Session 0: Preliminaries

- Self Introductions
- Workshop Objectives
- Workshop Outline
## S0—Self Introductions

- Name/Title
- Department/District
- What you Expect to Learn

## S0—Workshop Objectives

- Learn Use of PASSER V for Analysis and Optimization of Traffic signals:
  - Isolated Signals
  - Isolated Diamond Interchanges
  - Diamonds + Adjacent Signals
  - Arterials and Sub-arterials
S0—Workshop Outline

• S1: Introduction to PASSER V
  ✓ Features
  ✓ Input Data Requirements

• S2: Isolated Signals
  ✓ Review of Theory
  ✓ Isolated Signal Exercise

• S3: Signal Systems
  ✓ Review of Theory

S0—Workshop Outline (continued)

• S4: Diamond Interchange Exercise
  ✓ Additional Discussion

• S5: Arterial Exercise
  ✓ Create and Analyze Simple Arterial
  ✓ Review Additional Features

• S6: Diamond + Arterial Exercise
  ✓ Using Existing Data
**S0—Workshop Outline (continued)**

- S7: Workshop Conclusions
  - Survey
  - Suggestions and Questions

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**Session 1: Introduction to PASSER V**

- Background
- Features
- Input Data Requirements
- User Interface
**S1—PASSER V Background**

- Developed Under a TxDOT Project to Enhance PASSER II
- Applications
  - Isolated Signals
  - Signalized Arterials
  - Isolated Diamond Interchanges
  - Diamond + Adjacent Signals

**S1—PASSER V Features**

- Graphic User Interface
  - Multiple Document Architecture
- New Delay Model
- Can Coordinate Signals to provide
  - Maximum Progression
  - Minimum Delay
- Graphic Time-Space Diagram
**S1 – Using PASSER V**

- Draw the Facility
- Select Intersection or Link
- Enter Corresponding Data
- View Signal MOEs
- Analyze/Optimize Signals Systems
  - Select and Run Tool
  - View/Print Results

**S1 – Tools in PASSER V**

- PASSER II Optimizer
- PASSER III Optimizer
- GA-Based Optimizer
- Time-Space Generator
- Volume Analysis
- Delay Analysis
**S1 – PASSER V Limitations**

- Coordination Requires Same Cycle length at All Signals
  - No Double-Cycle or Conditional Service
- Cannot Undo Steps of Changes
  - Can Retrieve Original Data if Intact
- Cannot Handle following cases
  - Networks of Multiple Arterials
  - Un-Signalized Intersections

**Session 2: Isolated Signals**

- Overview of Theory
- PASSER V Input Data Needs
- Input Data Considerations
- Signal Exercise
S2–Cycle vs. Delay and Capacity

Delay/Capacity

Cycle Length

Critical Cycle Length, \( C_c \)

Minimum-Delay Cycle Length, \( C_m \)

S2–Cycle vs. Delay and Stops
**S2—Cycle Length vs. Delay**

**S2—Timing Isolated Signals**

- Select Best Timings
  - Cycle
  - Splits (or max, min, gap setting), and
  - Clearance Intervals
- To provide
  - Safe and
  - Efficient Operation
S2—Safety Issues

- Minimum Greens
- Vehicle Clearance Intervals
- Pedestrian Requirements
- Yellow Trap

S2—Clearance Intervals

Proper Settings Avoid a “Dilemma Zone”

<table>
<thead>
<tr>
<th>Speed mph (kph)</th>
<th>Yellow Change sec (level grade)</th>
<th>Red Clearance sec (60’ wide crossing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 (40)</td>
<td>2.84</td>
<td>2.18</td>
</tr>
<tr>
<td>35 (56)</td>
<td>3.57</td>
<td>1.55</td>
</tr>
<tr>
<td>45 (72)</td>
<td>4.31</td>
<td>1.21</td>
</tr>
<tr>
<td>55 (88)</td>
<td>5.04</td>
<td>0.99</td>
</tr>
<tr>
<td>65 (104)</td>
<td>5.78</td>
<td>0.84</td>
</tr>
</tbody>
</table>
**S2–Pedestrians**

\[ G_p = (4 \text{ to } 7 \text{ seconds}) + \frac{\text{Distance}}{W} \]

- **Pedestrians**
  - Minimum Pedestrian Time
  - 4 to 7 Distance / W
  - Yellow + All Red Clearance
  - Location of yellow + all red depends on policy of responsible as to allowing pedestrian flashing “DON’T WALK” to occur simultaneously with vehicular clearance.

- **Vehicles**
  - Minimum Vehicle Time
  - Vehicular Green
  - Yellow + All Red Clearance
  - Location of yellow + all red depends on policy of responsible as to allowing pedestrian flashing “DON’T WALK” to occur simultaneously with vehicular clearance.

**S2–Yellow Trap**

Demonstration of Lead-Lag “YELLOW TRAP”

Southbound

Northbound
**S2–Yellow Trap (continued)**

- What is Good Operation?
  - Minimum Delay,
  - Shortest Queues per Cycle,
  - Minimum Stops, or
  - Compromised Combination

- User decides based on situation
  - Approach Speeds
  - Traffic Counts
  - Driver Perception
**S2–PASSER V Data Needs**

- Turning Movement Counts (TMC)
  - Collect 15-Minute Data and Calculate PHF
  - AM, PM and Off-Peak
  - Collect Vehicle Mix Information
- Can Apply Growth Rates to Older Counts, as long as Traffic Patterns Haven’t Changed

**S2–PASSER V Data Needs**

- Number of Lanes
- Lane Use
- Lane Widths
- Turn Bays and Length
**S2–Input Considerations**

- Left-turn Treatment
  - Number of Opposing Lanes
  - Overlapping Turning Paths (may need to split phase)
  - Type of Signal Heads (3, 4 or 5 Section)
- Pretimed, Semi-actuated, or Fully-actuated
- Priority or Preemption

**S2–Performance Data**

- Delay, Stops, Queue Information for Existing Conditions
- Collection can be Costly
**S2–Isolated Signal Exercise**

- Draw an Isolated Signal
- Enter Data
- Analyze

**S2–Intersection Data**

- S.W. Military
  - AM: L 13, T 52, R 74
  - PM: L 19, T 68, R 150
  - Truck%: 2 1

- S. Presa
  - AM: L 88, T 397, R 86
  - PM: L 149, T 676, R 147
  - Truck%: 3 1

- Bay is 91' long
- Bay is 126' long
- Bay is 148' long
- Bay is 153' long

**Transportation Operations Group**
**S2–Data Entry**

- Draw Links
- Define Lanes
- Enter PM-peak Volumes
  - i.e. 149, 676, & 147 for EB
- Select Movement Type
  - EB and WB Prot (why?)
  - NB and SB Prot/Perm

**S2–Data Entry (continued)**

- Adjust Right-turn Volumes for RTOR
- Overlap (Yes for lefts)
- Min Splits
  - Peds if no buttons (Assumed)
    - NB: 4+ (12+11+12+13+12+11+14-14/7) = 23.5 ≈ 24 sec.
  - EB, WB, NB, SB: 19, 19, 24, 24
  - Clearance Times
**S2–Data Entry (continued)**

- Adjustments to Flows
- Trucks
- Ideal Saturation Flow
- Click Update Button

**S2–Analysis/Results**

- Delay vs. Cycle Analysis
- Controller: Ring-Barrier Display
- MOEs
Break!

After the break
Session 3: Signal Systems

Session 3: Signal Systems

• Overview:
  ✓ Engineering Theory
  ✓ Analysis Tools
**S3—Flow Stability Between Adjacent Systems**

- Min. Acceptable System Cycle Length
- Signal 3: Highest v/c ratio
- Signal 2
- Signal 1: Lowest v/c ratio

**S3—Signal Offset and Flow Between Adjacent Signals**
S3—Flow vs. Bands

S3—Effects of Changes in Offset
S3—Cannot Get Two-way Bands? Change Phasing!

S3—Changing Phasing can Improve 2-way Progression
**S3—Timing Adjacent Signals**

- **Objectives of Coordination**
  - Provide/Maintain Safety
  - Maintain Stable Flow
  - Minimize Systemwide Delay
  - Minimize Queues and Spillback
  - Maximize System Throughput
  - Minimize Number of Stops
  - Maximize Arterial Progression

- **Some Conflicts**

**S3—Types of Traffic Models**

- **Traffic Simulation Model**
  - Evaluates a Specified Scenario
  - Generates Performance Measures

- **Optimization Model**
  - Systematically Generates Scenarios
  - Evaluates Using Simulation
  - Selects the Best Scenario
  - Usually Applicable to Traffic Signals
**S3—Simulation Models**

- **Microscopic**
  - Keeps track of each vehicle
  - Time consuming
- **Mesoscopic**
  - Analyzes Flow profiles
  - Faster calculations
- **Macroscopic**
  - Analyzes Platoons
  - Fastest calculations

**S3—Simulation Models** (continued)

- **Microscopic**
  - Keeps track of each vehicle
  - Time consuming
- **Mesoscopic**
  - Analyzes Flow profiles
  - Faster calculations
- **Macroscopic**
  - Analyzes Platoons
  - Fastest calculations
- **Stochastic**
- **Deterministic**
S3—Simulation Accuracy

- Realistic Queues
  - Microscopic: CORSIM, Vissim, SimTraffic
  - Mesoscopic: new T7F
- Upward Queue Stack
  - Mesoscopic: old T7F, Synchro and P3
  - Macroscopic: P2, P3, P4

S3—Spillback & Starvation
S3—Blocking and Starvation

(continued)
S3—Starvation may not be Bad (Unused Capacity)

S3—Optimization Criteria

- Maximize Arterial Progression
- Minimize Systemwide Delay
- Minimize Stops
- Minimize Queues
- Maximize Throughput
- Minimize Blocking and Spillback
**S3–Magnitude of Problem**

Fixed Cycle=100 Sec

1. 100 Plans

2. Depends
   - 200, or
   - 10,000 Plans

3. 200x64 = 12,800 Plans

**S3–Optimization Methods**

- Exhaustive Search
- Smart Search Techniques
  - Hill-climbing
  - Heuristic
  - Mathematical Programming
  - Genetic Algorithms
- Most Programs Use a Combination
S3–Optimization Tool Types

• **Delay-Based**
  - Minimizes Delay (+Q and Stops)
  - Evaluates/Simulates Each Plan
  - Examples:
    » TRANSYT 7F: Exhaustive, Hill-climbing, GA
    » Synchro: Exhaustive + Heuristic Search
    » PASSER III: Exhaustive Search
    » PASSER V: Exhaustive, GA

• **Bandwidth-Based**
  - Maximizes Arterial Progression
    » Simple Objective Function
  - Simulates Traffic After Optimization
  - Examples:
    » PASSER II: Exhaustive and Heuristic
    » PASSER IV: Mathematical Programming
    » PASSER V: Exhaustive, Heuristic, GA
**S3- PASSER V Data Needs**

- Signal Spacing
- Link Speeds
- Types of Link

**Intersection Spacing (in feet)**

![Intersection Diagram]

**S3–Input Performance Data**

- Speed, Travel Time, or Delay Information for Existing Conditions
- May Need to Measure Speed for Use in PASSER V
- Can be Used to Calibrate or Validate Your Base Model
- Collection Can Be Costly
**Break!**

**After the break**

**Session 4: Diamonds**

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**Session 4: Diamond Interchange Analysis**

- Create a Diamond Interchange
- Enter Data and Analyze each Signal
- Apply Optimization Tools and View Output
  - PASSER III
  - GA-Based Optimizer
- Apply Other Tools
  - Volume Analysis
  - Time-Space Diagram
  - Delay Analysis
**S4–Interchange Data**

- SH 6 (East Bypass)
- Harvey Rd.
- Protected + Permitted
- Bay Length = 300'
- All lanes 12'
- Speed = 40 mph

**S4–Interchange Data (continued)**

- 2% Trucks on all approaches
**S4–Data Entry/Analysis**

- Draw Links/Define Interchange
- Enter data
- Select Tool and Analyze
- Review Results

**S4–How GA Works**

- Randomly Generate Population
- Perform Reproduction Operation
  - Select Pairs/Parents, and Generate Offspring
  - Note Population Has Doubled
**S4—How GA Works (continued)**

- Keep Best Half of New Population

Parents: [Diagram] 
Offspring: [Diagram]

- Perform Mutation Operation

Next Generation: [Diagram]

**S4—How GA Works (continued)**

- Stop If
  - No Improvement Possible or Maximum Generations Reached
  - Report the Best Plan

- Else
  - Repeat Process
S4—More Tools in PASSER V

- Volume Analysis
- Time-Space Diagram
- Delay Analysis

Adjourn for the Day!

Day 2, 8:30 A.M.
Session 5: Arterials
Session 5: Arterial Analysis

- Arterial Exercise
  - Create a simple Arterial
  - Enter Data and Analyze each Signal
  - Apply Various Tools
  - Review/Interpret Output

- Comparison of Synchro, TRANSYT and PASSER II

- Review Additional Concepts
  - Using Existing Data

S5—Arterial Data

*Assume all lanes at Somerset are 12' wide*
S5—Software Comparison

- Synchro, PASSER II, and TRANSYT 7F Using CORSIM
- 5 Small Arterials and 3 Large Arterials
- Compared Several MOEs
- Summary of Results Follow

S5—Cycle Comparison

<table>
<thead>
<tr>
<th></th>
<th>70% of Base</th>
<th>Base Volumes</th>
<th>120% of Base</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S4</td>
<td>P2</td>
<td>T7F</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>135</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>106</td>
<td>105</td>
</tr>
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<td>145</td>
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</tr>
<tr>
<td>4</td>
<td>65</td>
<td>110</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>120</td>
<td>110</td>
</tr>
</tbody>
</table>
**S5—Bands for Best Solutions**

Bar chart showing the band efficiency for different arteries using PASSER II and Synchro.

**S5—Delay for Best Solution**

Bar chart showing the delay for different arteries using PASSER II, Synchro, and TRANSYT-7F.
S5—Total Throughput

![Total Throughput Chart]

S5—Artery 1 Band vs. Cycle

![Artery 1 Band vs. Cycle Chart]
**S5—Artery 1 Delay vs. Cycle**

![Graph showing Artery 1 Delay vs. Cycle](image)

**S5—Throughput vs. Cycle**

![Graph showing Throughput vs. Cycle](image)
**S5–US 90A Band Efficiency**

![Graph showing S5–US 90A Band Efficiency](image)

- **P2 opt**
- **Synchro opt**

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**S5–US 90A Band**

![Graph showing S5–US 90A Band](image)

- **P2 opt**
- **Synchro opt**
**S5—Synchro’s Evaluation of PASSER II Results**

![Graph showing delay versus cycle length for PASSER II with two lines: one for Synchro opt and another for Sim P2 timing.]  

**S5—PASSER II’s Evaluation of Synchro Results**

![Graph showing delay versus cycle length for Synchro with two lines: one for Sim Syn timing and another for Synchro opt.]
S5–SH 71 in Bastrop

Break!

After the break
Session 6: Diamond and Adjacent Signals
Session 6: Diamond and Adjacent Signals

- Load Existing Data
- Apply Various Tools
- Review Output

S6–SH 195 Data

Interchange
Break!

After the break
Session 7: Conclusion

Session 7: Workshop
Conclusion

• Distribute Survey
  - Tell Us How We Did
  - Feedback About PASSER V
    - What You Liked or Disliked
    - Improvements You Would Like to See
    - Additional Features You Would Like to Have

• Open Question/Answer
  - Free to Leave as You Wish
TTI is Here to Help

• Nadeem Chaudhary
  ✓ n-chaudhary@tamu.edu
  ✓ (979) 845-9890

• Steve Venglar
  ✓ s-venglar@tamu.edu
  ✓ (512) 467-0946

• Chi-Leung Chu
  ✓ clchu@tamu.edu
  ✓ (979) 845-8408