

Airspace Management Decision Tool

*Behavioral and Structural Analysis
In Software Design*

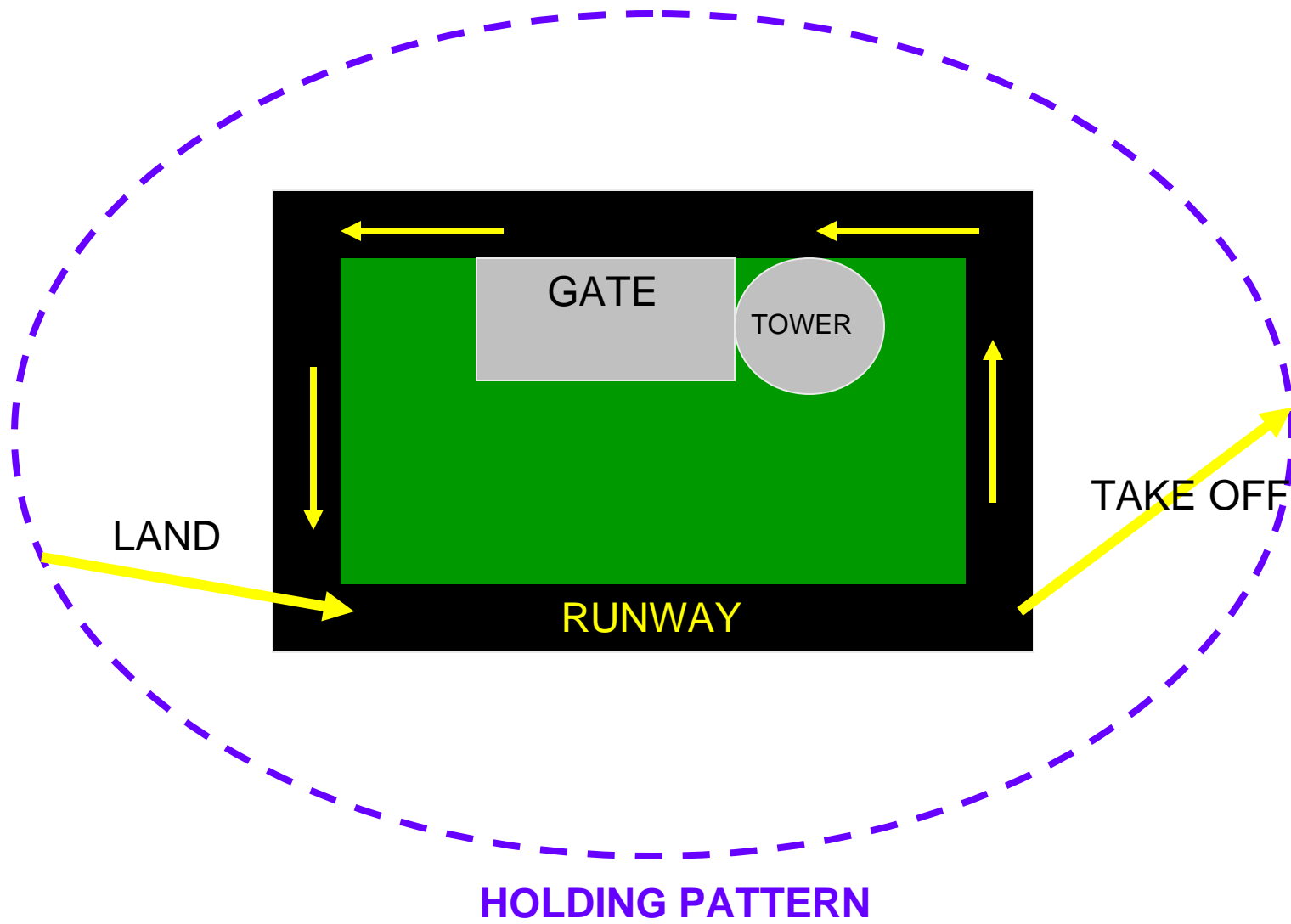
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ENPM642
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Introduction

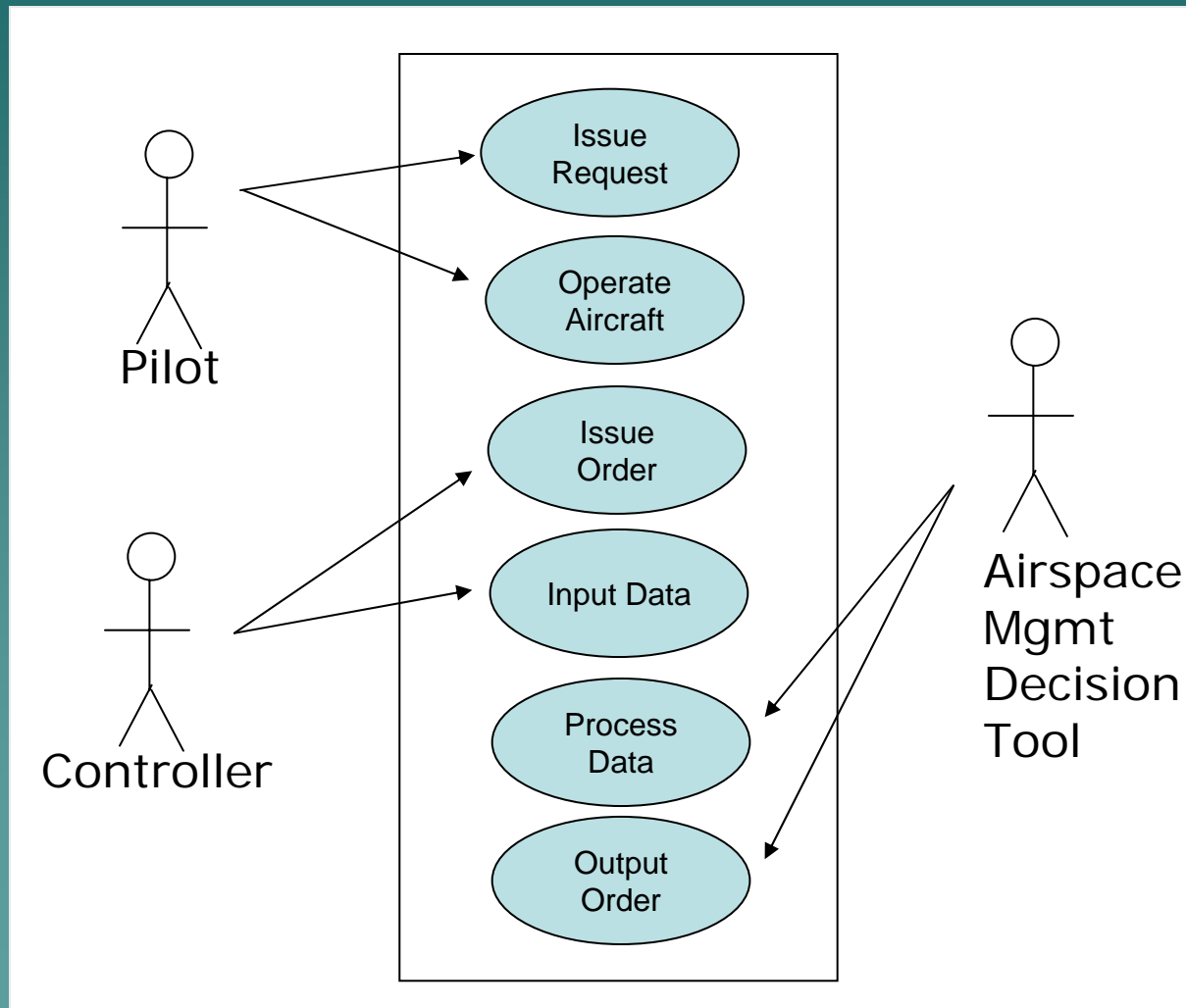
- ◆ World of Air Traffic Control (ATC) is a constantly changing environment
- ◆ NO COMPROMISES!!
SAFETY CRITICAL!!
- ◆ What happens during a shift change? How do controllers “inherit” situation awareness?

Solution

- ◆ Create a tool that models airport situations
 - Enable outgoing controller to enter current state
 - Enable incoming controller to enter pilot requests
 - Program outputs controller action and updates the current state



Use Case Diagram



Finite State Machine

- ◆ States: 4 combinations of aircraft in holding pattern & at terminal gate
- ◆ Inputs: 3; Request to enter holding pattern, request to land and taxi to gate, request to taxi to runway and take off
- ◆ Output: $4 \times 3 = 12$; Depends on initial state and input
- ◆ New State

Validation Tables

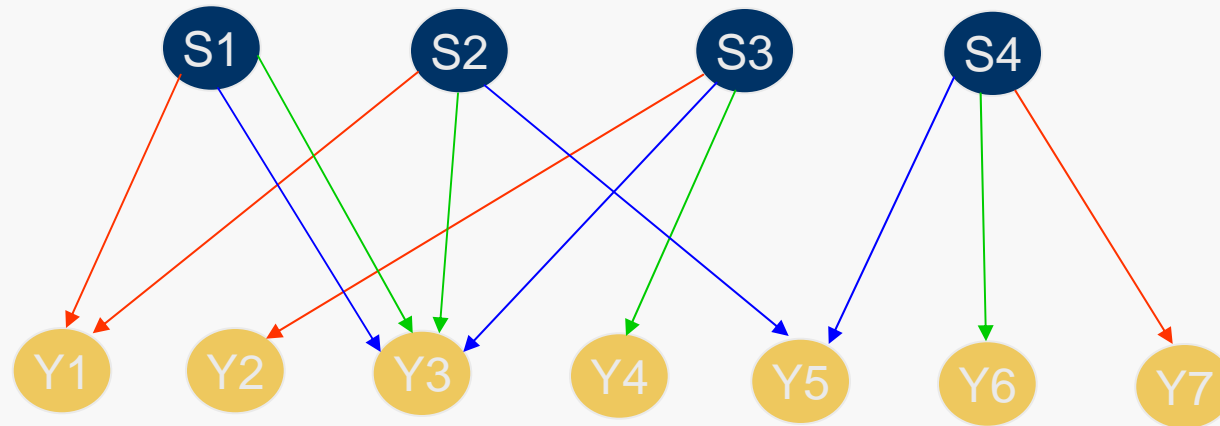
States (location of aircraft)		Input (Request from pilot)	
S1	[0,0]	X1	Hold
S2	[0,1]	X2	Land
S3	[1,0]		
S4	[1,1]	X3	Take Off

Output (Action for Controller)	
Y1	Order Hold
Y2	Order Land; Order Hold
Y3	Invalid Request
Y4	Order Land
Y5	Order Take Off
Y6	Order Take Off; Order Land
	Order Take Off; Order Land;
Y7	Order Hold

Output/Controller Action					
		Initial State			
		S1	S2	S3	S4
Input	X1	Y1	Y1	Y2	Y7
	X2	Y3	Y3	Y4	Y6
	X3	Y3	Y5	Y3	Y5

New State					
		Initial State			
		S1	S2	S3	S4
Input	X1	S3	S4	S4	S4
	X2	#	#	S2	S2
	X3	#	S1	#	S3

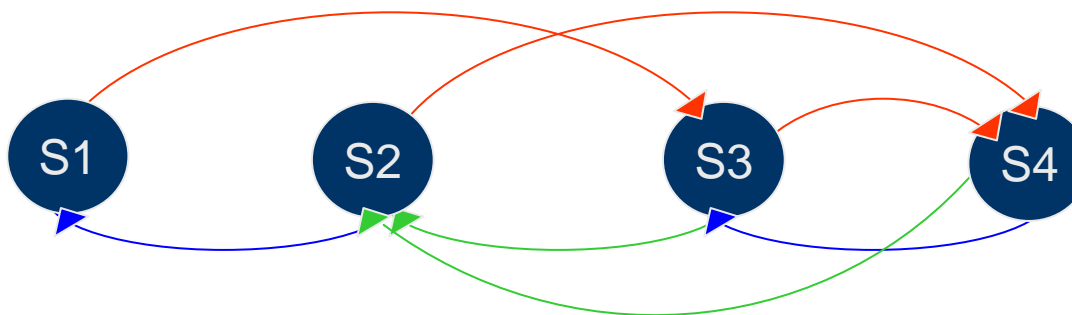
Finite State Machine (cont)



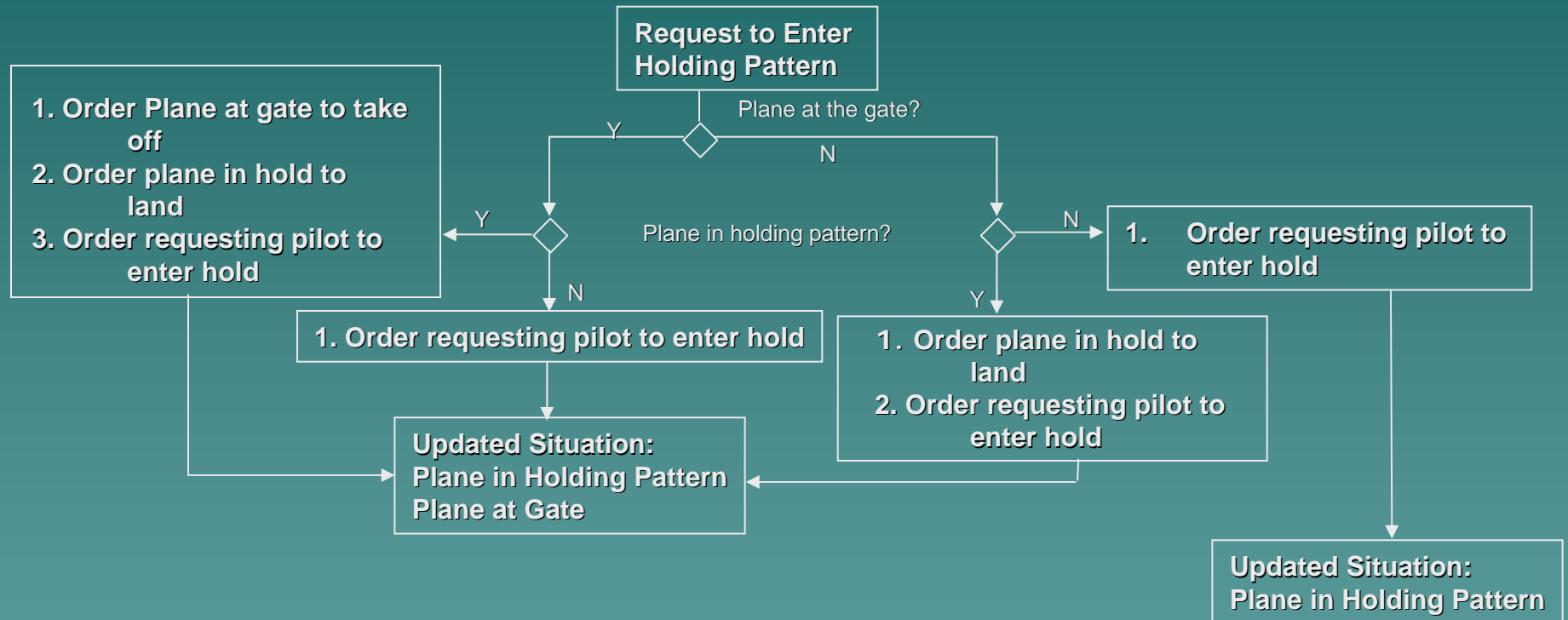
X1

X2

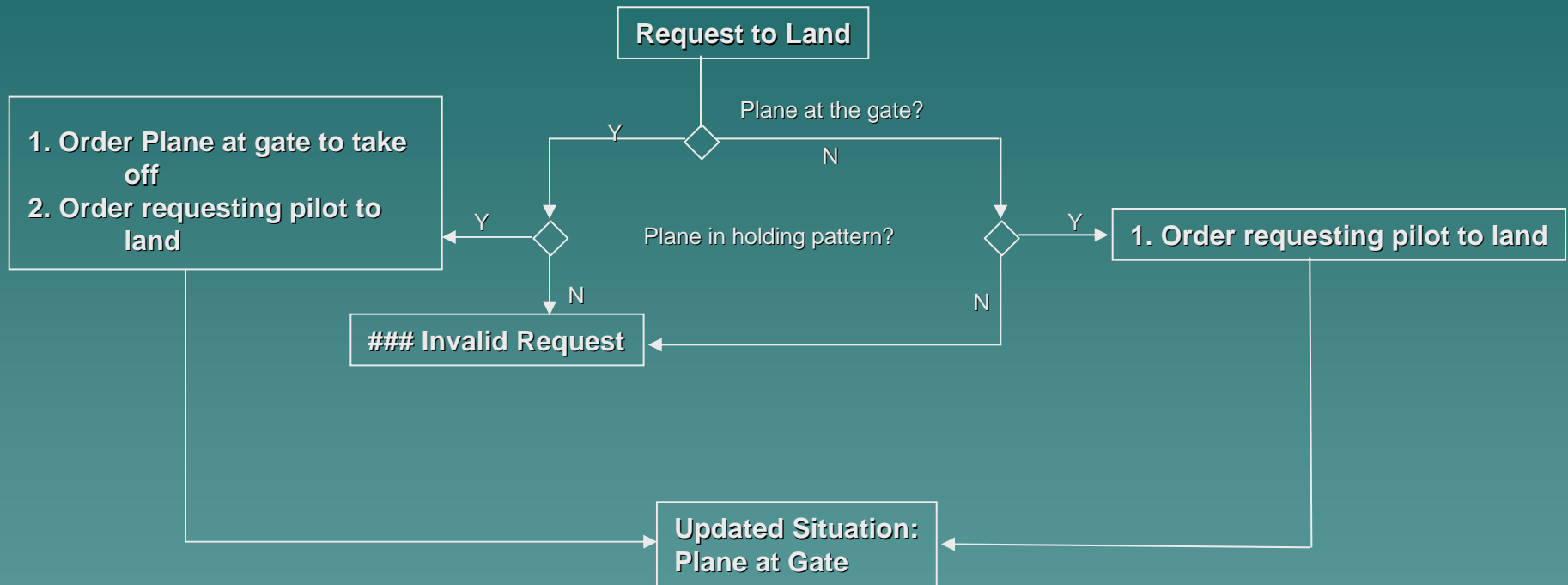
X3



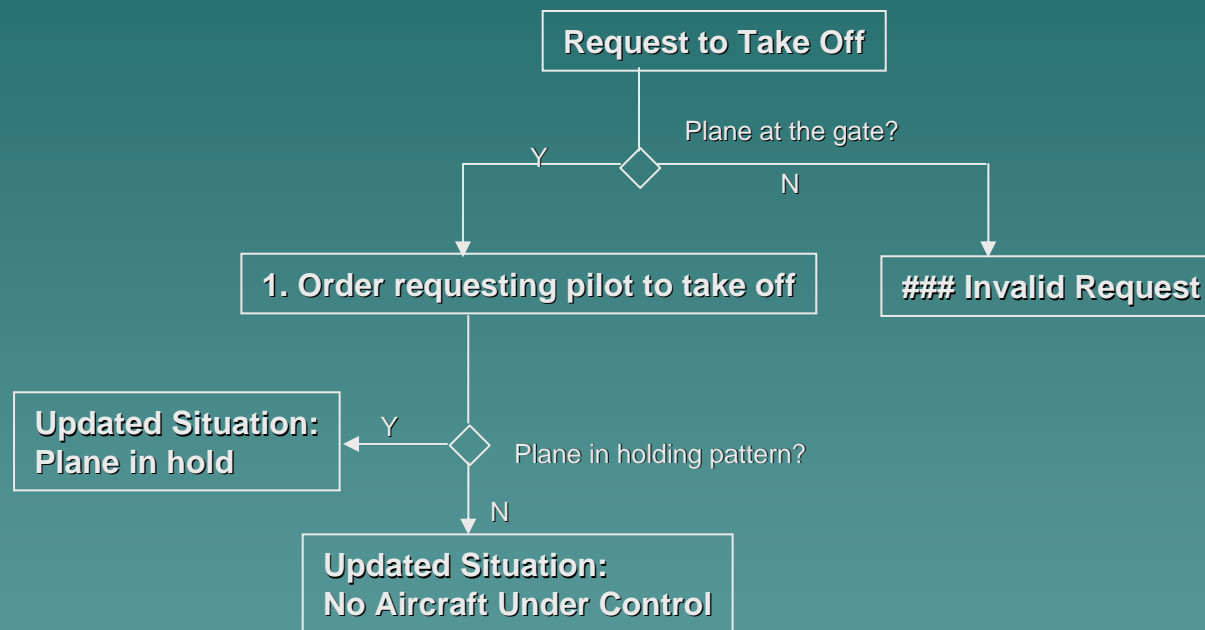
State Diagrams



State Diagrams (cont)



State Diagrams (cont)



MATLAB

```
Request=input('Enter Pilot Request','s')
```

```
    if Request=='E'
        if hold==1
            if gate==1
                disp('Order aircraft at gate to taxi to
runway and takeoff')
                disp('Order aircraft in hold to land and
taxi to gate')
                disp('Approve request to enter holding
pattern')
                hold=1;
                gate=1;
                current_state=[hold, gate]
            else disp('Order aircraft in hold to land
and taxi to gate')
                disp('Approve request to enter holding
pattern')
                hold=1;
                gate=1;
                current_state=[hold, gate]
            end
        else disp('Approve request to enter holding
pattern')
            hold=1;
            current_state=[hold, gate]
        end
        k=k+1;
    end
```

```
    if Request=='L'
        if hold==0
            disp('Invalid Request')
        else
            if gate==1
                disp('Order aircraft at gate to taxi and
takeoff')
                disp('Approve request to land')
                hold=0;
                gate=1;
                current_state=[hold, gate]
            end
            if gate==0
                disp('Approve request to land')
                hold=0;
                gate=1;
                current_state=[hold, gate]
            end
        end
        k=k+1;
    end
```

Next Steps

- ◆ System simulation and thorough verification through LTSA/UPPAAL modeling
 - Animation
 - Multiple Input, Dynamic Behavior validation