

# Freeway Traffic Demand Under Oversaturated Conditions

Honglong Li, Ph.D  
Chris Wellander  
Shenghong Li

**PB Americas, Inc**

2<sup>nd</sup> International Symposium on Freeway and Tollway Operations

Honolulu, Hawaii

June 24, 2009









Playback Time

7:12A 7:06:40A 7:12A

St

▶ ▶ STOP ▶ ▶

◀ ◀ ▶ ▶

C&C Co

Simulating

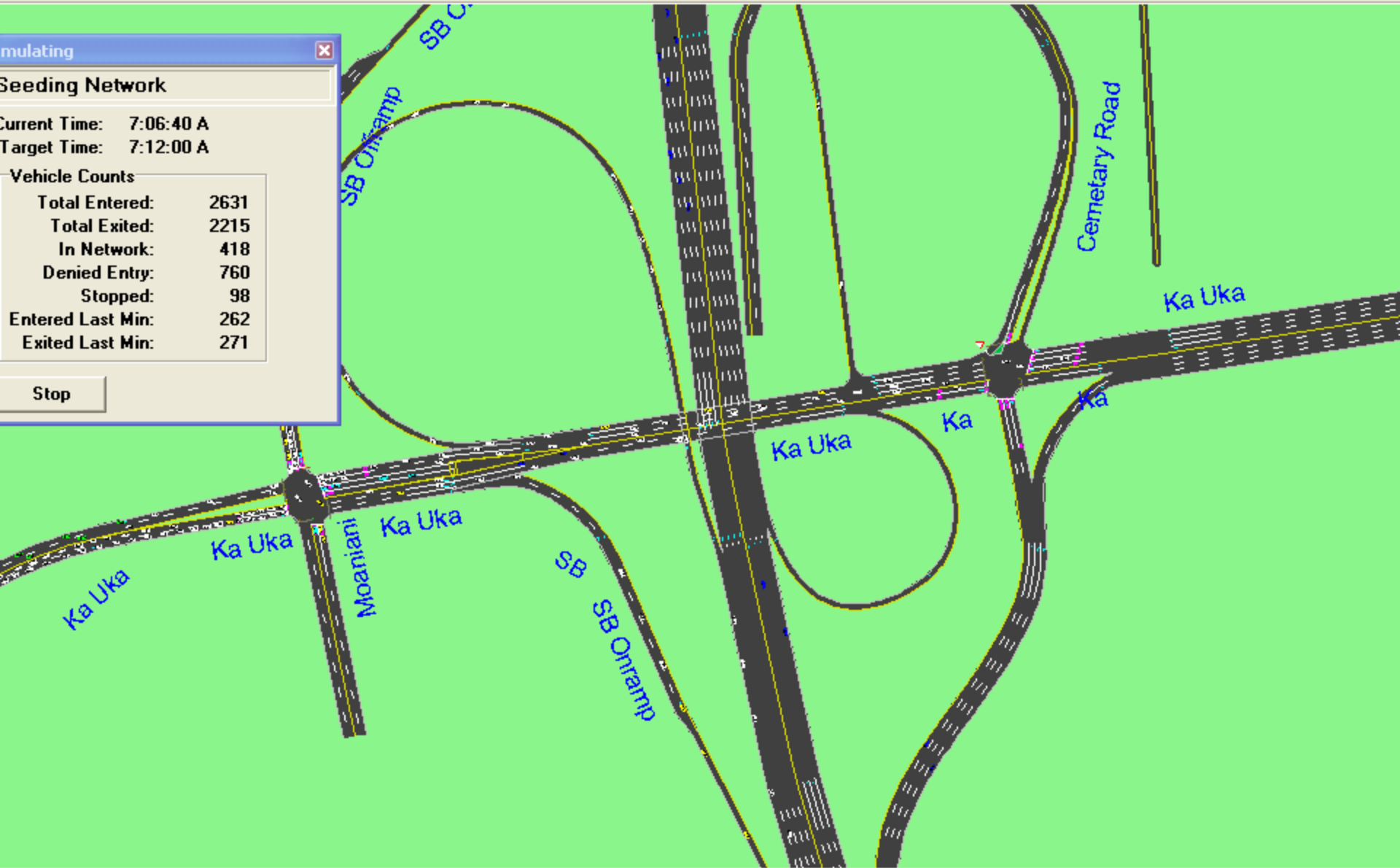
### Seeding Network

Current Time: 7:06:40 A  
Target Time: 7:12:00 A

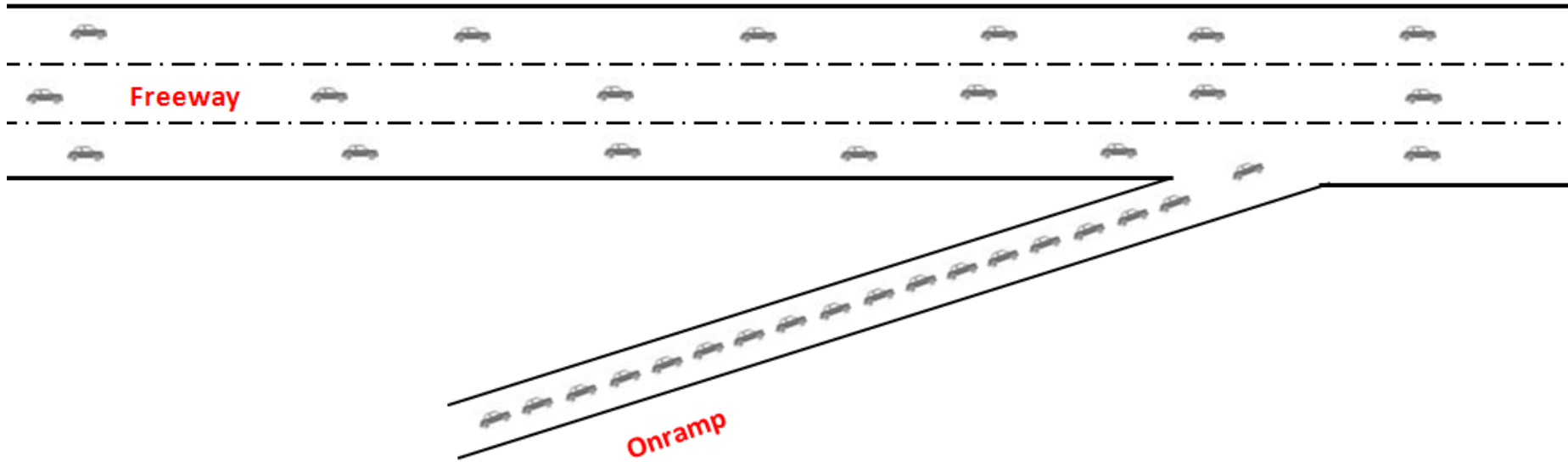
#### Vehicle Counts

Total Entered:	2631
Total Exited:	2215
In Network:	418
Denied Entry:	760
Stopped:	98
Entered Last Min:	262
Exited Last Min:	271

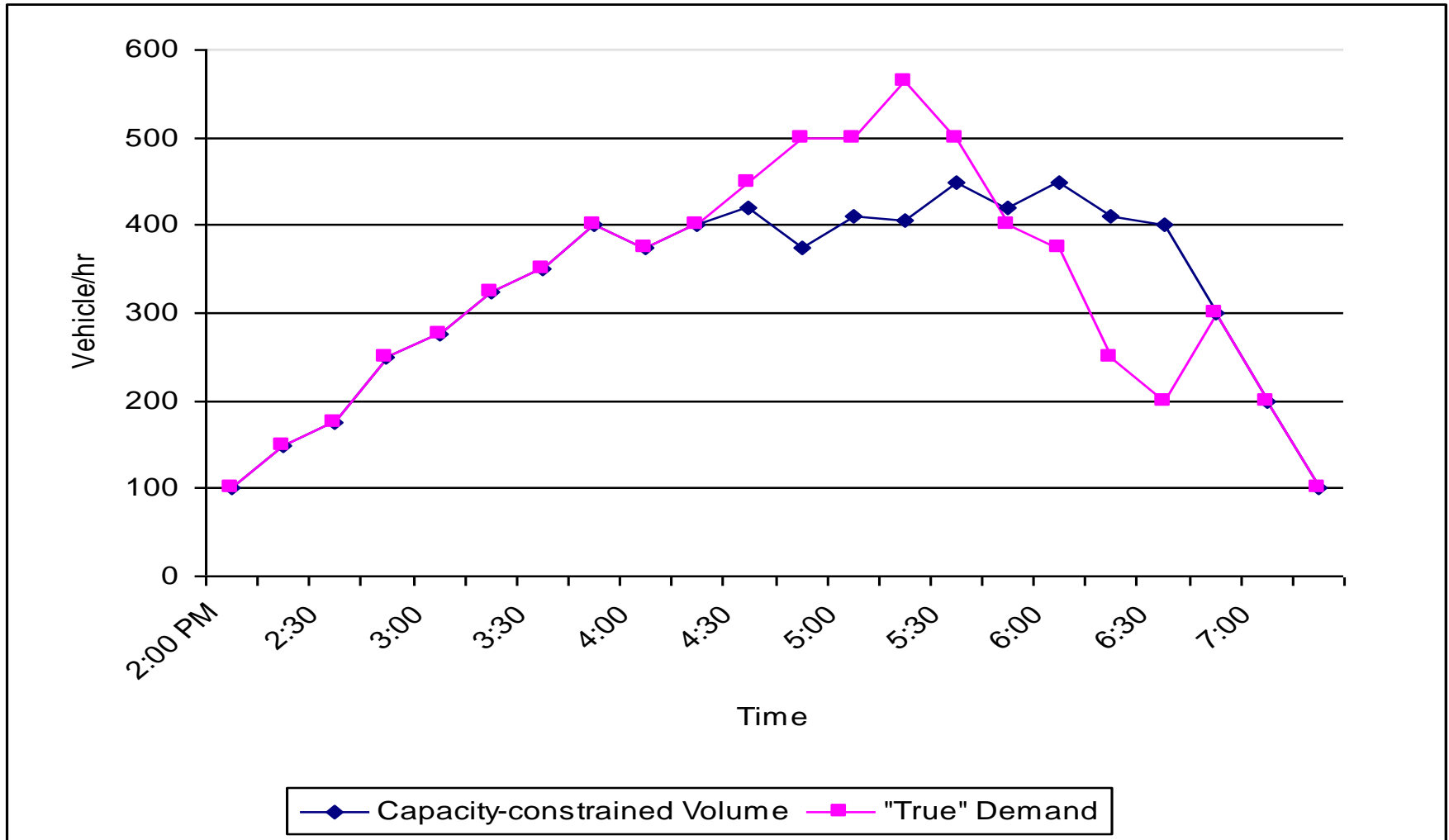
Stop



# Cause of Queuing



# Capacity-constrained Volumes



# Purpose of the Study

- to estimate the profile of the arrival rate (demand) that often capped by the capacity under the over-saturated conditions.
- A relationship between the profile of the arrival rate (demand) and the easily measurable field data such as queuing can be established.

# Literature Review

- Federal Highway Administration Publication recognizes the difficulty of estimating the true demand in Chapter 7 of Signalized Intersections: Informational Guide (1).
- *“An important element of developing an appropriate traffic profile is distinguishing between traffic demand and traffic volume. For an intersection, traffic demand represents the arrival pattern of vehicles, while traffic volume is generally measured based on vehicles’ departure rate. For the case of overcapacity or constrained situations, the traffic volume may not reflect the true demand of an intersection. In these cases, the user should develop a demand profile.”*

# Literature Review

*But the solution in the same document, measuring upstream vehicle arrivals is impractical and could distort the demand profile because:*

- 1. When the queue is fairly long and building up very quick, following the end of queue to measure arrival is impossible. The end of queue could fluctuate considerably when the downstream signal turns green and then red.*
- 2. The measured arrival rate is at the end of the standing queue. It is not the arrival rate at the intersection. This will distort the real demand when the queue is long because in cases of extreme congestion, it could take 15 plus minutes for the vehicles at the end of queue to travel to the on ramp.*

# Cause of Queuing

$$l_i = \lambda_i T - u_i T + l_{i-1}$$

$l_i$  = the queue for the interval  $i$ , in vehicles.  
the number of stopping vehicles behind freeway onramp  
at the end of interval  $i$

$\lambda_i$  = the arrival rate is for the interval  $i$ , in vehicles/minute.

$u_i$  = the departure rate for the interval  $i$ , in vehicles/minute.

$T$  = interval, in minutes. 5 minutes is the default value.

# Traffic Demand

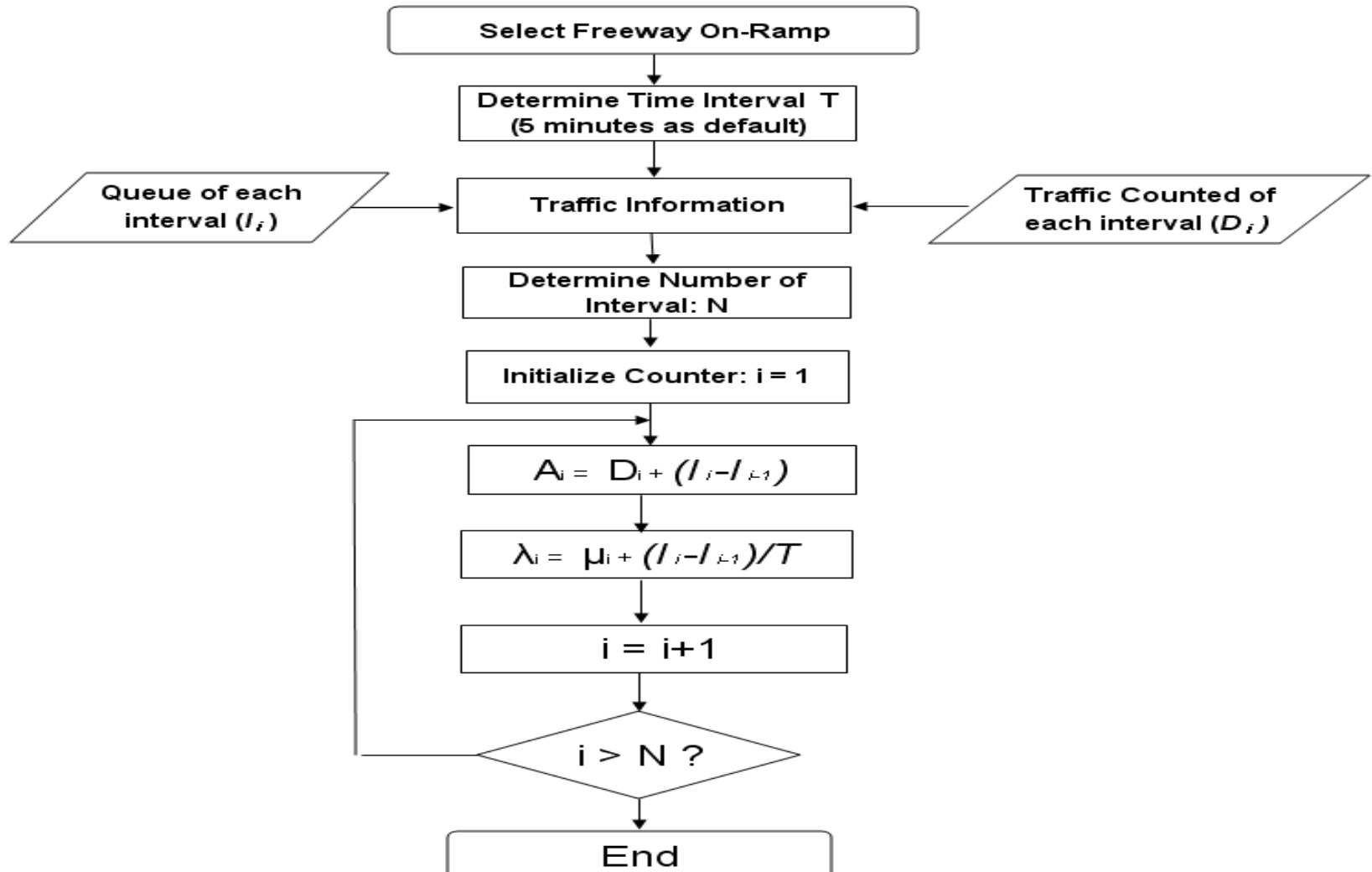
$$\lambda_i = u_i + (l_i - l_{i-1}) / T$$

$$\lambda_i = \begin{cases} u_i \\ u_i + q_i \end{cases}$$

Stable queuing

Unstable queuing

# Flow Chart



# Profile of Arrival Rate Calculator (PARC)

Freeway On-Ramp

Welcome to Use Profile of Arrival Rate Calculator  
Honglong Li, Chris Wellander, Shenghong Li

Forecast Save Reset Help About Close

**Data Select**

Name of On-Ramp  Date  (MMDDYYYY) Start Time  (HHMM) Interval  (s)

Data Sheet  Index  Queue  Volume Counted

**Results**

Ave AR <input type="text"/> (Veh/Min)	Min AR <input type="text"/> (Veh/Min)	Max AR <input type="text"/> (Veh/Min)
Ave DR <input type="text"/> (Veh/Min)	Min DR <input type="text"/> (Veh/Min)	Max DR <input type="text"/> (Veh/Min)
Peak Hour Demand <input type="text"/> (Veh)	Peak Hour Counted <input type="text"/> (Veh)	Total Volume <input type="text"/> (Veh)
Peak Hour <input type="text"/>	Peak Hour <input type="text"/>	Peak Hour shift <input type="text"/> Minutes

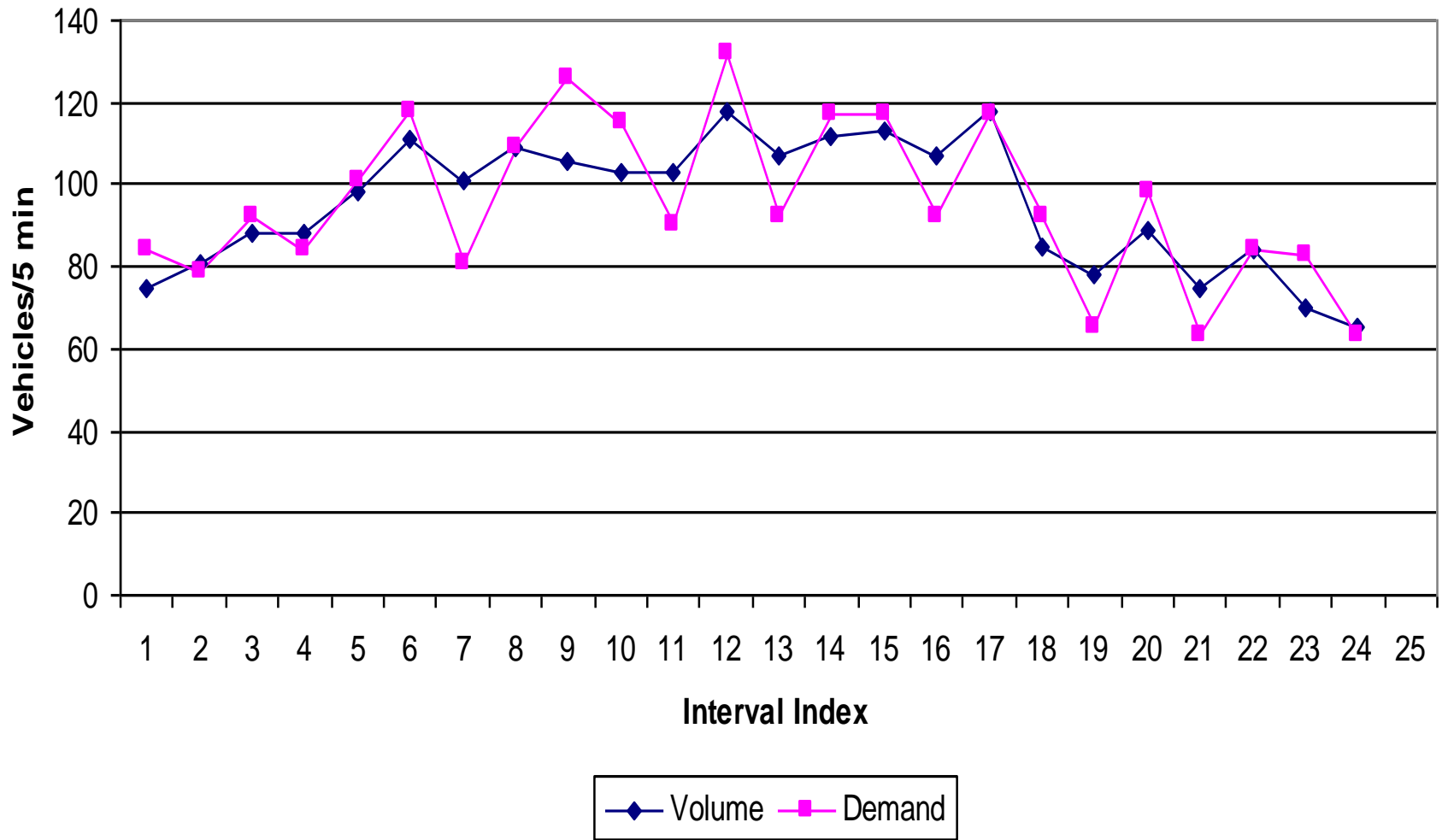
# Eastbound H1 Freeway Onramp



June 24, 2009

14

# Volume V.S. Demand by 5 minute Interval

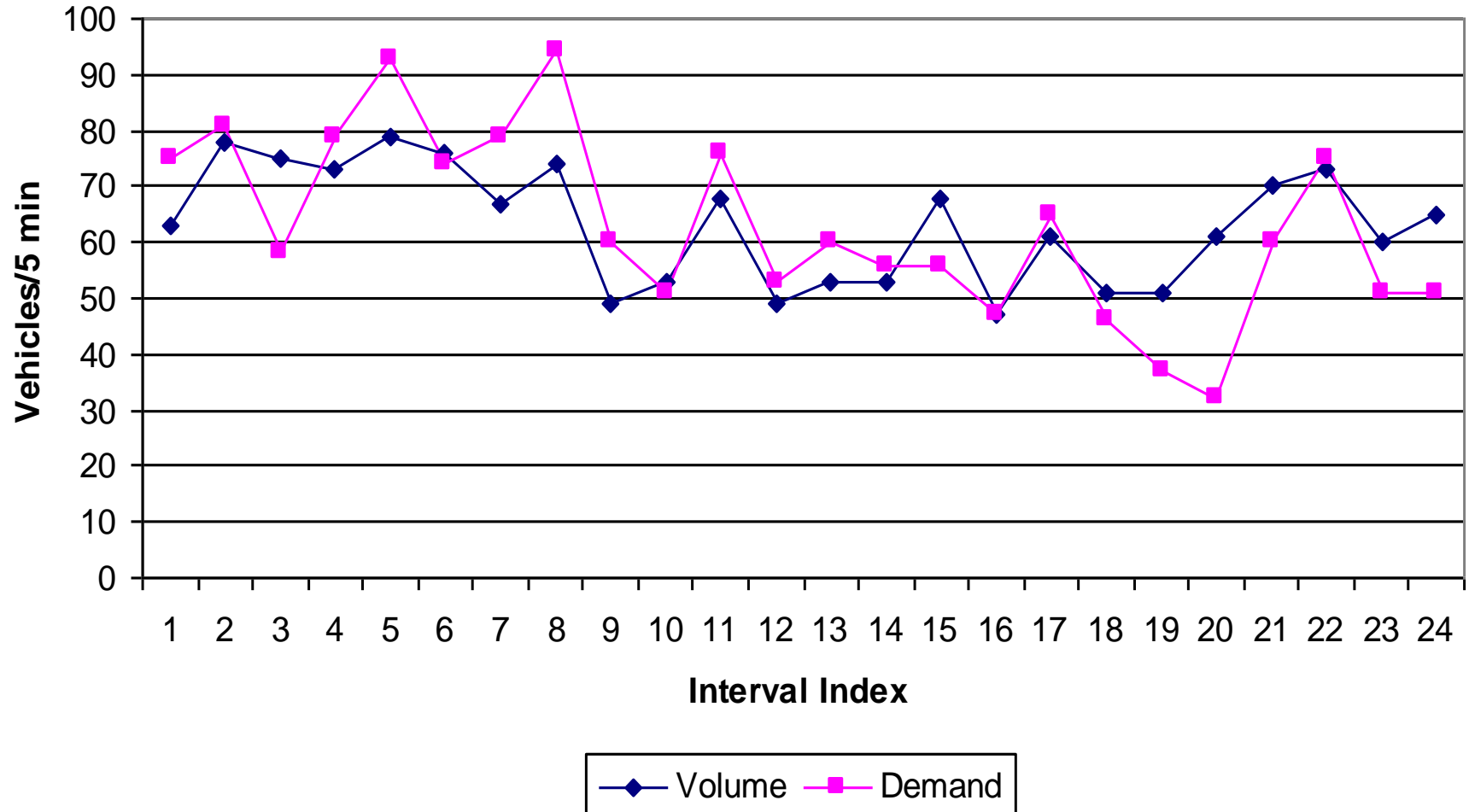


# Westbound H1 Freeway Onramp



Time Period	Departure	Arrivals	% Diff
1	63	75	19%
2	78	81	4%
3	75	58	-23%
4	73	79	8%
5	79	93	18%
6	76	74	-3%
7	67	79	18%
8	74	94	27%
9	49	60	22%
10	53	51	-4%
11	68	76	12%
12	49	53	8%
13	53	60	13%
14	53	56	6%
15	68	56	-18%
16	47	47	0%
17	61	65	7%
18	51	46	-10%
19	51	37	-27%
20	61	32	-48%
21	70	60	-14%
22	73	75	3%
23	60	51	-15%
24	65	51	-22%

# Volume V.S. Demand by 5 minute Interval



# Conclusion

- The proposed methodology closes the gap between the counts and the queuing in microsimulation
- The case study proved that the arrival rate peaked and valleyed under the over-saturated conditions whereas the volume counts fluctuated around the capacity.
- A demand profile must be established for the long and persistent queuing.
- The methodology can be extended for signalized intersections.



**Mahalo!**