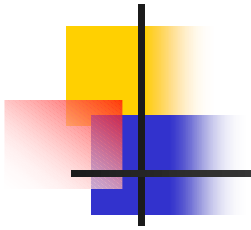
System Level Design & Analysis of Queuing System at Airport Boarding Pass Counter

Soe Zarni

Bargava Subramanian

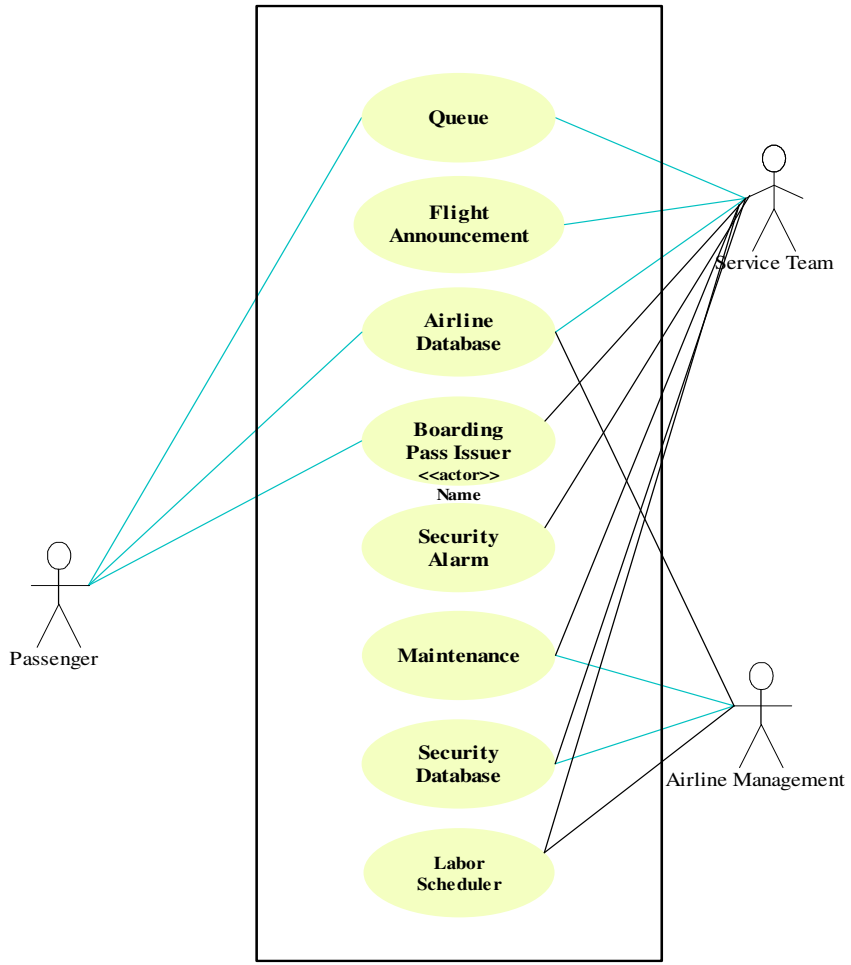
ENSE622

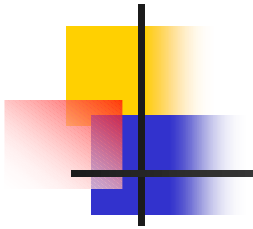


Introduction

- Passenger enters the airport
- Looks for the airline counter
- Checks the Flight check-in time
- Waits in queue
- Gets the boarding pass

Initial Use Case Diagram





Requirements

	Requirements	Goal	Scenario
	Management Requirements		
M1	The system must be reliable.	8,9	8.1,9.1
M2	The cost of the system must be minimum.	6	6.1
M3	The utilization of each employee must be at least 80%.	4,6,8	4.1,8.1,8.2

	Airline Requirements		
A1	The passengers must be able to check-in in time for the flights.	2,3	2.1,3.1
A2	The system must be able to handle the flight schedule changes.	3	3.1,3.2
A3	The system must make sure all the passengers already issued boarding passes are cleared for security from all database.	6	6.1

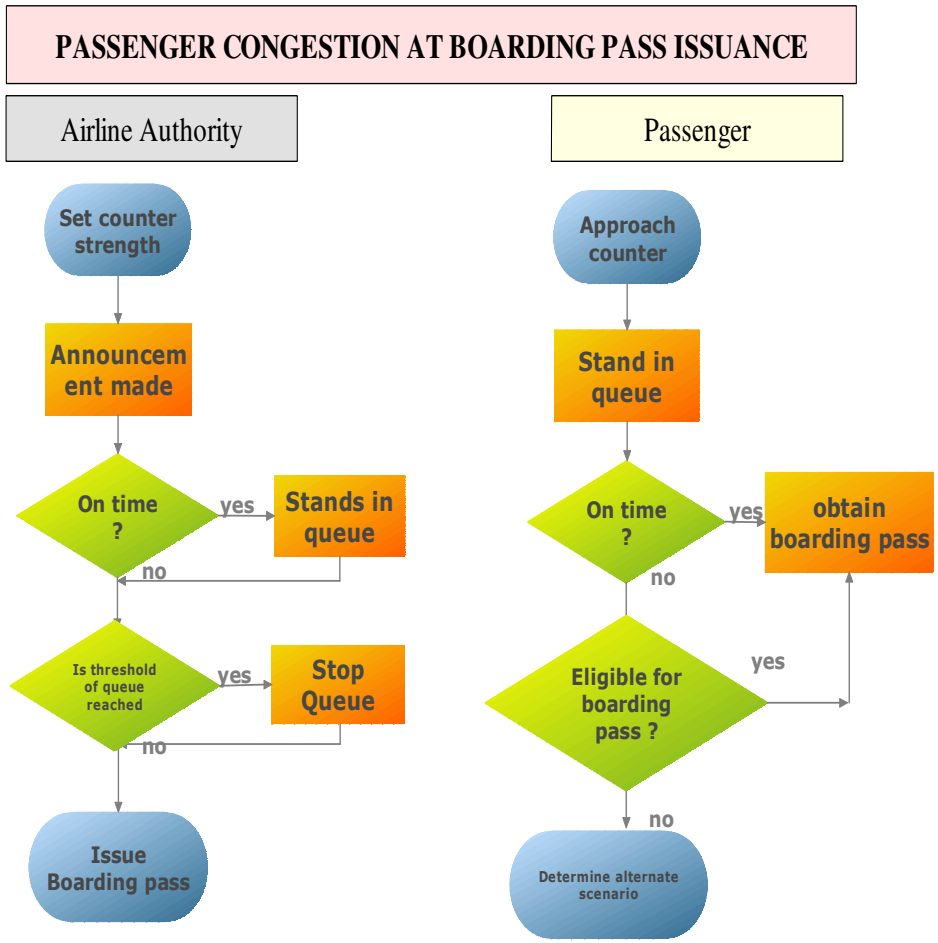
Requirements (contd.)

	Crew Counters Requirements		
C1	The system must be able to handle any queue size.	4,8,9	4.1,4.2,8.1, 9.1
C2	The system should have atleast a supervisor avalible at all time to solve problems and make decision.	6	6.1,6.2,6.3, 6.4
C3	The system must be able to handle late passengers and flight schedule changes.	5	5.1,5.2
C4	The late passengers must have priority to get the service.	2	2.1
	Passengers Requirements		
P1	The wait time in the queue must be as short as possible.	6	6.3,6.4
P2	The processing time for check-in time must be as quick as possible.	6	6.3
P3	The passengers must be able to board on the plane in time.	2,3	2.1,3.1
P4	There should be an alternative way if passenger missed the flight.	5	5.1,5.2

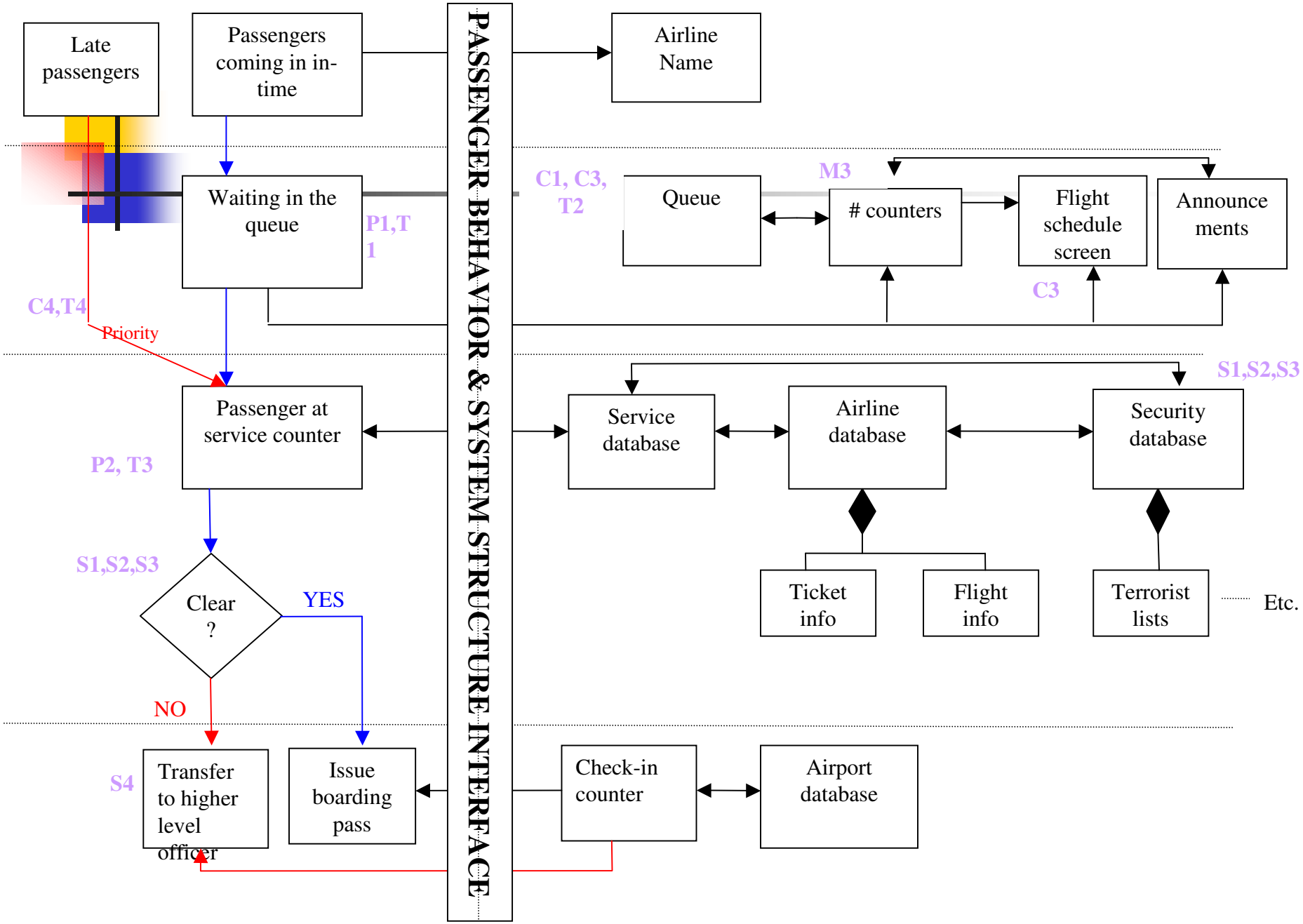
Requirements (Contd.)

	Security Requirements
S1	The passenger must have valid identification and/or documents.
S2	The passenger must be cleared from police criminal warrants.
S3	The passenger must be cleared from terrorist lists.
S4	The system must be able to report to security officer if there is any suspicious activity or passenger.
	Timing Requirements
T1	The waiting time of any passenger in the queue must be less than 15 mins.
T2	The number of passengers in the queue at any time must be less than 10.
T3	The service time of any passenger must be less than 10 mins.
T4	Any late passenger must get service in less than 3 mins of waiting time.

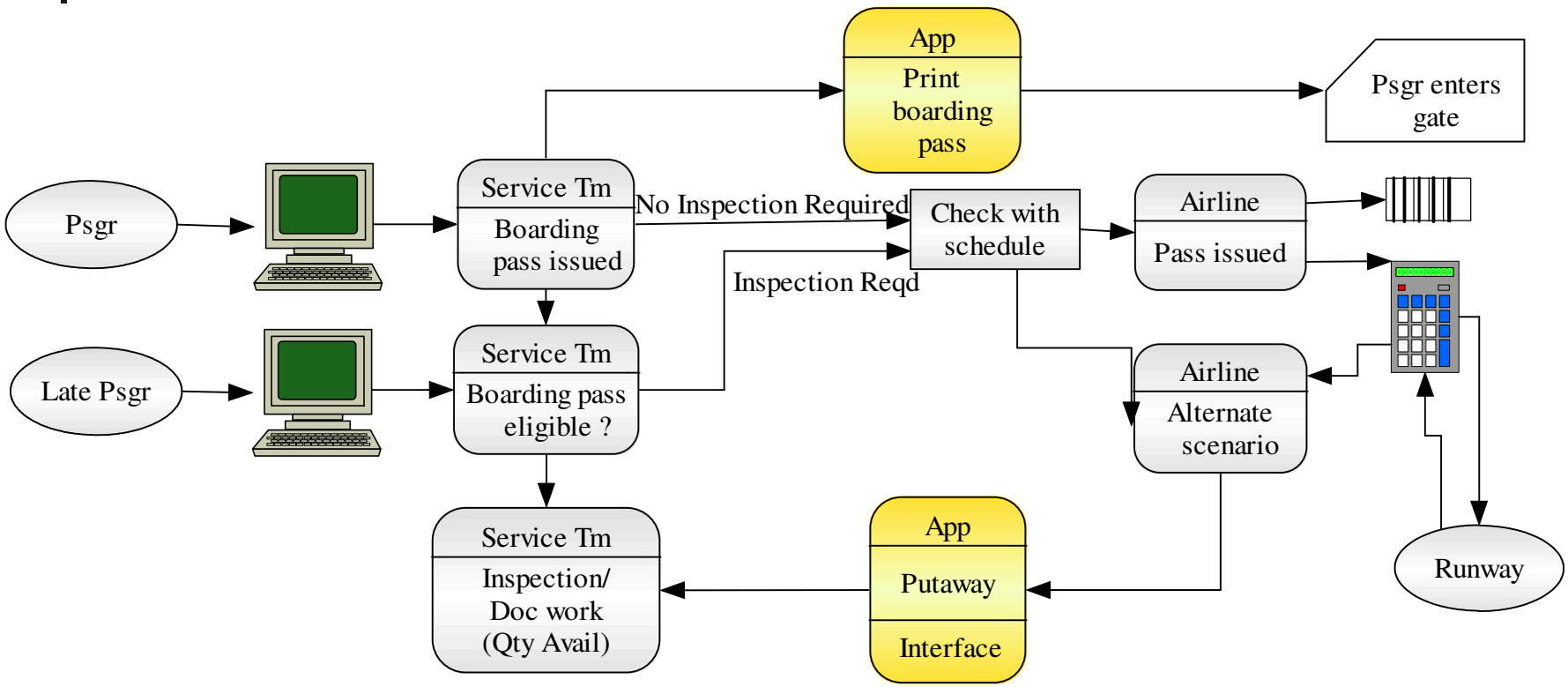
System Description



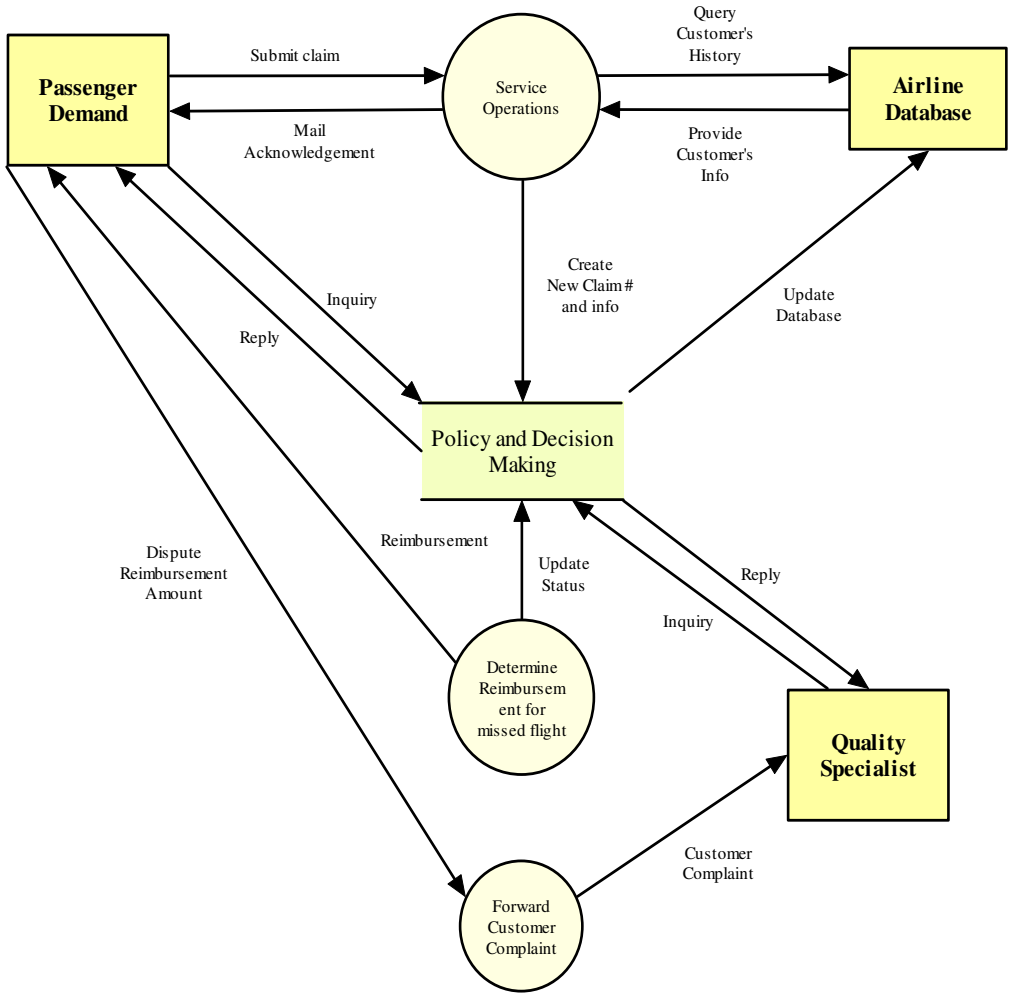
Mapping System Structure to Behavior



Time Driven Scenario – System Flow

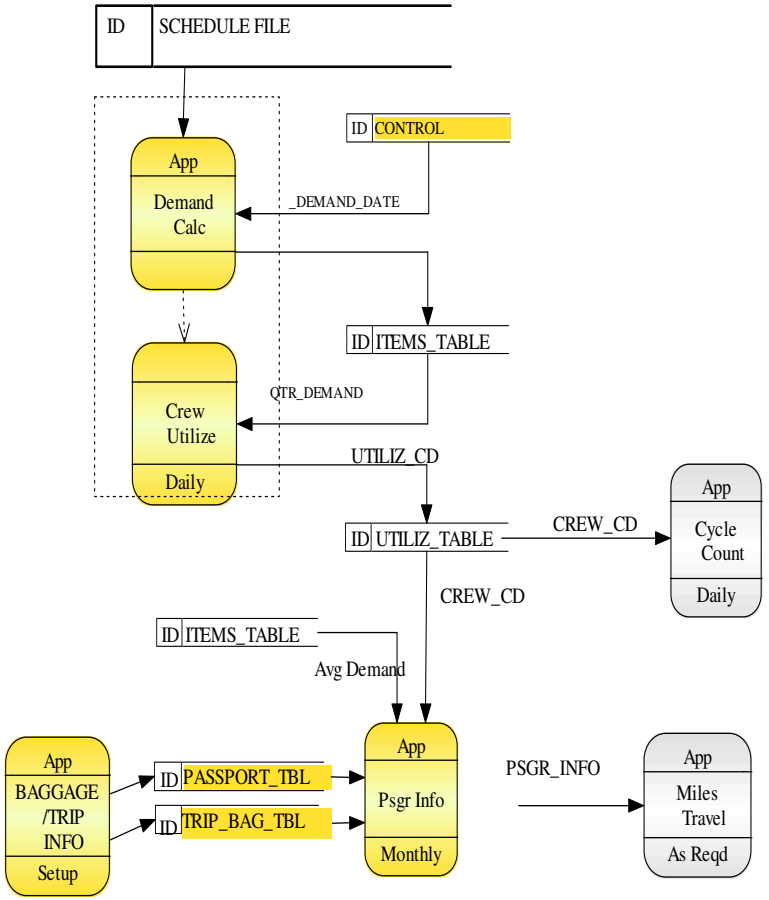


Context Diagram

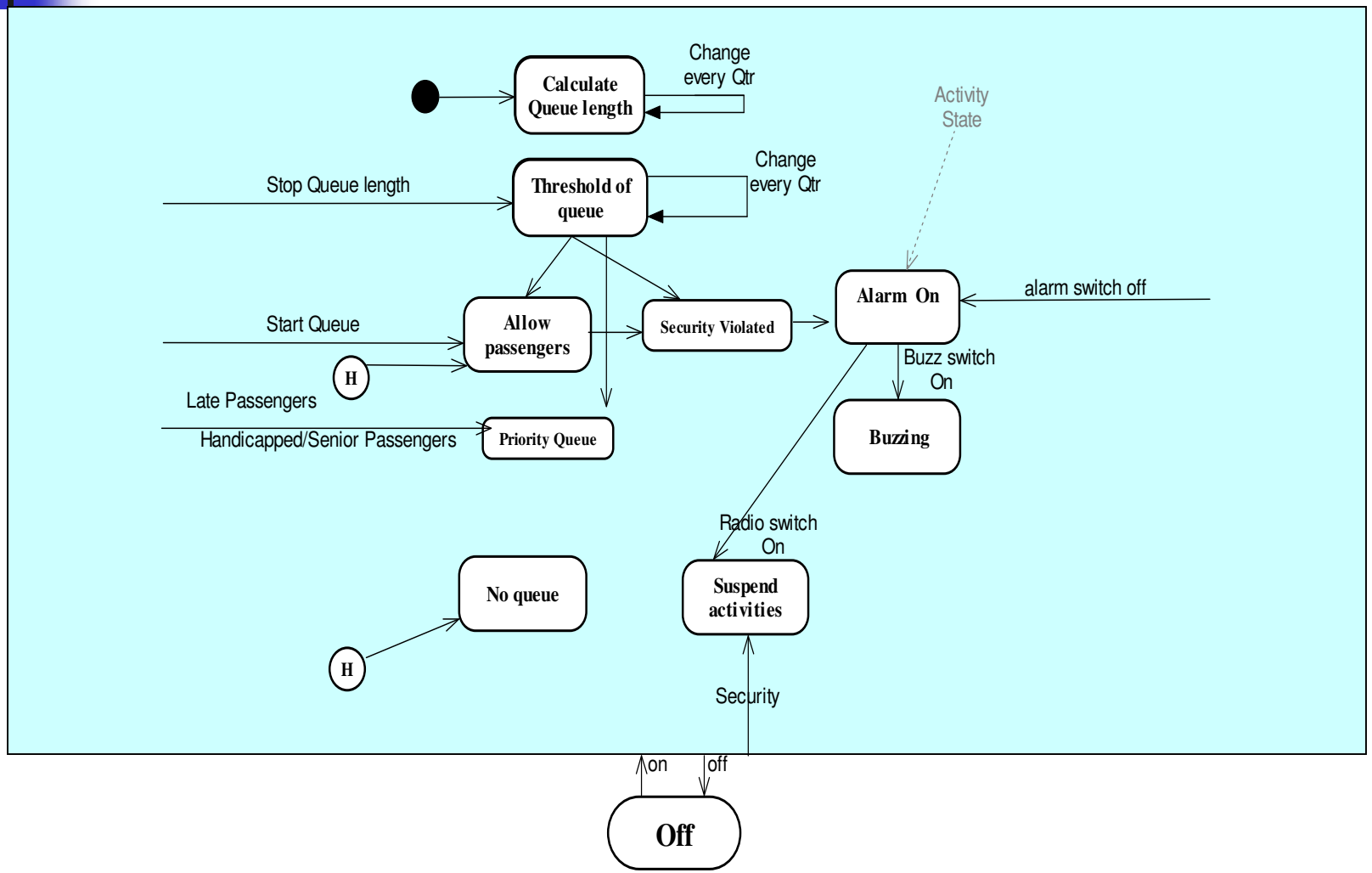


Passenger Information Flow

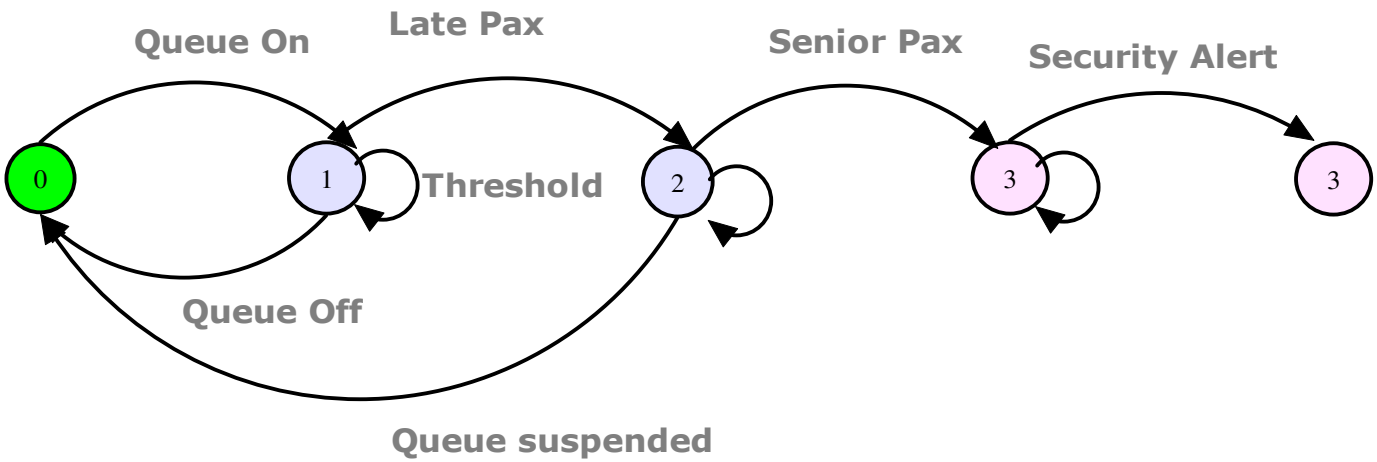
Passenger Information Flow



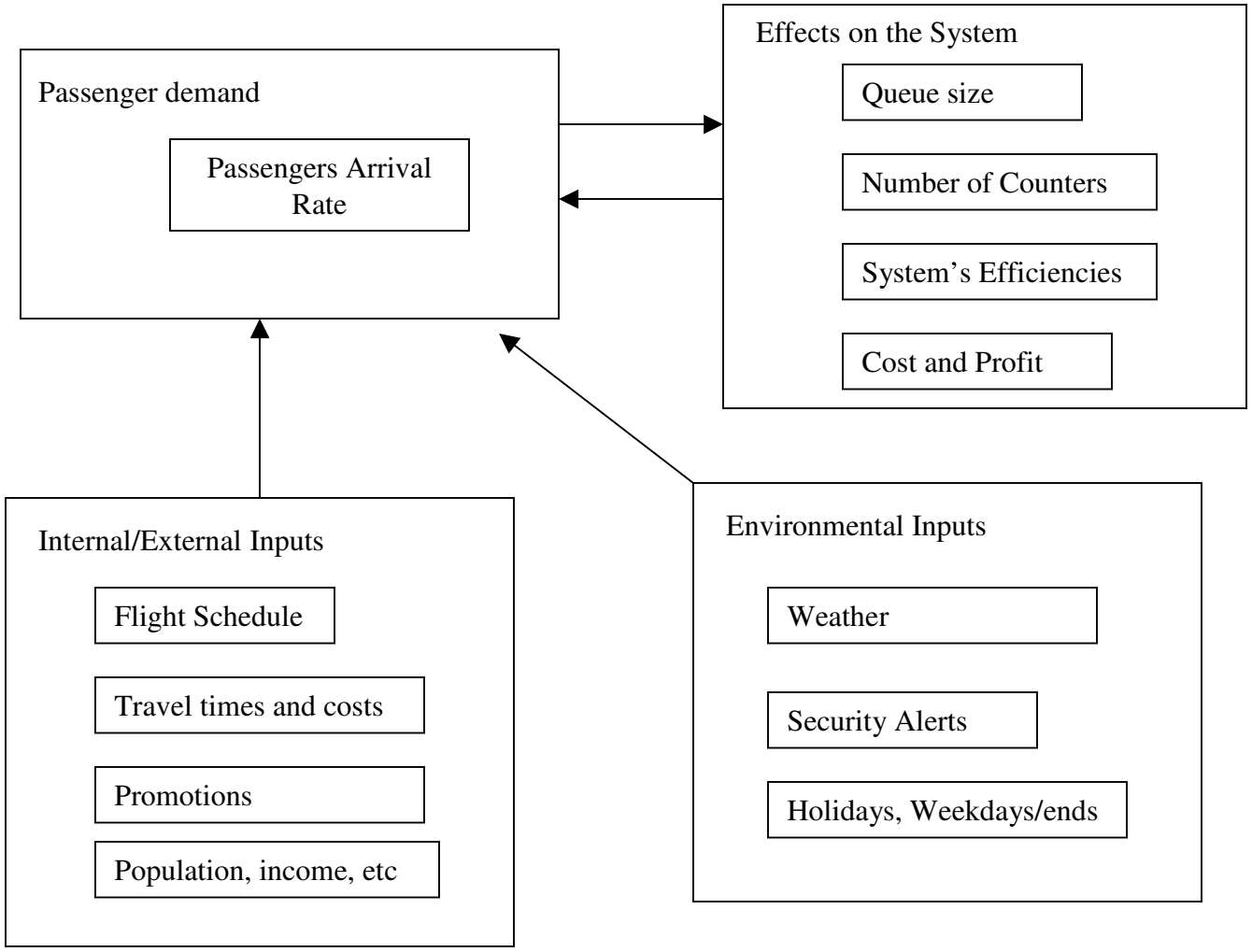
Concurrent State at the Queue



Labeled Transition System

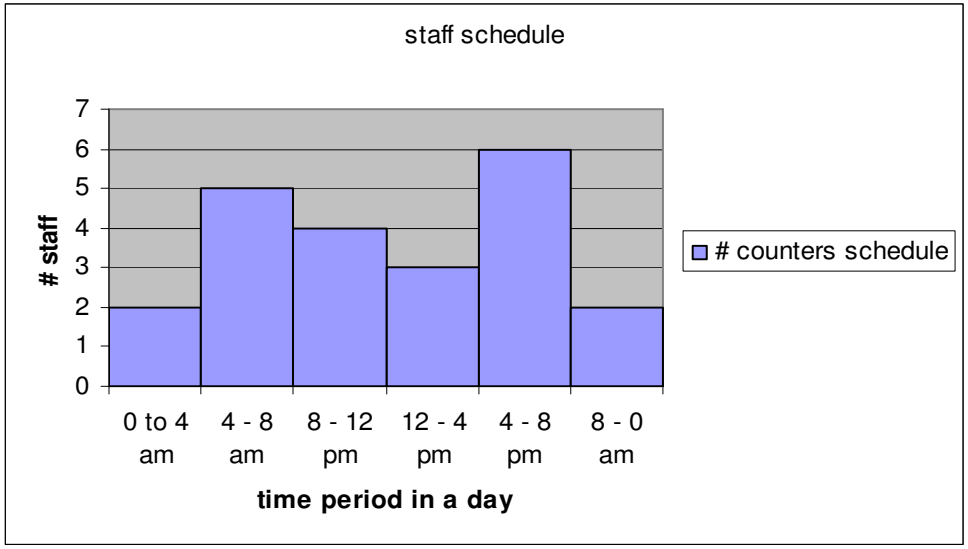


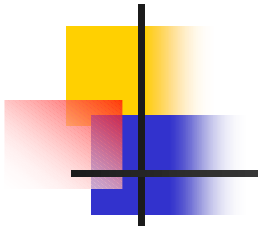
Effect of Passenger Demand



Crew Member Schedule

0 to 4 am	4 - 8 am	8 - 12 pm	12 - 4 pm	4 - 8 pm	8 - 0 am
2	5	4	3	6	2





Optimization & Trade-off

Min $x_1 + x_2 + x_3 + x_4 + x_5 + x_6$

ST

$x_1 + x_6 >= 2$

$x_1 + x_2 >= 5$

$x_2 + x_3 >= 4$

$x_3 + x_4 >= 3$

$x_4 + x_5 >= 6$

$x_5 + x_6 >= 2$

OPTIMIZATION RESULTS

- LP OPTIMUM FOUND AT STEP 5
- OBJECTIVE FUNCTION VALUE
- 1) 12.00000

VARIABLE	VALUE	REDUCED COST
X1	1.000000	0.000000
X2	4.000000	0.000000
X3	0.000000	0.000000
X4	5.000000	0.000000
X5	1.000000	0.000000
X6	1.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.000000
3)	0.000000	0.000000
4)	0.000000	-1.000000
5)	2.000000	0.000000
6)	0.000000	-1.000000
7)	0.000000	0.000000

- NO. ITERATIONS= 5

OPTIMIZATION RESULTS (Contd.)

- Arena model has been developed to simulate the system.


qModel2.doe


qModel1.doe

OPTIMIZATION RESULTS (Contd.)

* 8 hrs shift for every staff *

	0 to 4 am	4 to 8 am	8 to 12 pm	12 to 4 pm		4 to 8 pm	8 to 0 am	
arrival rate	1 per 2min	1per 50 sec	1 per 1 min	1 per 90 sec	plus docu work	1 per 45 sec	1 per 110 sec	
Optimized no. of staffs	1	4	0	5		1	1	
# of counters	2	5	4	5	5	6	2	
average utilization(%)	98.5	98.8	99	58.8	97.8	97.33	99.5	
WIP(min)	7.8	15.66	14.84	2.9	4.94	6.7	12.73	
average queue size	6	11	10	0	2	1	11	
late # in	17	34	29	21	16	37	19	
late # out	17	32	26	21	15	36	17	
total # in	121	289	241	161	161	320	131	
total # out	105	265	213	157	154	313	108	
cost($20/hr)	344	860	688	860	860	1032	344	4128

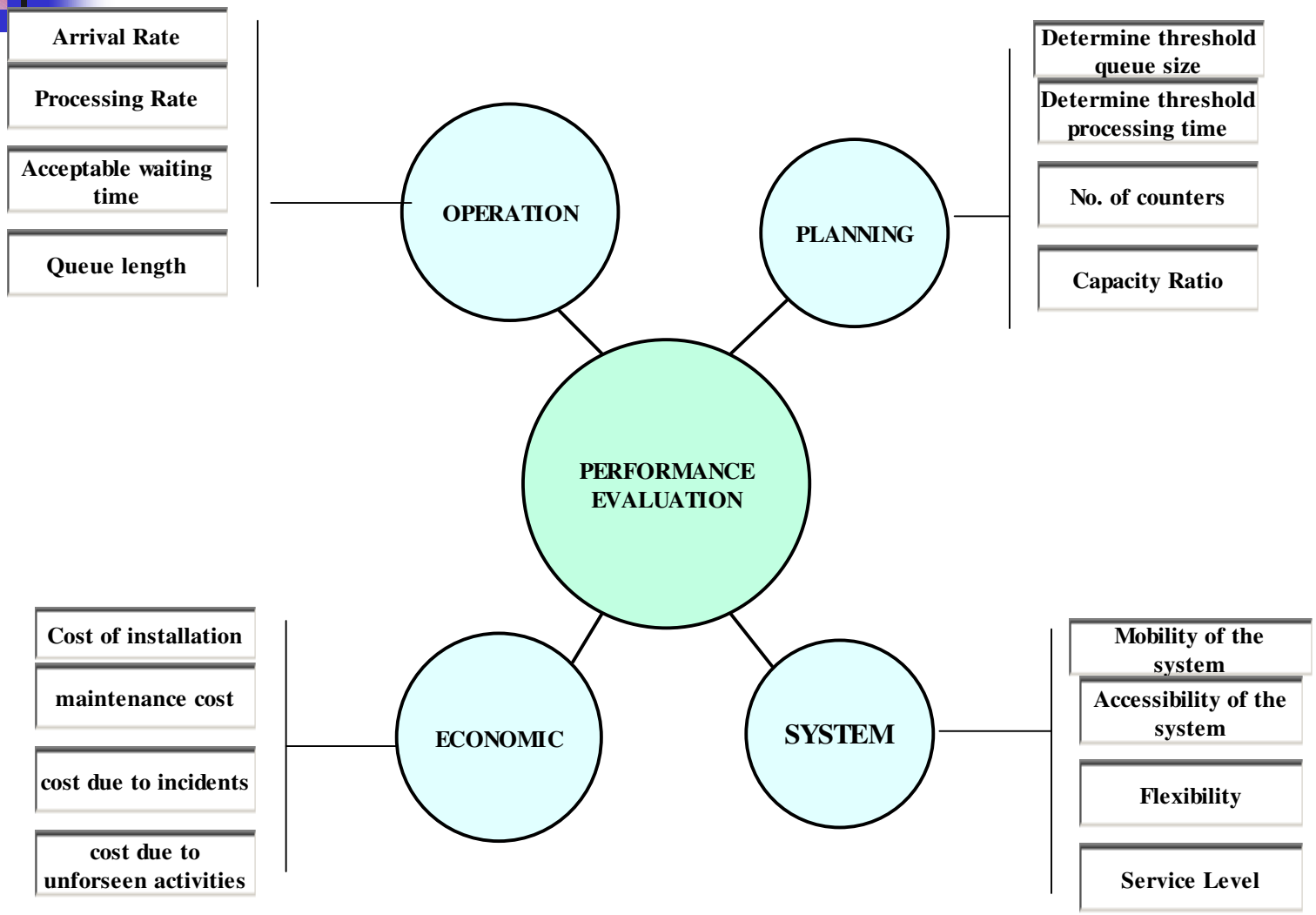
System Effectiveness

- To measure system behavior when system is extended to its critical point
- How does the operation change

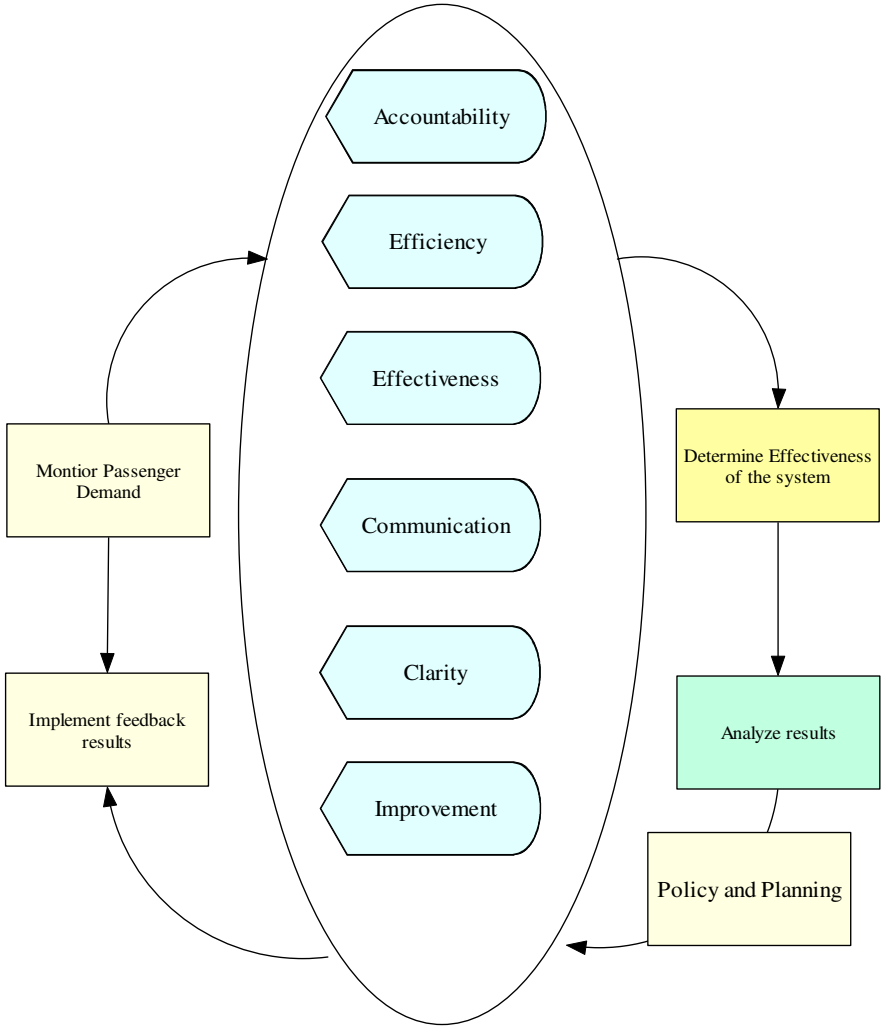
- When airport facilities are improved
- When demand increases
- What are the contingency measures ?

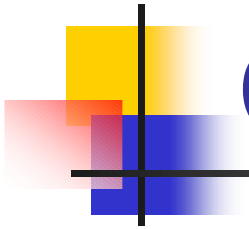
The objective is to identify critical points (congestion points)

Performance Evaluation



Performance Metrics





Conclusion

- A framework for queuing system at airports for boarding pass issuance has been developed.

Current Focus of further work

- Design Structure Matrices for the system
- Cause and Effect scenario
- How can a particular system for a particular airline be shared with a partner airline ? How do we represent them ?
- In American Airlines, boarding pass can be printed from home and passengers can directly go their respective gates. How is that scenario affecting the current system ?
- Scenarios for dynamic seat allocation and overflow booking are being looked at.