zone Reaction Point

Phase II Proposal

- **Outcome/Benefit:**
  - Location where drivers react given specific work zone characteristics
  - Indicates responsiveness to signing
  - Implications for sign placement
  - Reaction to back of queue
    - ✓ *Drivers texting may be more likely to miss end of queue*

Outcome and Benefits

- Final report
- Tech briefs summarizing key information relevant to stakeholders
  - Charts, figures, etc.
  - i.e. table of odds for different work zone characteristics
- Meet with TAC to identify outreach material
  - Webinar, presentations, etc.


Questions???
TRAFFIC CONTROL
PASS
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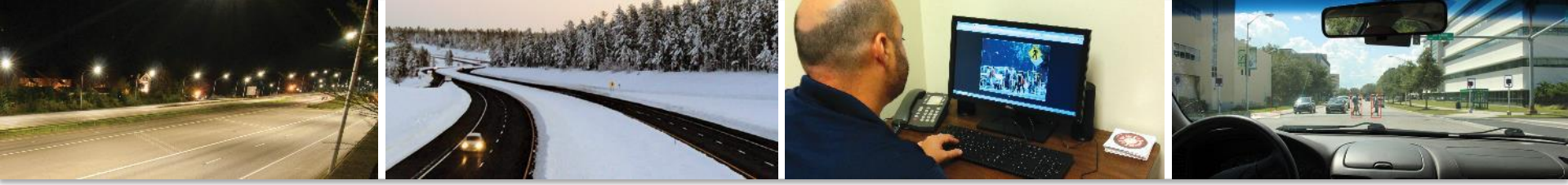
Research and Education



SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

FHWA SHRP2 Safety Implementation Update

SCOHTS Meeting

Michael Griffith, Director, FHWA Office of Safety Technologies

April 28, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Transportation Research Board
of the National Academies

Overview

- **FHWA SHRP2 Broad Agency Announcement (BAA)**
- **FHWA Safety Training and Analysis Center (STAC)**
- **SHRP2 NDS/RID Pooled Fund**

FHWA SHRP2 BAA

- **Proposal Solicitation:**

  "This BAA aims to address highway safety challenges by funding research using the SHRP2 NDS and RID data to support the vision and goals of the FHWA.

- **Two Phases**
  - Phase 1: 8 @ $100,000 / study
  - Phase 2: 3-5 awards @ $750,000 / study

FHWA SHRP2 BAA

- **All 8 Phase 1 Awards have been made**
  - Period of Performance: 9-18 months
  - Includes 12 State Partners
  - Broad Selection of Topic Areas

Performing Organization	Topic	Partner State(s)
MRIGlobal	Speed	MO
CUBRC	Enforcement	NY
Battelle	Intersections	AL / OH / CA / WS
Iowa State University	Rural Intersection Safety	IA / MN / WI / MI
University of Michigan	Work Zones	MI
TransAnalytics, Inc.	Vulnerable Road Users	MD
VTTI	Crash Surrogates	VA
University of Missouri	Work Zones	MO

SHRP2 Safety Data

- Driver data
- Driving data
- Vehicle data
- 3000+ participants
- 5.4 M trips
- Exposure info
- 1 M hrs video
- Crashes: 1,465
- Near-crashes: 2,710

Six NDS sites

Context for the trips

- New data collected
  - Roadway characteristics/features
  - 12,500 centerline miles
  - Consistent in six states
- Acquired data (DOTs, others)
  - 200,000 centerline miles
  - Crashes, Traffic, Weather, Road..
- GIS - linkable to other data sets

STAC Goals and Supporting Actions

- **Expand understanding of the SHRP2 Safety Data**
  - Training/ informational material for a variety of audiences
  - Executive decision makers to hands-on analysts
- **Expand access to these data, incl. PII**
  - Pilot test secure data access
  - Enclave at TFHRC
- **Expand usability of these data**
  - Data analysis tools and reduced data set development
- **Expand user base**
  - Research opportunities – Fellowships, Sabbaticals
  - BAA, IAP, Pooled Fund

STAC Website:

https://www.fhwa.dot.gov/research/resources/stac/

SHRP2 Naturalistic Driving Study Pooled Fund: Advancing Implementable Solutions

- Pooled Fund – 'vehicle' to provide value back to the DOTs
- Goal – To advance the development of solutions that address issues of high-priority to State and local transportation agencies with an emphasis on the broad areas of Safety, Operations, and Planning.
  - This could include development and improvement of countermeasures, development and improvement of predictive models and design guides, policy recommendations, etc …
  - A Technical Advisory Committee (TAC) with representation from participating members will direct the pooled fund activities.

SHRP2 Naturalistic Driving Study Pooled Fund: Advancing Implementable Solutions

- Pooled fund solicitation #1427
  http://www.pooledfund.org/Details/Solicitation/1427
- Pooled fund to begin in 2017; assume first TAC meeting this time next year.
- A minimum contribution of $50,000 *per State* per year for a 5-year period, or a total of $250,000 *per State* is suggested. *Waiver approved* to use 100% State Planning and Research (*SP&R*) Funds w/out non-Fed match.
- While we encourage the suggested minimum contribution based on the cross-cutting scope and potential high impact of this pooled fund, we understand that this may be an issue for some.
- In addition to the waiver and STAC services, FHWA will contribute, at a minimum, $750,000 over the 5 years of the project.

SHRP2 Naturalistic Driving Study Pooled Fund: Advancing Implementable Solutions

Webinar Series:

May 17, 2016, 1:00 PM – 2:30 PM, Registration required
To feature examples of research w/SHRP2 NDS/RID:

FLDOT(Pedestrians); MDOT(Speed); WSDOT(Lighting)
https://collaboration.fhwa.dot.gov/dot/fhwa/WC/Lists/Seminars/DispForm.aspx?ID=940

Future Webinars Tentative Dates:

Will provide additional examples of research being conducted.
o June 28, 2016 1:00 PM-2:00 PM (ET)
o August 9, 2016 1:00 PM-2:00 PM (ET)
o September 20, 2016 1:00 PM-2:00 PM (ET)
o November 1, 2016 1:00 PM-2:00 PM (ET)

NCHRP Discussion

- AASHTO Standing Committee on Research has selected the 2016 NCHRP projects

- The program for FY 2017 is expected to include 16 continuations and 37 new projects

- Requests for Proposals for these 37 new projects will be developed beginning in July

NCHRP Discussion (cont)

Considering the Safety Studies already underway –

- Implementation Assistance
- FHWA BAA studies
- Pool funded studies
  - What topics for further Safety Study would this Committee like to pursue using the NDS database ?
  - What topics might address new safety campaigns or measure the effectiveness of existing campaigns?
  - What topics might further the Toward Zero Deaths initiative?
  - How might the NDS data and research address additional Safety Manual topics?

Questions?

- **FHWA SHRP2 website: fhwa.dot.gov/goSHRP2**
  - Apply for implementation assistance by
  - Product details and webinars

- **AASHTO SHRP2 website: SHRP2.transportation.org**
  - Implementation information for AASHTO members
  - Information about SHRP2 safety implementation
- **Safety Implementation Managers:**
  - Aladdin Barkawi, FHWA: aladdin.barkawi@dot.gov
  - Kelly Hardy, AASHTO: khardy@aashto.org