

# EGYPT FWD Initiative

Advanced Embedded Systems Nanodegree,  
Embedded Software Design Masterclass by **SPRINTS Egypt**.

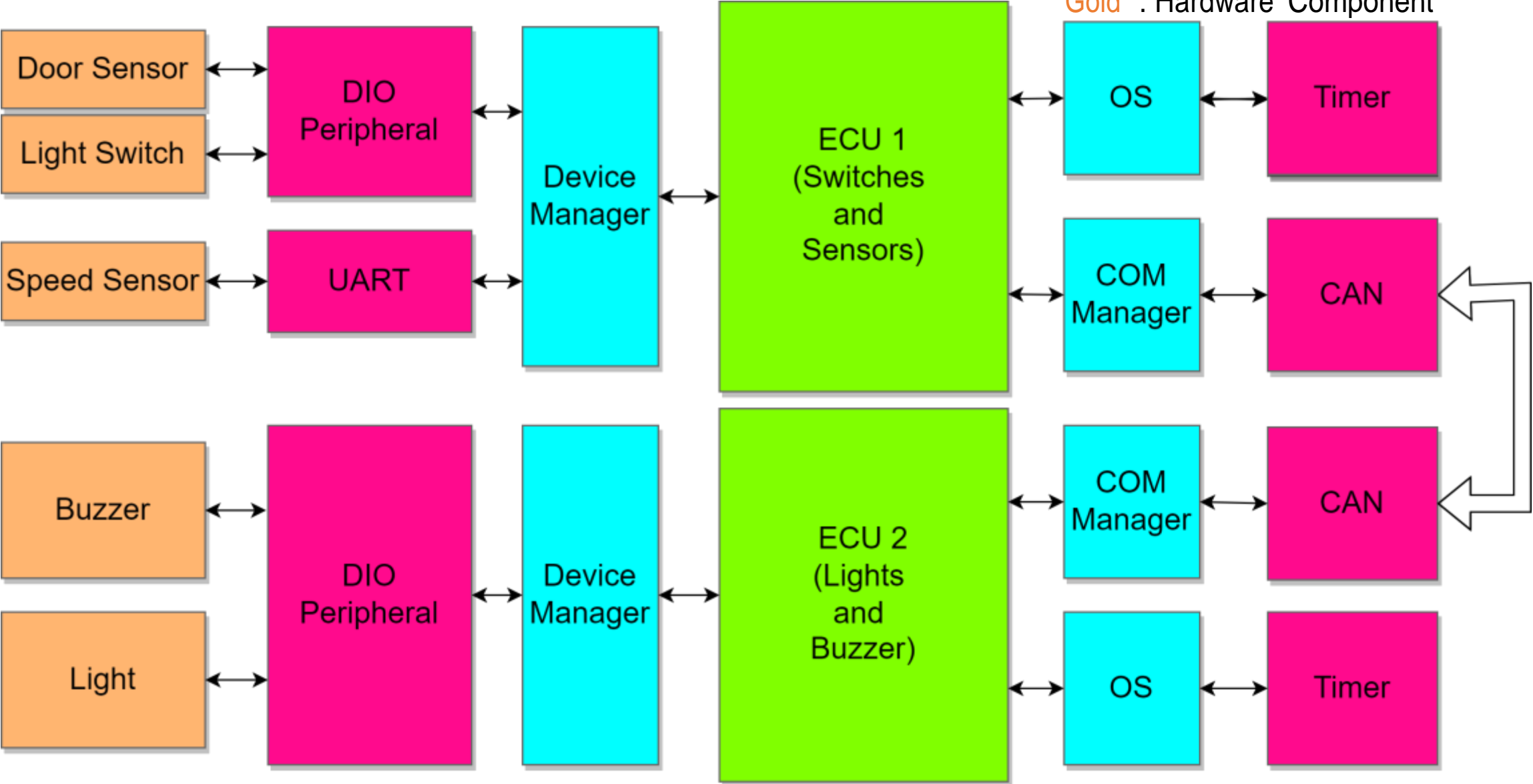
## Automotive Door Control System **Static** Design

A Graduation Project submitted in partial Fulfillment of  
Embedded Software Design Masterclass.

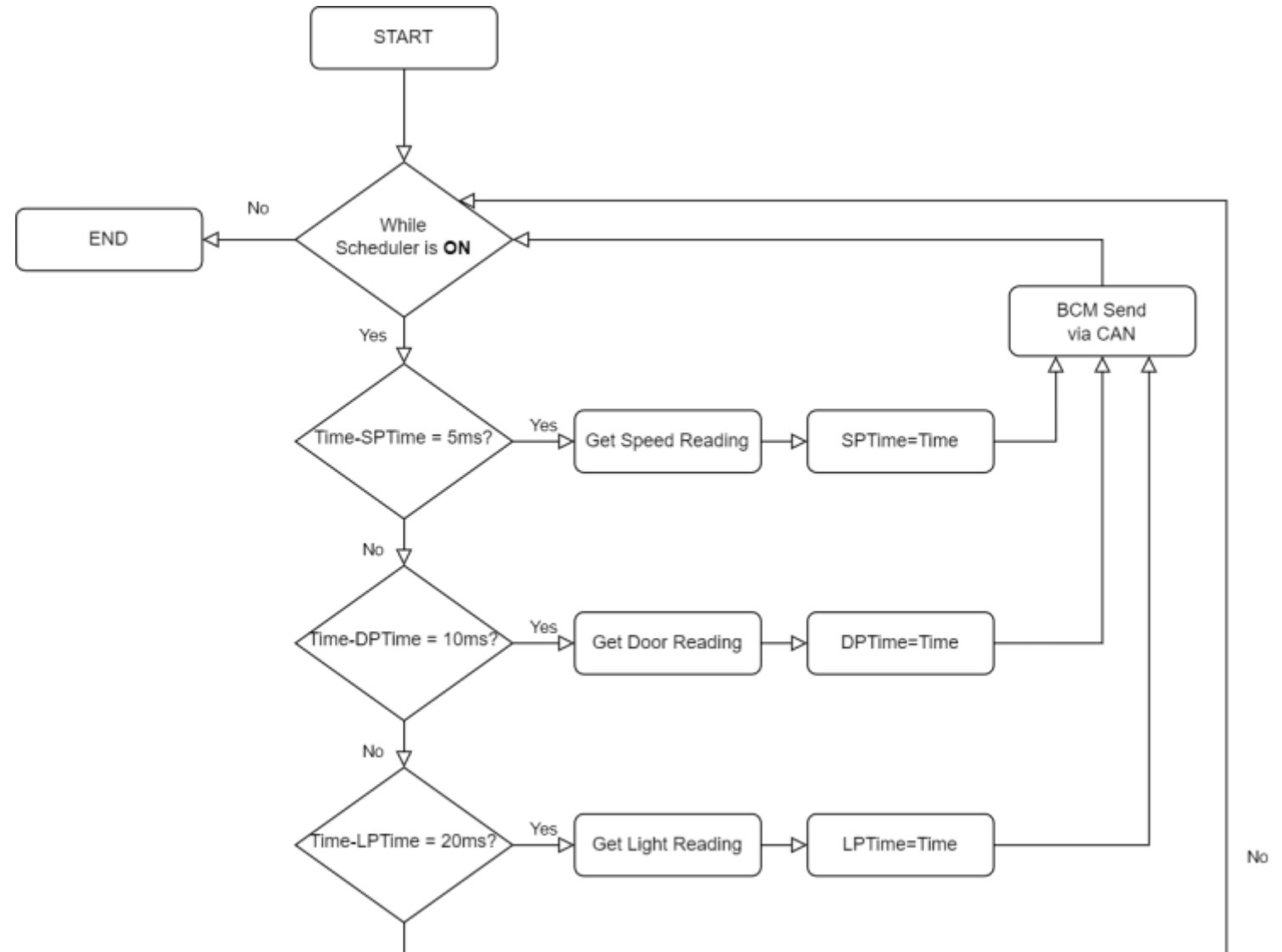
Prepared by  
**Muhammad Mokhtar Emara**  
**omriemara@gmail.com**

# System Schematic Diagram

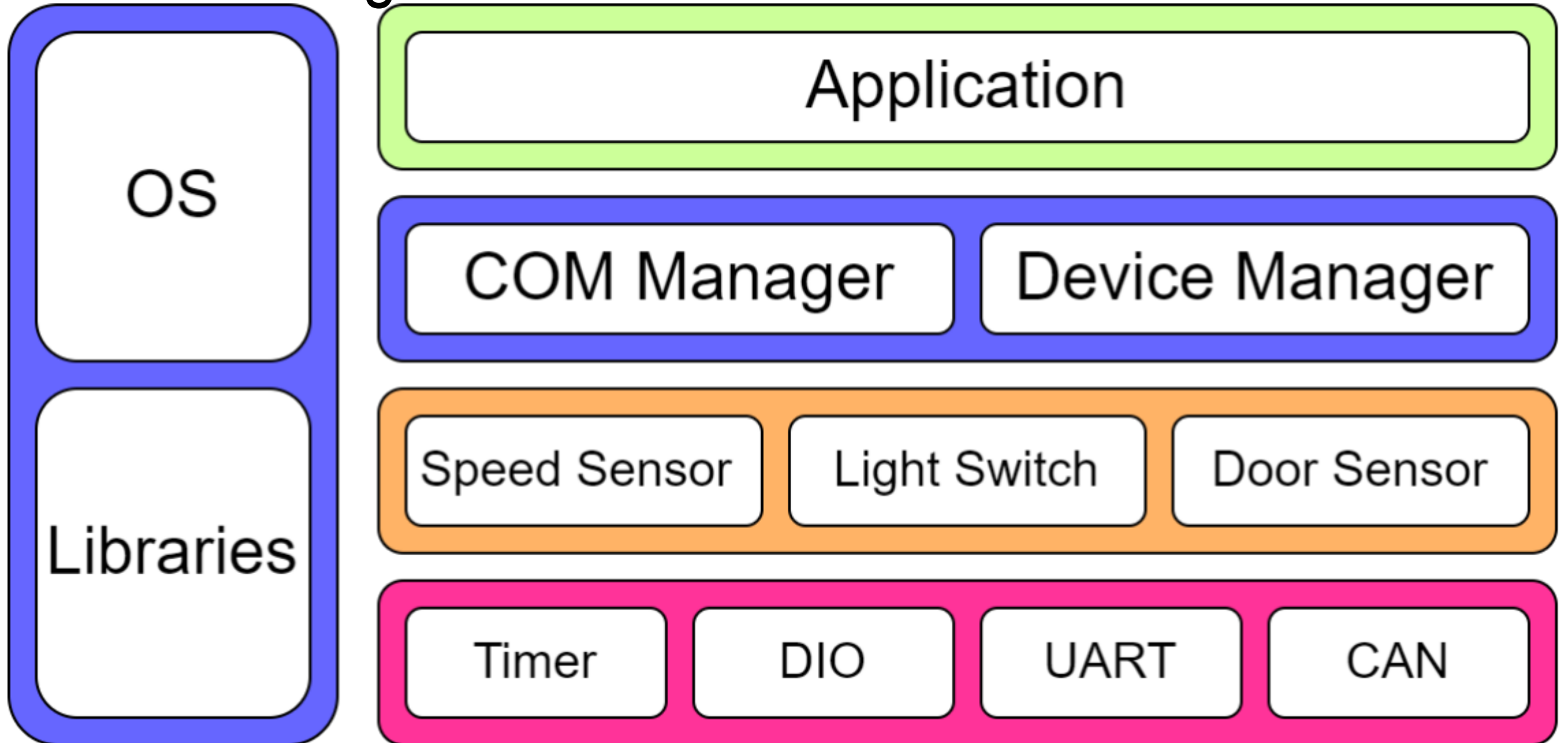
Green: Microcontroller  
Blue : Software Component  
Pink : Peripheral  
Gold : Hardware Component



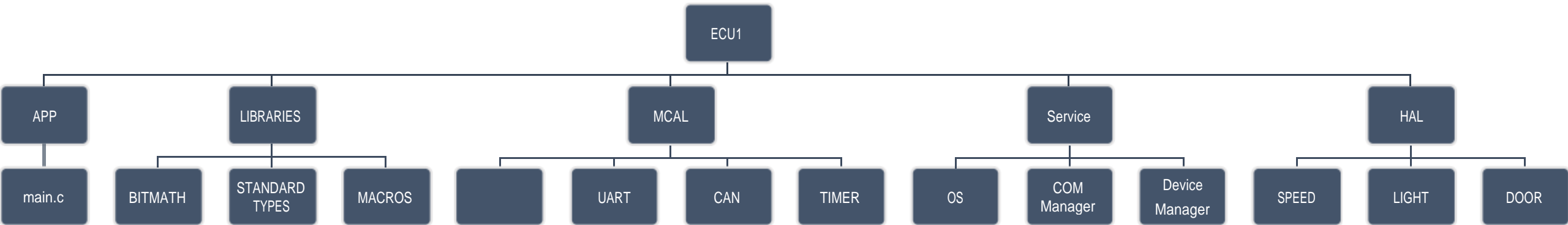
# ECU 1 Flowchart



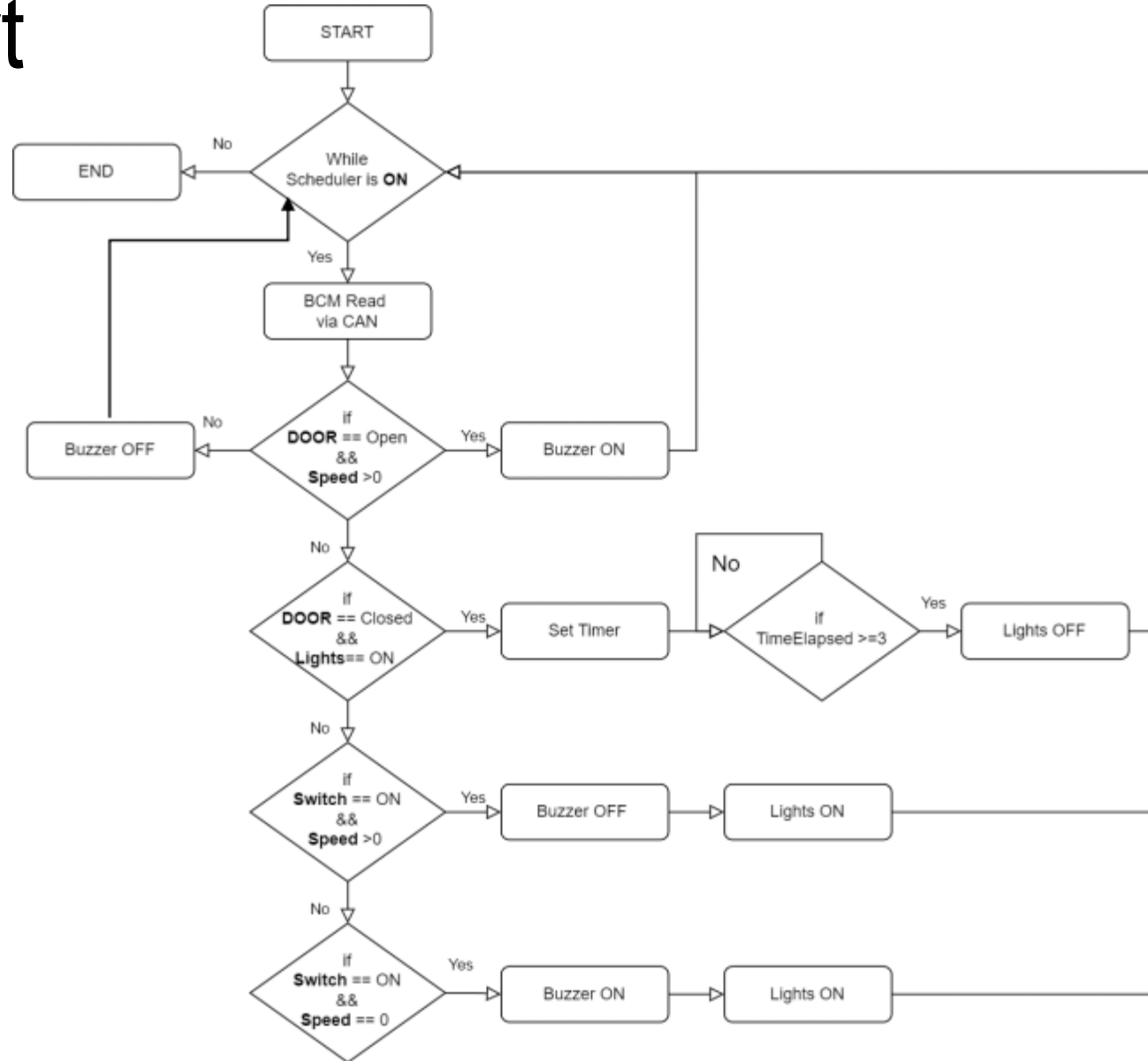
# Static Design of ECU 1



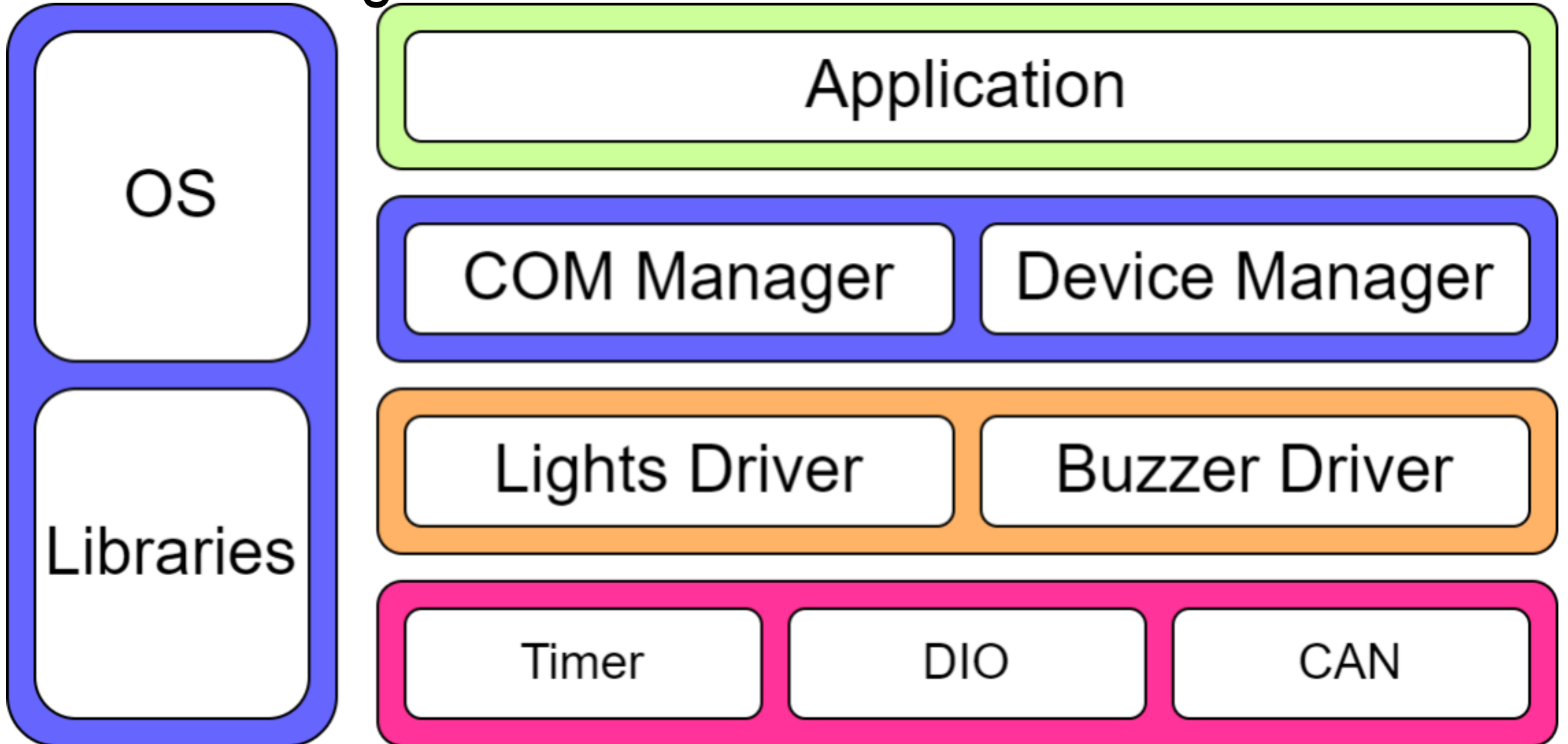
# Folder Structure of ECU 1



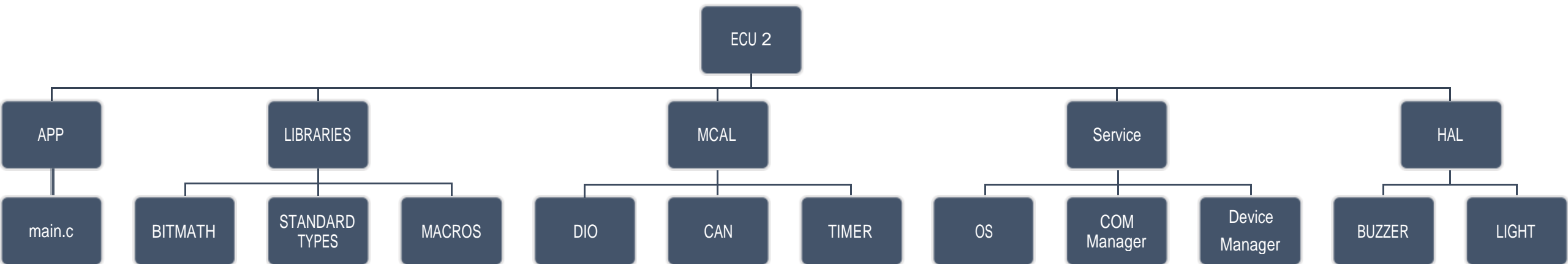
# ECU 2 Flowchart



# Static Design of ECU 2



# Folder Structure of ECU 2





# ECU 1&2 APIs : Timer

Typedef	Struct TimerCfg_t	Range
Enum	Timer_Mode	Mode_16→Mode_32→Mode_64
Enum	Timer_Number	Timer_0 → Timer_24 ( <b>depends on mode</b> )
Enum	Prescaler	Prescaler_8→Prescaler_16
int	Preload	0→2 <i>Timer_Mode</i>
Typedef	enum ACK_t	ACK_OK   ACK_ERROR

# ECU 1&2 APIs : Timer

API Name	ACK_t xTimer_Init(TimerCfg_t Timer)
Description	Initialize timer peripheral with provided config
Input Parameters	TimerCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : Timer

API Name	ACK_t vTimer_Start(TimerCfg_t Timer)
Description	Start timer
Input Parameters	TimerCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : Timer

API Name	ACK_t vTimer_Stop(TimerCfg_t Timer)
Description	Stop timer
Input Parameters	TimerCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : DIO

Typedef      Struct PinCfg_t		RANGE
Enum	Pin_Number	Pin_0 → Pin_43
Enum	Pin_Direction	Pin_Input→ Pin_Output
Enum	Pin_Mode	Pin_High→Pin_Low
Enum	Pin_Special_Function	Pin_*FunctionName*
Typedef      Enum Pin_Status		RANGE
Description	Pin reading value	Pin_High→Pin_Low
Typedef	enum ACK_t	ACK_OK         ACK_ERROR

# ECU 1&2 APIs : DIO

API Name	ACK_t xDio_Init(PinCfg_t Pins[])
Description	Initialize dio peripheral with provided configs
Input Parameters	PinCfg_t["Number of pins"]
Output Parameters	ACK_t

# ECU 1&2 APIs : DIO

API Name	ACK_t xDio_Set(PinCfg_t Pin)
Description	Set DIO pin high
Input Parameters	PinCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : DIO

API Name	ACK_t xDio_Clear(PinCfg_t Pin)
Description	Un-set DIO pin to low
Input Parameters	PinCfg_t
Output Parameters	ACK_t



# ECU 1&2 APIs : DIO

API Name	Pin_Status xDio_Get(PinCfg_t Pin)
Description	Get DIO pin status
Input Parameters	PinCfg_t
Output Parameters	Pin_Status

# ECU 1&2 APIs : UART

Typedef		Struct UartCfg_t
Enum	UART_Mode	UART_HW→UART_SW
Enum	Baudrate	9600→115200
Enum	RX_Pin	Pin_0→Pin_43
Enum	TX_Pin	
Typedef		Char UA
Description	Message string to be used for sending and receiving	
Typedef	enum ACK_t	ACK_OK   ACK_ERROR

# ECU 1&2 APIs : UART

API Name	ACK_t xUart_Init(UartCfg_t UART)
Description	Initialize UART peripheral with config
Input Parameters	UartCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : UART

API Name	ACK_t xUart_Send(UartCfg_t UART)
Description	Send from UART peripheral
Input Parameters	UartCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : UART

API Name	ACK_t xUart_Receive(UartCfg_t UART)
Description	Receive from UART peripheral
Input Parameters	UartCfg_t
Output Parameters	UART_Msg

# ECU 1&2 APIs : CAN

Typedef	Struct CANCfg_t	RANGE
Enum	CAN_Mode	CAN_Mode1→CAN_ModeX
Enum	Baudrate	9600→115200
Typedef Char C		
Description	Message string to be used for sending and receiving	
Typedef	enum ACK_t	ACK_OK   ACK_ERROR

# ECU 1&2 APIs : CAN

API Name	ACK_t xCAN_Init(CANCfg_t CAN)
Description	Initialize CAN peripheral with config
Input Parameters	CANCfg_t
Output Parameters	ACK_t

# ECU 1&2 APIs : CAN




API Name	ACK_t xCAN_Send(CANCfg_t CAN)
Description	Send data over CANBUS
Input Parameters	CANCfg_t
Output Parameters	ACK_t











# ECU 1&2 APIs : CAN

API Name	CAN_Msg xCAN_Receive(CANCfg_t CAN)
Description	Receive data over CANBUS
Input Parameters	CANCfg_t
Output Parameters	CAN_Msg

# ECU 1&2 APIs : COM Manager

Typedef      Struct COM_Device_t		RANGE
Enum	COM_Protocol	CAN / UART / I2C
Enum	Channel	Channel_0→Channel_3
char	COM_Msg[]	
 The image shows an error icon, which is a red square with a white 'X' inside.	 The image shows an error icon, which is a red square with a white 'X' inside. enum	 The image shows an error icon, which is a red square with a white 'X' inside.

# ECU 1&2 APIs : COM Manager

 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> <b>ACK_t</b> <b>COM_Device_t</b>
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> <b>Description</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> Initialize a Communication manager
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> <b>Input Parameters</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> COM_Device_t
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> <b>Output Parameters</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the link and location.</small> ACK_t















# ECU 1&2 APIs : COM Manager

API Name	ACK_t xCom_Send(COM_Device_t Manager)
Description	Send message using communication manager
Input Parameters	COM_Device_t
Output Parameters	ACK_t

# ECU 1&2 APIs : COM Manager









API Name	ACK_t xCom_Receive(COM_Device_t Manager)
Description	Receive message using communication manager
Input Parameters	COM_Device_t
Output Parameters	COM_Device_t

# ECU 1&2 APIs : Device Manager









 <small>The struct message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small>	 <small>The struct message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <b>Struct</b>	 <small>The struct message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small>
 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <b>Enum</b>	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> Device_ID	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> Device_0→Device_2 for ECU1 Device_0→Device 1 for ECU 2
 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <b>Enum</b>	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> Interface_Type	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> UART / DIO
 <small>The char message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <b>char</b>	 <small>The char message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> Device_Msg[]	
 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small>	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <b>enum</b>	 <small>The enum message cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small>



# ECU 1&2 APIs : Device Manager

 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>ACK_t</div> <div>Device_t</div>
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>Description</div>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>Initialize device manager</div>
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>Input Parameters</div>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>Device_t</div>
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>Output Parameters</div>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the path points to the correct file and location.</small> <div>ACK_t</div>

# ECU 1&2 APIs : Device Manager

 <small>The description cannot be displayed. The description cannot be displayed. The description cannot be displayed. The description cannot be displayed. The description cannot be displayed.</small>	 <b>ACK_t</b> <b>Device_t</b>
 <b>Description</b>	 Receive device reading using device manager
 <b>Input Parameters</b>	 Device_t
 <b>Output Parameters</b>	 Device_t











<div> <div></div> <div></div> </div>	<div> <div></div> <div>Struct</div> </div>	<div> <div></div> <div></div> </div>
<div> <div></div> <div>Enum</div> </div>	<div> <div></div> <div>Sensor_Type</div> </div>	<div> <div></div> <div>Type_UART or Type_I2C</div> </div>
<div> <div></div> <div>Enum</div> </div>	<div> <div></div> <div>TX_Pin</div> </div>	<div> <div></div> <div>Pin_0→Pin_43</div> </div>
<div> <div></div> <div>Enum</div> </div>	<div> <div></div> <div>RX_Pin</div> </div>	
<div> <div></div> <div></div> </div>	<div> <div></div> <div>Char</div> </div>	
<div> <div></div> <div>Description</div> </div>	<div> <div></div> <div>Message string to be used for sending and receiving</div> </div>	
<div> <div></div> <div></div> </div>	<div> <div></div> <div>enum</div> </div>	<div> <div></div> <div></div> </div>



# ECU 1 APIs : Speed Sensor

	 <b>ACK_t</b> <b>SpeedCfg_t</b>
 <b>Description</b>	 Initialize a speed sensor with the given config
 <b>Input Parameters</b>	 SpeedCfg_t
 <b>Output Parameters</b>	 ACK_t

# ECU 1 APIs : Speed Sensor

 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small>	 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> <b>Speed_Msg</b> <b>SpeedCfg_t</b>
 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> <b>Description</b>	 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> Get speed reading from sensor
 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> <b>Input Parameters</b>	 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> SpeedCfg_t
 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> <b>Output Parameters</b>	 <small>The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated. The SpeedMsg sensor is deprecated.</small> Speed_Msg

# ECU 1 APIs : Light Sensor

Typedef	Struct LightCfg_t	Range
Enum	Sensor_Type	Type_UART / Type_DIO
Enum	Pin	Pin_0→Pin_43
Typedef	Enum Light_Status	
Description	Light sensor reading	
Typedef	enum ACK_t	ACK_OK   ACK_ERROR










# ECU 1 APIs : Light Sensor








API Name	ACK_t xLight_Init(LightCfg_t Light)
Description	Initialize a light sensor with the given config
Input Parameters	LightCfg_t
Output Parameters	ACK_t

# ECU 1 APIs : Light Sensor









API Name	Light_Status xLight_Read(LightCfg_t Light)
Description	Read a light sensor
Input Parameters	LightCfg_t
Output Parameters	Light_Status

# ECU 1 APIs : Door Sensor

	 <h1>Struct</h1>	
 <h1>Enum</h1>	 <h1>Sensor_Type</h1>	 <h1>Type_UART / Type_DIO</h1>
 <h1>Enum</h1>	 <h1>Pin</h1>	 <h1>Pin_0→Pin_43</h1>

				Enum	
	Description			Door sensor reading	
			enum		

# ECU 1 APIs : Door Sensor




 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> <b>ACK_t</b> <b>DoorCfg_t</b>
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> <b>Description</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> Initialize a Door sensor with the given config
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> <b>Input Parameters</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> DoorCfg_t
 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> <b>Output Parameters</b>	 <small>The first image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the file path is correct for the image.</small> ACK_t



# ECU 1 APIs : Door Sensor

API Name	Door_Status xDoor_Read(DoorCfg_t Door)
Description	Read a Door sensor
Input Parameters	DoorCfg_t
Output Parameters	Door_Status

# ECU 2 APIs : Light Actuator

	 <b>Struct</b>	
<b>Enum</b>	Actuator_Type	Type_UART / Type_DIO
<b>Enum</b>	Pin	Pin_0→Pin_43
<b>Typedef</b>	<b>enum</b> ACK_t	ACK_OK   ACK_ERROR

# ECU 2 APIs : Light Actuator

API Name	ACK_t xLight_Init(LightCfg_t LED)
Description	Initialize a Light actuator with the given config
Input Parameters	LightCfg_t
Output Parameters	ACK_t

# ECU 2 APIs : Light Actuator

API Name	ACK_t xLight_SetAction(LightCfg_t LED)
Description	Set actuator action
Input Parameters	LightCfg_t
Output Parameters	ACK_t

# ECU 2 APIs : Buzzer Actuator

Typedef	Struct BuzzerCfg_t	RANGE
Enum	Actuator_Type	Type_UART / Type_DIO
Enum	Pin	Pin_0→Pin_43
Typedef	enum ACK_t	ACK_OK   ACK_ERROR

# ECU 2 APIs : Buzzer Actuator

API Name	ACK_t Buzzer_Init(BuzzerCfg_t Buzzer)
Description	Initialize a Buzzer actuator with the given config
Input Parameters	BuzzerCfg_t
Output Parameters	ACK_t

# ECU 2 APIs : Buzzer Actuator

API Name	ACK_t xBuzzer_SetAction(BuzzerCfg_t Buzzer)
Description	Set actuator action
Input Parameters	BuzzerCfg_t
Output Parameters	ACK_t