2016

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Final Report

Hands-on Workshop: Dynamic ATM Strategy Selection Tool FREEVAL-DSS (Workshop 1, Chicago, IL)

(Project # 2016-002)

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Disclaimer

Acknowledgment of Sponsorship

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ACKNOWLEDGEMENTS

We greatly appreciate the assistance from the following individuals in making the necessary arrangements for the workshop whose outcomes are reported herein.

- Dr. Lily Elefteriadou, Professor at the University of Florida and Director of STRIDE center
- Joshua Harris, Clark Dietz Inc.
- Mr. Bob Bryson, retired, City of Milwaukee

EXECUTIVE SUMMARY

This activity is a natural follow-up for the STRIDE Project 2013-009S –"Dynamic Traffic Control Interventions for Enhanced Mobility and Economic Competitiveness". A deliverable of the project was the development of a dynamic version of FREEVAL, the computational engine of freeway facilities in the upcoming HCM update. The FREEVAL-DSS tool (for **D**ynamic **S**trategy **S**election) enables the user to intervene within a FREEVAL run after each 15 minutes and implement one or more ATM strategies from a select menu.

The workshop was intended to be a mechanism to both receive feedback on the tool, as well as disseminate its capabilities. 15 participants attended the 2.5 hour workshop which was conducted in conjunction with the Mid-Western ITE conference, which was held in Chicago, IL on June 26, 2016. The formal feedback received from the participants was extremely positive, and spurred the presenters to plan to offer a subsequent workshop in West Palm Beach FL in conjunction with an upcoming Transpo 2016 conference in November.

1. BACKGROUND

According to the latest Urban Mobility Report, US urban motorists in 2011 traveled an additional 5.5 billion hours and purchased an extra 2.9 billion gallons of fuel as a result of congestion. The economic impact of degraded mobility has been estimated at $21 billion, which is quickly eroding the nation's economic competitiveness. The Federal Highway Administration estimates that about half of all congestion delays are caused by non-recurrent congestion events, including incidents, weather, work zones, demand surges and inadequate base capacity.

Yet methods for assessing the effectiveness of active traffic management (ATM) strategies aimed at improving mobility are still rooted at a planning level approach rather than the operational levels of implementation. This research has intended to develop efficient methods that dynamically evaluate the current traffic system performance, propose interventions that can ameliorate the performance as needed, and implement and re-evaluate the effectiveness of the intervention.

The research team has developed methods and a computerized tool (FREEVAL-DSS) that will propose and implement near real time active traffic management strategies on simulated freeway facilities. In a way, what the tool does is create a virtual (simulation) lab for assessing ATM methods in the same fashion they would be considered, evaluated and implemented in a freeway traffic management center (TMC), that is: observe conditions→diagnose problem→propose solution →implement solution→observe, and so on.

FREEVAL-DSS allows assessing alternative improvement strategies *before* actual implementation in their operations. In addition, it will add to the knowledge based on the development of real-time decision support systems at traffic management centers. The utilization of a macroscopic rather than a microscopic simulation model as a basis for the development will ensure an efficient use, calibration, and implementation of the developed environment.

The research team proposed conducting a hands-on workshop on findings of STRIDE 2013-009S project and primarily FREEVAL-DSS tool. This will be the first workshop on disseminating the outcomes and findings of STRIDE project 2013-009S. The project team may propose to hold another workshop based on future opportunities.

2. OBJECTIVE

The objective of this project was to offer a free, 2.5 hours hands-on workshop on the FREEVAL-DSS tool which was developed under STRIDE Project 2013-009S -*Dynamic Traffic Control Interventions for Enhanced Mobility and Economic Competitiveness.* The workshop was offered with all the necessary perquisite materials that users need to acquire in order to be able to effectively use the FREEVAL-DSS tool. The project team held the workshop at the Mid-Western ITE conference in Chicago IL on June 26, 2016.

3. WORKSHOP DESCRIPTION

The workshop was held on June 26 2016 at the Mid-Western ITE conference in Chicago IL. It was a two and half hours workshop that was subdivided into two sessions. Dr. Nagui Rouphail and Dr. Behzad Aghdashi were the instructors at this workshop. Appendix A contains the power point presentation that the presenters used in this workshop. Table 1 shows the outline of the workshop material.

Table 1 – FREEVAL-DSS workshop outline

Time	Description
2:00PM to 2:25PM	Introductions; FREEVAL Core Methodology & DSS (Rouphail)
2:25PM to 2:55PM	FREEVAL-DSS Demo Examples (Aghdashi)
2:55PM to 3:10PM	Program Installation & BREAK
3:10PM to 4:10PM	Hands on Exercise using I-290 Chicago (Rouphail and Aghdashi)
4:10PM to 4:20PM	New & upcoming Features in FREEVAL-Pro (Aghdashi)
4:20PM to 4:30PM	Questions, Feedback, and Evaluation (Rouphail and Aghdashi)

The total number of participants was 15. Appendix B contains photos from this workshop. The participants were asked to bring their own laptops for the hands-on portion of the workshop where they tried to implement Active Traffic Management (ATM) strategies on the example facilities. The project team provided each participant with a free copy of the FREEVAL-DSS tool, the FREEVAL User Guide, and the PowerPoint presentation slides.

4. WORKSHOP OUTCOMES

The sections below describe results from our survey, comments from participants, and suggestions of our proof-of-concept study location.

4.1. WORKSHOP EVALUATION

The project team provided each participant with a feedback form. Fourteen participants completed the feedback form and gave it to the presenters at the end of session #2. Table 2 shows the evaluation results. The rating scheme is 1 to 5, with 1=poor and 5=excellent.

Table 2 – Workshop Evaluation Results

Feedback Item	Participant #1	Participant #2	Participant #3	Participant #4	Participant #5	Participant #6	Participant #7	Participant #8	Participant #9	Participant #10	Participant #11	Participant #12	Participant #13	Participant #14	**Average**
Overall Value of This Workshop	5	4	5	5	4	5	5	4	4	4	4	4	5	5	**4.50**
Workshop Material and Presentation	5	5	4	5	4	4	5	4	4	4	4	5	4	4	**4.36**
Quality of the Instruction	5	5	5	5	5	5	5	4	5	4	5	4	5	5	**4.79**
Time Allocation and Duration	5	5	5	4	5	5	5	4	5	4	3	5	4	5	**4.57**

4.2. COMMENTS RECEIVED FROM PARTICIPANTS

Below are actual comments from participants:

4.2.1. Suggestions for Workshop Presentation

- More information on the administration mode. Perhaps a full day workshop to go over all features and truly improve ourselves regarding the tool.
- Well done and easy to follow
- Would have liked more time on reliability. How changes to highway affect reliability.
- Examples were clear and concise
- Good workshop I have to ask about applicability of tool that wasn't clear during the presentation
- Need more workshop presentations regarding upcoming FREEVAL
- Need more case studies with same insights

4.2.2. Evaluation of Instructors

- Good job overall
- Very good presentation and answers to questions
- Very nice job by both
- More background on the software project

4.2.3. Additional Comments

- The workshop was easy to follow even for someone who doesn't have experience with FREEVAL
- Good job. Thank you for holding this session
- I am excited about this software
- Thanks you.
- Very useful. Thanks
- Very good presentation
- For a user, there is no way to save your run to document the results. For consultants this is critical. It would also be very helpful to have output showing where and when strategies implemented.

5. CONCLUSIONS

The workshop disseminated the findings of STRIDE project 2013-009S Dynamic Control Interventions for Enhanced mobility. The primary focus of the workshop was on the FREEVAL-DSS tool that had been developed under the same project. The participants were asked to bring their laptops to enable a hands-on experience with the tool and try to improve traffic condition on the example facilities by implementing a series of ATM strategies.

APPENDIX A: PRESENTATIONS SLIDES

Institute for Transportation Research and Education – N.C. State University

Active Traffic Management (ATM) at Your Fingertips

Workshop
2016 Midwestern ITE Meeting
Chicago, IL June 26, 2016

Behzad Aghdashi, Nagui Rouphail, NC State University

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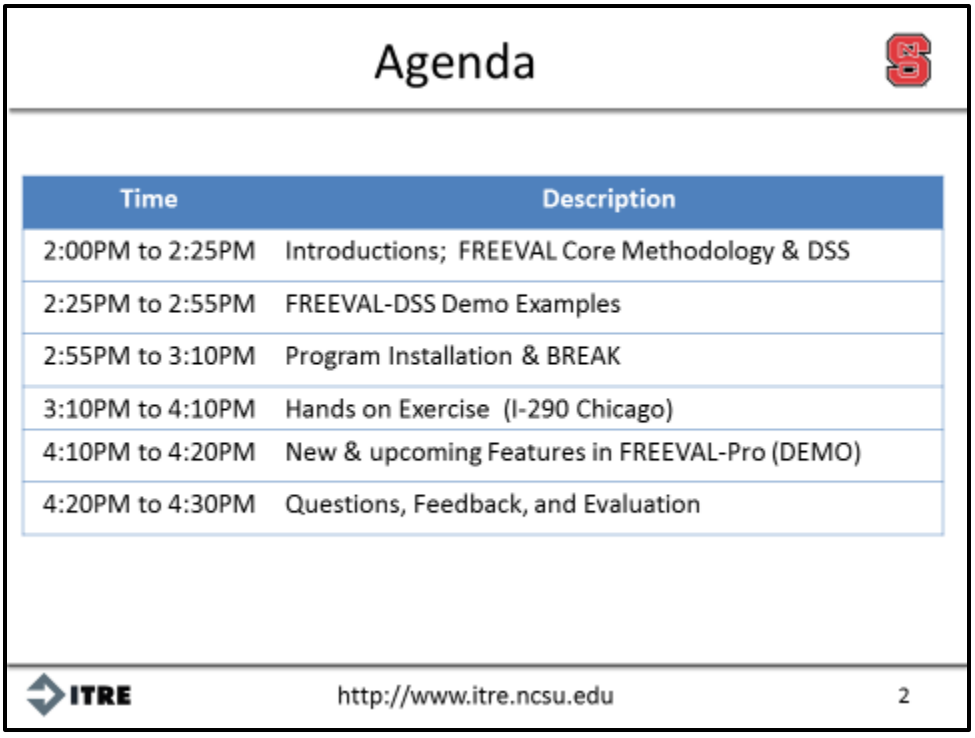

Agenda

Time	Description
2:00PM to 2:25PM	Introductions; FREEVAL Core Methodology & DSS
2:25PM to 2:55PM	FREEVAL-DSS Demo Examples
2:55PM to 3:10PM	Program Installation & BREAK
3:10PM to 4:10PM	Hands on Exercise (I-290 Chicago)
4:10PM to 4:20PM	New & upcoming Features in FREEVAL-Pro (DEMO)
4:20PM to 4:30PM	Questions, Feedback, and Evaluation

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Workshop Outline

- Basis: 6th Edition HCM Freeway Facilities Method
- FREEVAL 2015e Computational Engine
- Capabilities and Limitations
- Dynamic Strategy Selection (DSS) Framework
- Discussion

HCM Freeway Facilities

- Distinguishes between Different Segment Types
  - Basic Freeway Segments
  - Weaving Segments
  - On-ramp and Off-Ramp Segments
- Extended Time-Space Domain
  - Queue propagation between segments and across time periods
- Flow Regimes
  - Undersaturated (**all** d/c<1.0)
  - Oversaturated (**any** d/c>1.0)
- Capacity and Free-Flow Speed Calibration
  - Work Zone Effects
  - Incidents and Weather
  - Capacity Reduction Due to Congestion
- Implemented in FREEVAL Software

Why Analyze Freeways as Facilities?

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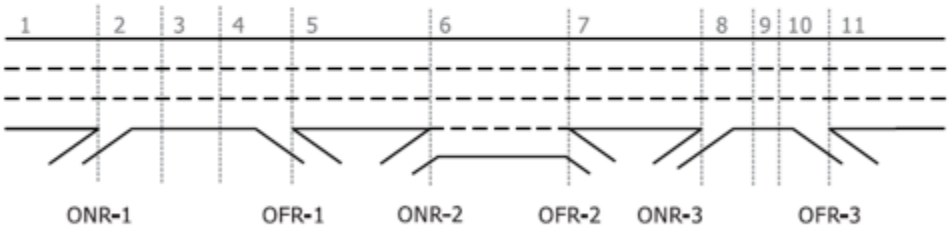
Freeway Facilities

- Method combines the analysis of multiple segments along an extended length of a freeway (up to 10-15mi)
- Considers oversaturated conditions with queue spillback
- Consider operations over multiple (15 min) analysis periods



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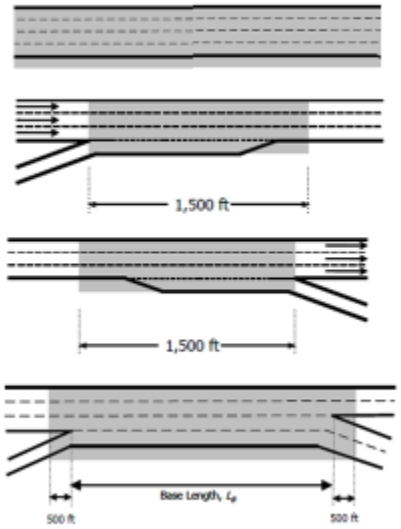
Freeway Facility Comprised of Segment Types

- Basic **B** segment (Ch. 12)
- On-Ramp **ONR** segment (Ch. 13)
  (1,500 ft, ~ 455 meters)
- Off-Ramp **OFR** segment (Ch. 13)
  (1,500 ft, ~ 455 meters)
- Weaving **W** segment (Ch. 14)



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Capabilities of the Freeway Facility Methodology

- Enables the modeling of oversaturated & under-saturated conditions in an extended time-space domain (24 hrs. / 15 mi)
- Models all active and highlights hidden mainline bottlenecks
- Tracks queues as they form and dissipate across segments and time intervals
- Allows time-variant demands and capacities each 15 min
- Can model the effect of incidents, weather and work zones
- Validated against field data and compared to microsimulation very favorably

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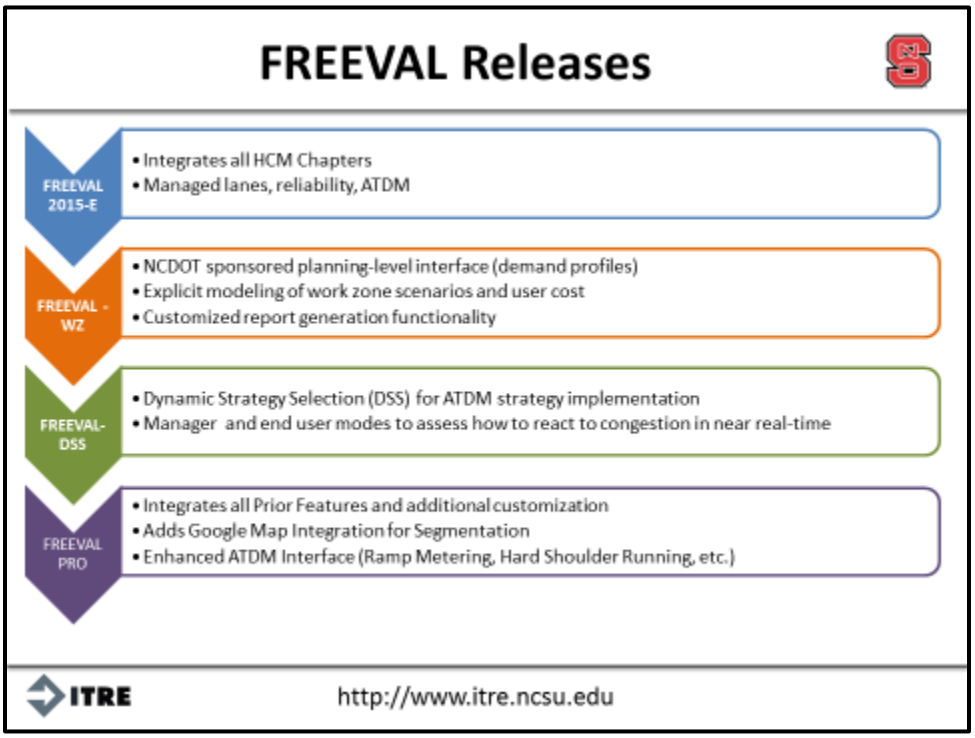
What the methodology's limitations are...

- Does not account for off-ramp congestion due to surface street control and spillback onto mainline
- Not reliable in reporting the effect of multiple overlapping queues
- Less reliable for the analysis of extended length facilities (free-flow travel time greater than 15 minutes)
- Requires extensive demand inputs in each time period – cannot map sensor data to demand (Yet !)
- Time consuming in manually segmenting the facility into HCM analysis segments (work in progress)

What is FREEVAL ?

- FREEVAL is a macroscopic (not micro simulation) model for analyzing freeway facilities based on HCM methods
- Requires a small set of inputs and minimal run time.
- Facilitates the analysis of multiple segments along extended length of freeway
- Can analyze both active and hidden bottlenecks.
- Analyzes multiple time periods up to 24 hours.
- Facility lengths of 9 to 12 miles can be analyzed.
- Current release is in Java, so machine independent


FREEVAL Releases
FREEVAL 2015-E
• Integrates all HCM Chapters
• Managed lanes, reliability, ATDM
FREEVAL - WZ
• NCDOT sponsored planning-level interface (demand profiles)
• Explicit modeling of work zone scenarios and user cost
• Customized report generation functionality
FREEVAL-DSS
• Dynamic Strategy Selection (DSS) for ATDM strategy implementation
• Manager and end user modes to assess how to react to congestion in near real-time
FREEVAL PRO
• Integrates all Prior Features and additional customization
• Adds Google Map Integration for Segmentation
• Enhanced ATDM Interface (Ramp Metering, Hard Shoulder Running, etc.)
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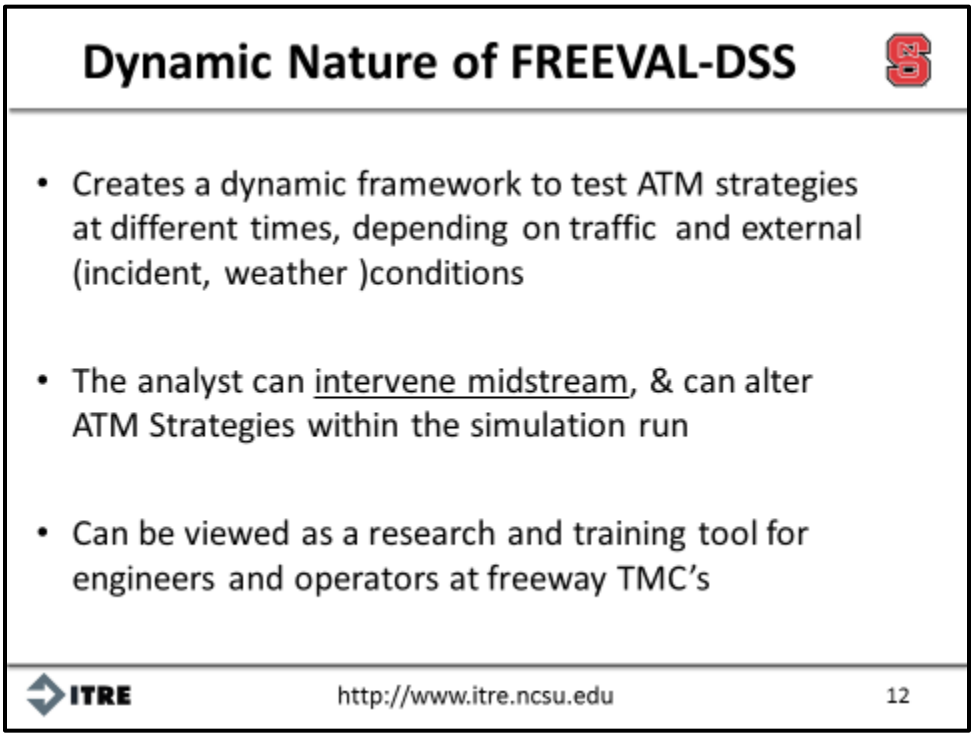
Dynamic Nature of FREEVAL-DSS
• Creates a dynamic framework to test ATM strategies at different times, depending on traffic and external (incident, weather)conditions
• The analyst can intervene midstream, & can alter ATM Strategies within the simulation run
• Can be viewed as a research and training tool for engineers and operators at freeway TMC's
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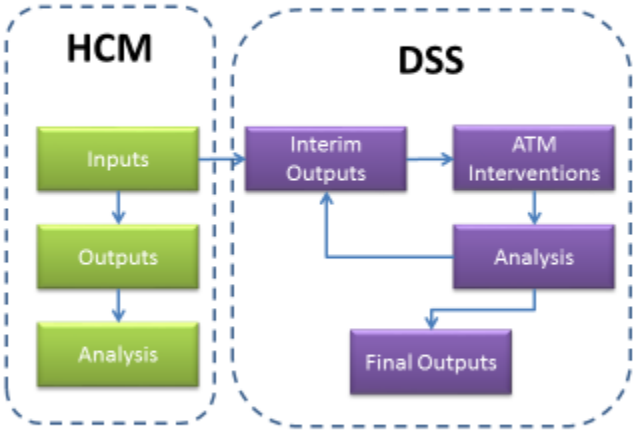
DSS Concept Implementation



ATM strategies Covered in FREEVAL-DSS

- DSS→ **D**ynamic **S**trategy **S**election
- Ramp Metering
  - Adaptive (ALINEA and Fuzzy logic) and Fixed Rate
  - Local and System Wide
- Hard Shoulder Running on user selected segments
- Traffic Diversion
  - Upstream of the facility
  - Into Managed Lanes (HOV/HOT)
  - Via VMS into off-ramps
- Incident Management

Roles of Administrator vs. End User

- The framework accommodates two types of operators: **Administrator** (Professor; Supervisor ?) and **End User** (Student ; TMC Technician?)
- The **Administrator** configures the facility, specifies various congestion sources including **weather events, incident events, work zones,** or **demand surges**.
- The **Administrator** also configures the **menu of available ATM strategies** and the **form of output options** to the End User(s)
- The **End user** has access to administrator-selected ATM **interventions** from an available menu of options, after any 15 minute interval. Interventions can also be stopped or extended in time and space

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FREEVAL- DSS Phases

- Consists of three phases:
  - **Phase 1: Scenario Configuration** by the **Administrator**
  - **Phase 2: Simulation and ATM Interventions** by **End User**.
  - **Phase 3: Analysis Summary** and execution of multiple FREEVAL runs to compare Performance under various ATM strategies.

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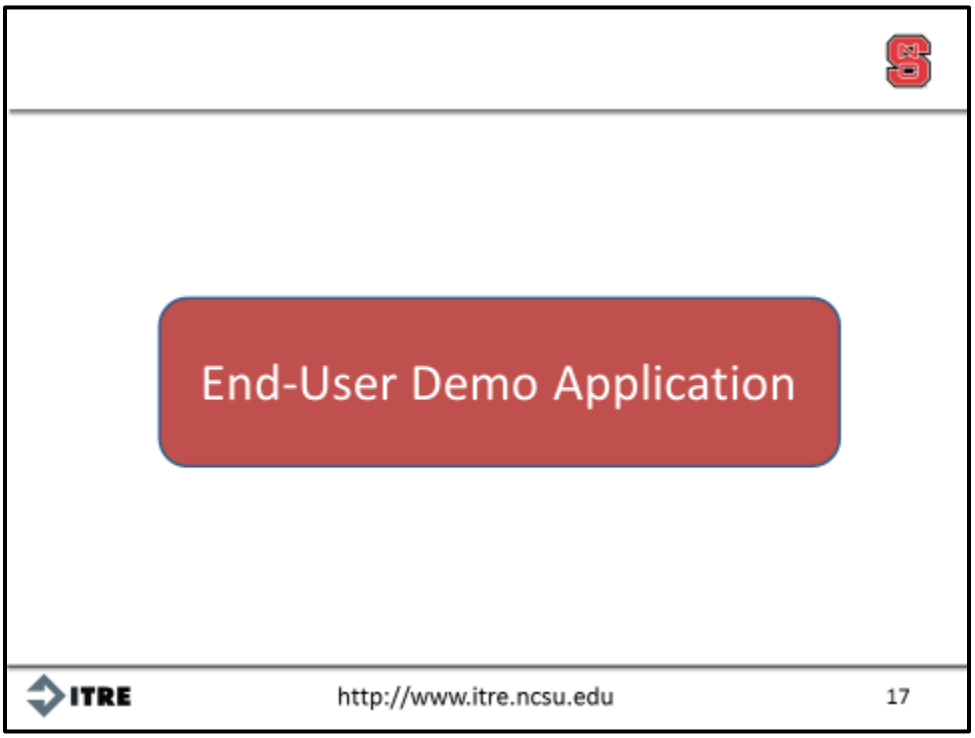
End-User Demo Application
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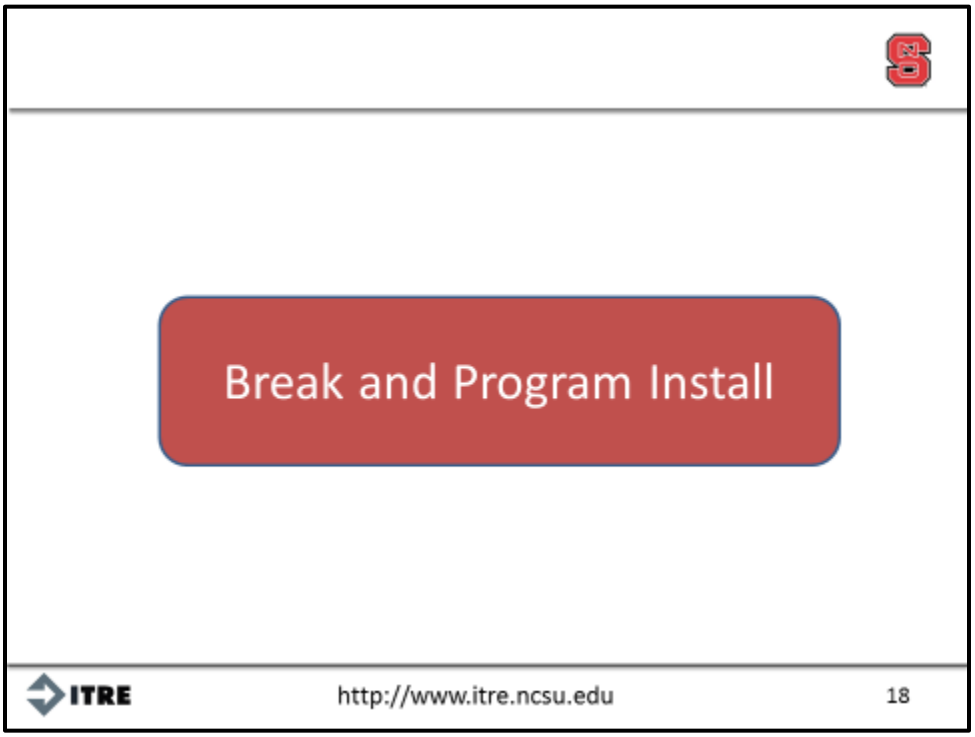
Break and Program Install
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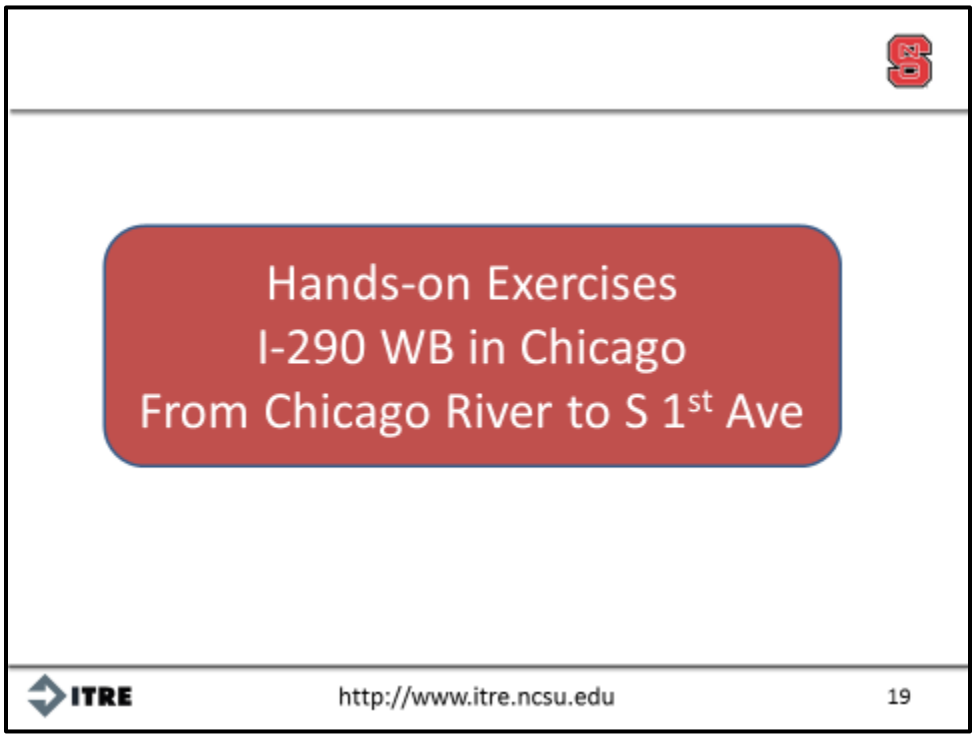
Hands-on Exercises
I-290 WB in Chicago
From Chicago River to S 1st Ave
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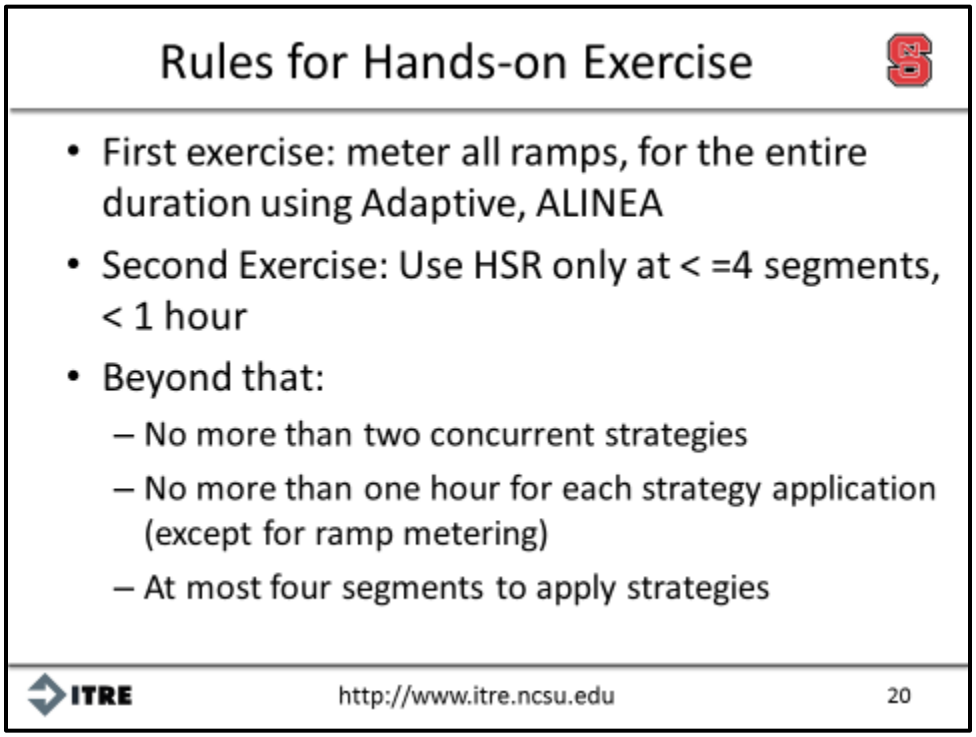
Rules for Hands-on Exercise
First exercise: meter all ramps, for the entire duration using Adaptive, ALINEA
Second Exercise: Use HSR only at < =4 segments, < 1 hour
Beyond that:
– No more than two concurrent strategies
– No more than one hour for each strategy application (except for ramp metering)
– At most four segments to apply strategies
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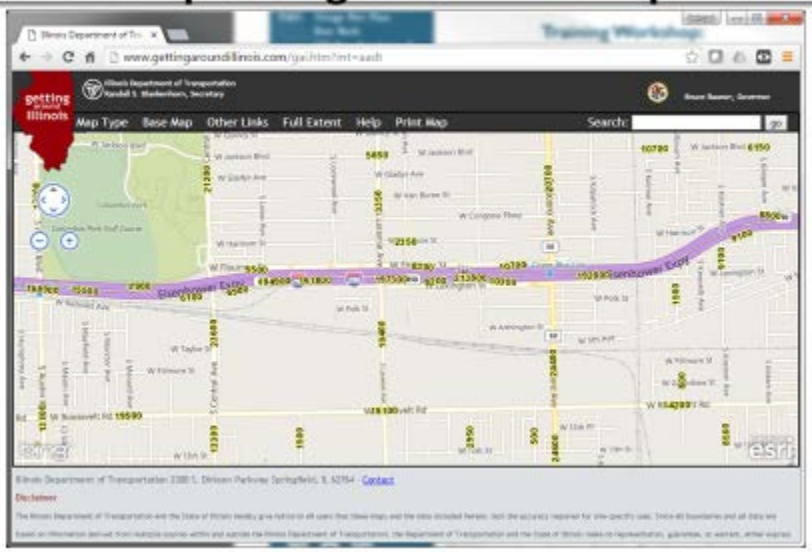
AADT for I-290 Exercise: Populating the demand inputs



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New and Upcoming Features

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Discussion and Questions

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APPENDIX B: PICTURES FROM THE WORKSHOP