

FINAL REVIEW



TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION



TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

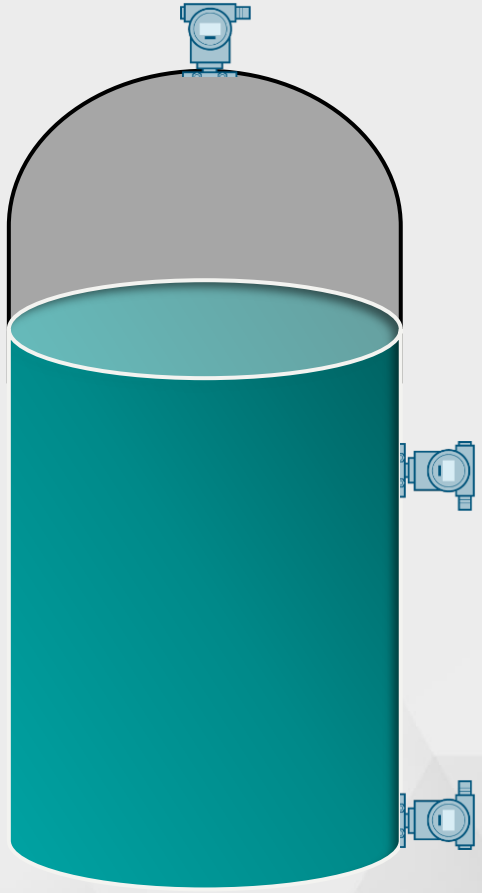
TEST APPLICATION

WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION

Use case of the project



Measure the fluid's level in a tank with pressure sensors which communicate with each other based on ethernet

Pressure measurement sensors

Pressure sensors types

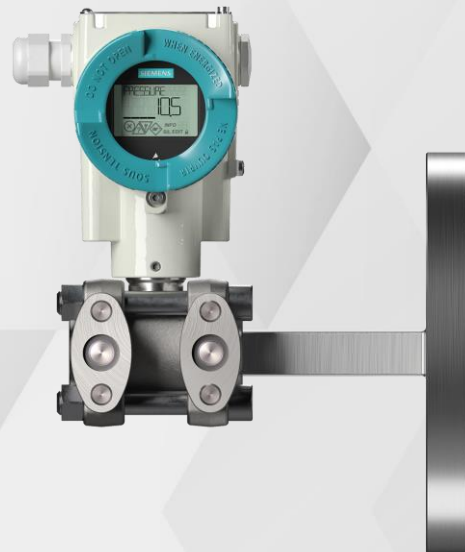
- Relative pressure
- Absolute pressure
- Differential pressure



Sitrans P200/210/220



Sitrans P-Compact



Sitrans P320/420

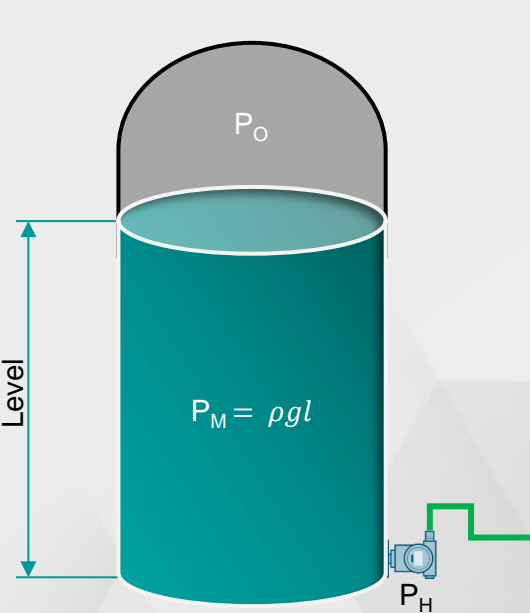
Fundamental physics basics

- l : level
- ρ : density
- g : gravity
- P_H : high pressure
- P_O : over pressure
- P_L : low pressure
- P_D : density pressure
- h : height of P_D

One sensor

$$\rightarrow l = \frac{P_H - P_O}{\rho g}$$

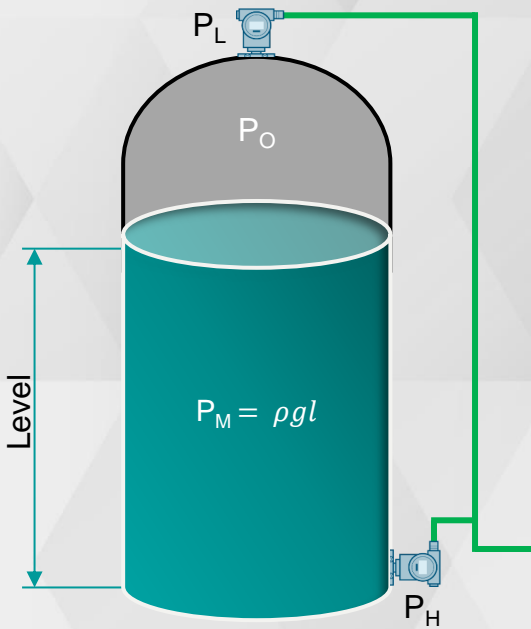
with ρ and P_O known



Two sensors

$$\rightarrow l = \frac{P_H - P_L}{\rho g}$$

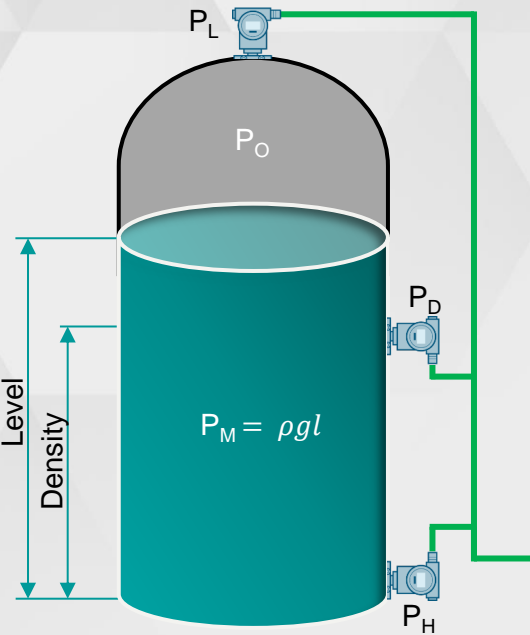
with ρ known



With three sensors

$$\rightarrow \rho = \frac{P_H - P_D}{g h}$$

$$l = \frac{P_H - P_L}{\rho g}$$



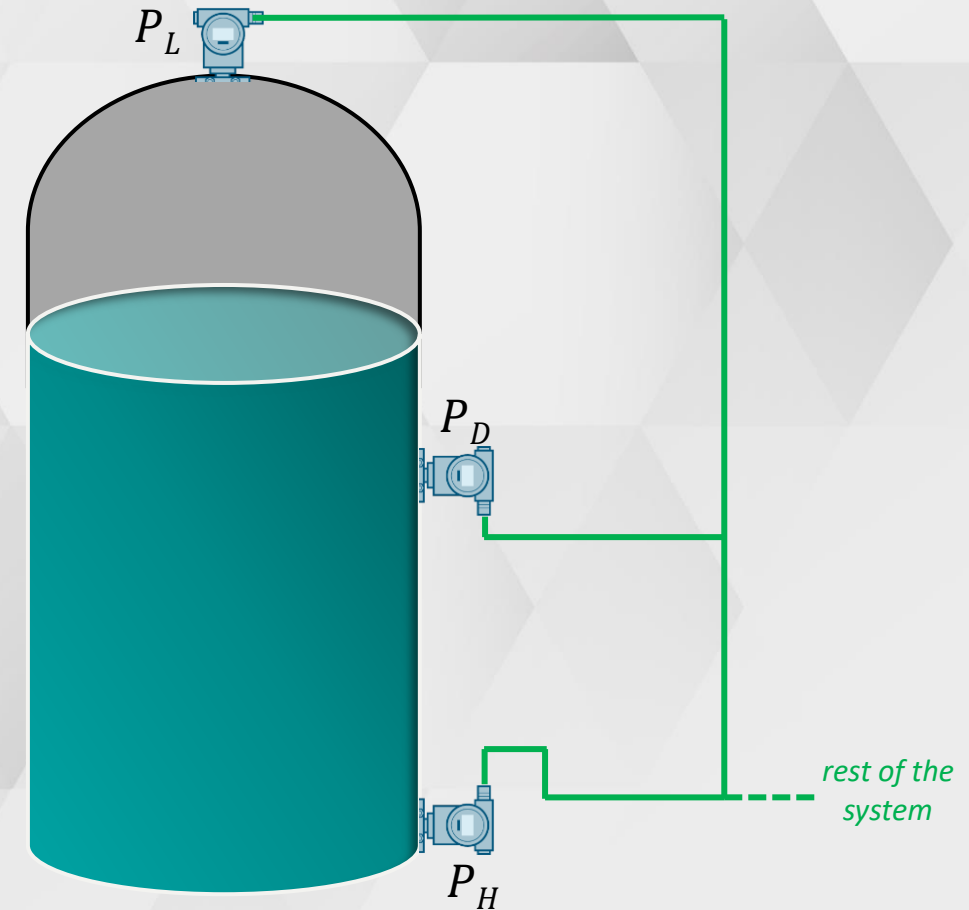
System requirements

Requirements

- Same firmware for all boards
- System must be configurable in runtime
- Configuration use case
 - 1 sensor → P_H
 - 2 sensor → P_H with P_L
 - 3 sensor → P_H with P_D and P_L
- Measurement cycle should be synchronized

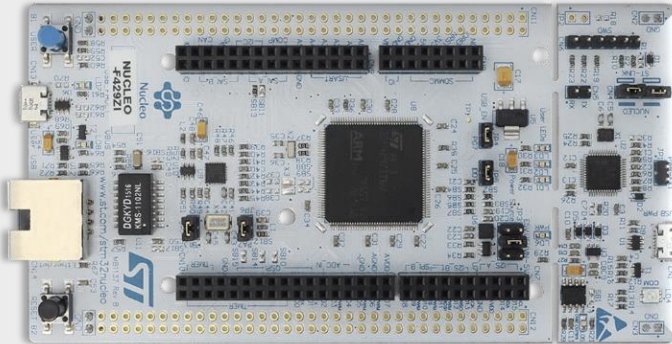
Limitations

- No physical pressure sensors available
- ➔ System behaviour must be simulated



Use components

- Pressure sensor represented by **STM32 evalboards**



- **embOS** as operating system on the board



- **Embedded Studio** to build and flash project on the board

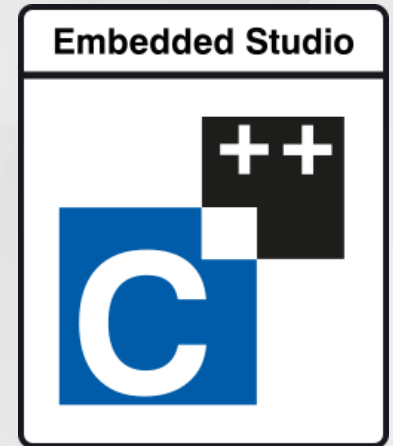




TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

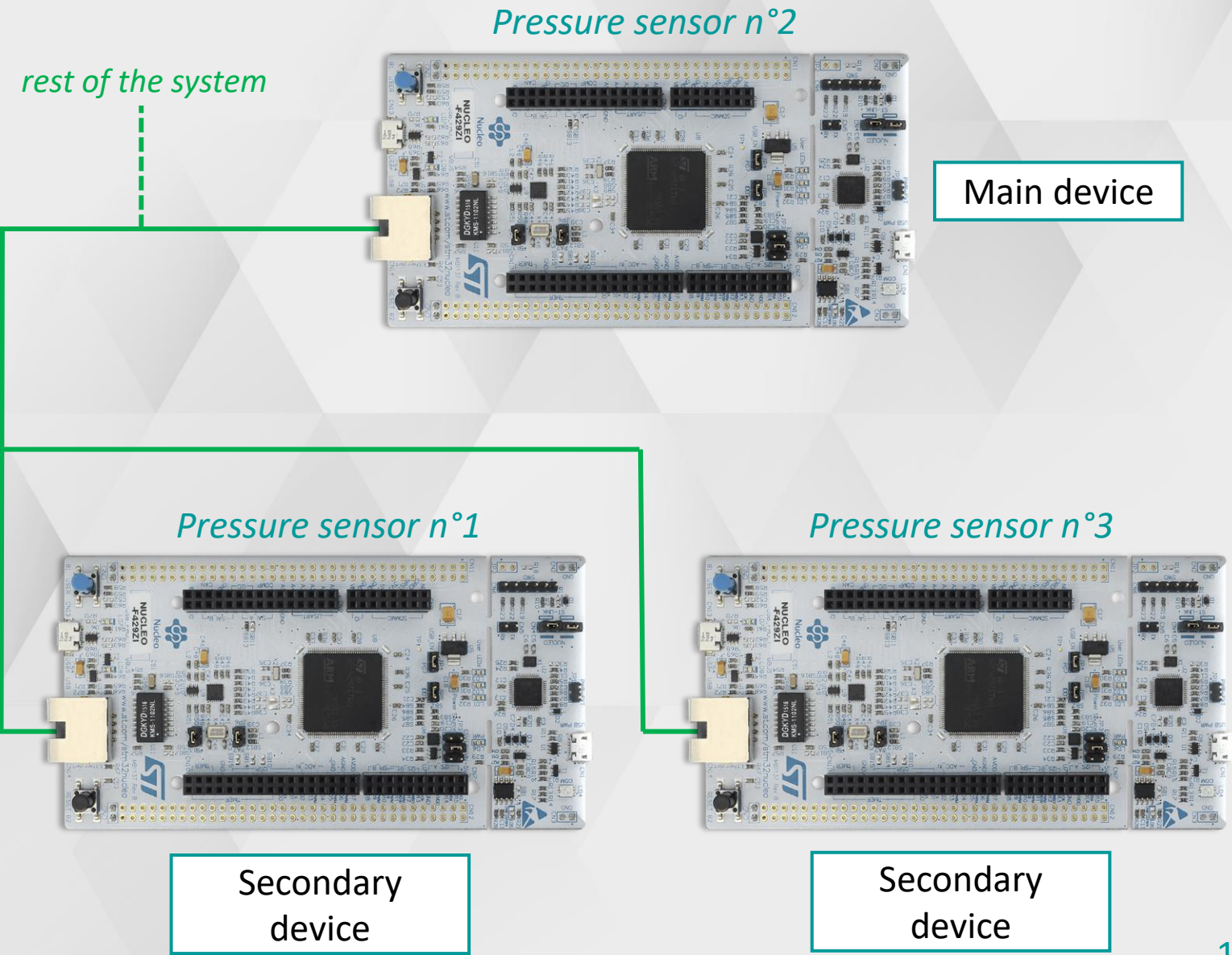
WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION

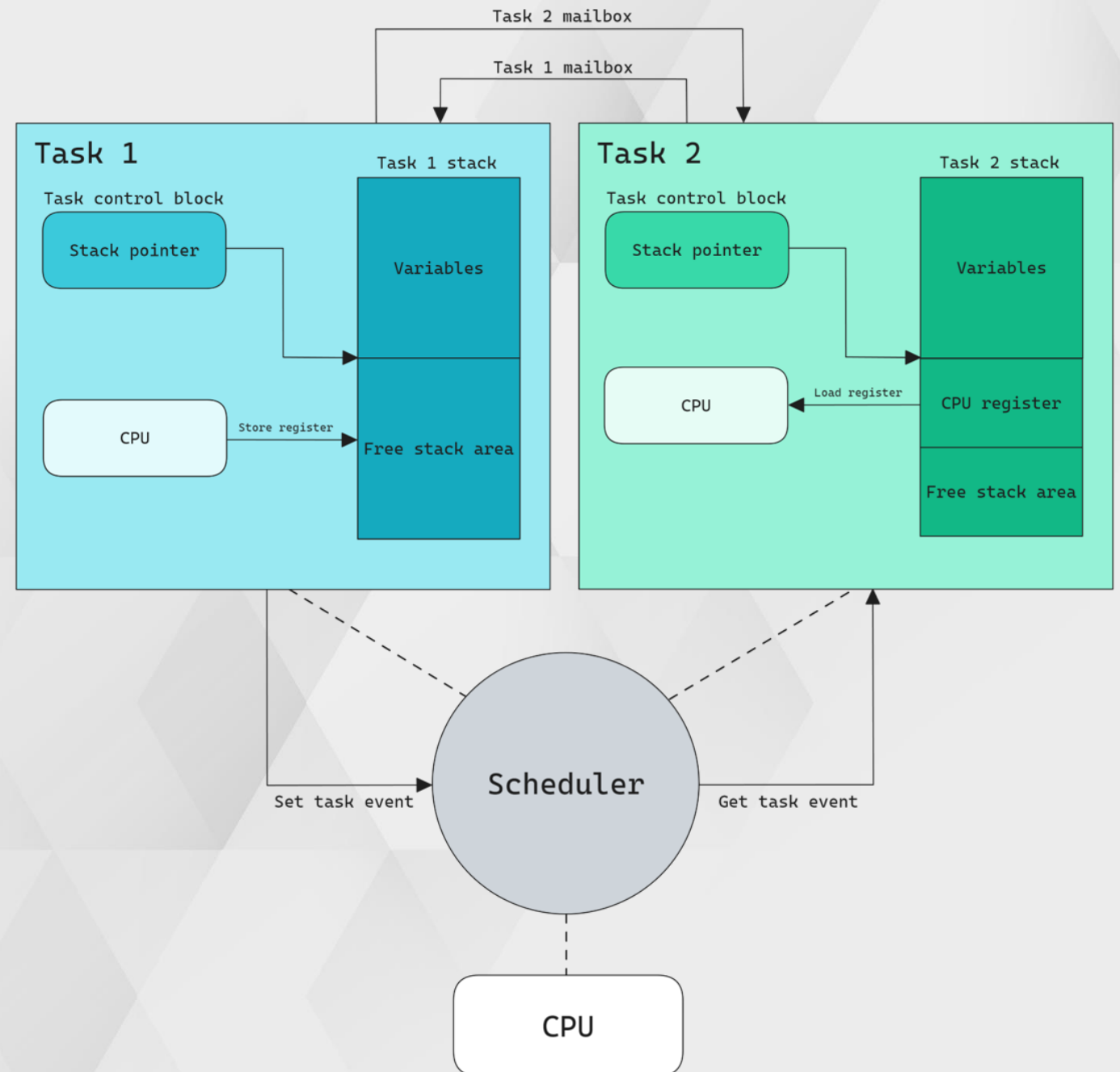
Global system

- Main/Secondary device system

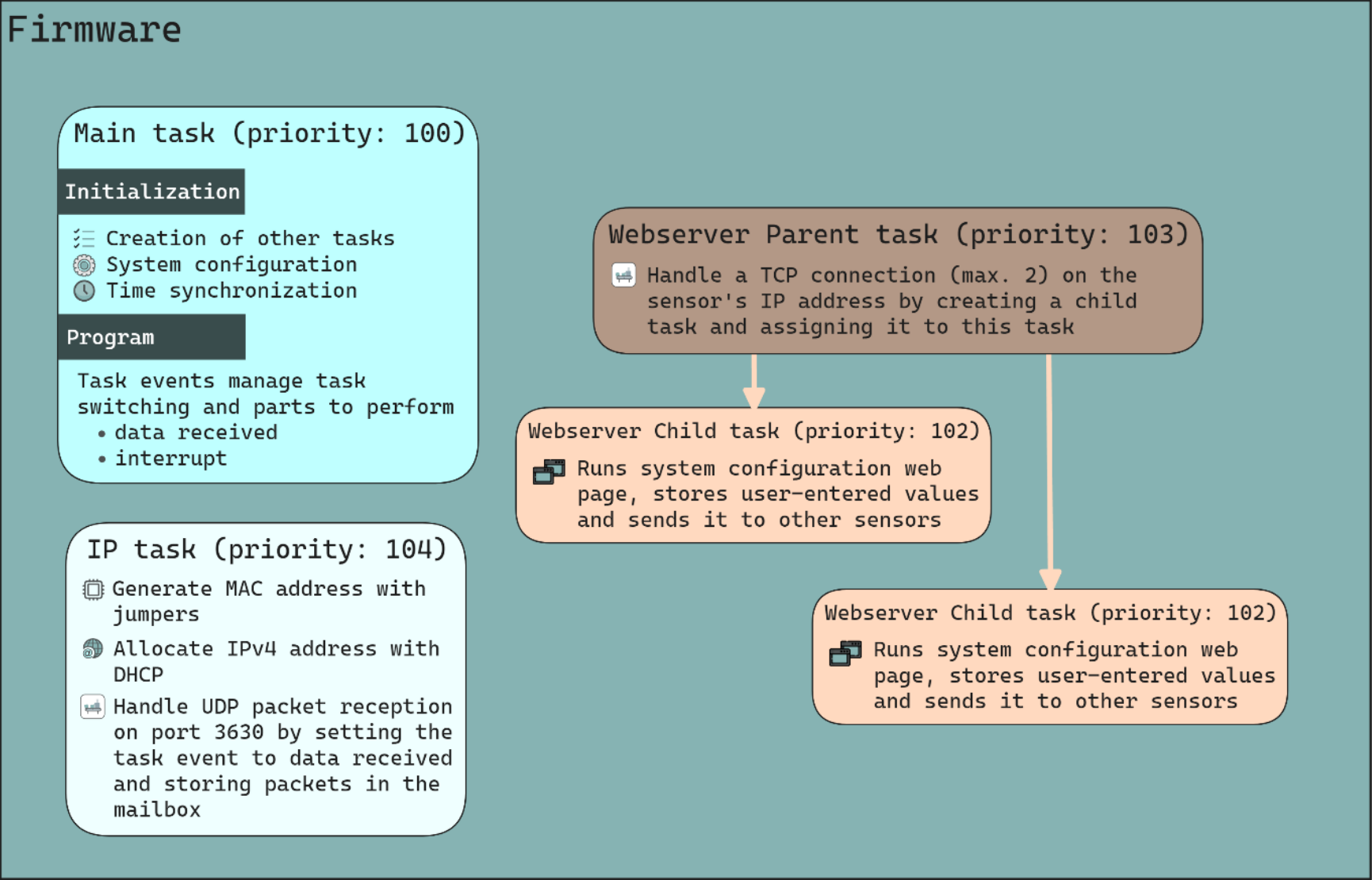


Use EmbOS features

- **Task** : independent unit of work based on **priority**
- **Task event** : digital signal which wake up a sleeping/waiting task
- **Mailbox** : mechanism for inter-task communication and data exchange
- **Software Timer** : user-specified routine after a specified delay



System Architecture



Data Protocol (1)

Cross communication protocol									
message ID 64 bits	length 32 bits	type 8 bits	payload						
		0x01 (time synchro)	type 8 bits	timestamp 64 bits	offset 32 bits				
			0x01 (initialization)						
			0x02 (cycle)						
		0x02 (configuration)	type 8 bits	payload					
			0x01 (send tank info)	diameter 32 bits	diameter unit 8 bits	volume 32 bits	volume unit 8 bits	heigth 32 bits	heigth unit 8 bits
			0x02 (get tank info)						
			0x03 (sensor info)	number 8 bits	IP address 32 bits	role 8 bits	type 8 bits	heigth 32 bits	heigth unit 8 bits
			0x04 (get sensor info)						
			0x05 (fluid information)	density 64 bits	density unit 8 bits	gas pressure 32 bits	pressure unit 8 bits		
			0x06 (get fluid info)						
			0x07 (cycle information)	cycle time 32 bits	time unit 8 bits	frame loss 8 bits			
		0x03 (pressure)	type 8 bits	payload					
			0x01 (send pressure)	pressure 64 bits	pressure unit 8 bits	quality code 8 bits			
			0x02 (get pressure)						
		0x04 (level)	type 8 bits	payload					
			0x01 (send level)	level 32 bits	level unit 8 bits				
			0x02 (get level)						

Data Protocol (2)

XCom module

XCom Init

Create the XCom structure according to the type of message

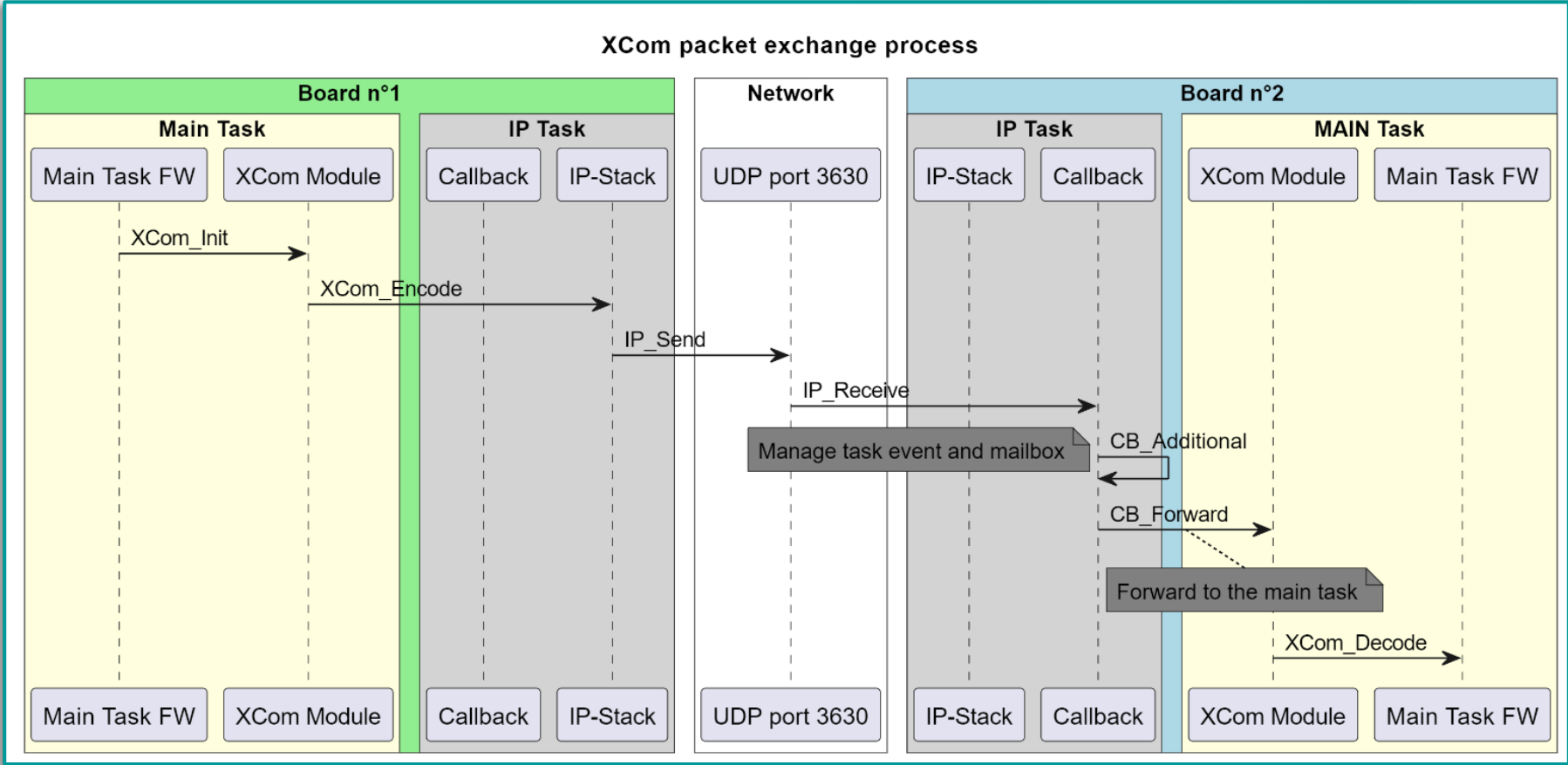
XCom Encode

Convert the XCom structure into network endian 8-bit array

XCom Decode

Convert the network endian 8-bit array into XCom structure

Data Protocol (3)



Configuration Webpage (1)

Boards Configuration

Add a board

IP Address	Pressure Type	Position	
<div></div>	High		

Low Pressure

Density Pressure

High Pressure

Next

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Configuration Webpage (2)


Tank Configuration

	Value	Unit
Diameter	<input type="text"/>	m ▼
Volume	<input type="text"/>	m3 ▼
Height	<input type="text"/>	m ▼

Previous

Next

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Configuration Webpage (3)

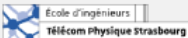
Fluid Configuration

Default density :	Water
Default gas pressure :	Atmospheric pressure

Previous

Next

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Configuration Webpage (4)

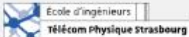
Warnings Configuration

	Value
Wanted cycle of communication in ms	40
The maximum of acceptable packet loss before saying that the connection is lost	5

Previous

Next

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Configuration Webpage (5)

Debug Configuration

	IP
IP Address of the test application	

Previous

Submit

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Time synchronization

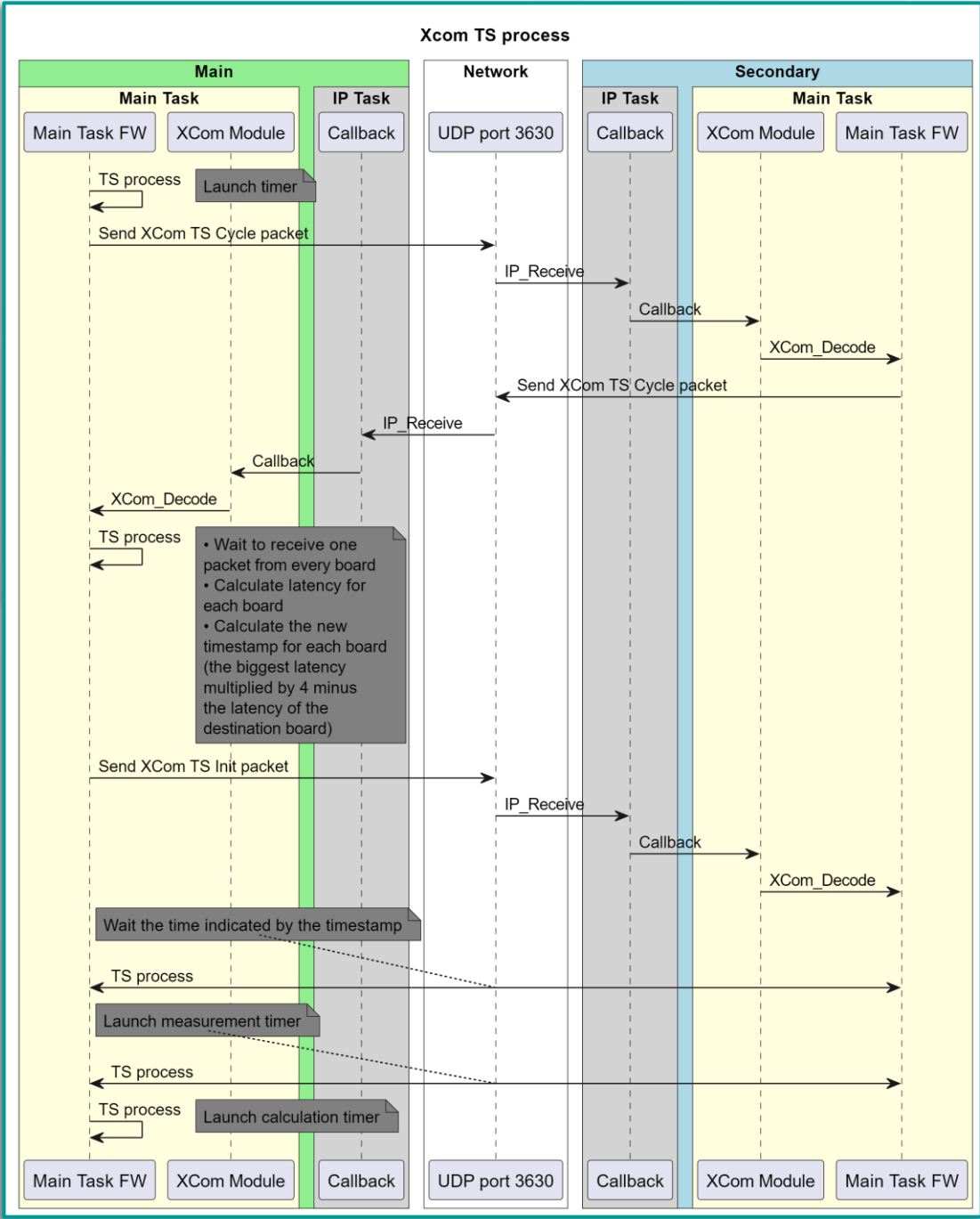




TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION

Send page

Send part

Home Send Read Test

IP Address → 10.0.0.3 , pressure value → 10315

Submit

Pa

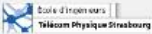
Pa

bar

psi

Success to send

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Read page

Read part

Home Send Read Test

Enter an IP address →

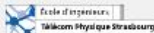
10.0.0.3

Submit

Result

0 Pa

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Test page

Test part

Home Send Read Test

Select number of IP Addresses: 3

IP Address →

, pressure value →

Pa

IP Address →

, pressure value →

Pa

IP Address →

, pressure value →

Pa

Submit

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TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

WIRESHARK PLUGIN

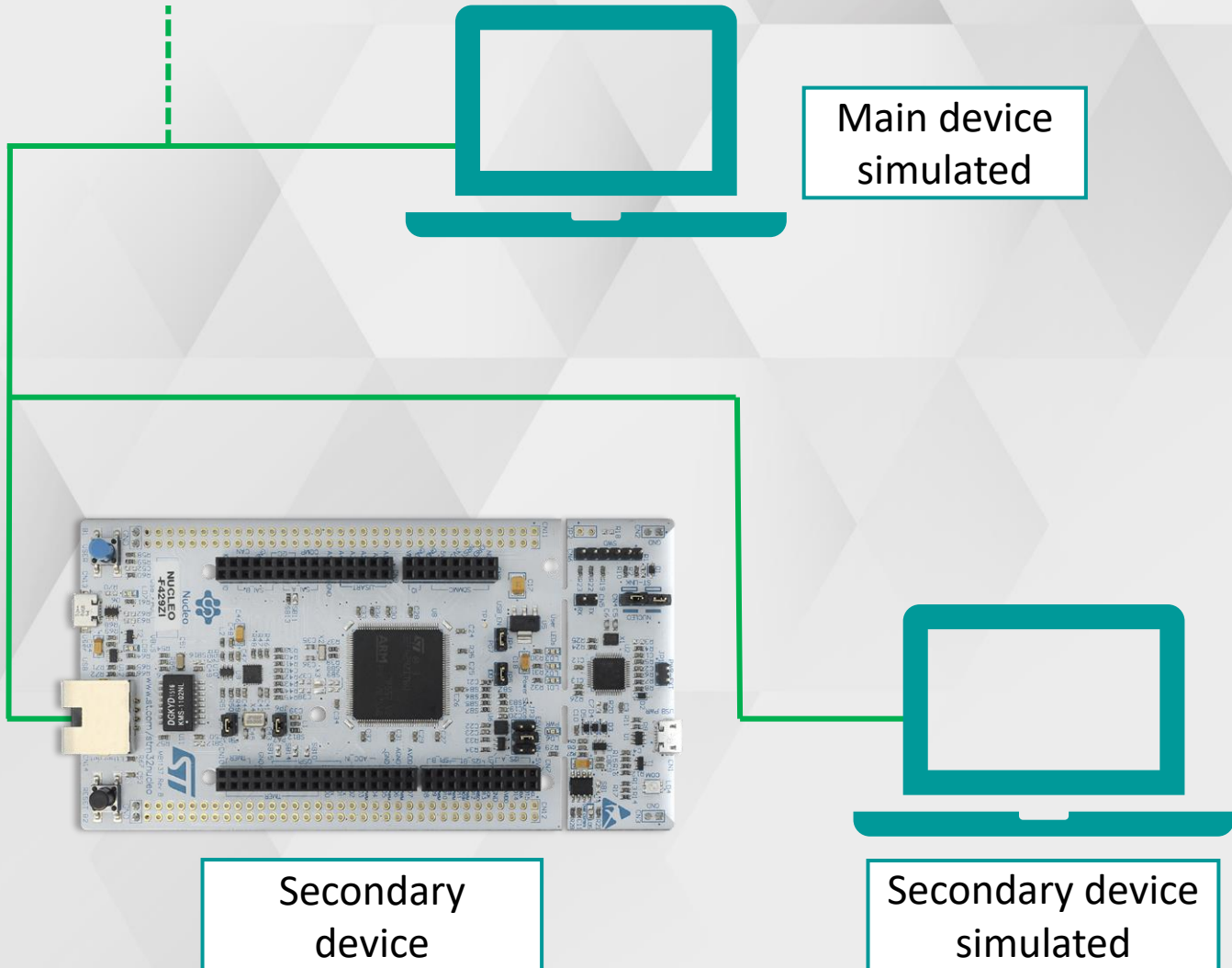
WORK ORGANIZATION

PROJECT CONCLUSION

Simulate Boards Behaviour

- Limited number of boards

rest of the system



Simulation Applications

- 2 Applications: client and server

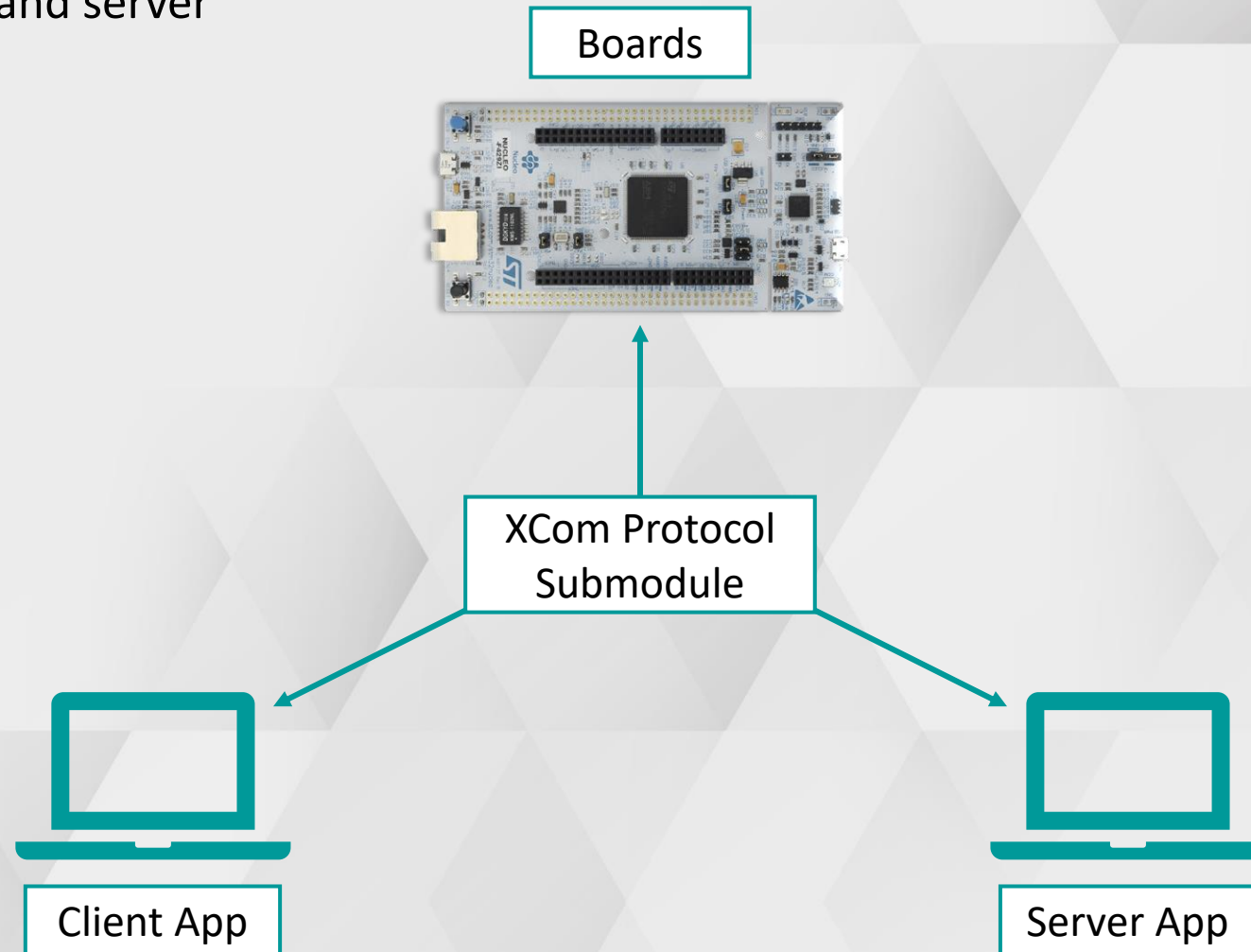




TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION

Before The Plugin

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.0.21	192.168.0.26	UDP	68	54044 → cs-remote-db(3630) Len=26
2	0.000582	192.168.0.21	192.168.0.26	UDP	56	54045 → cs-remote-db(3630) Len=14
3	0.003243	192.168.0.26	192.168.0.21	UDP	71	cs-remote-db(3630) → cs-remote-db(3630) Len=29
4	0.004095	192.168.0.21	192.168.0.26	UDP	56	54046 → cs-remote-db(3630) Len=14
5	0.007436	192.168.0.26	192.168.0.21	UDP	68	cs-remote-db(3630) → cs-remote-db(3630) Len=26
6	0.008079	192.168.0.21	192.168.0.26	UDP	56	54047 → cs-remote-db(3630) Len=14
7	0.011632	192.168.0.26	192.168.0.21	UDP	66	cs-remote-db(3630) → cs-remote-db(3630) Len=24
8	0.013441	192.168.0.21	192.168.0.26	UDP	62	54048 → cs-remote-db(3630) Len=20
9	0.013880	192.168.0.21	192.168.0.26	UDP	56	54049 → cs-remote-db(3630) Len=14
10	0.016878	192.168.0.26	192.168.0.21	UDP	62	cs-remote-db(3630) → cs-remote-db(3630) Len=20
11	0.017677	192.168.0.21	192.168.0.26	UDP	56	54050 → cs-remote-db(3630) Len=14
12	0.021049	192.168.0.26	192.168.0.21	UDP	61	cs-remote-db(3630) → cs-remote-db(3630) Len=19
13	5.764056	192.168.0.21	192.168.0.26	TCP	55	63276 → http(80) [ACK] Seq=1 Ack=1 Win=63326 Len=1
14	5.767481	192.168.0.26	192.168.0.21	TCP	60	http(80) → 63276 [RST] Seq=1 Win=0 Len=0

> Frame 10: 62 bytes on wire (496 bits), 62 bytes captured on interface 0

> Ethernet II, Src: IBM_ff:ff:00 (00:22:00:ff:ff:00), Dst: 08:00:27:00:00:00

> Internet Protocol Version 4, Src: 192.168.0.26, Dst: 192.168.0.21

> User Datagram Protocol, Src Port: cs-remote-db (3630), Dst Port: cs-remote-db (3630)

> Data (20 bytes)

Data: 0000000000000000300000001403010000284b0002

[Length: 20]

0000 08 8f c3 f1 b2 51 00 22 00 ff ff 00 08 00 45 00Q.".....E.

0010 00 30 86 a7 00 00 40 11 72 96 c0 a8 00 1a c0 a8 .0...@.r.....

0020 00 15 0e 2e 0e 2e 00 1c 36 75 00 00 00 00 00 006u.....

0030 00 03 00 00 00 14 03 01 00 00 28 4b 00 02(K..

With the pluggin

xcom.

No.		Source	Destination	Protocol	Length	Info
	xcom.conf.type					
	xcom.id					
	xcom.len	192.168.0.21	192.168.0.26	XCOM	68	Time Syncro
	xcom.lv.type	192.168.0.21	192.168.0.26	XCOM	56	Configuration
	xcom.lv.unit	192.168.0.26	192.168.0.21	XCOM	71	Configuration
	xcom.lv.val	192.168.0.21	192.168.0.26	XCOM	56	Configuration
	xcom.pr.qual	192.168.0.26	192.168.0.21	XCOM	68	Configuration
	xcom.pr.type	192.168.0.21	192.168.0.26	XCOM	56	Configuration
	xcom.pr.unit	192.168.0.26	192.168.0.21	XCOM	66	Configuration
	xcom.pr.val	192.168.0.21	192.168.0.26	XCOM	62	Configuration
	xcom.ts.id	192.168.0.21	192.168.0.26	XCOM	56	Pressure
	xcom.ts.off	192.168.0.21	192.168.0.26	XCOM	62	Pressure
	xcom.ts.time	192.168.0.26	192.168.0.21	XCOM	56	Level
	xcom.type	192.168.0.21	192.168.0.26	XCOM	61	Level
11	0.017677	192.168.0.26	192.168.0.21	XCOM	61	Level
12	0.021049	192.168.0.26	192.168.0.21	XCOM	61	Level
13	5.764056	192.168.0.21	192.168.0.26	TCP	55	63276 → http(80) [ACK] Seq=1 Ack=1 Win=63326 Len=1
14	5.767481	192.168.0.26	192.168.0.21	TCP	60	http(80) → 63276 [RST] Seq=1 Win=0 Len=0

> Frame 10: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0
> Ethernet II, Src: IBM_ff:ff:00 (00:22:00:ff:ff:00), Dst: 08:00:27:00:00:00
> Internet Protocol Version 4, Src: 192.168.0.26 (192.168.0.26), Dst: 192.168.0.21 (192.168.0.21)
> User Datagram Protocol, Src Port: cs-remote-db (3636), Dst Port: 63276
Xcom Protocol
MSG ID: 3
Length: 20
Type: Pressure (0x03)
Field Pressure
Type: XCOM_SEND_PRESSURE (0x01)
Unit: 0x284b
Value: 0
quality Code: QUALITY_CODE_SIMULATE (0x02)

0000 08 8f c3 f1 b2 51 00 22 00 ff ff 00 08 00 45 00Q..E.
0010 00 30 86 a7 00 00 40 11 72 96 c0 a8 00 1a c0 a8 ..@..r.....
0020 00 15 0e 2e 0e 2e 00 1c 36 75 00 00 00 00 006u.....
0030 00 03 00 00 00 14 03 01 00 00 28 4b 00 02(K..

31



TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

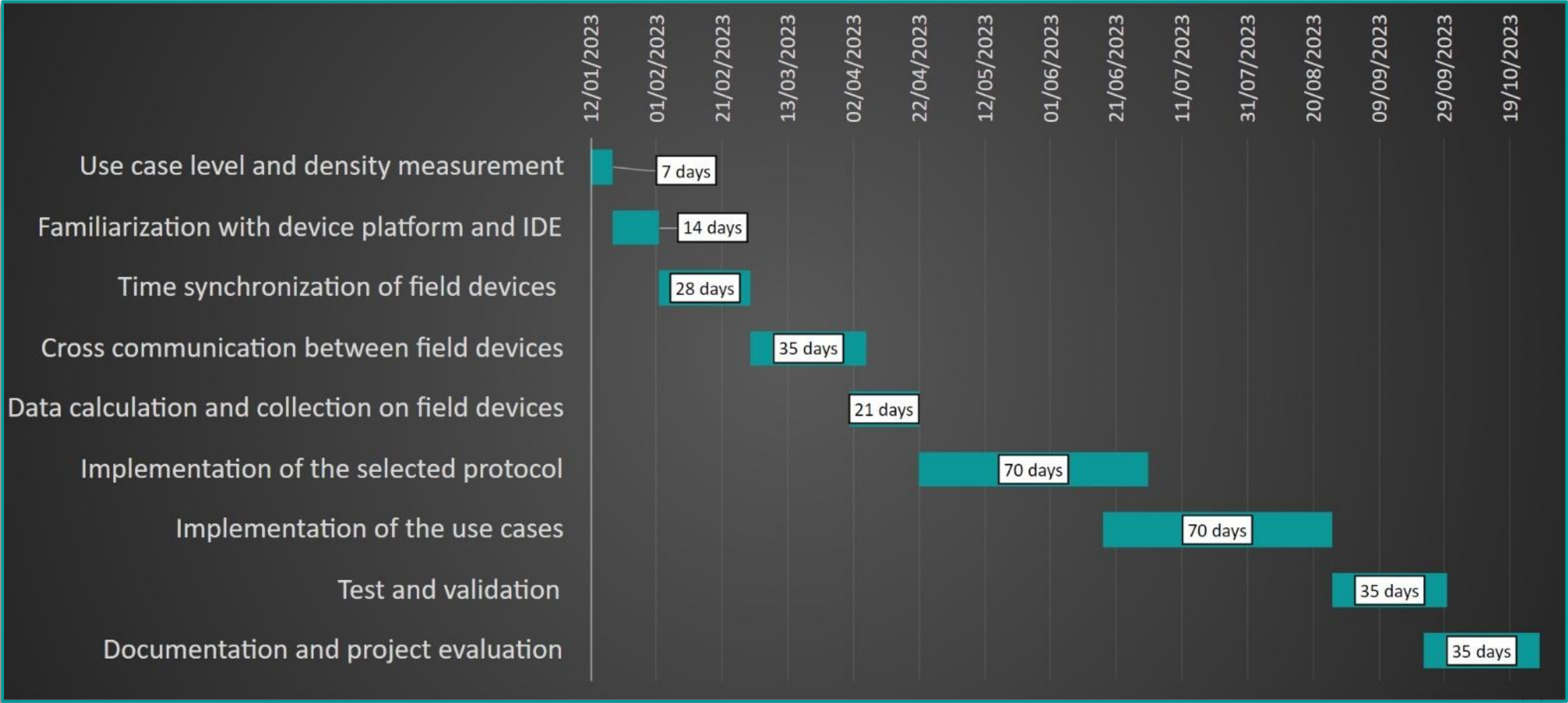
TEST APPLICATION

WIRESHARK PLUGIN

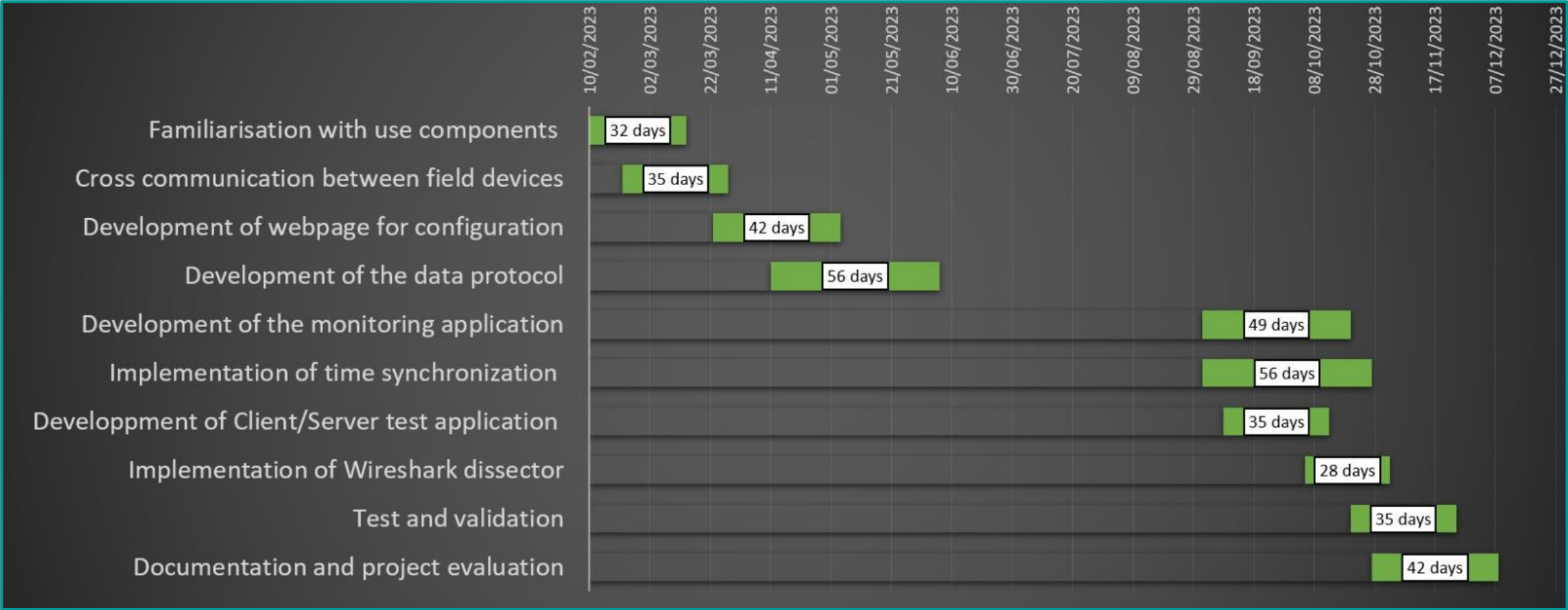
WORK ORGANIZATION

PROJECT CONCLUSION

Initial Gantt chart




Final Gantt chart



Tools used (1)





Field Level Cross Communication

ID de groupe : 425604

Nouveau sous-groupe

Nouveau projet

Cooperation with Télécom Physique Strasbourg (TPS)

Sous-groupes et projets

Projets partagés

Projets archivés

Rechercher

Nom

XCom Test

0 2 1

X

XCom Test Client

0

il y a un mois

X

XCom Test Server

0

il y a un mois

M

Monitoring App

Monitoring and configuration App for PoC of Field Level Cross Communication

0

il y a un mois

XCom Firmware

PoC and testing firmware of the XCom protocol for NUCLEO-F429ZI eval board

0

il y a 2 semaines

XCom Protocol

Field Level Cross Communication Protocol

0

il y a un mois

X

XCom Webpage Cfg

0

il y a un mois

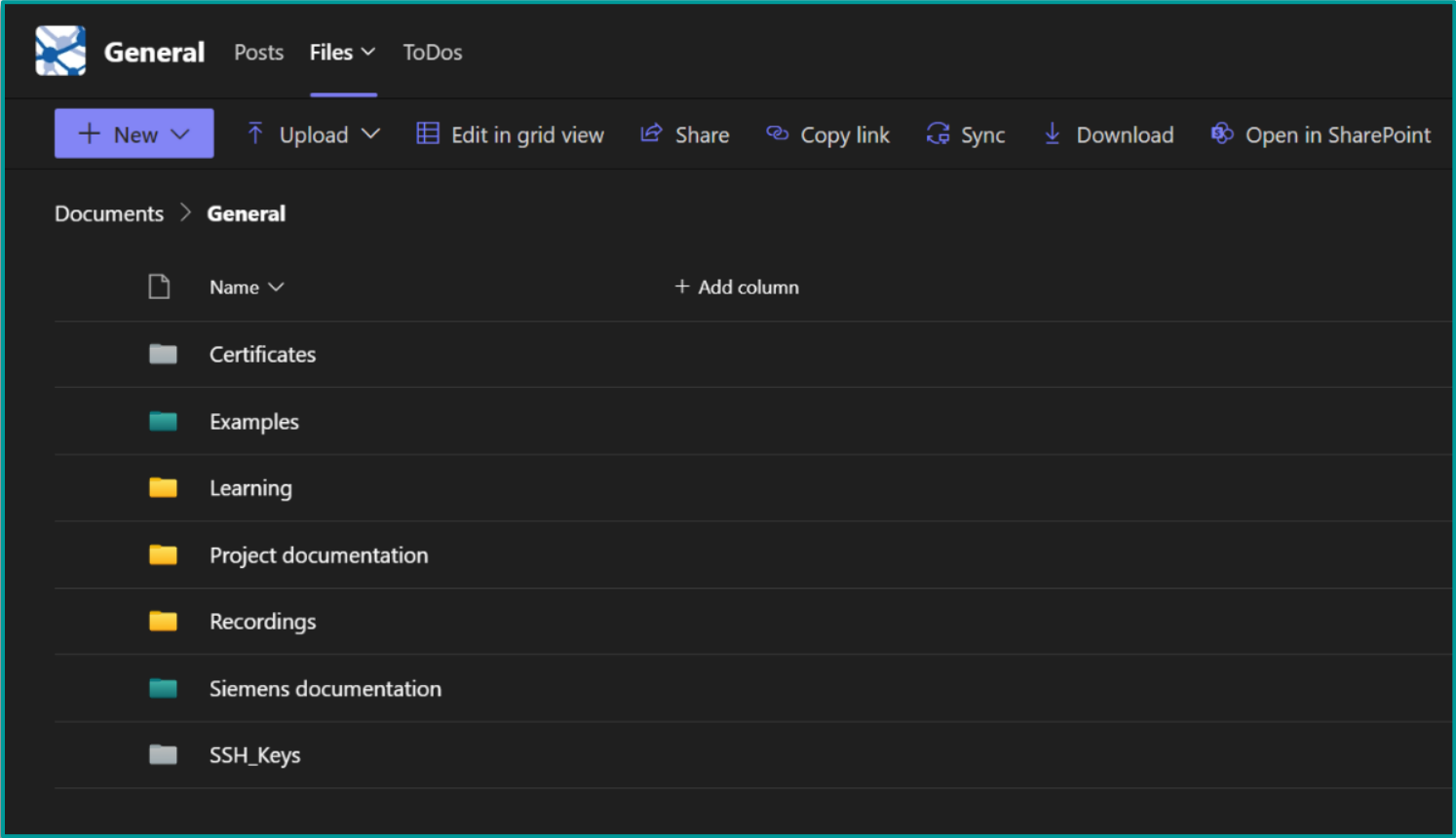
X

Xcom Wireshark

0

il y a un mois

Tools used (2)



Assignment and day-to-day work

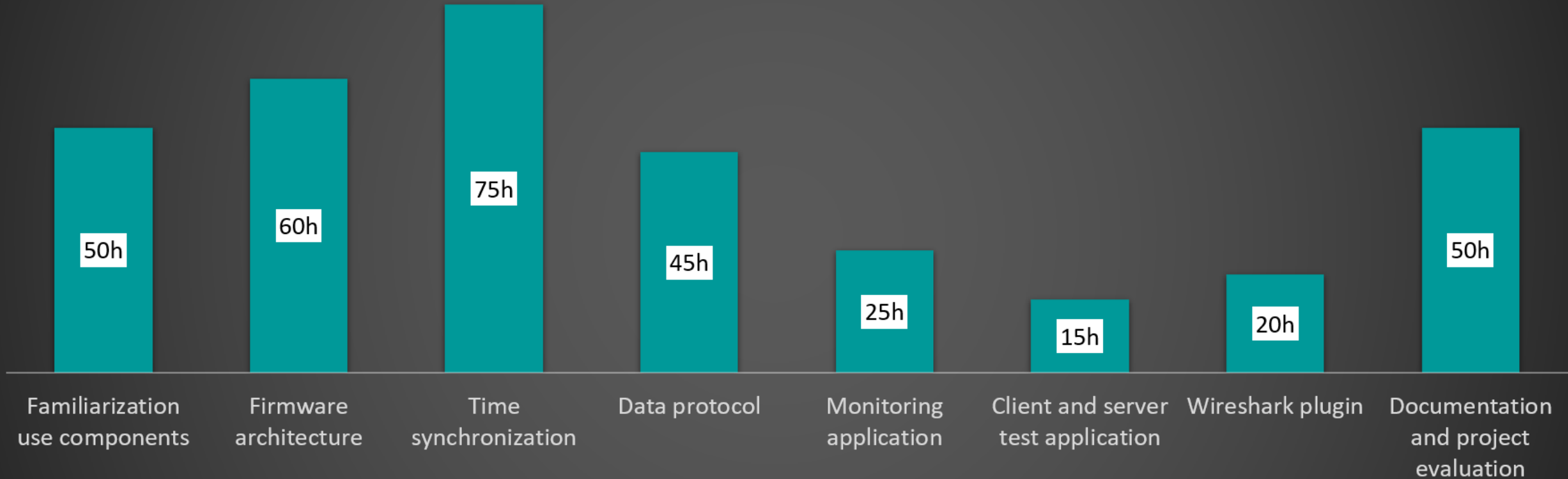




TABLE OF CONTENTS

PROJECT PRESENTATION

FIRMWARE

MONITORING APPLICATION

TEST APPLICATION

WIRESHARK PLUGIN

WORK ORGANIZATION

PROJECT CONCLUSION

