Highway Capacity Manual Methodologies for Corridors Involving Freeways and Surface Streets

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CAMBRIDGE SYSTEMATICS

INTRODUCTION

- The Highway Capacity Manual (HCM) has been a historical reference on traffic engineering for planning and operational analysis;
- HCM is traditionally strong on facility-based measures, which is useful for agencies to identify critical points and bottlenecks;
- Lack of a methodology for performance of corridors comprising multiple adjacent facilities;

OBJECTIVES

- Develop a set of common performance measures to evaluate corridors with multiple different facilities;
- Provide methods to evaluate the quality of trip as perceived by the user;
- Integrate the existing HCM methodologies for different facilities;
- Evaluate how congestion propagates from one facility to another (queue spillback).
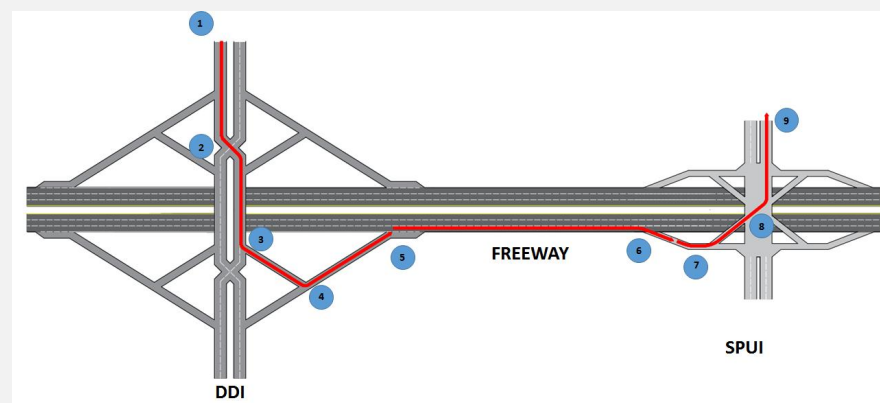
Sample corridor with defined origin and destination and multiple facilities

REVIEW OF HCM METHODS

- Different Level of Service (LOS) criteria for each facility:
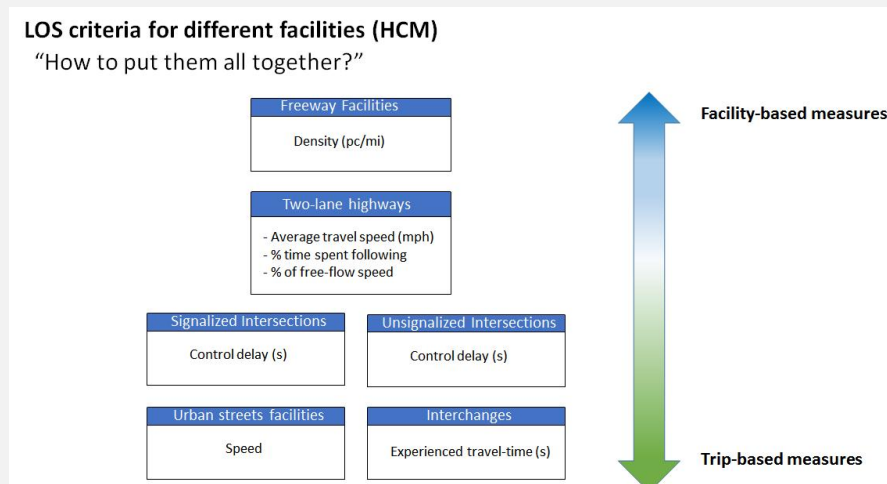
*Representation of LOS criteria for HCM facilities*

- Interface between adjacent facilities is not addressed by current method: how does congestion propagate from one facility to another?
  - Queue spillback from freeways into urban streets;
  - Queue spillback from urban streets into freeways.

- Only one LOS range (F) is used to define congested conditions, which does not accurately represents how user evaluate the quality of trip.

RECOMMENDED PERFORMANCE MEASURES

- A mix of facility-based and trip-based measures must be considered for a full system analysis

- Travel-time based measures, including Travel Time Reliability, are considered the most suitable for evaluating the quality of trips:

$$\text{Travel Time Index} = \frac{\text{Actual travel time}}{\text{Free–flow travel time}}$$

- Lane speed variability must be considered, since the set of lanes used in a trip varies according to a series of factors, to be investigated during data collection:
  - Lane speed / flow variability
  - Facility length / user distance from entry/exit points
  - Presence of a queue spillback into freeway / work zones / lane closures
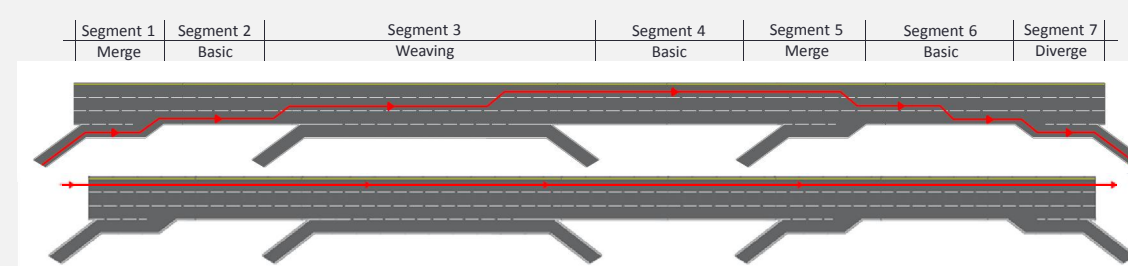
How different would travel times be between the two routes?

METHODOLOGY ADJUSTMENTS

IMPACT OF QUEUE SPILLBACK FROM FREEWAYS INTO URBAN STREETS
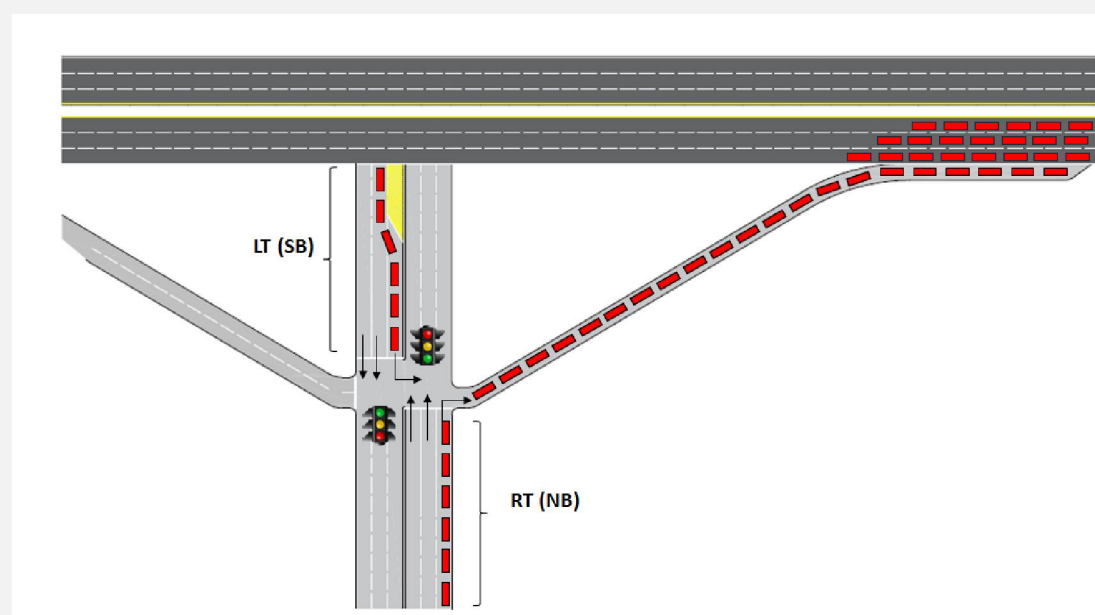
*Impact of an onramp queue spillback into a typical diamond intersection*

Adjustment of effective green time (g') on upstream intersection, as function of:
- Number of affected lane groups
- Cycle phasing
- Discharge rate at freeway x arrival rate at the intersection movements

METHODOLOGY ADJUSTMENTS

IMPACT OF QUEUE SPILLBACK FROM URBAN STREETS INTO FREEWAYS

- Influence area of ramps is altered by the presence of a queue spillback;
- Capacity on diverge segments is reduced by an adjustment factor CAF, function of:
  - Number of lanes outside influence area
  - Queue lenght
  - Spillback regime
  - Driver aggressiveness
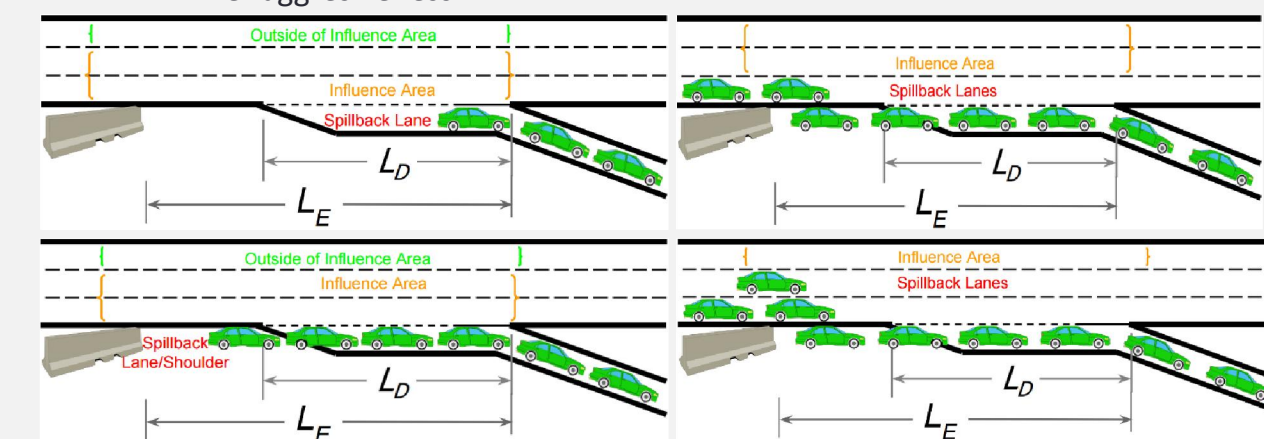
Proposed spillback regimes for queue spillback into freeways (source: ARMSTRONG)

- Impacts of queue spillback are different for each freeway lane
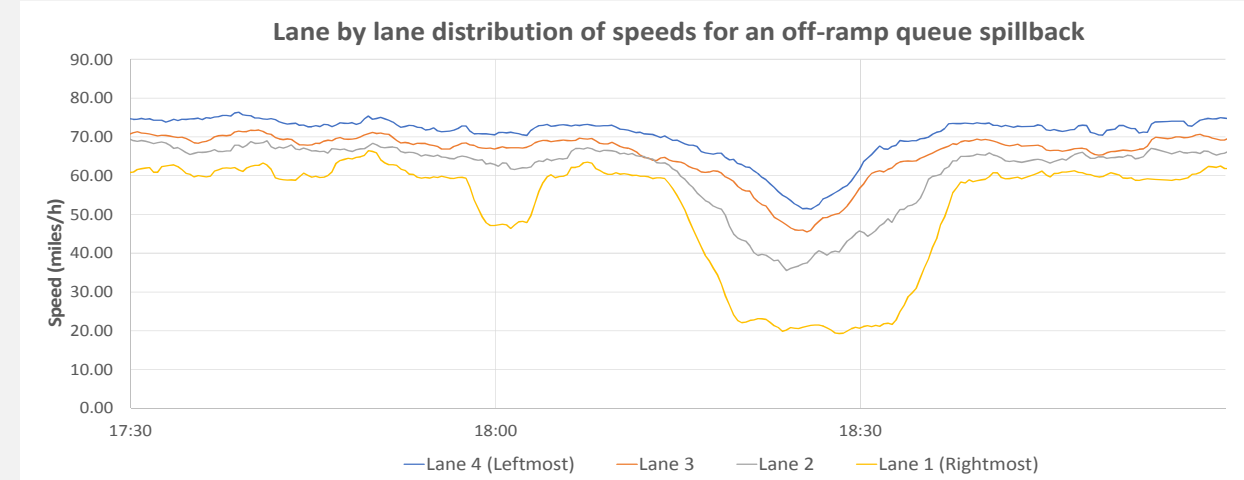
Sample observation of speeds during off-ramp congestion (I-295, Jacksonville/FL)

CONCLUSIONS

- Trip-based measures are a logical step in evolution of HCM, and its relevance tends to grow rapidly as more data becomes accessible from the development of new technologies (GPS data, connected/autonomous vehicles, etc);
- An apropriate evaluation of how congestion propagates between adjacent facilities is essential for an effective corredor performance evaluation;
- Data will be colected to validate and calibrate the proposed adjustment to the methodology.

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