

Three Level Diamond – Single Controller or Multiple Controllers

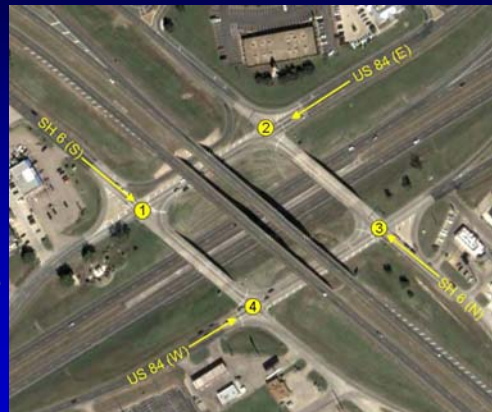
Srinivasa Sunkari, P.E.
Texas Transportation Institute



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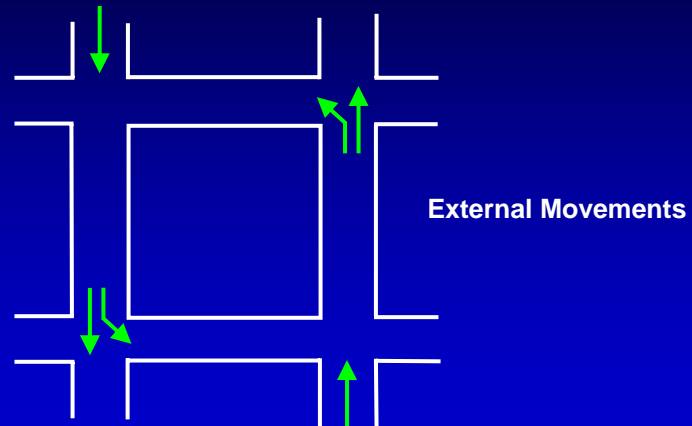
Study Objective

- Evaluate interchange operation using
 - *Single controller*
 - Three phase
 - Four phase
 - *Four controller*
 - Existing condition
- Use hardware in the loop simulation

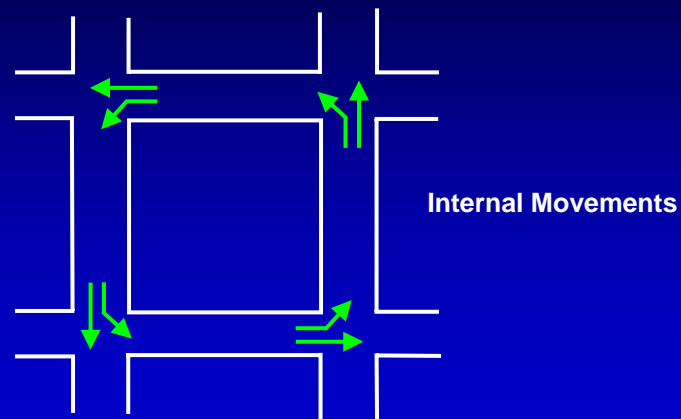


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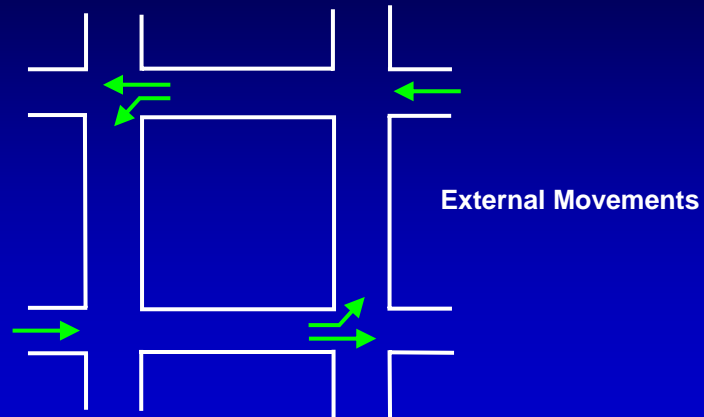
Three Phase Sequence - 1



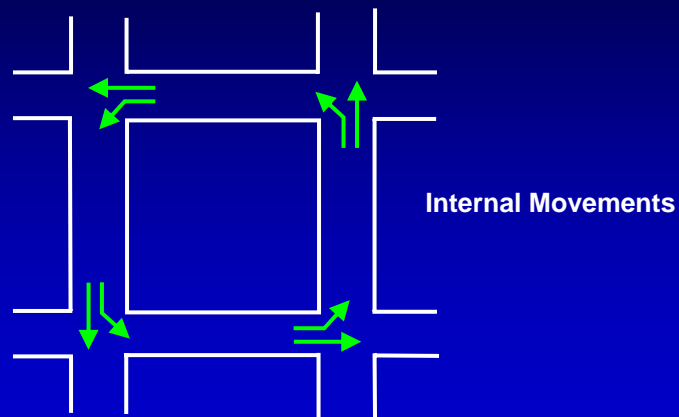
Three Phase Sequence - 2



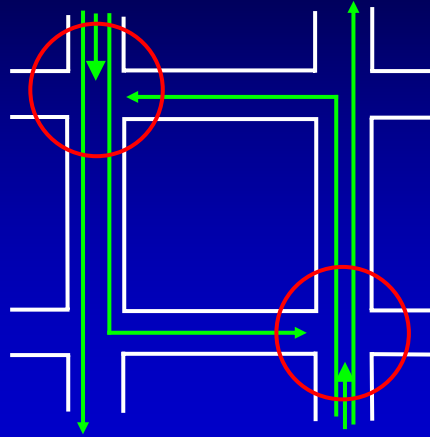
Three Phase Sequence - 3



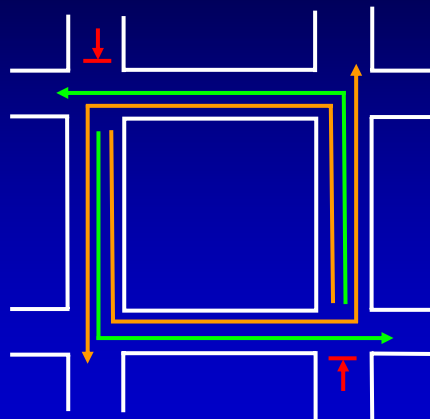
Three Phase Sequence - 4



Three Phase Constraints



Three Phase Movements



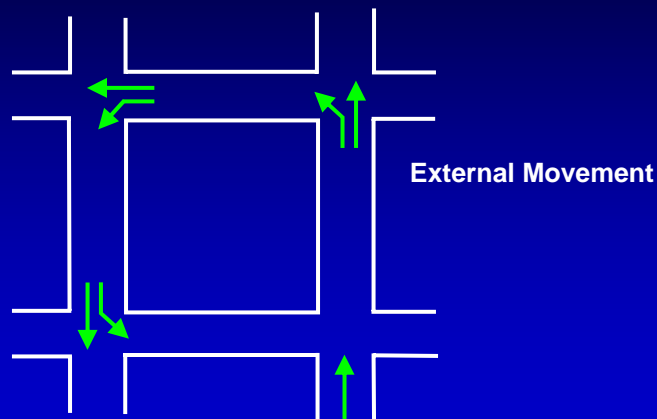
Three Phase - Summary

- Two external approaches operating simultaneously
- Internal clearance phases follow
- Advantages
 - Efficient
 - Maintains progression
 - Smaller cycle length
- Disadvantages
 - Limited in phase length duration
 - Smaller cycle length
- Existing four controller operation is similar to a three phase type operation



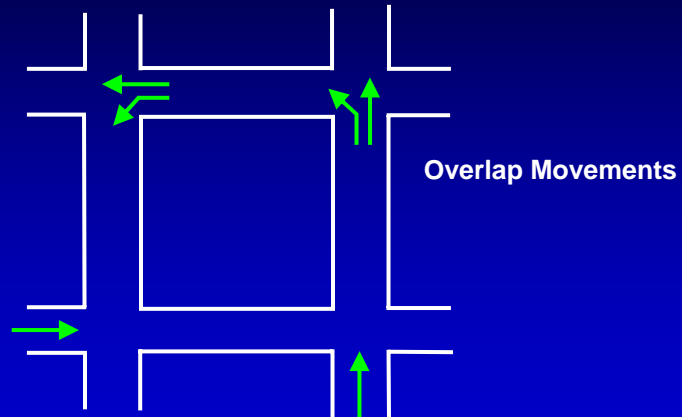
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Four Phase Sequence - 1

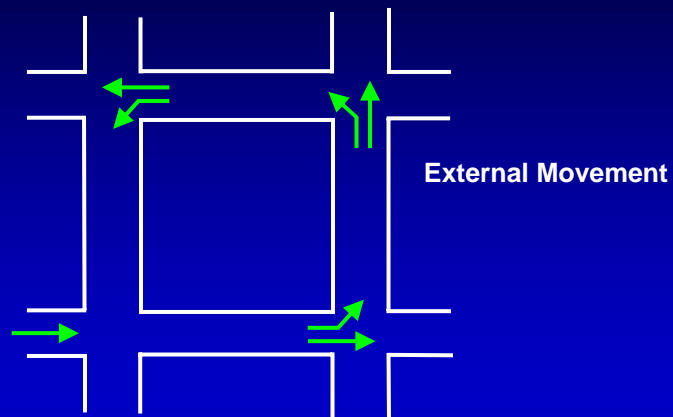


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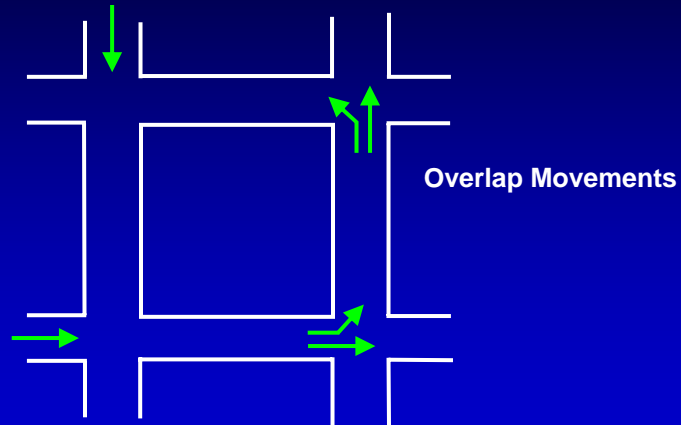
Four Phase Sequence - 2



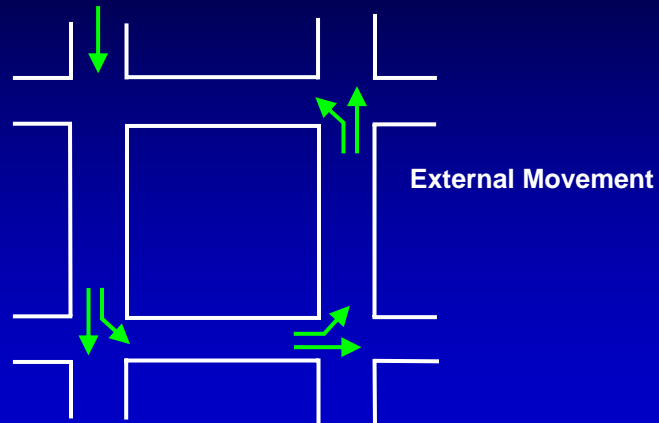
Four Phase Sequence - 3



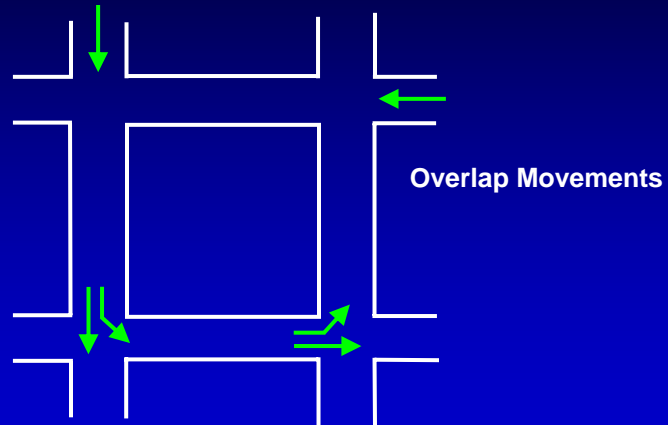
Four Phase Sequence - 4



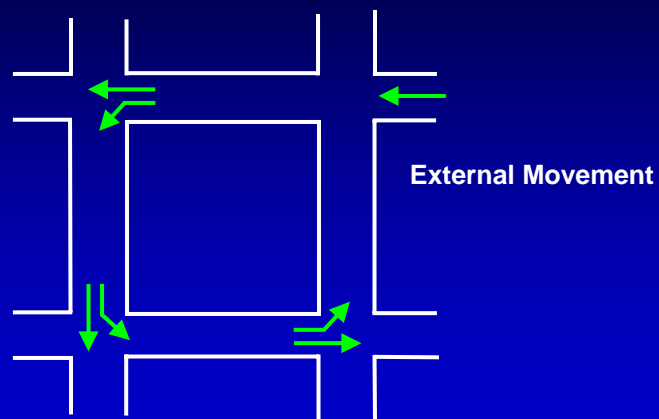
Four Phase Sequence - 5



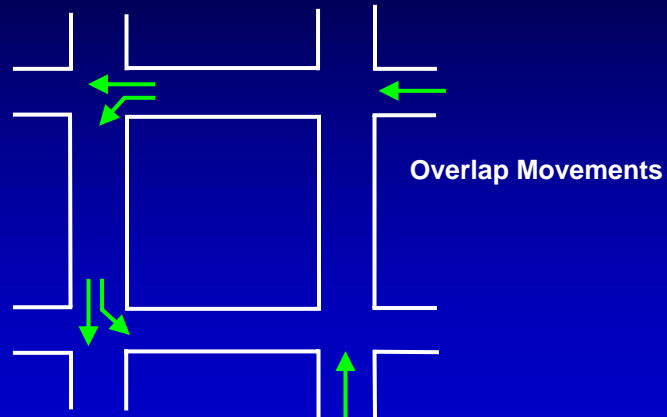
Four Phase Sequence - 6



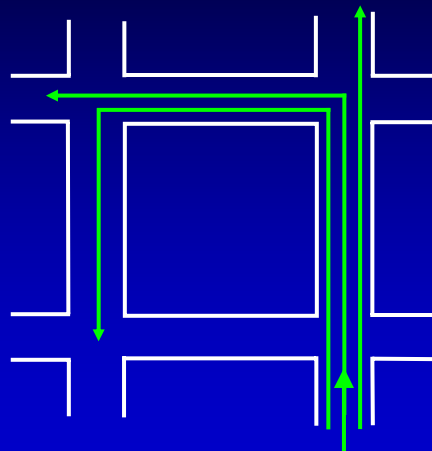
Four Phase Sequence - 7



Four Phase Sequence - 8



Four Phase Movements



Four Phase - Summary

- One external approach operating at a time
- Overlap movements to improve efficiency
- Advantages
 - No constraints on external phase durations
 - Maintains progression
 - Larger cycle length
- Disadvantages
 - Larger cycle length



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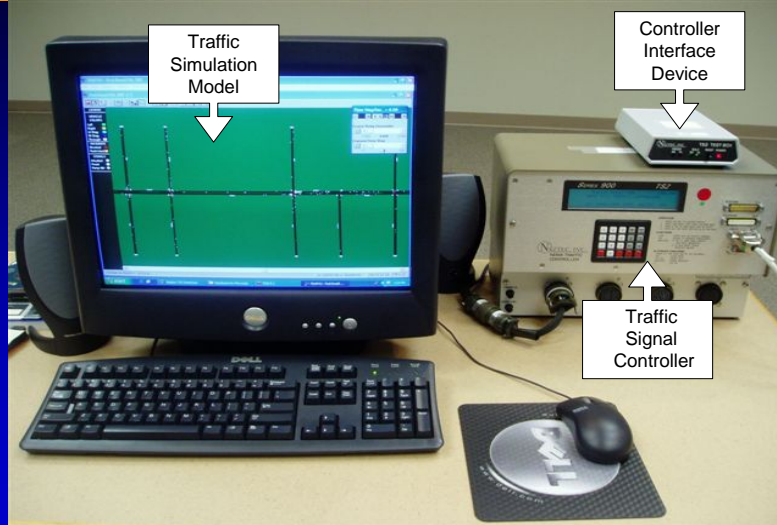
Evaluation Procedure

- Collected volume, geometric, and timing data
- Created a CORSIM simulation model
- Used hardware-in-the-loop simulation
 - Traffic signal controller replaces CORSIM controller
 - Brings realism to simulation



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Hardware-in-the-Loop



HITL Simulation – Four Controllers



HITL Simulation – One Controller



MOE's – Delay (Hours)

	AM Peak	Noon Peak	PM Peak
Existing	42.3	38.5	40.6
Four Phase	39.6	33.7	33.6
Three Phase	43.4	38.9	38.9
Reduction	6.2%	12.5%	17.4%

MOE's – Stops

	AM Peak	Noon Peak	PM Peak
Existing	4747	4366	4325
Four Phase	4522	3698	3736
Three Phase	4307	3709	3794
Reduction	4.1%	7.5%	7.2%



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MOE's – Fuel Consumption (Gal.)

	AM Peak	Noon Peak	PM Peak
Existing	146.0	137.8	138.2
Four Phase	139.9	127.5	128.2
Three Phase	145.7	136.2	136.4
Reduction	4.1%	7.5%	7.2%



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Cycle Lengths (Seconds)

	AM Peak	Noon Peak	PM Peak
Existing	79	70	79
Four Phase	103	104	104
Three Phase	100	80	76

Yearly User Savings

- **Based on 300 days**
 - \$12.50 for each hour of delay reduced
 - \$0.15 for each stop reduced
 - \$2.25 for each gallon of fuel consumption reduced
- **Savings equaled \$275,000 per year**

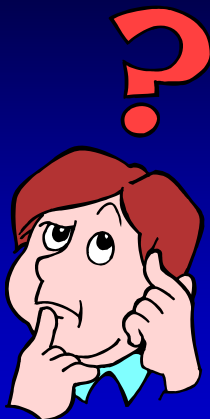
Comparison

- **Single Controller**

- Can operate fully actuated
- Cycle length changes on demand
- Easy to fine-tune the settings
- Need good detection to operate efficiently

- **Four Controller**

- Can operate only coordinated
- Cycle length changes by TOD
- Complicated to fine-tune the settings
- In case of detector failure, will operate to keep the interior clear





3-Level Diamond Signal Operations

Signals at U.S. Highway 84
Frontage Roads and State
Highway 6 Frontage Roads

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February 2, 2007



Outline

- Definition
- Area Traffic Patterns
- Traffic Operations
- Improvements
- Q & A

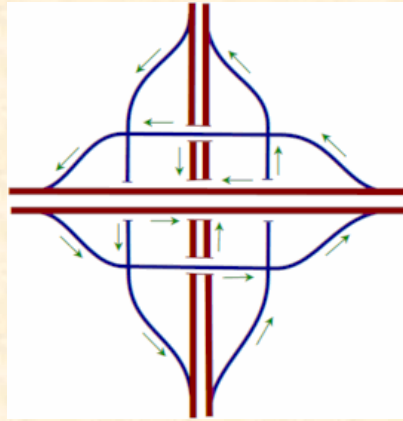
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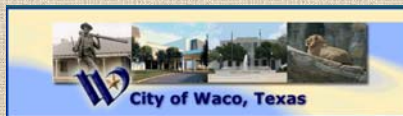


3-Level Diamond Interchange



2005 Aerial

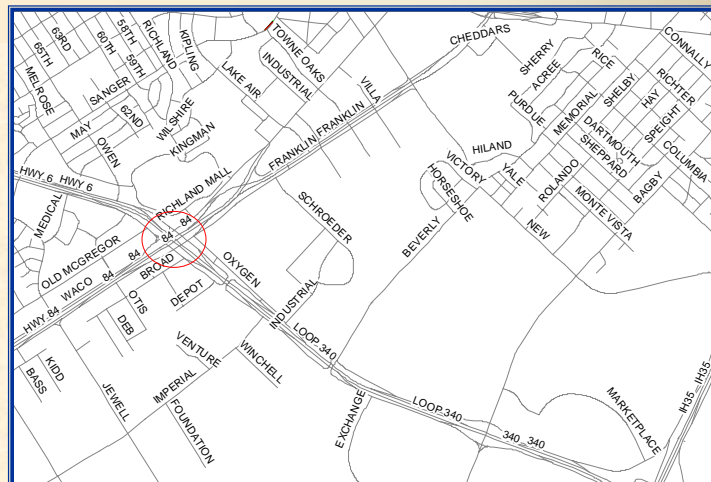
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Area



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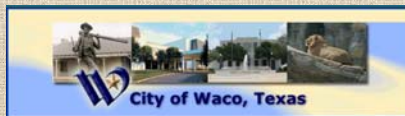
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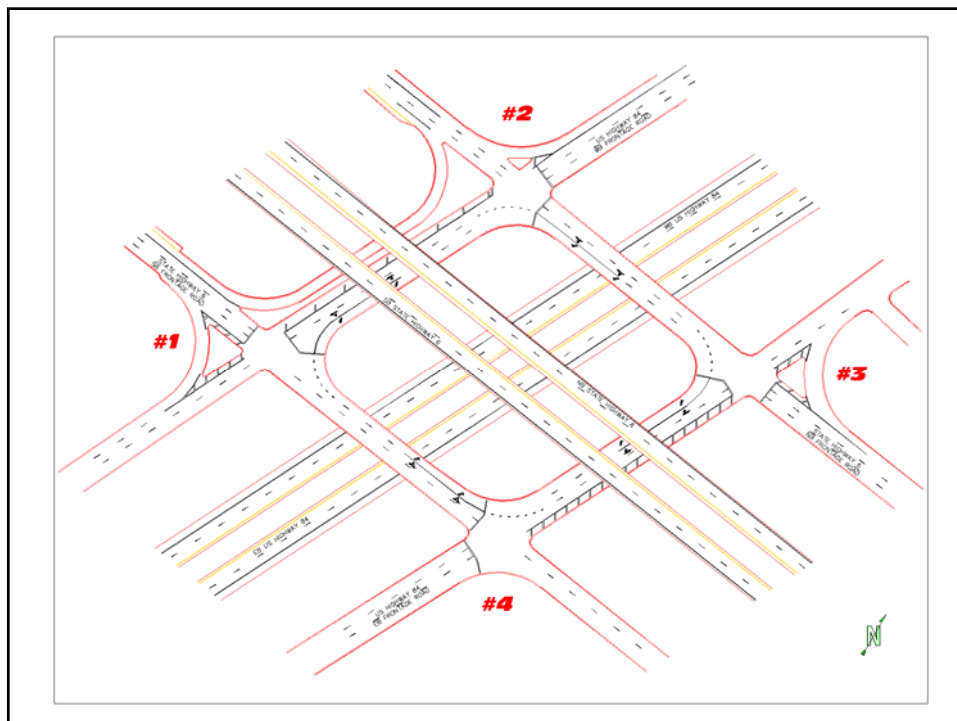
Traffic Operations

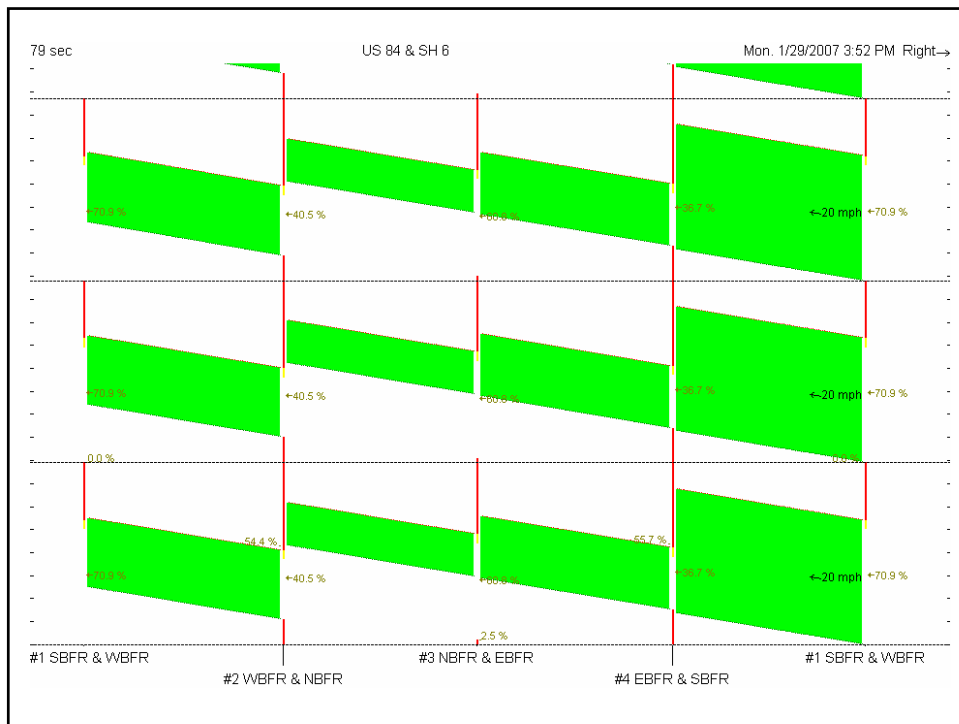
- Four Signals/Four Controllers
- Time Space Diagram
- Basic Philosophy
 - Goals
 - Constraints
 - Rationale
- Is it broken?

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Improvements

- Detection \$7,260
- Signage \$20k - \$30k
- U-Turn Bridge \$1.1 Million*
- Single Controller \$250k - \$350k**

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Potential Guide Signs



Westbound US 84 approach



Southbound SH 6 approach

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Q & A



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