CE474: Traffic Systems Design-Fall 2004

Class 4 – Traffic Flow Theory at Signalized intersections
September 1st, 2004

Ahmed Abdel-Rahim
Civil Engineering Department, University of Idaho

Assignment A1.03: *Document and assess the extent of available resources*

- The purpose of this assignment is to review, assess, and document the resources that are available to support your design project.
- Each student is assignment one of the resources that is available on the class web site.
- For the document (resource) that has been assigned to you:
  1. review the document and the information that is included,
  2. prepare a one to two paragraph summary of the purpose and intent of the document (in your own words), and
  3. prepare an outline of the major sections of the document (including a one to two sentence summary of each of these sections.
- This assignment is due at the beginning of class on Tuesday, September 7th. An electronic copy of this assignment must be emailed to me by 5:00 pm on September 7th.

Also Due by the lab on September 7th.

- CORSIM working file for your intersection:
  - Actual volume
  - Actual geometry
  - Actual signal phasing

Student	Resource
Kebab, Mohammad Wassim Reed, James Evan Arellano, Lisa Jo	Idaho Transportation Department Traffic Manual (available on ITD CDROM)
Luo, Min Candia-Martinez, Mario Pakalapati, Srinivas Raju	Traffic Engineering Handbook (available as handout)
Wu, Lei Carter, Steven Neil Aeneni, Shravan Kumar	Traffic Control Systems Handbook (available on FHWA/DOT CDROM)
McLenna, Patrick Michael Gangula, Sreenath Reddy Baden, Andrew Christopher	NIATT Web-based Signal Design Tutorial
Orton, Brent Lee Auch, Alisha Fern	Manual of Uniform Traffic Control Devices (MUTCD)
Carter, Steven Neil Palmer, Charles Ray	Design Guidelines for Deploying Closed Loop Systems

Microscopic Flow Characteristics
Time Headway - Classification

- Random Headway State
  (Negative Exponential-Poisson count Distribution)

- Constant Headway State
  (Normal Distribution)

- Intermediate Headway State
  (Pearson type II, Gamma, Enlarg, Negative Exponential , shifted Negative Exponential)

Constant Headway State-Normal Distribution

Mean time headway (h) = 3600/V

Normal distribution with mean (μ) and standard deviation s

95% confidence interval in the range (μ ± 2s)

Minimum headway (α) = μ - 2s or = $\bar{t}$ – 2s

Then s=(h - α)/2

Constant Headway State-Normal Distribution

Normal Distribution:

To get the probability $P\ (A \leq X < B)$

$Z = (B - A)$

From the table using the value (Z/S)

Constant Headway State-Normal Distribution

Example: V= 2000 vph: $\bar{t}$ = 3600/2000 = 1.8 seconds

Assuming a minimum headway of 0.8 seconds standard deviation s= (1.8 – 0.8)/2 = 0.5

To obtain the probability: P $(1.0 \leq h < \bar{t})$

Z= 1.8 – 1.0 = 0.8

Z/s= 0.8 / 0.5 = 1.6

From the Table:

P $(1.0 \leq h < 1.8) = 0.445$

44.5% of the headway between the mean headway (1.8 seconds) and 1.0 second

Intermediate Headway State

- Generalized Mathematical Model Approach
- Composite Model Approach
- Other Approaches

Intermediate Headway State

- Composite Model Approach

	Random		Constant		Total	
Headway	Probability	Frequency	Probability	Frequency	Probability	Frequency
1-2						
2-3						
19-20						
>20						

Queuing Theory - Introduction

Application:

- Analyze Facilities that have kwon Demand (arrival) and Supply (service)

Examples:

- Highway Applications [Intersections, Bottlenecks (Incidents), Toll Plazas, merge areas, etc.]
- Ports, Shipping and Packaging facilities
- Bank Tellers, Grocery Checkout, Airport, etc.
- and Many other Applications

Queuing Theory - Introduction

What Should we know?

- Arrival Distribution
- Service Distribution

Queuing Theory is either:

- **Deterministic** [Both Arrival and Service Distributions are Deterministic]
- **Stochastic** [Random arrivals and departures]

Queuing Theory - Equations

Definitions

- λ = Arrival Rate
- μ = Service Rate
- $\rho = \lambda / \mu$
- **C** = Number of Service Channels
- **M** = Random Arrival/Service rate (Poisson)
- **D** = Deterministic Service Rate (Constant rate)

Queuing Theory - Equations

M/D/1 case (random Arrival, Deterministic service, and one service channel)

Expected average queue length

$E(m)= (2\rho- \rho^2)/ 2 \ (1- \rho)$

Expected average total time

$E(v) = 2- \rho / 2 \mu \ (1- \rho)$

Expected average waiting time

$E(w) = \rho / 2 \mu \ (1- \rho)$

Queuing Theory - Equations

M/M/1 case (Random Arrival, Random Service, and one service channel)

The probability of having zero vehicles in the systems $P_o = 1 - \rho$

The probability of having n vehicles in the systems

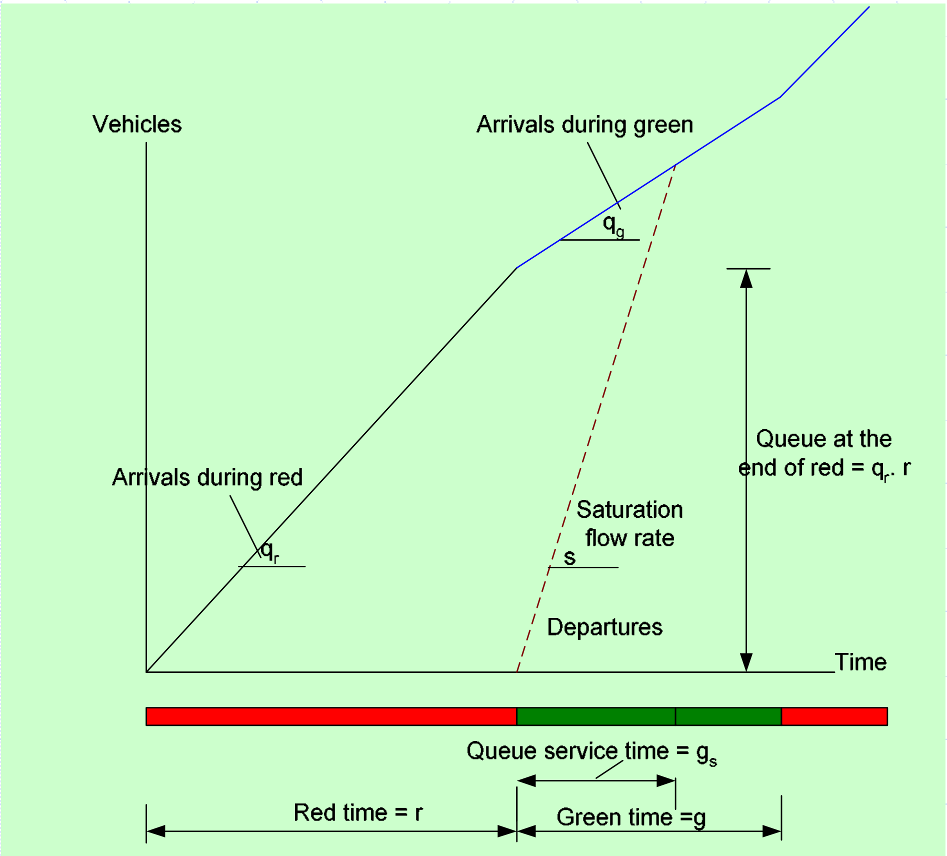
$P_n = \rho^n P_o$

Expected average queue length $E(m) = \rho^2 / (1 - \rho)$

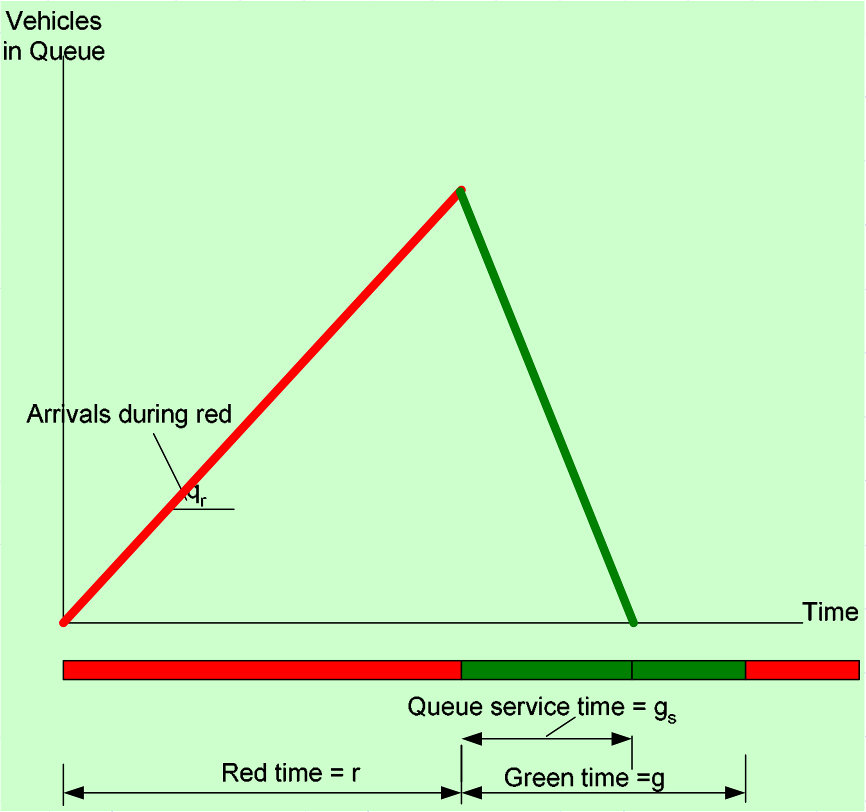
Expected average total time $E(v) = \rho / \lambda \ (1 - \rho)$

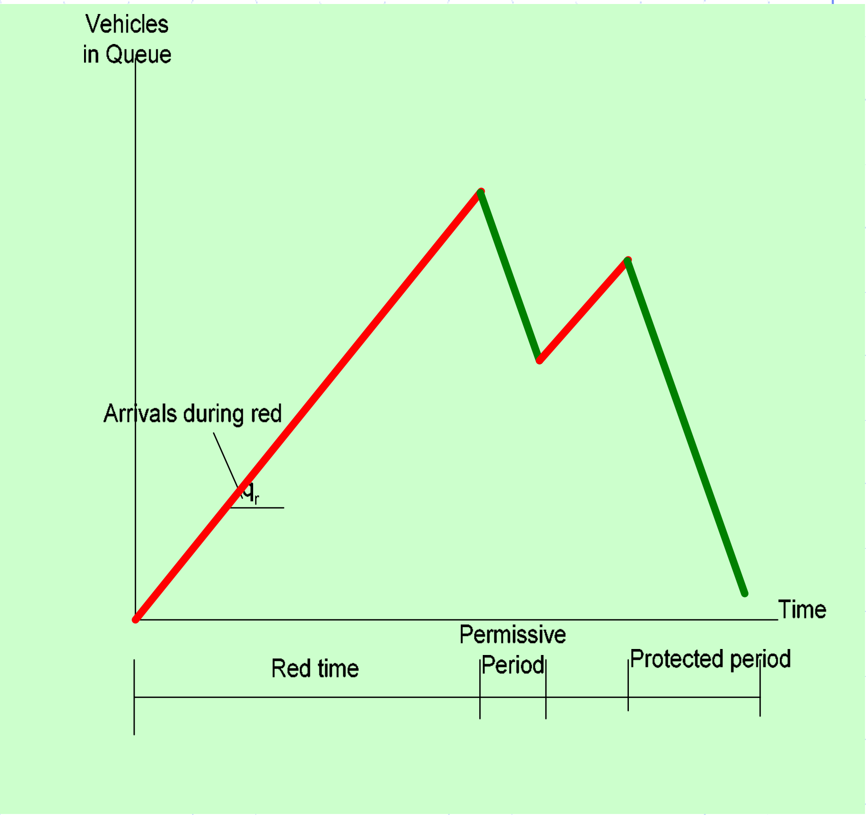
Expected average waiting time $E(w) = E(v) - 1/\mu$

Deterministic queuing theory: D/D/1 case
Queue forming and dissipation



Queue Forming Polygon





Queue Forming Polygon
Permissive/Protected Left Turn