CMPE 180-90

Lecture – FSM Factoring

(Ref: H&H Chapter 3, section 4)

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Design Components:

- Ta and Tb are sensors
- La and Lb are trafiic lights
- Sensor indicates true if students are present and false if street is empty
- Each light receives digital inputs specifying whether it should be green, yello or red.

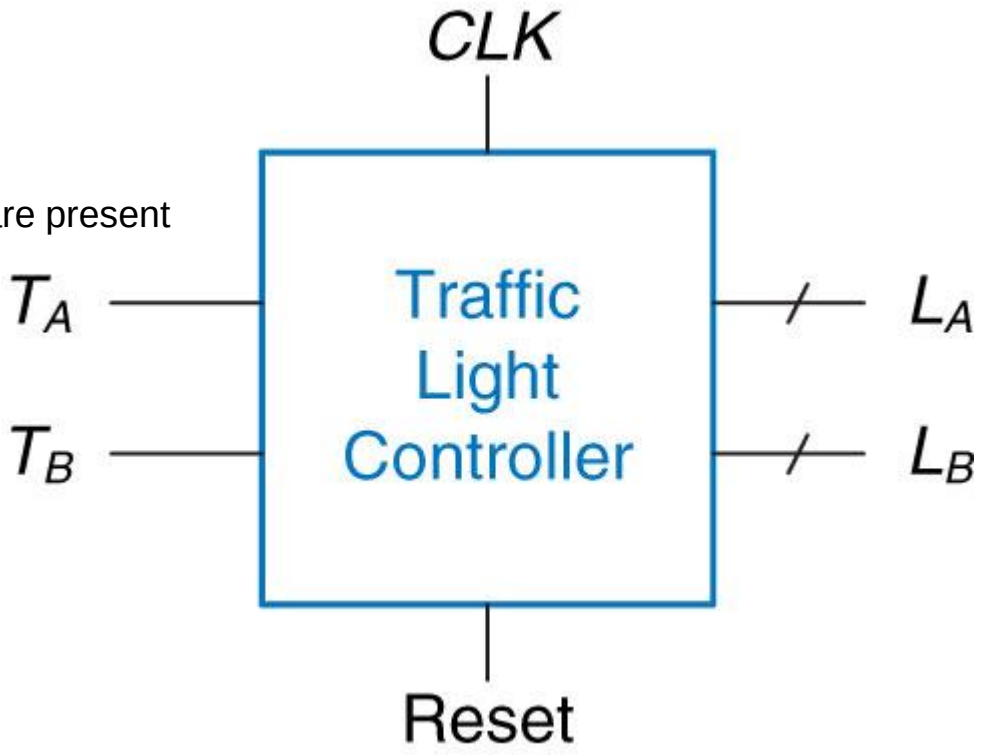


Figure 3.24 Black box view of finite state machine

How it works:

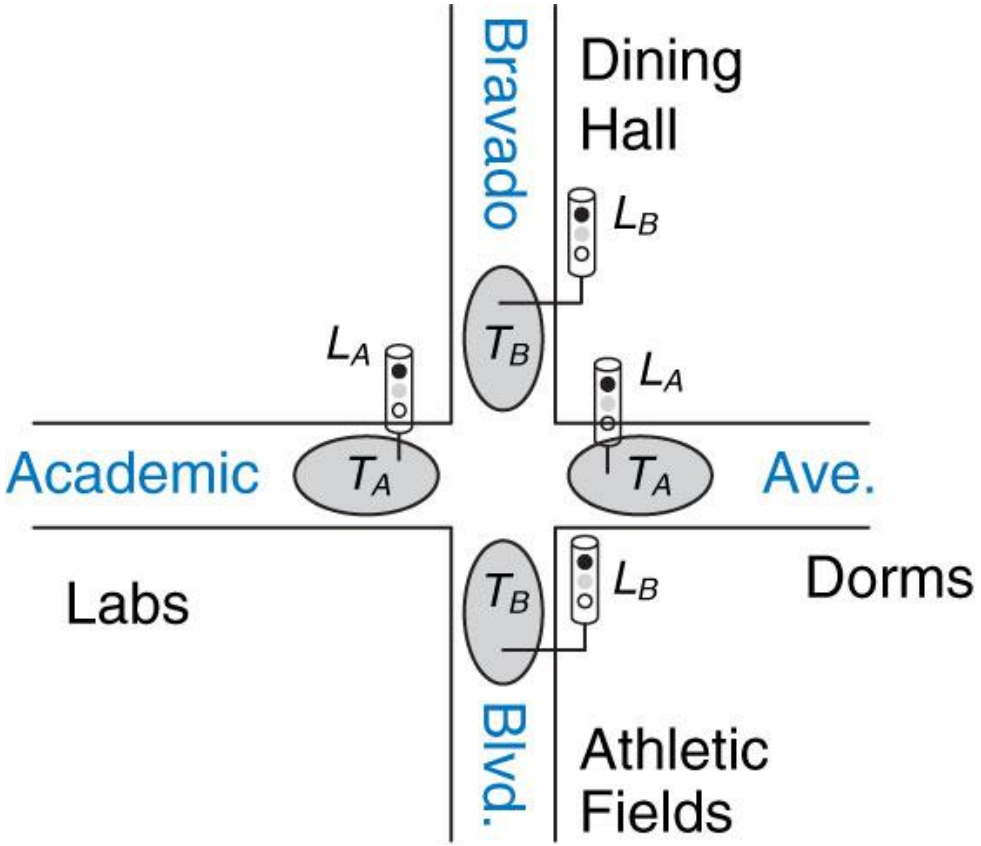
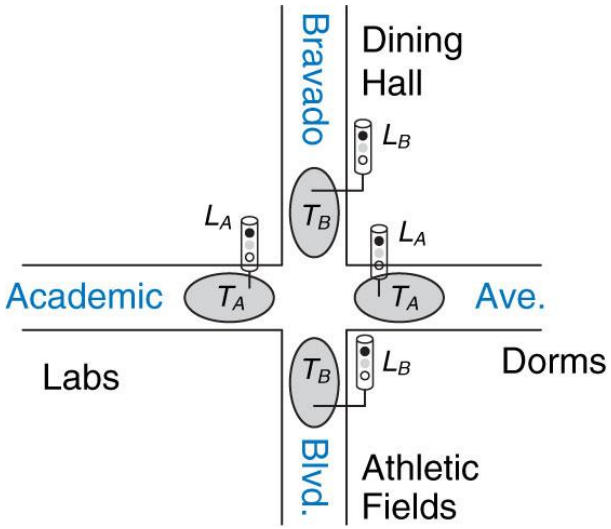


Figure 3.23 Campus map

State Transition Diagram:

S0, S1, etc are states



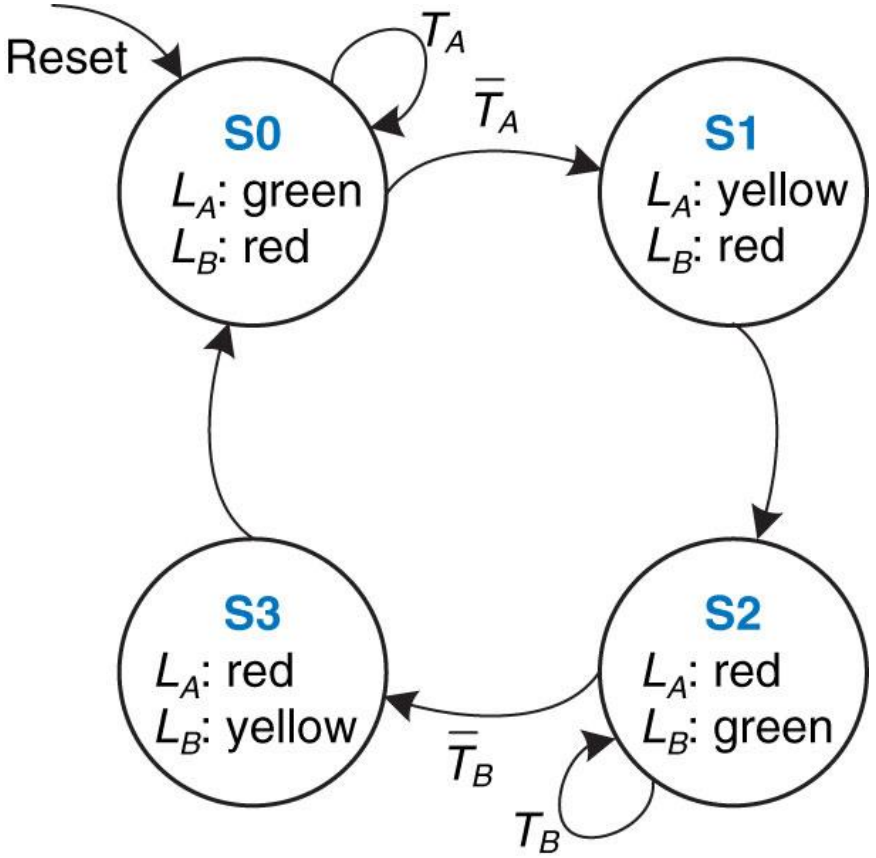


Figure 3.25 State transition diagram

State Transition Table:

S_0, S_1, S_2, ... are state bits

Current State	Inputs		Next State
S	T_A	T_B	S^+
S0	0	X	S1
S0	1	X	S0
S1	X	X	S2
S2	X	0	S3
S2	X	1	S2
S3	X	X	S0

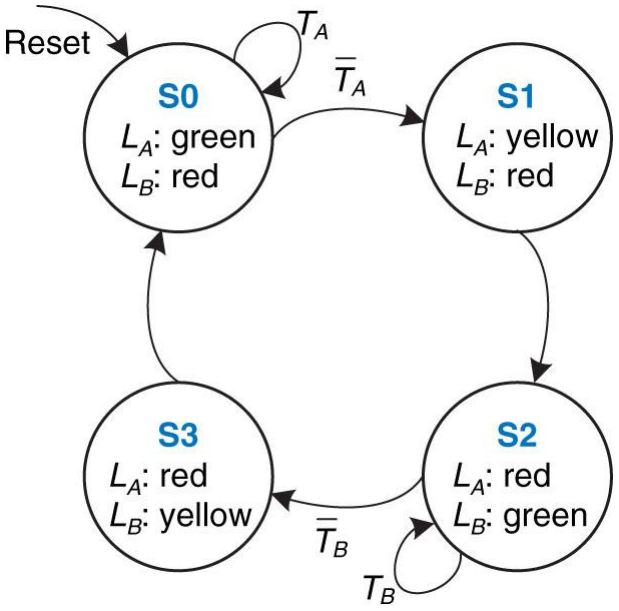
Current State		Inputs		Next State	
S_1	S_0	T_A	T_B	S^+_1	S^+_0
0	0	0	X	0	1
0	0	1	X	0	0
0	1	X	X	1	0
1	0	X	0	1	1
1	0	X	1	1	0
1	1	X	X	0	0

FSM Encoded State Transition Table

State	Encoding
S0	00
S1	01
S2	10
S3	11

Traffic Lights FSM Design

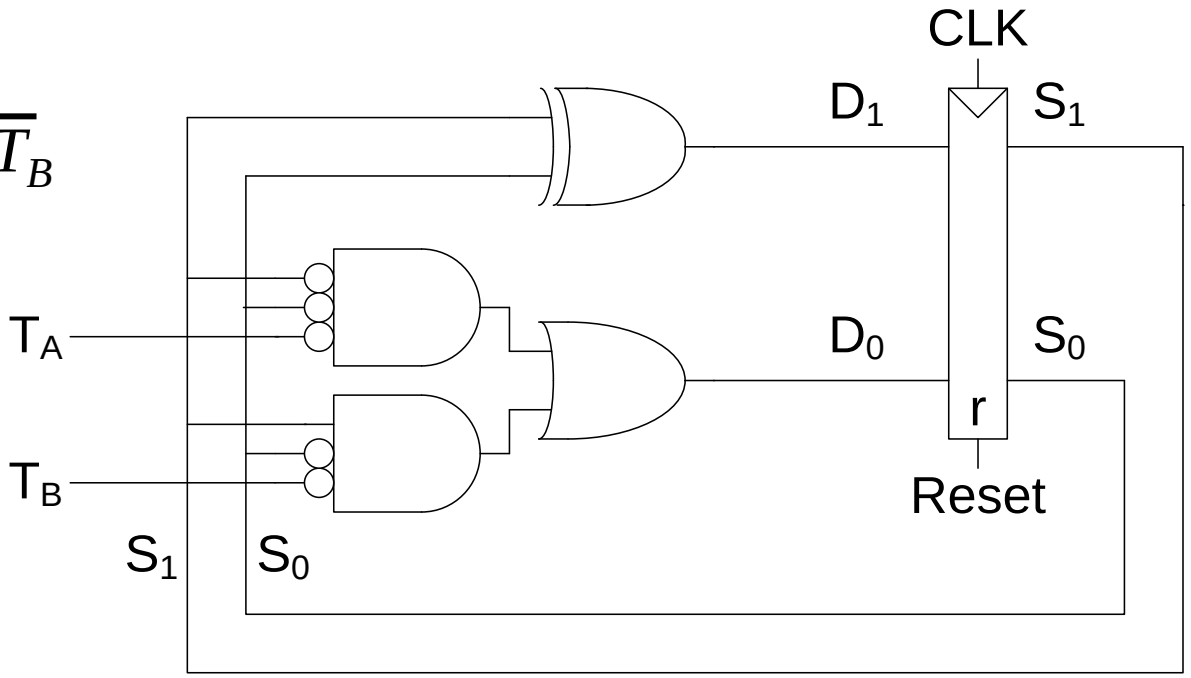
Lx1	Lx0	
0	0	GREEN
0	1	YELLOW
1	0	RED
1	1	don't care



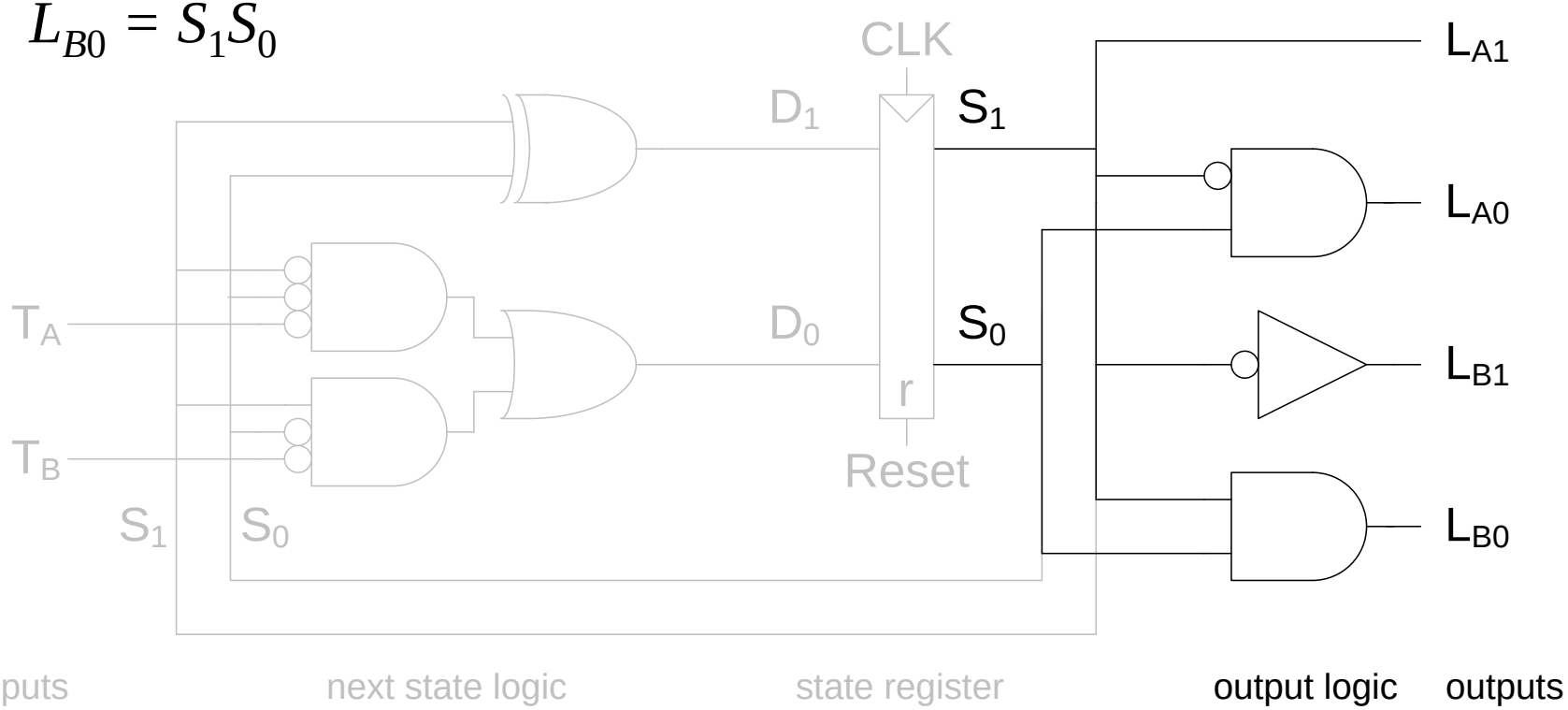
S_1	S_0	Ta	Tb	S_1^+	S_0^+	La1	La0	Lb1	Lb0
0	0	0	0	0	1	0	0	1	0
		0	1	0	1	0	0	1	0
		1	0	0	0	0	0	1	0
		1	1	0	0	0	0	1	0
0	1	0	0	1	0	0	1	1	0
		0	1	1	0	0	1	1	0
		1	0	1	0	0	1	1	0
		1	1	1	0	0	1	1	0
1	0	0	0	1	1	1	0	0	0
		0	1	1	0	1	0	0	0
		1	0	1	1	1	0	0	0
		1	1	1	0	1	0	0	0
1	1	0	0	0	0	1	0	0	1
		0	1	0	0	1	0	0	1
		1	0	0	0	1	0	0	1
		1	1	0	0	1	0	0	1

$$D_1 = S_1 \oplus S_0$$
$$D_0 = \overline{S}_1\overline{S}_0\overline{T}_A + S_1\overline{S}_0\overline{T}_B$$

$$L_{A1} = S_1$$
$$L_{A0} = \overline{S}_1 S_0$$
$$L_{B1} = \overline{S}_1$$
$$L_{B0} = S_1 S_0$$



$$L_{A1} = S_1$$
$$L_{A0} = \overline{S_1} S_0$$
$$L_{B1} = \overline{S_1}$$
$$L_{B0} = S_1 S_0$$



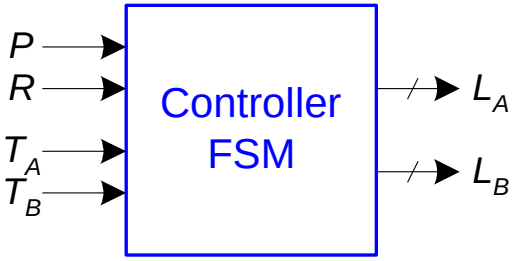
Factoring State Machines

Parade FSM

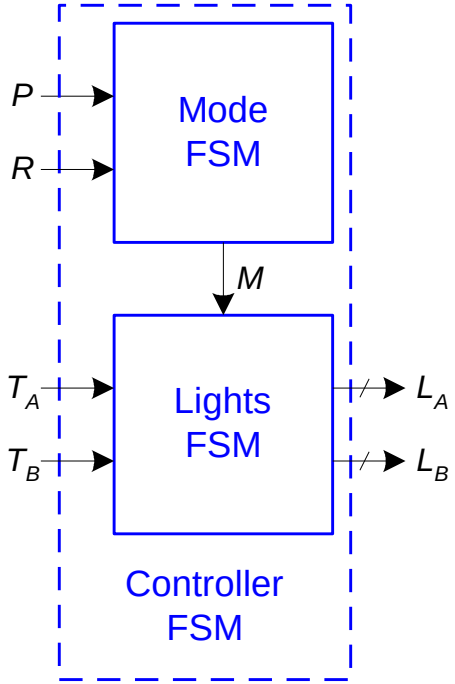
- Break complex FSMs into smaller interacting FSMs
- Example: Modify traffic light controller to have Parade Mode.
  - Two more inputs: *P*, *R*
  - When ***P* = 1**, enter Parade Mode & Bravado Blvd light stays green
  - When ***R* = 1**, leave Parade Mode

Parade FSM

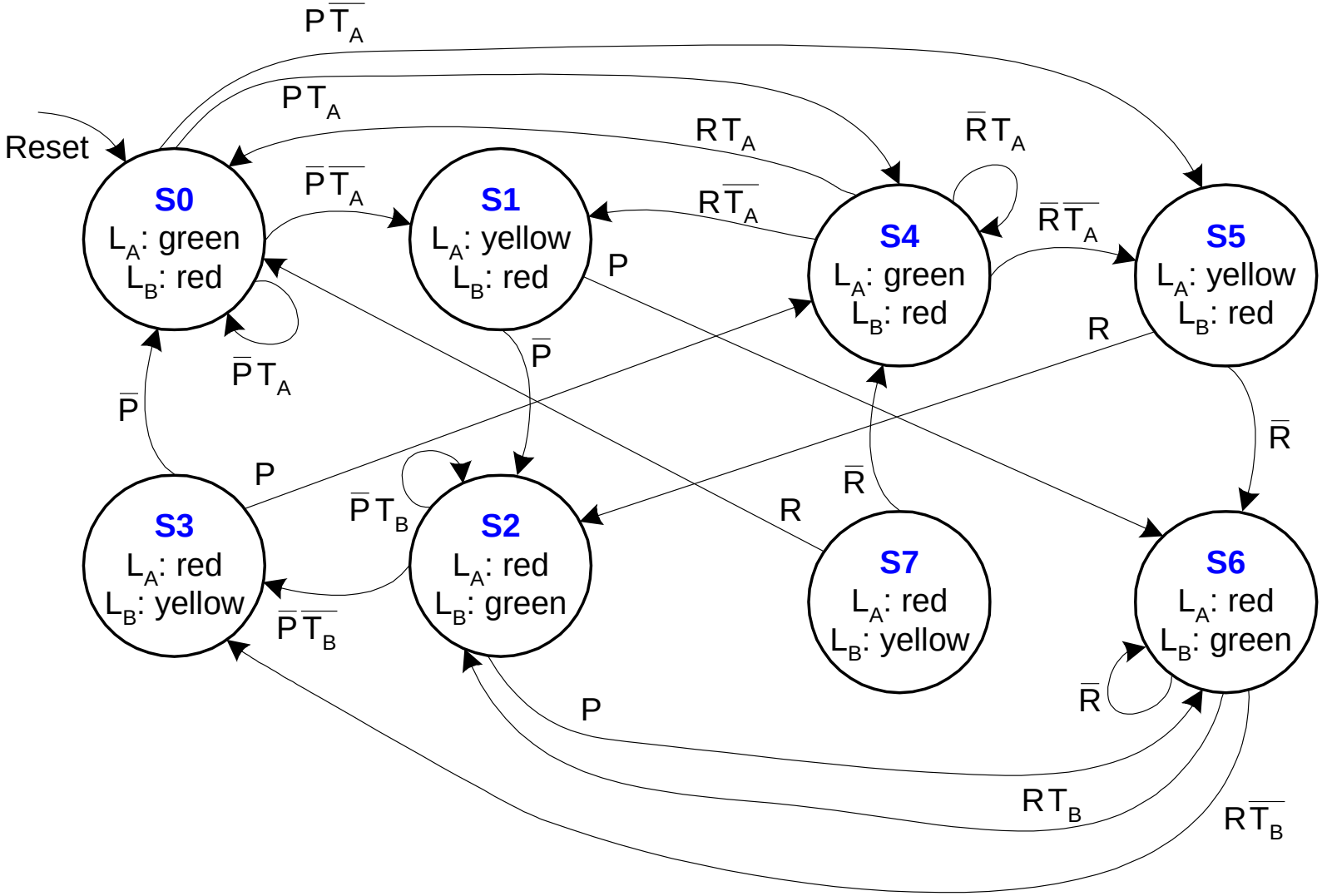
Unfactored FSM



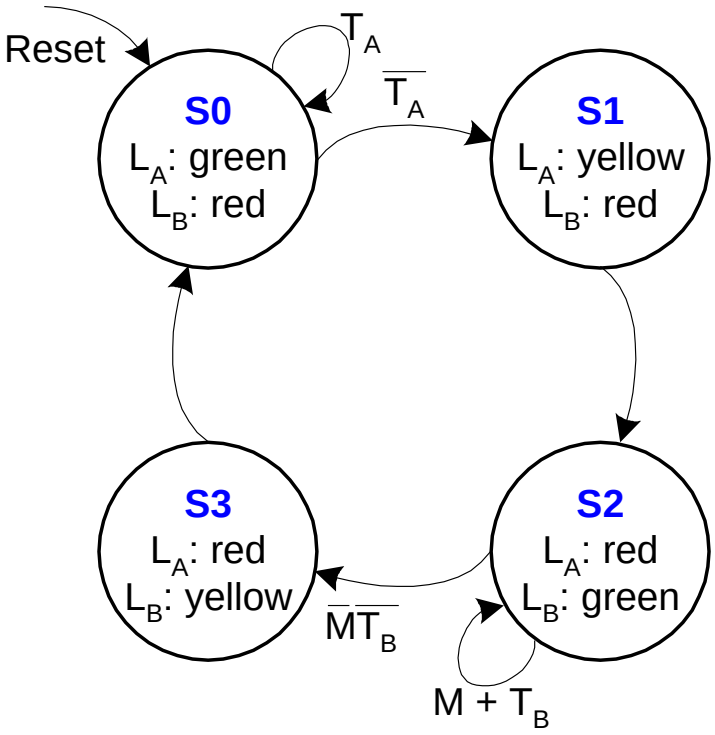
Factored FSM



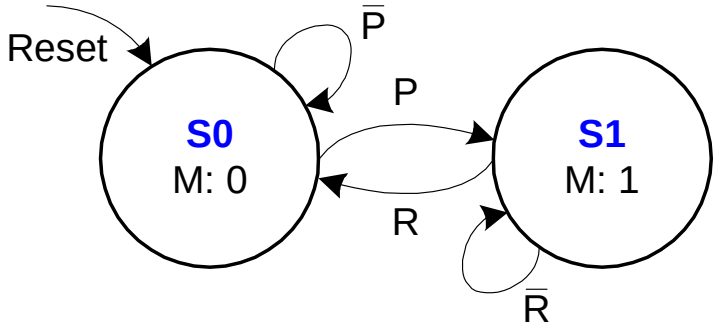
Unfactored FSM



Factored FSM



Lights FSM



Mode FSM

Further improvements
in the design?