

# 2010 Highway Capacity Manual

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ICRT Ch 26 Chair, 2010 HCM

# 2010 HCM Format / Schedule

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## 2010 Highway Capacity Manual

5<sup>th</sup> Edition

TRB

HCQS

Publicatio

Contact

Research

### Highway Capacity Volumes

1. Concepts
2. Uninterrupted Flow Facilities
3. Interrupted Flow Facilities
4. Applications Guide

### Updates

- NEW** **Chapter 26 (Adopted):** Interchange Ramp Terminals
- NEW** **Chapter X (Evaluation Copy):** Local Urban Streets
- NEW** **NCHRP Report XXX:** Analysis of Freeway Weaving Sections

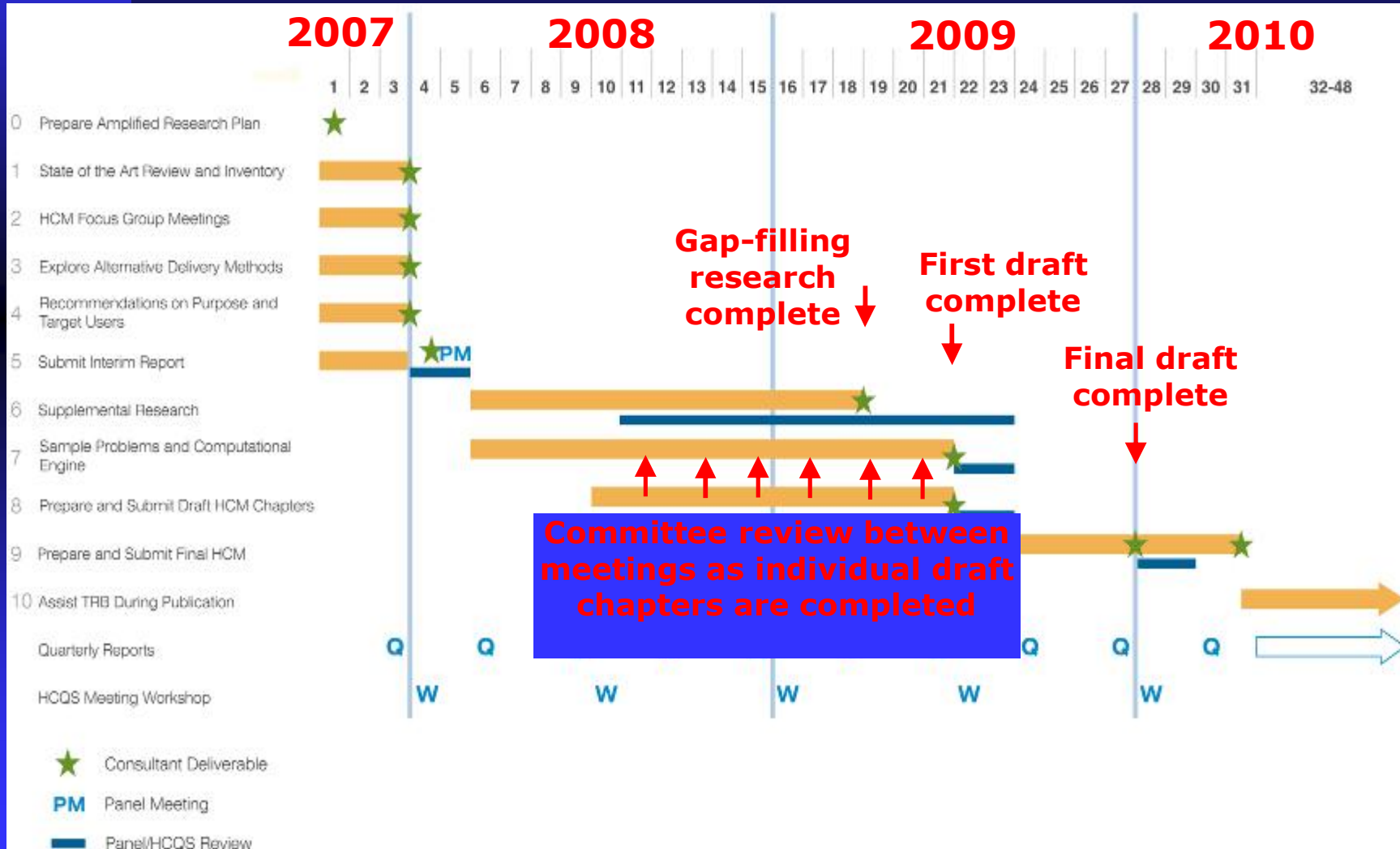


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# NCHRP 3-92 Project Schedule



# Incorporation of New Research

- **NCHRP 3-60 (Interchange Ramp Terminals)**
- **NCHRP 3-64 (HCM Applications Guide)**
- **NCHRP 3-65 (Applying Modern Roundabouts in the United States)**
- **NCHRP 3-70 (Multi-Modal Arterial Level of Service)**
- **NCHRP 3-75 (Analysis of Freeway Weaving)**
- **NCHRP 3-79 (Predicting Travel Speeds for Urban Streets)**
- **NCHRP 3-82 (Default Values for HCM)**
- **NCHRP 3-85 (Guidelines for the Use of Alternative Traffic Analysis Tools)**
- **NCHRP 20-7 (Two-lane Highways)**
- **TCRP A-15A (Transit Capacity and Quality of Service – 2<sup>nd</sup> Edition)**
- **NCHRP 3-92**
  - ◆ **Signalized Intersection Methodology (New Delay Method and Structure Changes reflecting Modern Actuated Control)**
  - ◆ **Gap Acceptance for Six Lane Two-Way Stop Controlled Intersections**
  - ◆ **75 Mph Speed Flow Curve for Freeways**

# Roundabouts

# 2010 HCM - Roundabouts

- Roundabouts: Need for improved HCM procedure
- •Anchor to empirical U.S. performance
- •Ability to analyze multilane roundabouts
- •Able to be calibrated to local and/or changing conditions

# Roundabouts – Key Findings

- Key Operational Findings from NCHRP 572
- •U.S. roundabouts currently exhibit lower capacities than observed in other countries
- •Capacity clearly sensitive to geometry in the aggregate (number of lanes)
- •Secondary effects of geometry on capacity (e.g., lane width, diameter) masked by variations in driver behavior
- •Lane-by-lane analysis of multilane roundabouts needed



# Roundabouts – Procedure

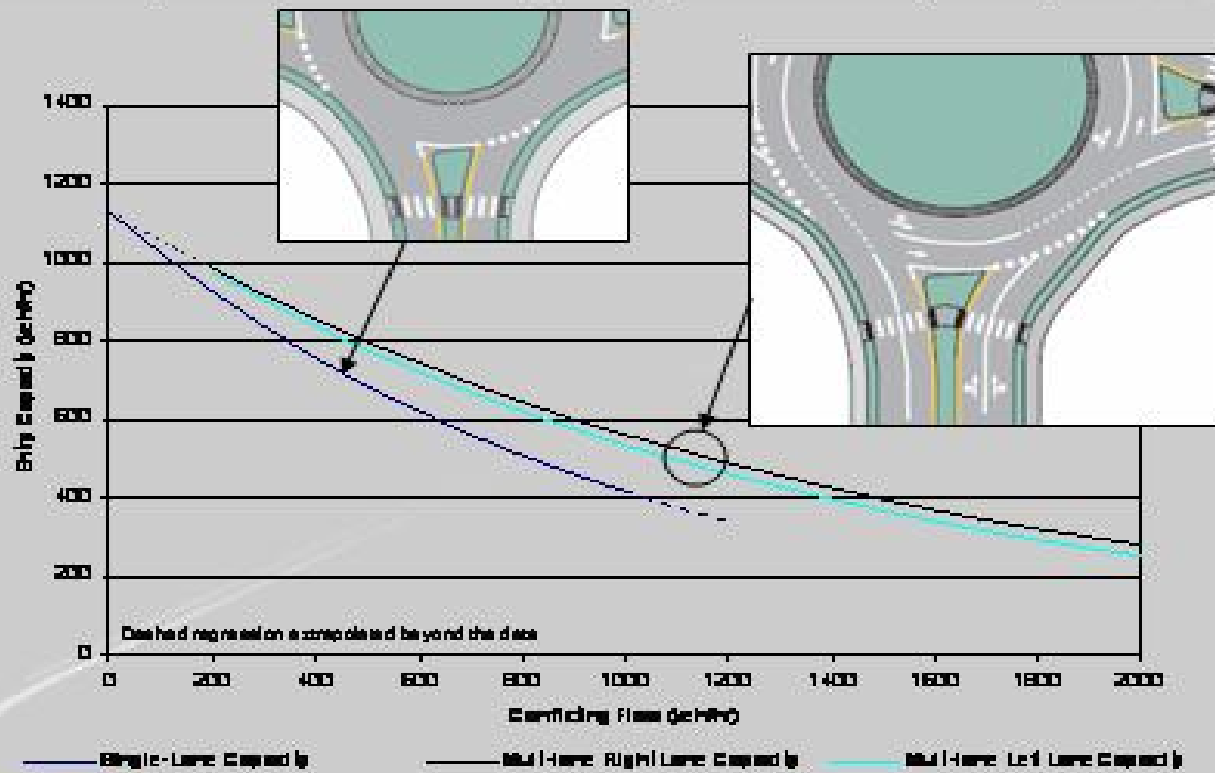
- •Can be calibrated to locally measured critical headway and follow-up headway
- •Sensitive to turning movement assignment to individual lanes
- •Sensitive to lane utilization
- •User has ability to assign traffic by lane to match existing or projected conditions
- •Right-turn bypass lanes
  - ◆ –Type 1: Yielding
  - ◆ –Type 2: Non-yielding (acceleration or add lane)
- •PCE adjustment for heavy vehicles
- •PHF adjustment for peak 15-minute flows
- •LOS definitions

# Roundabouts – Alternative Tools

- •2010 HCM will explicitly recognize that HCM procedures are not the only way to analyze problems
- •Applicability of alternative tools to roundabouts
  - –Geometric configurations not included in model
  - –Oversaturated conditions requiring multiple-period analysis
  - –Interaction effects with other intersections
- •Overview of characteristics of applicable alternative tools for roundabouts
  - –Deterministic tools (e.g., SIDRA, RODEL)
  - –Simulation (e.g., VISSIM)
- •Need for calibration

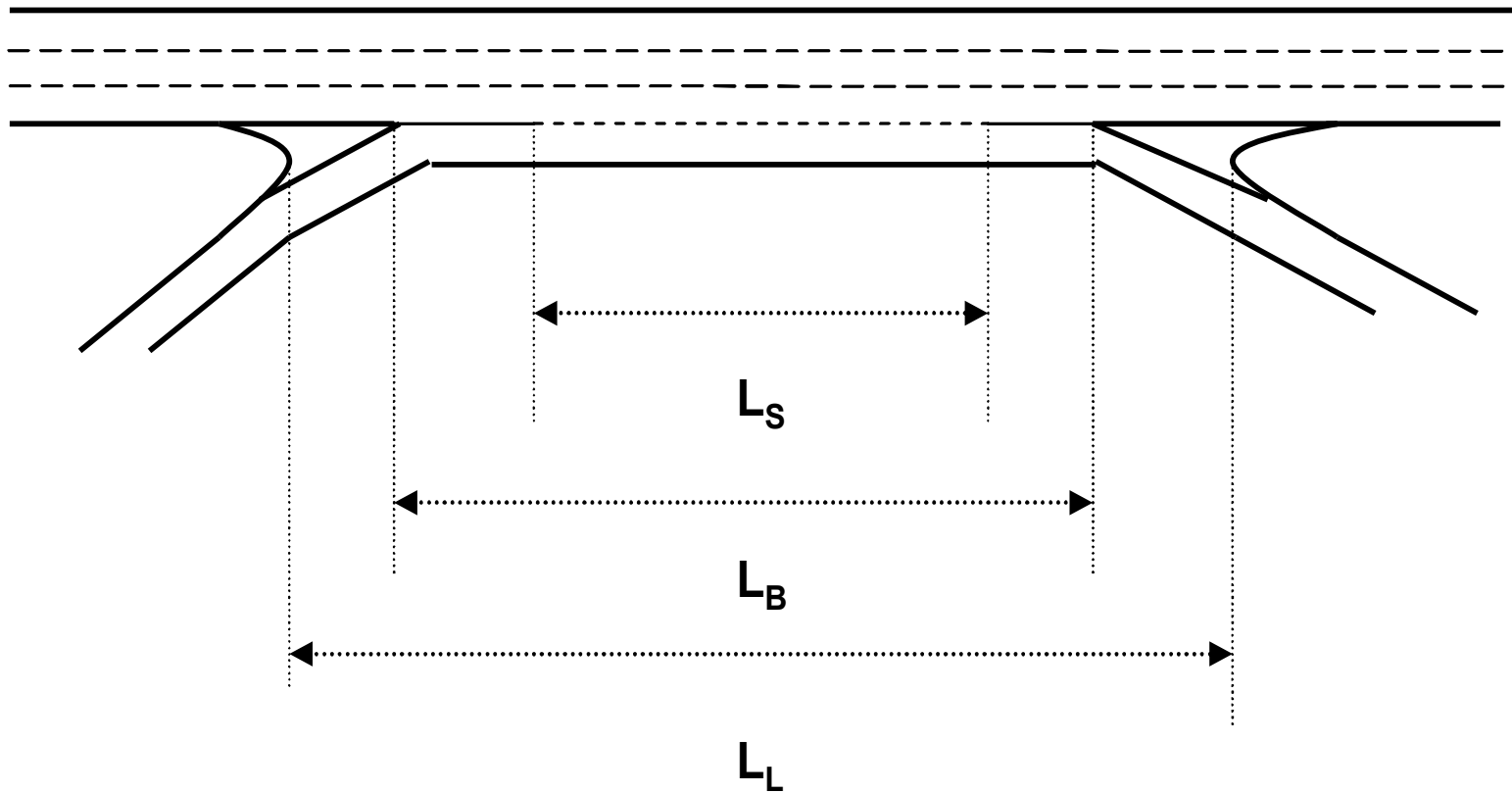
# Roundabouts

Proposed HCM capacity models (cont.)



# Weaving

# WEAVING - A New Way to Measure Length



## WEAVING - No More:

Configuration Types (A,B, and C)  
Unconstrained vs. Constrained Operation

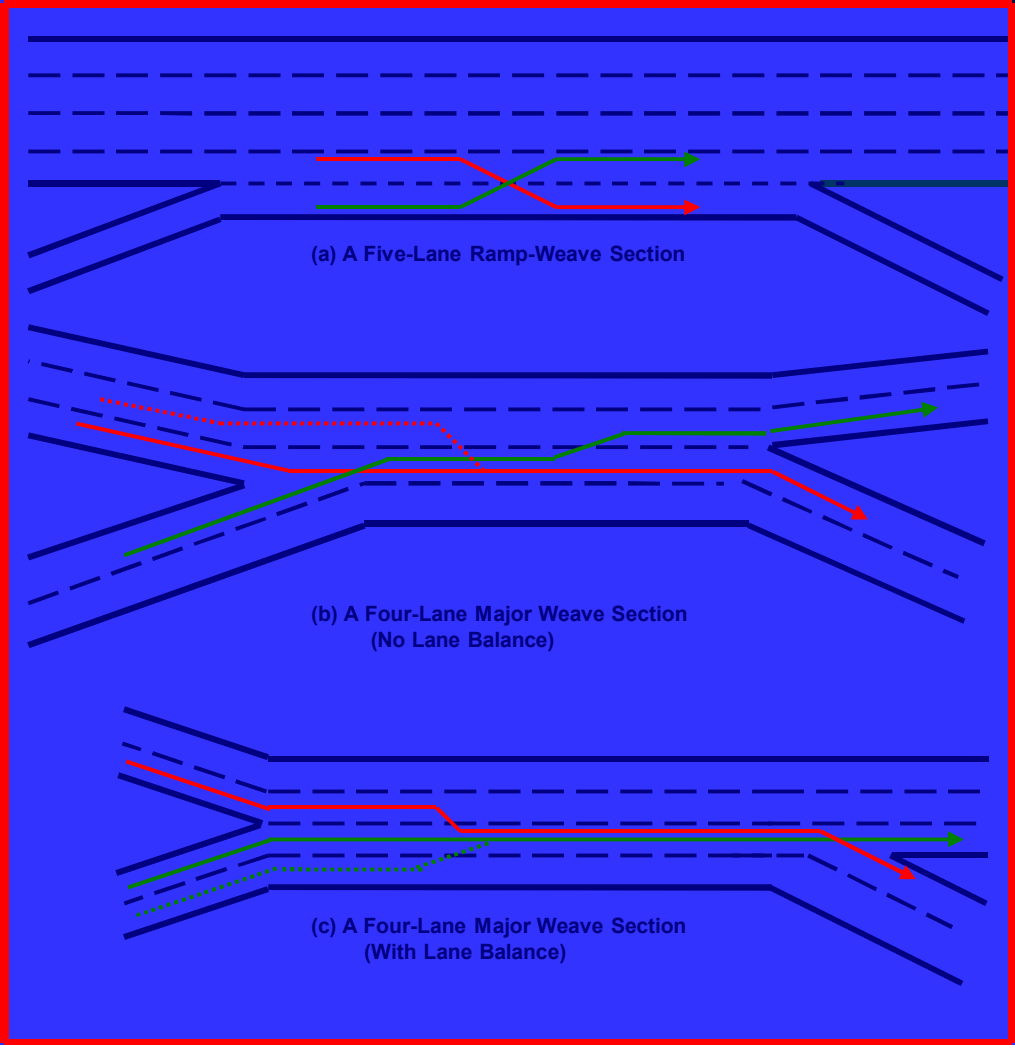
### New Variables Describing Configuration:

$LC_{MIN}$  = minimum number of lane changes for all weaving vehicles to successfully complete their desired weaving maneuvers.

$N_{WL}$  = number of lanes *from which* a weaving maneuver can be made with no more than one lane change.

Two-Sided Weaving Segments Considered as a Special Case

# Examples of Configuration Parameters



## Determine the Capacity of the Weaving Section

### Two Controls on Capacity

Capacity of the weaving section occurs at a point where the average of all vehicles in the section reaches 43 pc/mi/ln.

Capacity of the weaving section occurs at a point where the weaving vehicle demand flow rate reaches:

2,400 pc/h for cases in which  $N_{WL} = 2$

3,500 pc/h for cases in which  $N_{WL} = 3$

If  $c_w < v$ , Level of service F exists.

If  $c_w \geq v$ , continue to estimate speeds, densities, and LOS.



$$D = \frac{v / N}{S}$$

### Level of Service Criteria:

LOS	Density (pc/mi/ln)	
	Freeway Weaving Sections	Weaving Sections on C-D Roadways or Multilane Highways
A	0 – 10	0 – 12
B	>10 – 20	> 12 – 24
C	> 20 – 28	> 24 – 32
D	> 28 – 35	> 32 – 36
E	> 35	> 36
F	v/c > 1.00	

# Urban Streets

# Vision for Chapter 15



## ■ Scope

- ◆ Urban street segment and facility evaluation
- ◆ Auto, bike, and pedestrian modes
- ◆ Recognize that sophisticated software tools are available and better suited to some applications

## ■ Attributes

- ◆ Useful to planner, designer, traffic engineer

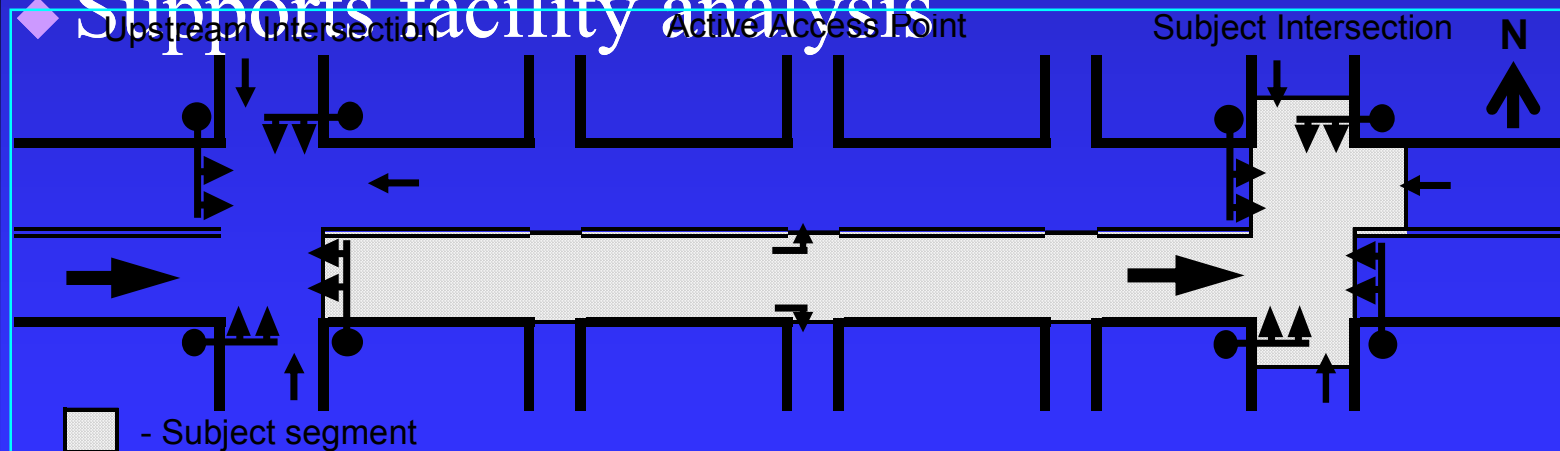
## ■ Pedestrian and Bike Methodology

- ◆ Developed by NCHRP Project 3-70

# Automobile Methodology

## ■ Analysis Unit

- ◆ Segment
- ◆ Includes all movements at signals NEW!
- ◆ Can include movements at access points NEW!
- ◆ Supports facility analysis



# Methodology

- Actuated Phase Duration Prediction
  - ◆ Controller operation inputs
    - ◆ Simultaneous gap-out
    - ◆ Dallas phasing
  - ◆ Controller phase inputs
    - ◆ Passage time
    - ◆ Minimum green
    - ◆ Recall
    - ◆ Dual entry
  - ◆ HCM Chapter 16 -Appendix B



# Methodology

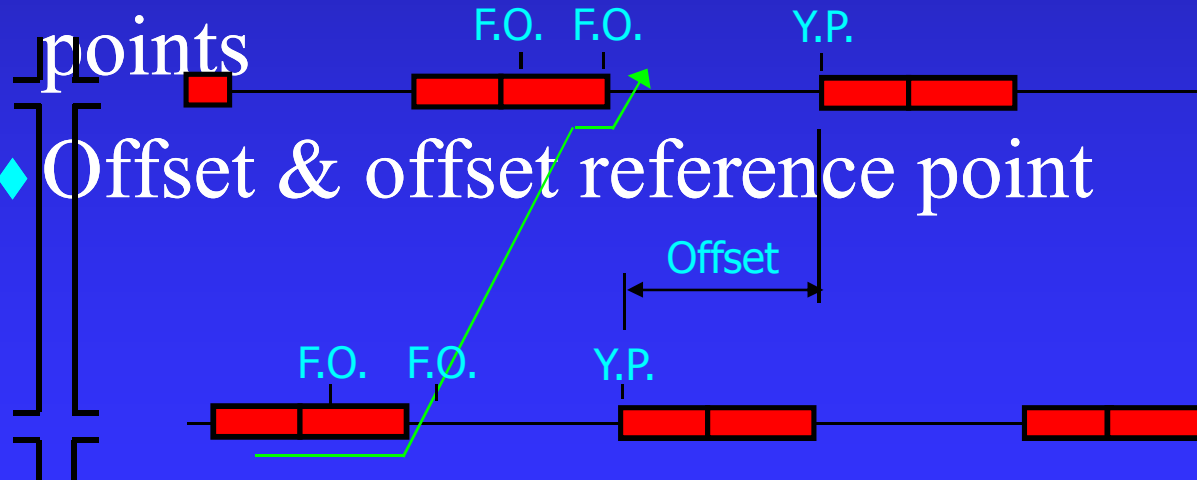
## ■ Coordinated-Actuated Operation



### ◆ Controller inputs

◆ Force mode

◆ Splits → used to estimate force off & yield



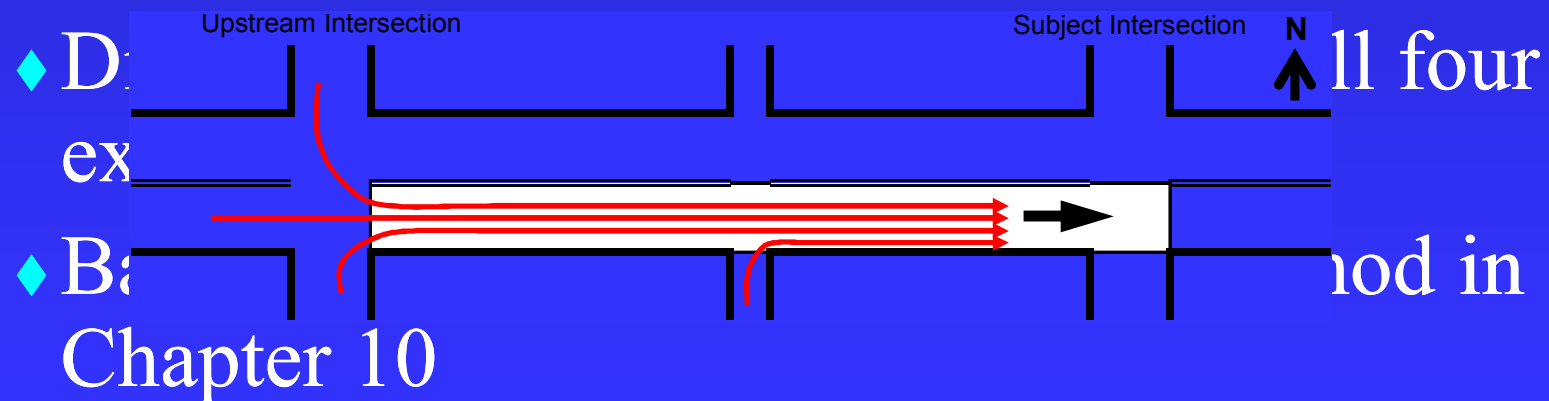
◆ Offset & offset reference point

# Methodology



## ■ Arrival Flow Profile Prediction

- ◆ Computes adjusted volume
  - ◆ Balance flows between junctions
  - ◆ Check and honor capacity constraints to entry flows
- ◆ Computes O-D matrix



# Methodology

## ■ Spillback Prediction



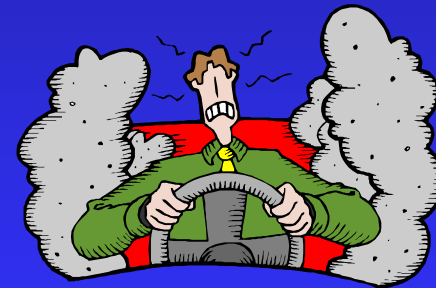
- ◆ Sustained queue backs up for length of segment
- ◆ Model prediction
  - ◆ Identify time when spillback occurs
- ◆ Uses
  - ◆ Indicates green needs to be better allocated
  - ◆ Indicates simulation should be considered





# Performance Measures

- Average travel speed
- Control delay
- Stop rate 



# Interchange Ramp Terminals

# Highway Capacity Manual Chapter Interchange Ramp-Terminals



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# Background - Purpose 360:

- New Interchange Chapter:
  - ◆ Develop Accepted Analytic Procedure
  - ◆ Single and Dual Intersection Interchanges
  - ◆ SPUI's, Diamonds, Par-Clo's

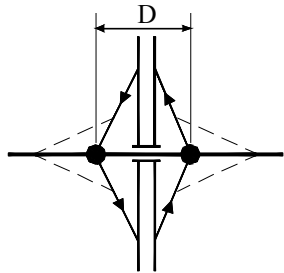
# Chapter 26 – Major Changes:

- **Identify a Process to Analyze Interchanges**
- **Level of Service Changed to Reflect Experience**
  - ◆ **Single or Multi-Intersection Device**
  - ◆ **More Complicated than Intersection Analysis**
  - ◆ **More Delay than Typical Intersections**
- **Origin-Destinations Important**
- **Operational Impacts of Intersection Spacing**
- **Lane Utilization (Particularly Left-Turns)**
- **Demand Starvation (Unused Green)**
- **Interchange Selection Process**

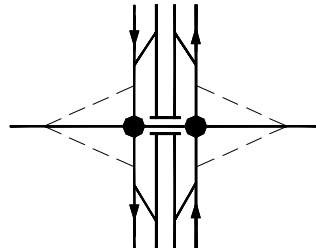
# Chapter 26 – Why Needed?

- No Guidance Today
- Pandora's Box of Procedures Used
  - ◆ HCM, Intersections
  - ◆ Simulation
  - ◆ Others
- No Uniform Method to Check Against
- Results
  - ◆ Good?
  - ◆ Bad?
  - ◆ Reliable?
- Cost \$30M & Up, Based on Unfounded Analysis

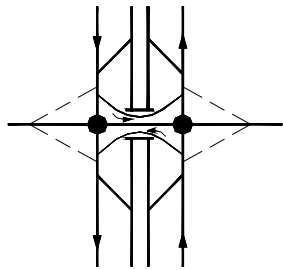
# Types of Interchanges



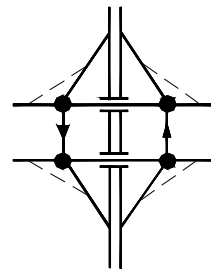
Conventional,  $D > 800$  ft  
Compressed,  $D \approx 400-800$  ft  
Tight Urban,  $D < 400$  ft



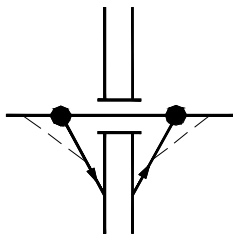
Diamond with continuous frontage roads



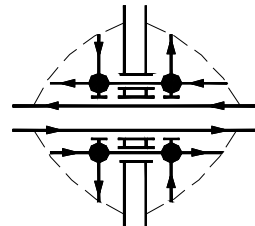
Diamond with U-turn lanes and service roads



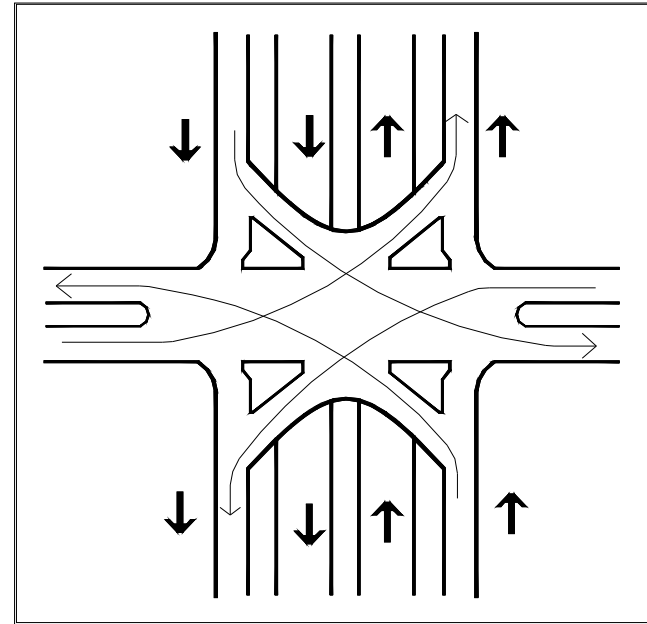
Split diamond interchange  
(cross roads, one- or two- way)



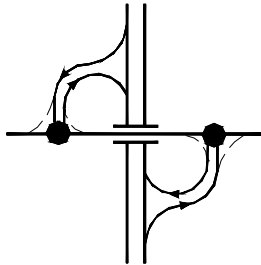
Partial (half) diamond interchange



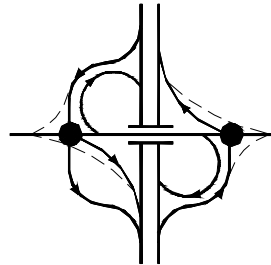
Three-level diamond interchange



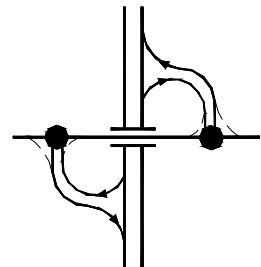
# Types of Interchanges (cont'd)



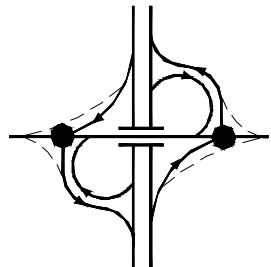
Parclo A, 2 Quadrants



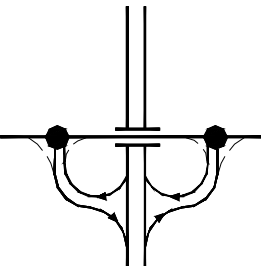
Parclo A, 4 Quadrants



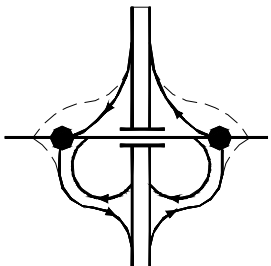
Parclo B, 2 Quadrants



Parclo B, 4 Quadrants



Parclo AB, 2 Quadrants



Parclo AB, 4 Quadrants



# Unique Operational Characteristics of Interchanges

EXHIBIT 26-4. ILLUSTRATION AND NOTATION OF ORIGIN-DESTINATION DEMANDS AT AN INTERCHANGE

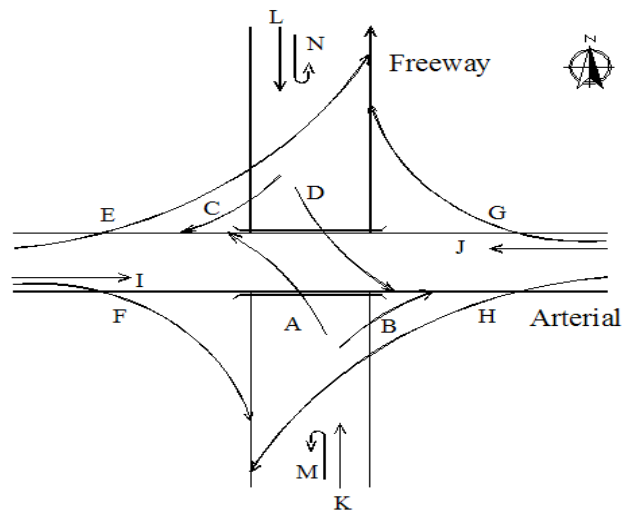
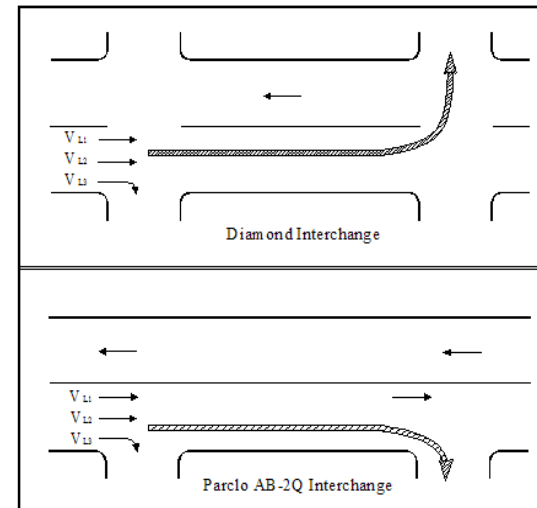


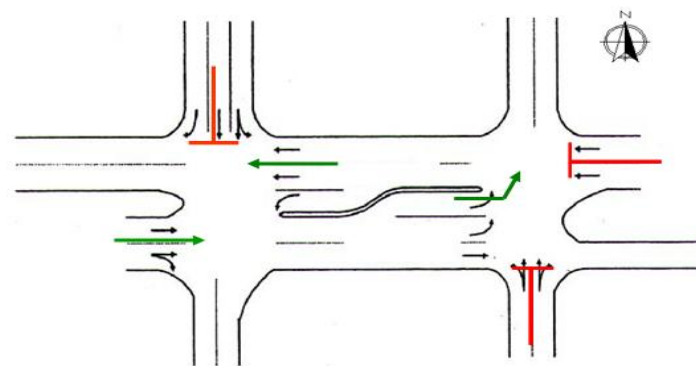
EXHIBIT 26-7. LANE UTILIZATION FOR THE EXTERNAL THROUGH MOVEMENT



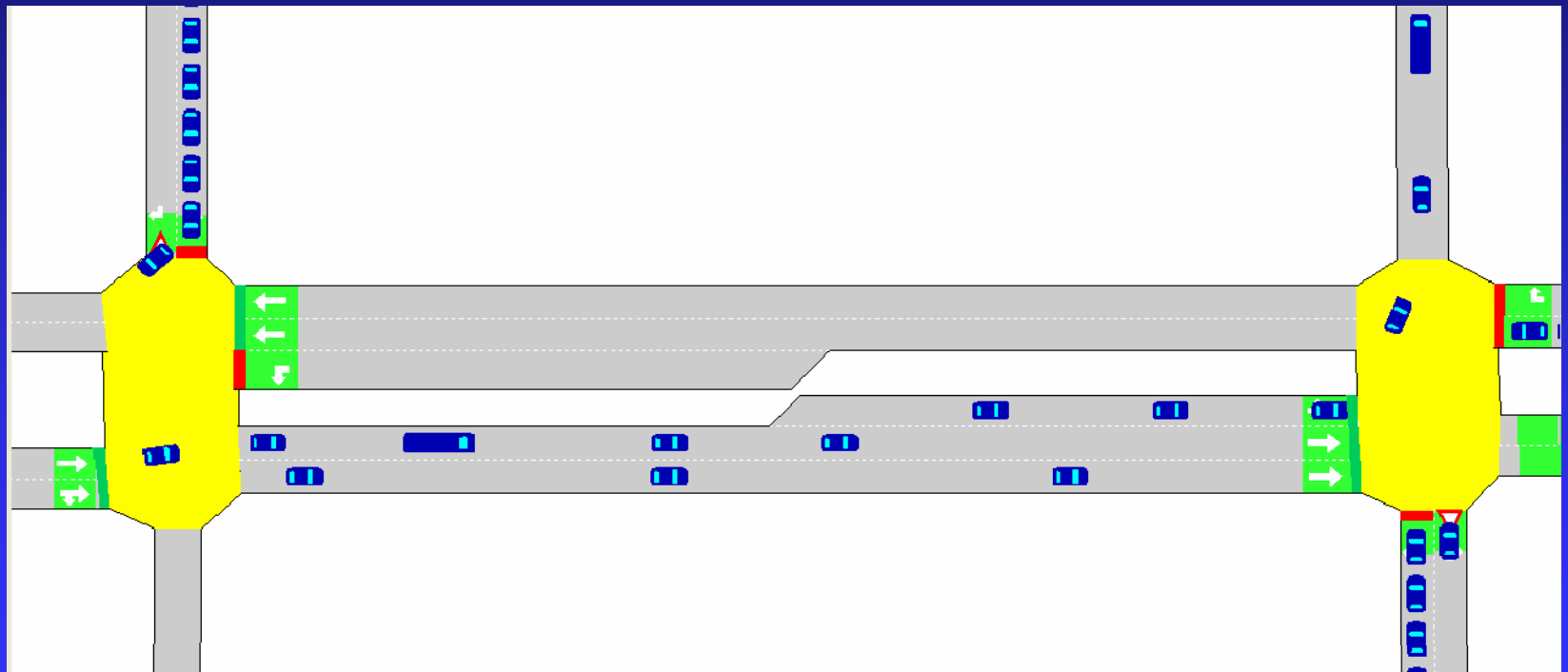
# Unique Operational Characteristics of Interchanges (cont'd)

- Queue presence in the internal link
- Distance between the two intersections.
- Demand starvation potential.

EXHIBIT 26-8. DEMAND STARVATION AT THE INTERNAL LINK OF A DIAMOND INTERCHANGE



# Demand Starvation



# Level of Service Framework

<u>LOS</u>	<u>Delay</u>
A	<15
B	15-30
C	30-55
D	55-85
E	85-120
F	$V/C > 1.0, Rq > 1.0$

# Performance Measures and LOS

- Average Queue Storage Ratio for each lane group
- V/C for each lane group
- Average Control Delay for each lane group, and for each Origin-Destination
- **LOS determination based on Origin-Destinations**

# Next Steps

- HCS+ Now Incorporates Interchanges
- NCHRP 3-60 Extension
  - Collecting Additional Field Data
  - **Incorporate Nearby Intersections**
  - **Include 3-65 Roundabouts**
- HCM 2010 to incorporate New Interchange Method

