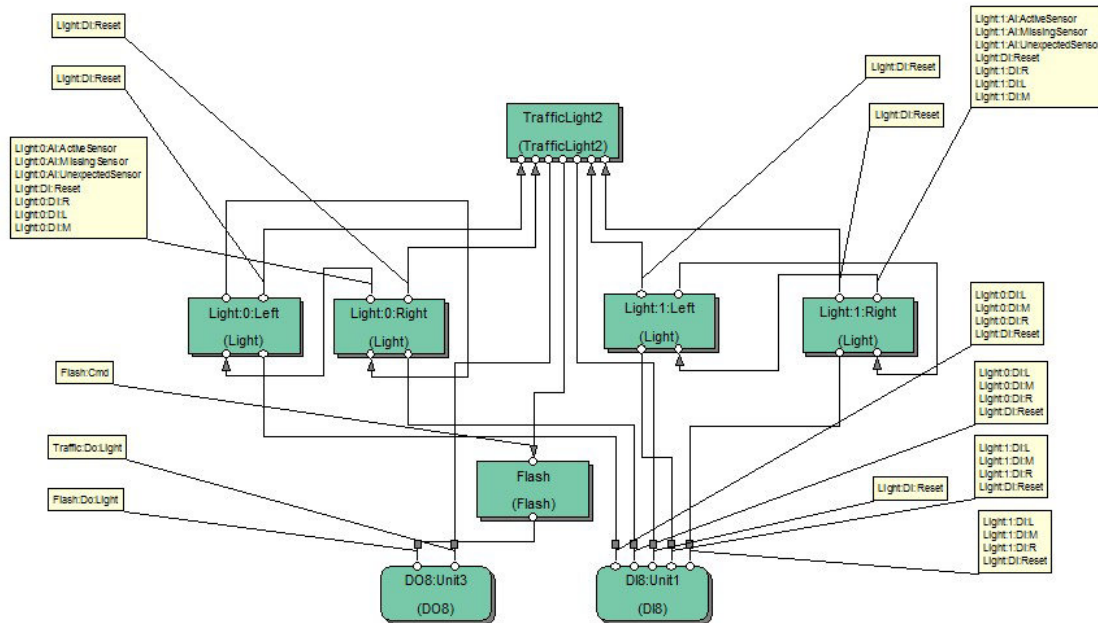


Project: TrafficLight

The control system contains three types of state machines: *TRAFFICLIGHT*, *LIGHT* and *FLASH*. *TRAFFICLIGHT* performs the direct control of the Red light and enable/disable *FLASH* sending it commands: *Cmd_Flash_Enable* and *Cmd_Flash_Disable*. *LIGHT* transforms the sequences of sensor changes into states which represent train positions. *FLASH* carries out only auxiliary function: it generates the flash cycle.

<http://www.stateworks.com/active/download/Traffic-Light-Control.pdf>



VFSM type: CMD (predefined v fsm)

Object name: Flash:Cmd

Properties	
Name	Value
Type	Flash

VFSM type: TI (predefined v fsm)

Object name: Flash:Ti:Timer1

Properties	
Name	Value
Const	10
Clock	100ms

Object name: Flash:Ti:Timer2

Properties	
Name	Value
Const	10
Clock	100ms

Object name: Light:0:Left:Ti:Delay

Properties	
Name	Value
Const	1
Clock	100ms

Object name: Light:0:Left:Ti:Timer

Properties	
Name	Value
Const	Light:Par:Timeout
Clock	sec

Object name: Light:0:Right:Ti:Delay

Properties	
Name	Value
Const	1
Clock	100ms

Object name: Light:0:Right:Ti:Timer

Properties	
Name	Value
Const	Light:Par:Timeout
Clock	sec

Object name: Light:1:Left:Ti:Delay

Properties	
Name	Value
Const	1
Clock	100ms

Object name: Light:1:Left:Ti:Timer

Properties	
Name	Value
Const	Light:Par:Timeout
Clock	sec

Object name: Light:1:Right:Ti:Delay

Properties	
Name	Value
Const	1
Clock	100ms

Object name: Light:1:Right:Ti:Timer

Properties	
Name	Value
Const	Light:Par:Timeout
Clock	sec

VFSM type: AL(predefined v fsm)
Object name: Light:0:AI:ActiveSensor

Properties	
Name	Value
Category	2
Text	Rail:0 There are still active sensors

Object name: Light:0:AI:MissingSensor

Properties	
Name	Value
Category	1
Text	Rail:0 Missing sensor signal during 1 minute

Object name: Light:0:AI:UnexpectedSensor

Properties	
Name	Value
Category	1
Text	Rail:0 Received unexpected sensor signal

Object name: Light:1:AI:ActiveSensor

Properties	
Name	Value
Category	2
Text	Rail:1 There are still active sensors

Object name: Light:1:AI:MissingSensor

Properties	
Name	Value
Category	1
Text	Rail:1 Missing sensor signal during 1 minute

Object name: Light:1:AI:UnexpectedSensor

Properties	
Name	Value
Category	1
Text	Rail:1 Received unexpected sensor signal

VFSM type: DI(predefined v fsm)

Object name: Light:0:Di:L
 Object name: Light:0:Di:M
 Object name: Light:0:Di:R
 Object name: Light:1:Di:L
 Object name: Light:1:Di:M
 Object name: Light:1:Di:R
 Object name: Light:Di:Reset
 Object name: Traffic:Di:Light

VFSM type: DO (predefined v fsm)

Object name: Flash:Do:Light
 Object name: Traffic:Do:Light

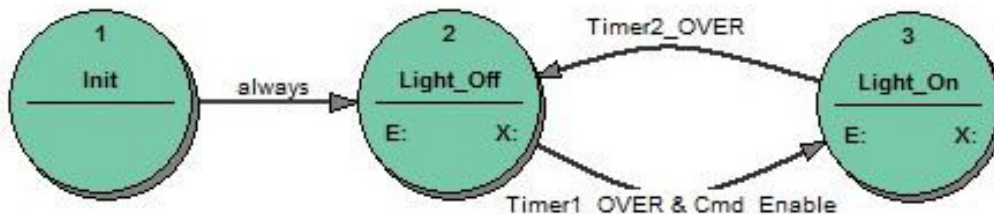
VFSM type: PAR (predefined v fsm)

Object name: Light:Par:Timeout

Properties	
Name	Value
Category	PP
Format	ushort
Unit	sec
LimitLow	0
LimitHigh	100
InitValue	20

VFSM type: Flash (user v fsm)

FLASH generates a cycling Do signal that is used to drive a flashing (yellow) crossing light. FLUSH oscilates between two states. The oscilation are enabled/disabled by the command Enable or the digital input Enable. The oscilation period is determined by the Timer.



Prefix: FLA

Object name: Flash

It is the first and only instantiation of the Flash state machine.

Properties	
Name	Value
MyCmd	Flash:Cmd
Timer1	Flash:Ti:Timer1
Timer2	Flash:Ti:Timer2
Light	Flash:Do:Light

IOid name: MyCmd (type: CMD-IN)

-->Virtual Input: Cmd_Disable (2)

-->Virtual Input: Cmd_Enable (1)

IOid name: Timer1 (type: TI)

-->Virtual Input: Timer1_OVER (OVER)

-->Virtual Output: Timer1_ResetStart (ResetStart)

-->Virtual Output: Timer1_Stop (Stop)

IOid name: Timer2 (type: TI)

-->Virtual Input: Timer2_OVER (OVER)

-->Virtual Output: Timer2_ResetStart (ResetStart)

-->Virtual Output: Timer2_Stop (Stop)

IOid name: Light (type: DO)

-->Virtual Output: Light_Off (Low)

-->Virtual Output: Light_On (High)

Light_Off	always	
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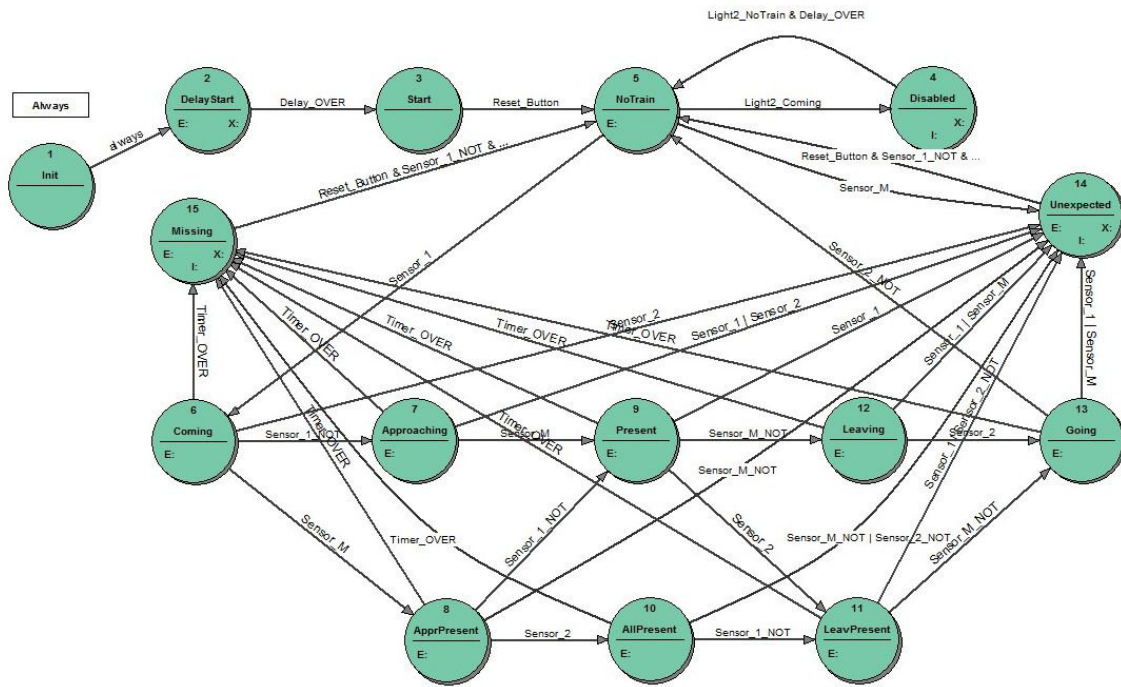
Di

Light_On	Timer1_OVER and Cmd_Enable	
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Light_Off	Timer2_OVER	
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Total number of states: 3**VFSM type: Light(user v fsm)**

LIGHT The state machine is a part of a system that controls traffic lights on a train/road crossing. *LIGHT* does not perform any direct control function; it just translates the sensor changes into states that represent the train position. The train movements is detected by Sensors L, M, R (check boxes Left, Middle, Right on the picture). By the specification the Sensors L and R are numbered as 1 and 2 (for one direction 1->L and 2->R, for the other direction it is vice-versa). Sensor 1 is the sensor which signals that a train has entered the controlled zone. Sensor 2 is the sensor which signals that a train is leaving the controlled zone. In the system configuration (see project) the proper sensors are then used for each direction. We assume that a train may come from both directions but only one train can enter the sensor zone. The traffic lights may be in the following states: - both lights grey if the control system is not working, - yellow light flashing if there is no train between sensors 1 and 2 or a train just passed the sensor M and is still between sensors M and 1 moving towards 2, i.e. leaving the sensors zone, - red light on if there is a train between sensor 1 and M moving towards M, i.e. approaching the road, - red light on and yellow light flashing if the situation is not well defined: after a system start, when received an unexpected sensor signal and when the expected sensor signal has not come after a certain time. These situations are considered as unsafe ones and can be resolved only by a manual control: if the situation is cleared the operator may Reset the system. The time needed by the train to pass the distance between two sensors is measured by a timer. By entering most states the timer is started. When the timer elapses the situation is considered as an unsafe one and *LIGHT* enters the Missing state (train disappeared?).



Prefix: LIG

Object name: Light:0:Left

It is the first instantiation of the Light state machine: reflecting the position of trains coming on the rail 0 from the left side.

Properties	
Name	Value
My-Cmd	
Light2	Light:0:Right
Delay	Light:0:Left:Ti:Delay
Timer	Light:0:Left:Ti:Timer
AI_ActiveSensor	Light:0:AI:ActiveSensor
AI_MissingSensor	Light:0:AI:MissingSensor
AI_UnexpectedSensor	Light:0:AI:UnexpectedSensor
Reset	Light:Di:Reset
Sensor_1	Light:0:Di:L
Sensor_2	Light:0:Di:R
Sensor_M	Light:0:Di:M

Object name: Light:0:Right

It is the second instantiation of the Light state machine: reflecting the position of trains coming on the rail 0 from the right side.

Properties	
Name	Value
My-Cmd	
Light2	Light:0:Left
Delay	Light:0:Right:Ti:Delay
Timer	Light:0:Right:Ti:Timer
AI_ActiveSensor	Light:0:AI:ActiveSensor

AI_MissingSensor	Light:0:AI:MissingSensor
AI_UnexpectedSensor	Light:0:AI:UnexpectedSensor
Reset	Light:Di:Reset
Sensor_1	Light:0:Di:R
Sensor_2	Light:0:Di:L
Sensor_M	Light:0:Di:M

Object name: Light:1:Left

It is the third instantiation of the Light state machine: : reflecting the position of trains coming on the rail 1 from the left side.

Properties	
Name	Value
My-Cmd	
Light2	Light:1:Right
Delay	Light:1:Left:Ti:Delay
Timer	Light:1:Left:Ti:Timer
AI_ActiveSensor	Light:1:AI:ActiveSensor
AI_MissingSensor	Light:1:AI:MissingSensor
AI_UnexpectedSensor	Light:1:AI:UnexpectedSensor
Reset	Light:Di:Reset
Sensor_1	Light:1:Di:L
Sensor_2	Light:1:Di:R
Sensor_M	Light:1:Di:M

Object name: Light:1:Right

It is the fourth instantiation of the Light state machine: reflecting the position of trains coming on the rail 1 from the right side.

Properties	
Name	Value
My-Cmd	
Light2	Light:1:Left
Delay	Light:1:Right:Ti:Delay
Timer	Light:1:Right:Ti:Timer
AI_ActiveSensor	Light:1:AI:ActiveSensor
AI_MissingSensor	Light:1:AI:MissingSensor
AI_UnexpectedSensor	Light:1:AI:UnexpectedSensor
Reset	Light:Di:Reset
Sensor_1	Light:1:Di:R
Sensor_2	Light:1:Di:L
Sensor_M	Light:1:Di:M

IOid name: My-Cmd (type: CMD-IN)

IOid name: Light2 (type: VFSM)

light

-->Virtual Input: Light2_Coming (Coming)

-->Virtual Input: Light2_NoTrain (NoTrain)

IOid name: Delay (type: TI)

-->Virtual Input: Delay_OVER (OVER)
 -->Virtual Output: Delay_ResetStart (ResetStart)
 -->Virtual Output: Delay_Stop (Stop)

IOid name: Timer (type: TI)

-->Virtual Input: Timer_OVER (OVER)
 -->Virtual Output: Timer_ResetStart (ResetStart)
 -->Virtual Output: Timer_Stop (Stop)

IOid name: AI_ActiveSensor (type: AL)

-->Virtual Output: AI_ActiveSensor_Com (Coming)
 -->Virtual Output: AI_ActiveSensor_Go (Going)

IOid name: AI_MissingSensor (type: AL)

-->Virtual Output: AI_MissingSensor (Staying)

IOid name: AI_UnexpectedSensor (type: AL)

-->Virtual Output: AI_UnexpectedSensor (Staying)

IOid name: Reset (type: DI)

-->Virtual Input: Reset_Button (HIGH)

IOid name: Sensor_1 (type: DI)

-->Virtual Input: Sensor_1 (HIGH)
 -->Virtual Input: Sensor_1_NOT (LOW)

IOid name: Sensor_2 (type: DI)

-->Virtual Input: Sensor_2 (HIGH)
 -->Virtual Input: Sensor_2_NOT (LOW)

IOid name: Sensor_M (type: DI)

-->Virtual Input: Sensor_M (HIGH)
 -->Virtual Input: Sensor_M_NOT (LOW)

The system goes always into the Start state.

DelayStart	always	
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Without the state DelayStart the state machine Light enters immediately the state Start and the state machine TrafficLight does not get the event. In effect the outputs Do_Light are not initialized (see the state machine TrafficLight).

Start	Delay_OVER	
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The functioning of the state machine is started by the Reset button which causes LIGHT to go into the state NoTrain.

NoTrain	Reset_Button	
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LIGHT waits in this state until a "partner" state machine which controls the other direction returns into the state NoTrain. The Delay timer delays the return to the state NoTrain which ensures that the Sensor_1 is there already inactive.

	Light2_NoTrain	Delay_ResetStart
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NoTrain	Light2_NoTrain and Delay_OVER	
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The train is over the Sensor 1 entering the controlled zone. The expected changes are: the Sensor 1 becomes inactive (short train) or the Sensor M becomes active (long train) which leads to transitions correspondingly to states Approaching or ApprPresent. The erroneous changes like an active signal from the Sensor 2 forces LIGHT to go to the Unexpected state.

Approaching	Sensor_1_NOT	
ApprPresent	Sensor_M	
Unexpected	Sensor_2	
Missing	Timer_OVER	

The train is between Sensors 1 and M moving towards M. If the Sensor M becomes active (the train crosses the road) LIGHT goes to the Present state. The unexpected active signal from the Sensor 1 (the train has changed its movement direction or another train has entered the controlled zone?) or 2 (the train has missed the Sensor M or another train entered the controlled zone?) forces LIGHT to go to the Unexpected state.

Present	Sensor_M	
Unexpected	Sensor_1 or Sensor_2	
Missing	Timer_OVER	

There is a long train over both Sensors 1 and M moving towards M. If the Sensor 1 becomes inactive LIGHT goes to the Present state. If the Sensor 2 becomes active LIGHT goes to the state AllPresent. Disappearance of the Signal M is considered as an error.

Present	Sensor_1_NOT	
AllPresent	Sensor_2	
Unexpected	Sensor_M_NOT	
Missing	Timer_OVER	

The train is over the Sensor M. If the expected sensor changes occur: Sensor M becomes inactive or Sensor 2 becomes active LIGHT goes correspondingly to the states: Leaving or LeavPresent. If Sensor 1 becomes active it is an error.

Leaving	Sensor_M_NOT	
LeavPresent	Sensor_2	
Unexpected	Sensor_1	
Missing	Timer_OVER	

There is a very long train over all three Sensors 1, M and 2. The only expected change is Sensor 1 becoming inactive. Other sensor changes are errors.

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LeavPresent	Sensor_1_NOT
Unexpected	Sensor_M_NOT or Sensor_2_NOT
Missing	Timer_OVER

The train is over the Sensor M and 2 moving towards 2. The only expected change is Sensor M becoming inactive. Other sensor changes are errors.

Going	Sensor_M_NOT
Unexpected	Sensor_1 or Sensor_2_NOT
Missing	Timer_OVER

The train left the sensor M and is between M and 2. The only expected change is Sensor 2 becoming active. Other sensor changes are errors.

Going	Sensor_2
Unexpected	Sensor_1 or Sensor_M
Missing	Timer_OVER

The train is over the Sensor 2 leaving the controlled zone. The only expected change is Sensor 2 becoming inactive. Other sensor changes are errors.

NoTrain	Sensor_2_NOT
Unexpected	Sensor_1 or Sensor_M
Missing	Timer_OVER

By entering the state the alarm UnexpectedSensor is generated and the Timer is stopped. LIGHT can leave this state if the Reset button is activated and all sensors are inactive. In such a case it goes to the NoTrain state. The active Reset button while at least one sensor is still active generate an alarm info about this situation.

	Reset_Button and (Sensor_1 or Sensor_M or Sensor_2)	AI_ActiveSensor_Com
NoTrain	Reset_Button and Sensor_1_NOT and Sensor_M_NOT and Sensor_2_NOT	

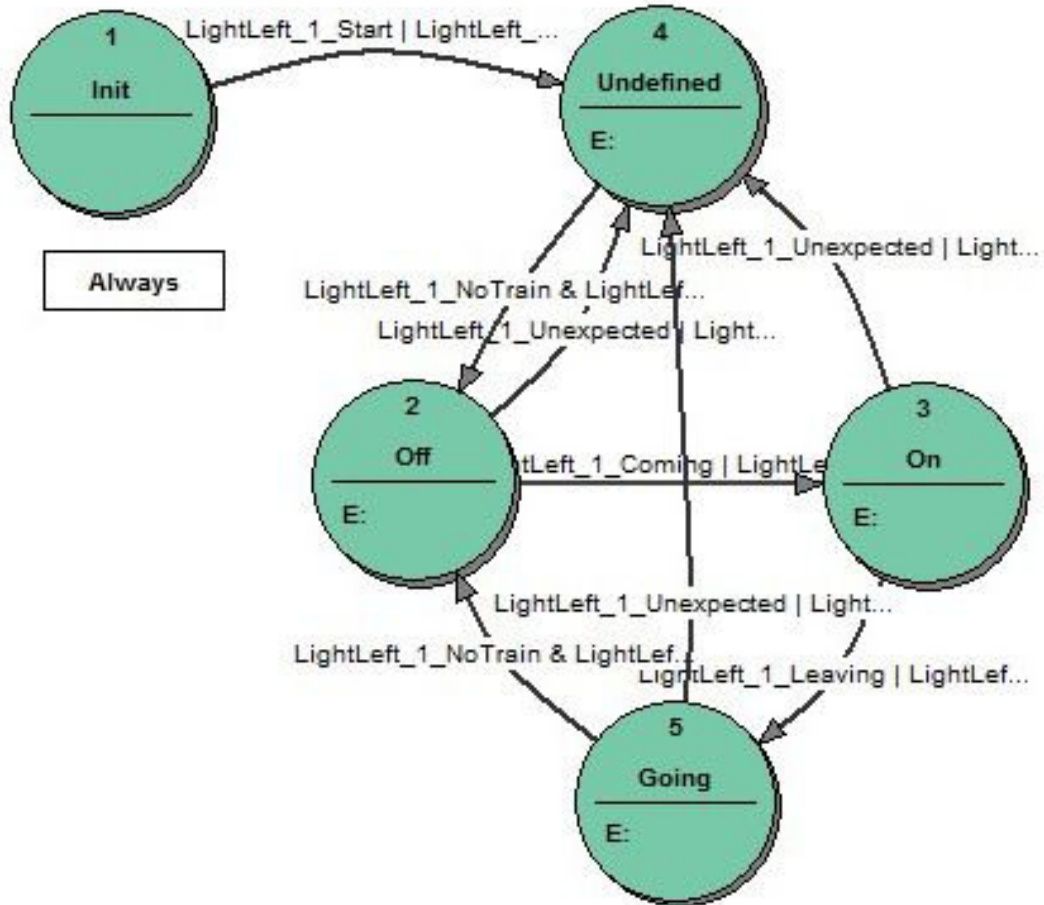
By entering the state the alarm MissingSensor is generated and the Timer is stopped. LIGHT can leave this state if the Reset button is activated and all sensors are inactive. In such a case it goes to the NoTrain state. The active Reset button while at least one sensor is still active generate an alarm info about this situation.

	Reset_Button and (Sensor_1 or Sensor_M or Sensor_2)	AI_ActiveSensor_Com
NoTrain	Reset_Button and Sensor_1_NOT and Sensor_M_NOT and Sensor_2_NOT	

Total number of states: 15

VFSM type: TrafficLight2 (user v fsm)

TRAFFICLIGHT2 The state machine switches on/off the (red) lamp and enables/disables the (yellow) flash lamp. It does it by knowing the states of the state machines Light.



Prefix: TR2

Object name: TrafficLight2

Properties	
Name	Value
MyCmd	
LightLeft_1	Light:0:Left
LightLeft_2	Light:1:Left
LightRight_1	Light:0:Right
LightRight_2	Light:1:Right
Flash	Flash:Cmd
Di_Light	Light:Di:Reset
Do_Light	Traffic:Do:Light

IOid name: MyCmd (type: CMD-IN)

-->Virtual Output: MyCmd_Clear (0)

IOid name: LightLeft_1 (type: VFSM)

light

-->Virtual Input: LightLeft_1_AllPresent (AllPresent)
 -->Virtual Input: LightLeft_1_ApprPresent (ApprPresent)
 -->Virtual Input: LightLeft_1_Approaching (Approaching)
 -->Virtual Input: LightLeft_1_Coming (Coming)
 -->Virtual Input: LightLeft_1_DelayStart (DelayStart)
 -->Virtual Input: LightLeft_1_Disabled (Disabled)
 -->Virtual Input: LightLeft_1_Going (Going)
 -->Virtual Input: LightLeft_1_Init (Init)
 -->Virtual Input: LightLeft_1_LeavPresent (LeavPresent)
 -->Virtual Input: LightLeft_1_Leaving (Leaving)
 -->Virtual Input: LightLeft_1_Missing (Missing)
 -->Virtual Input: LightLeft_1_NoTrain (NoTrain)
 -->Virtual Input: LightLeft_1_Present (Present)
 -->Virtual Input: LightLeft_1_Start (Start)
 -->Virtual Input: LightLeft_1_Unexpected (Unexpected)

IOid name: LightLeft_2 (type: VFSM)*light*

-->Virtual Input: LightLeft_2_AllPresent (AllPresent)
 -->Virtual Input: LightLeft_2_ApprPresent (ApprPresent)
 -->Virtual Input: LightLeft_2_Approaching (Approaching)
 -->Virtual Input: LightLeft_2_Coming (Coming)
 -->Virtual Input: LightLeft_2_DelayStart (DelayStart)
 -->Virtual Input: LightLeft_2_Disabled (Disabled)
 -->Virtual Input: LightLeft_2_Going (Going)
 -->Virtual Input: LightLeft_2_Init (Init)
 -->Virtual Input: LightLeft_2_LeavPresent (LeavPresent)
 -->Virtual Input: LightLeft_2_Leaving (Leaving)
 -->Virtual Input: LightLeft_2_Missing (Missing)
 -->Virtual Input: LightLeft_2_NoTrain (NoTrain)
 -->Virtual Input: LightLeft_2_Present (Present)
 -->Virtual Input: LightLeft_2_Start (Start)
 -->Virtual Input: LightLeft_2_Unexpected (Unexpected)

IOid name: LightRight_1 (type: VFSM)*light*

-->Virtual Input: LightRight_1_AllPresent (AllPresent)
 -->Virtual Input: LightRight_1_ApprPresent (ApprPresent)
 -->Virtual Input: LightRight_1_Approaching (Approaching)
 -->Virtual Input: LightRight_1_Coming (Coming)
 -->Virtual Input: LightRight_1_DelayStart (DelayStart)
 -->Virtual Input: LightRight_1_Disabled (Disabled)
 -->Virtual Input: LightRight_1_Going (Going)
 -->Virtual Input: LightRight_1_Init (Init)
 -->Virtual Input: LightRight_1_LeavPresent (LeavPresent)
 -->Virtual Input: LightRight_1_Leaving (Leaving)
 -->Virtual Input: LightRight_1_Missing (Missing)
 -->Virtual Input: LightRight_1_NoTrain (NoTrain)
 -->Virtual Input: LightRight_1_Present (Present)
 -->Virtual Input: LightRight_1_Start (Start)
 -->Virtual Input: LightRight_1_Unexpected (Unexpected)

IOid name: LightRight_2 (type: VFSM)*light*

-->Virtual Input: LightRight_2_AllPresent (AllPresent)
 -->Virtual Input: LightRight_2_ApprPresent (ApprPresent)
 -->Virtual Input: LightRight_2_Approaching (Approaching)
 -->Virtual Input: LightRight_2_Coming (Coming)

-->Virtual Input: LightRight_2_DelayStart (DelayStart)
 -->Virtual Input: LightRight_2_Disabled (Disabled)
 -->Virtual Input: LightRight_2_Going (Going)
 -->Virtual Input: LightRight_2_Init (Init)
 -->Virtual Input: LightRight_2_LeavPresent (LeavPresent)
 -->Virtual Input: LightRight_2_Leaving (Leaving)
 -->Virtual Input: LightRight_2_Missing (Missing)
 -->Virtual Input: LightRight_2_NoTrain (NoTrain)
 -->Virtual Input: LightRight_2_Present (Present)
 -->Virtual Input: LightRight_2_Start (Start)
 -->Virtual Input: LightRight_2_Unexpected (Unexpected)

IOid name: Flash (type: CMD-OUT)

flash

-->Virtual Output: Flash_Disable (2)
 -->Virtual Output: Flash_Enable (1)

IOid name: Di_Light (type: DI)

-->Virtual Input: Di_Light_HIGH (HIGH)
 -->Virtual Input: Di_Light_LOW (LOW)
 -->Virtual Input: Di_Light_UNKNOWN (UNKNOWN)

IOid name: Do_Light (type: DO)

-->Virtual Output: Do_Light_High (High)
 -->Virtual Output: Do_Light_Low (Low)

Undefined	LightLeft_1_Start or LightLeft_2_Start or LightRight_1_Start or LightRight_2_Start
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On entering the state the (red) lamp is switched off but the (yellow) flash lamp is enabled. There are two imaginable situations: - if any state machine Light goes into the state Coming the TrafficLight goes to the state On, - if any state machine Light goes to the state Unexpected the TrafficLight goes to the state Undefined. Note that if the transition of the state machine Light to the state Disabled is ignored by the TrafficLight (it is an intern blocking mechanism between two state machines Light that control the traffic on one rail).

On	LightLeft_1_Coming or LightLeft_2_Coming or LightRight_1_Coming or LightRight_2_Coming
Undefined	LightLeft_1_Unexpected or LightLeft_2_Unexpected or LightRight_1_Unexpected or LightRight_2_Unexpected

On entering the state the (red) lamp is switched on and the (yellow) flash lamp is disabled. There are two imaginable situations: - if any state machine Light goes to the state Leaving or Going the TrafficLight goes to the state Going - if any state machine Light goes to the state Unexpected or Missing the TrafficLight goes to the state Undefined

Going	LightLeft_1_Leaving or LightLeft_1_Going or LightLeft_2_Leaving or LightLeft_2_Going or LightRight_1_Leaving or LightRight_1_Going or LightRight_2_Leaving or LightRight_2_Going
Undefined	LightLeft_1_Unexpected or LightLeft_2_Unexpected or LightRight_1_Unexpected or LightRight_2_Unexpected or LightLeft_1_Missing or LightLeft_2_Missing or LightRight_1_Missing or LightRight_2_Missing

All state machines Light work and are in the state Start but the there is no distinct information about the trains positions. Therefore on entering

the state the state machine switches on the (red) lamp and enables the (yellow) flash lamp. This is the responsibility of an operator to reset the system. Resetting the system the operator acknowledges that there are no trains in the supervised area. The reset signal goes directly to all state machines Light that go to the state NoTrain. At that moment the TrafficLight systems takes over control of the traffic lights going to the state Off.

Off	LightLeft_1_NoTrain and LightLeft_2_NoTrain and LightRight_1_NoTrain and LightRight_2_NoTrain
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On entering the state the (red) lamp is switched off and the (yellow) flash lamp is enabled. There are two imaginable situations: - if all state machines Light are in the state NoTrain the TrafficLight goes to the state Off - if any state machine Light goes to the state Unexpected or Missing the TrafficLight goes to the state Undefined

Off	LightLeft_1_NoTrain and LightLeft_2_NoTrain and LightRight_1_NoTrain and LightRight_2_NoTrain
Undefined	LightLeft_1_Unexpected or LightLeft_2_Unexpected or LightRight_1_Unexpected or LightRight_2_Unexpected or LightLeft_1_Missing or LightLeft_2_Missing or LightRight_1_Missing or LightRight_2_Missing

Total number of states: 5

VFSM type: DO8 (unit)

Prefix: DOU

Object name: DO8:Unit3

Properties	
Name	Value
CommPort	0
PhysAddr	3
Do0	Flash:Do:Light
Do1	Traffic:Do:Light
Do2	
Do3	
Do4	
Do5	
Do6	
Do7	

IOid name: Do0 (type: DO)

IOid name: Do1 (type: DO)

IOid name: Do2 (type: DO)

IOid name: Do3 (type: DO)

IOid name: Do4 (type: DO)

IOid name: Do5 (type: DO)

IOid name: Do6 (type: DO)

IOid name: Do7 (type: DO)

VFSM type: DI8 (unit)

Prefix: DIU

Object name: DI8:Unit1

Properties	
Name	Value
CommPort	0
PhysAddr	1
Di0	Light:0:Di:L
Di1	Light:0:Di:M
Di2	Light:0:Di:R
Di3	Light:1:Di:L
Di4	Light:1:Di:M
Di5	Light:1:Di:R
Di6	Traffic:Di:Light
Di7	Light:Di:Reset

IOid name: Di0 (type: DI)

IOid name: Di1 (type: DI)

IOid name: Di2 (type: DI)

IOid name: Di3 (type: DI)

IOid name: Di4 (type: DI)

IOid name: Di5 (type: DI)

IOid name: Di6 (type: DI)

IOid name: Di7 (type: DI)