

2018.04.10

# Toy OBDH system

Juan A. de la Puente  
<jpuente@dit.upm.es>



Algunos derechos reservados. Este documento se distribuye bajo licencia  
Creative Commons Reconocimiento-NoComercial-CompartirIgual 3.0 Unported.  
<http://creativecommons.org/licenses/by-nc-sa/3.0/deed.es>

# Overview

---

- The aim of this project is to build a simple mockup of a satellite OBDH system performing basic housekeeping telemetry
  - ▶ periodic sensor sampling
  - ▶ periodic basic telemetry
  - ▶ on-request housekeeping telemetry with recent data

# Functional requirements

---

- A temperature sensor is periodically sampled with period  $T_S$
- A basic TM message is sent periodically with period  $T_B$ . The message contains the average value of the temperatures measured since the last basic TM
- The system can receive a TC from the ground station requesting a temperature report. It replies with a housekeeping TM message including the values of all temperatures stored since the last basic TM message and their respective reading times.
- TM messages are stamped with the current time.
- Time stamp values are given in seconds from the system start time, with a resolution of at least 1 ms.

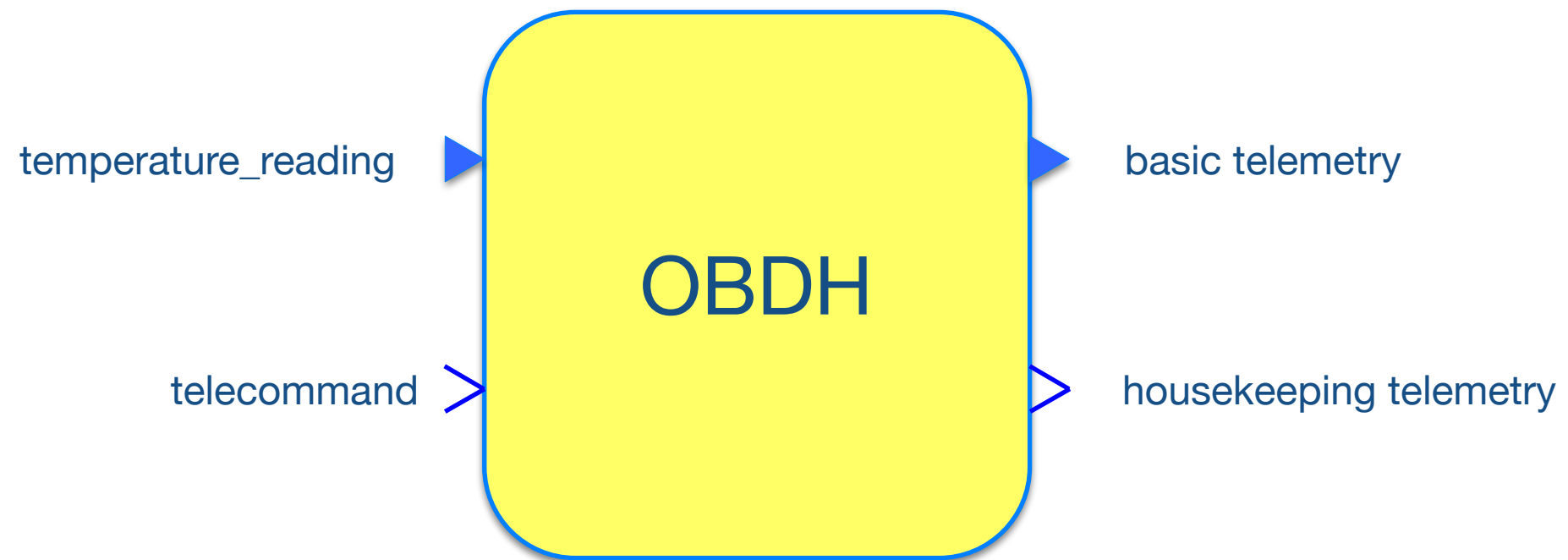
# Temporal requirements

---

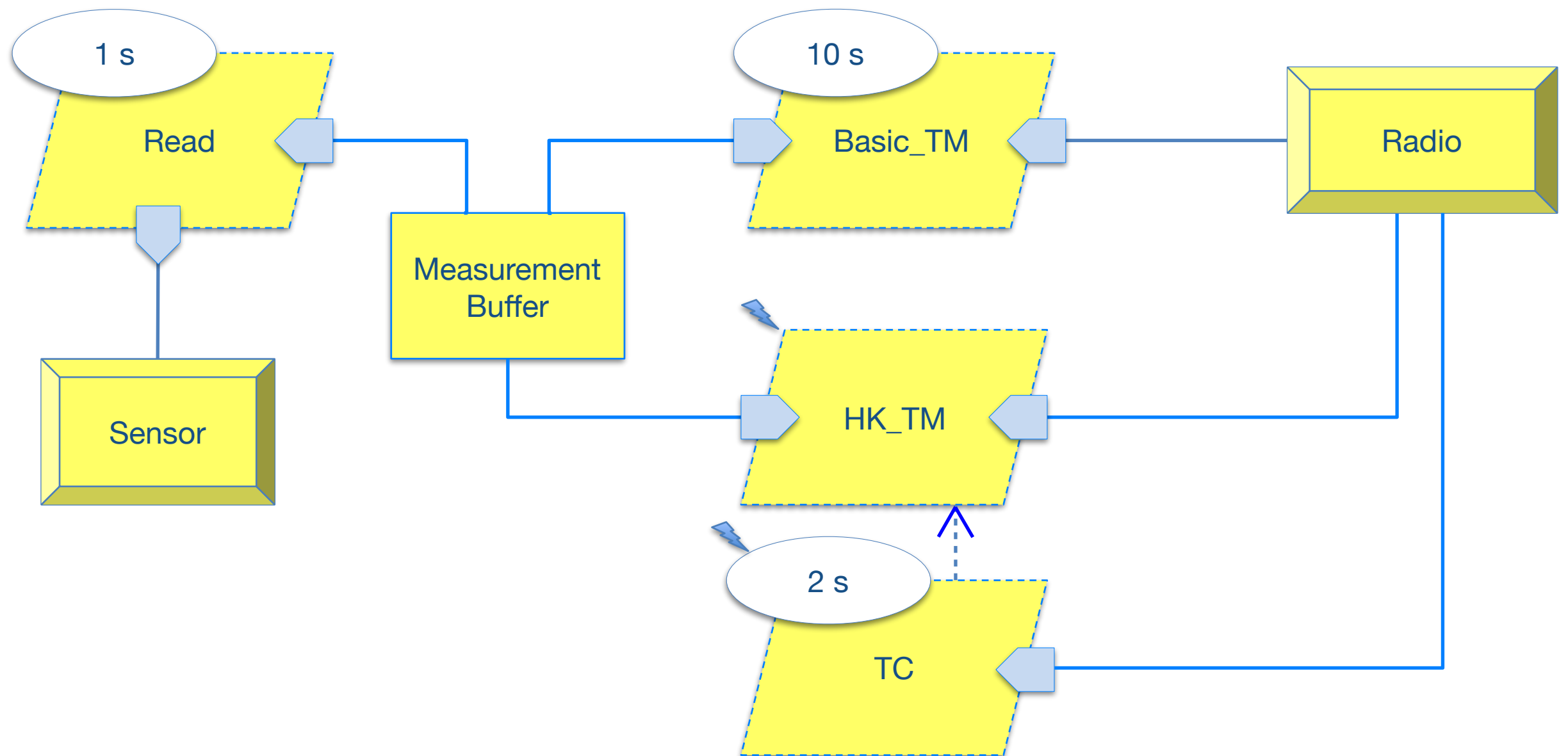
- Temperature must be sampled every  $T_S = 1$  s
  - ▶ reading to be completed before  $D_S = 0.1$  s
- Basic telemetry must be sent every  $T_B = 10$  s
  - ▶ message must be sent before  $D_B = 0.5$  s
- Telecommands are separated by at least  $T_C = 2$  s
  - ▶ processing must be completed before  $D_C = 0.05$  s
- Housekeeping telemetry messages are sent after reception of a TC
  - ▶ message must be sent before  $D_H = 0.2$  s

# Context diagram

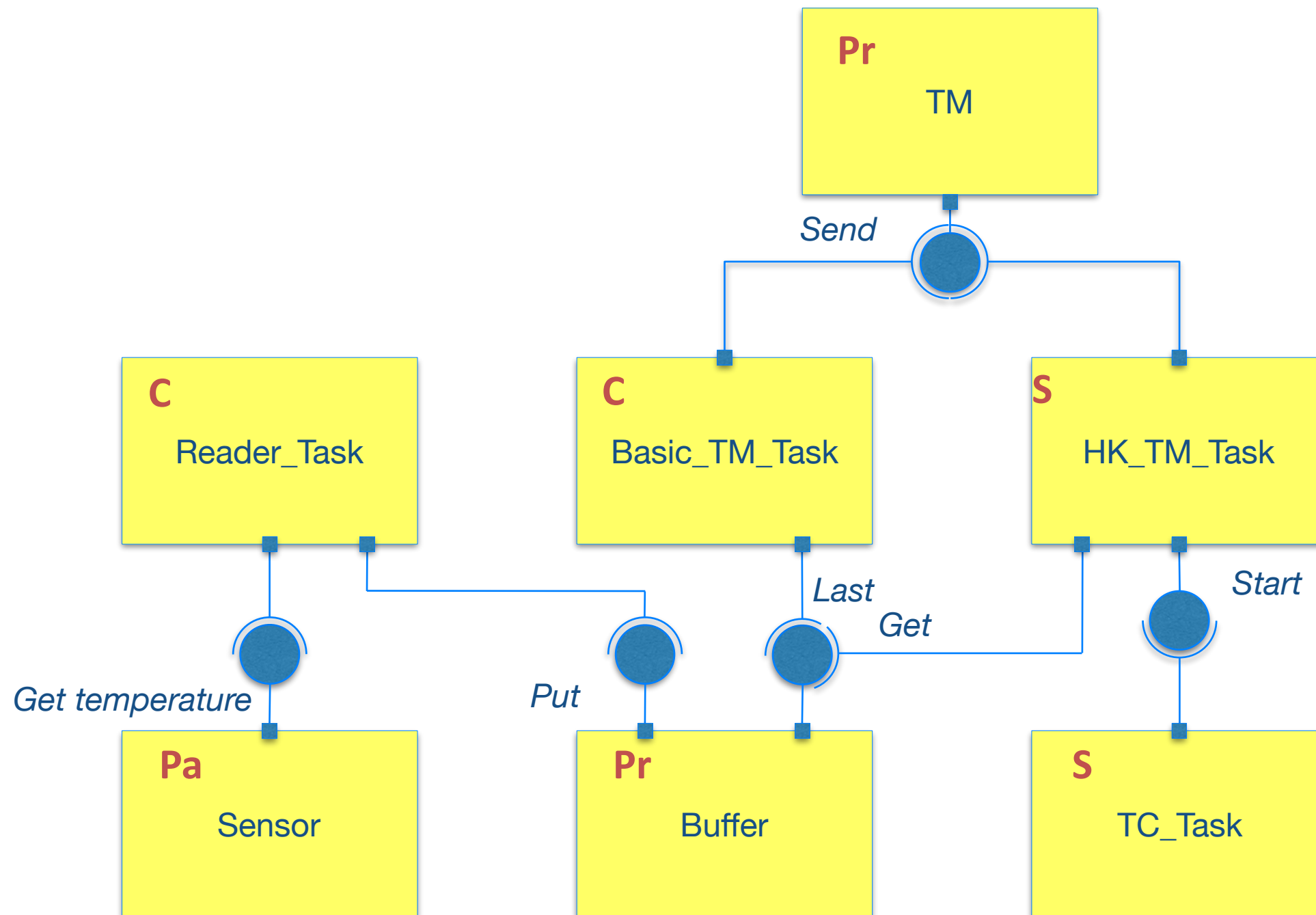
---



# Architectural design (AADL)

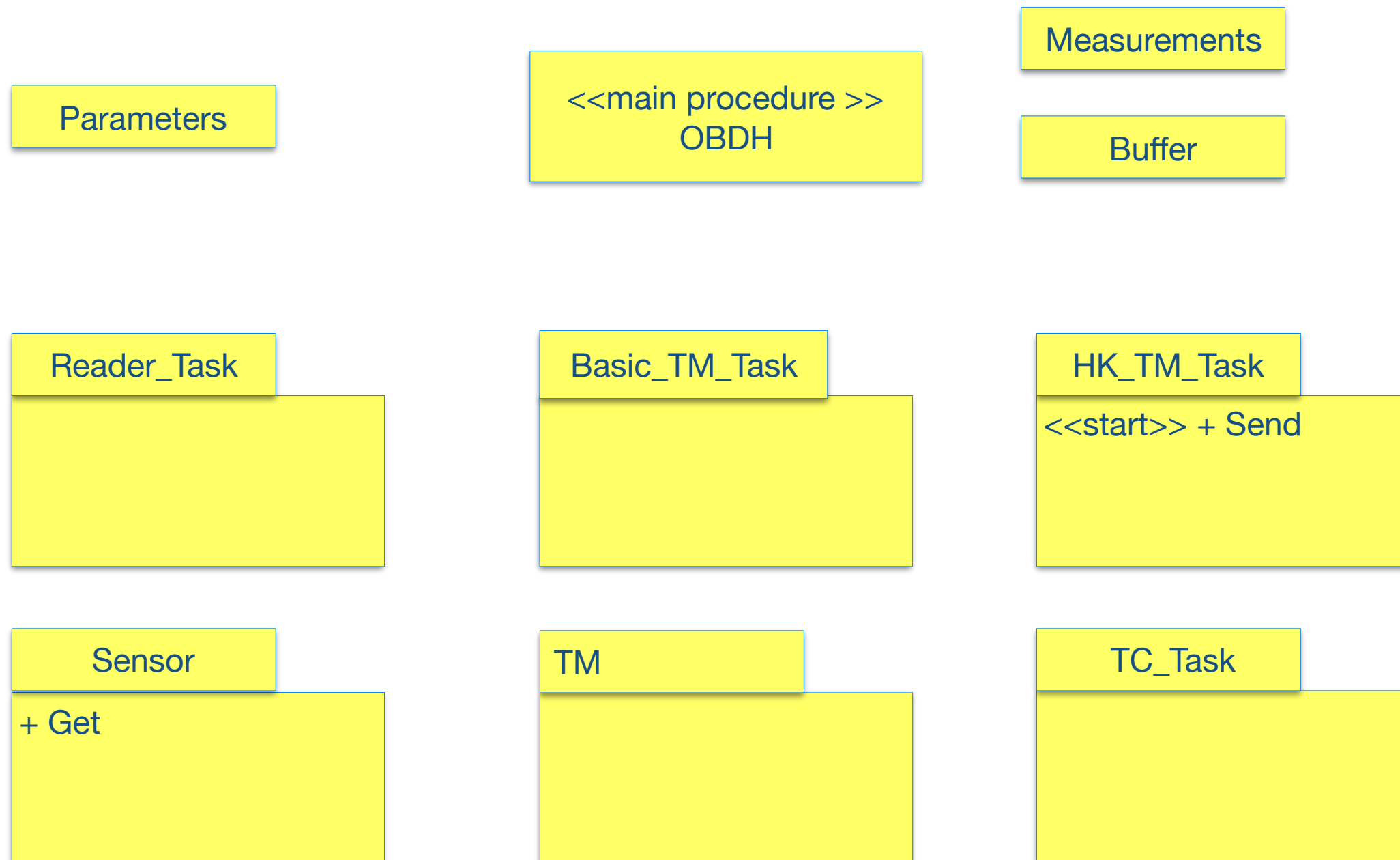


# Architectural design (UML)



# Detailed design

---



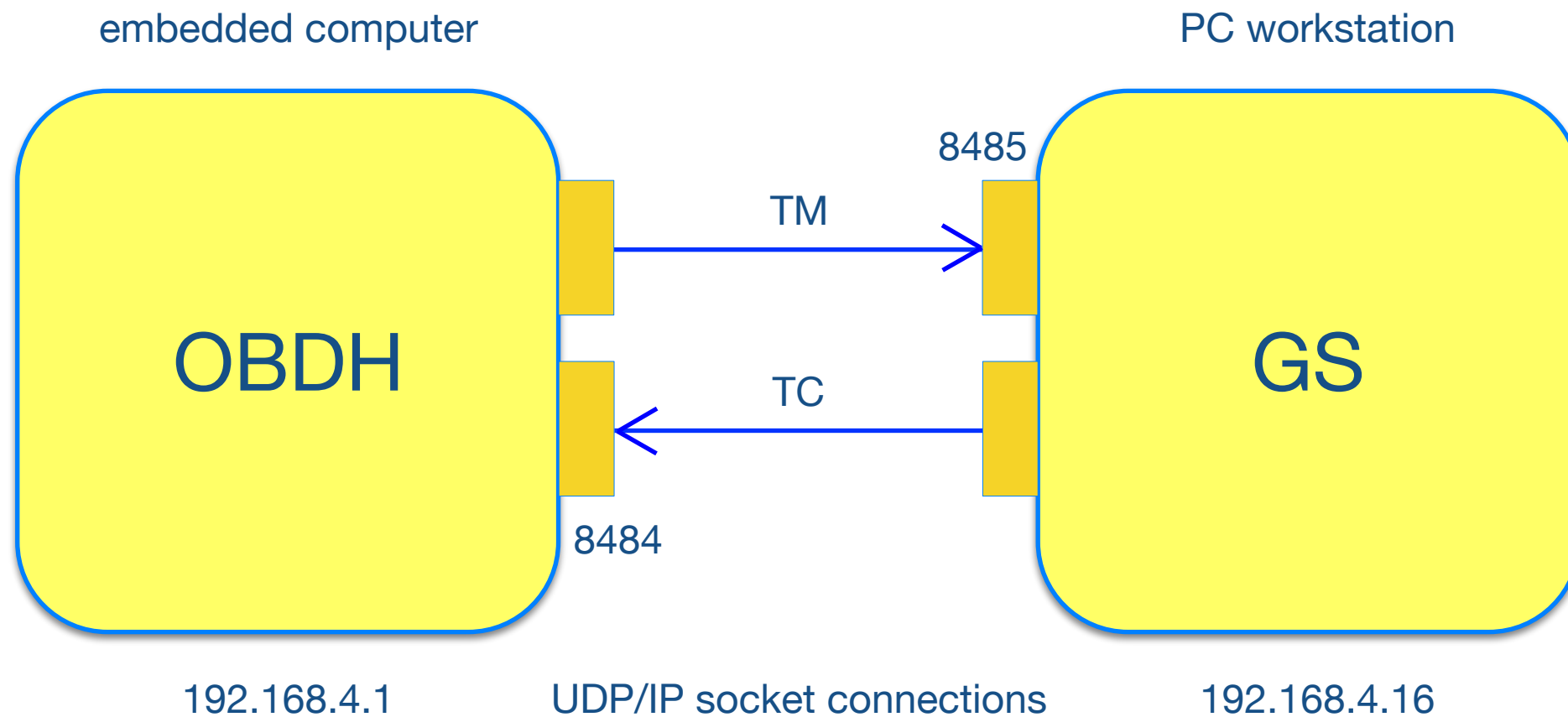


# RT Analysis

Task		P	T	C	B	R	D
TC	S	4	2,0	0,020	0,001	0,021	0,050
Reader	P	3	0,1	0,010	0,002	0,032	0,100
HK_TM	S	2	2,0	0,12	0,005	0,165	0,200
Basic_TM	P	1	10,0	0,050	0,000	0,210	0,500
PO							
HK event		4		0,001			
TC event		4		0,001			
Buffer		3		0,002			
TM		2		0,005			

# Ground station

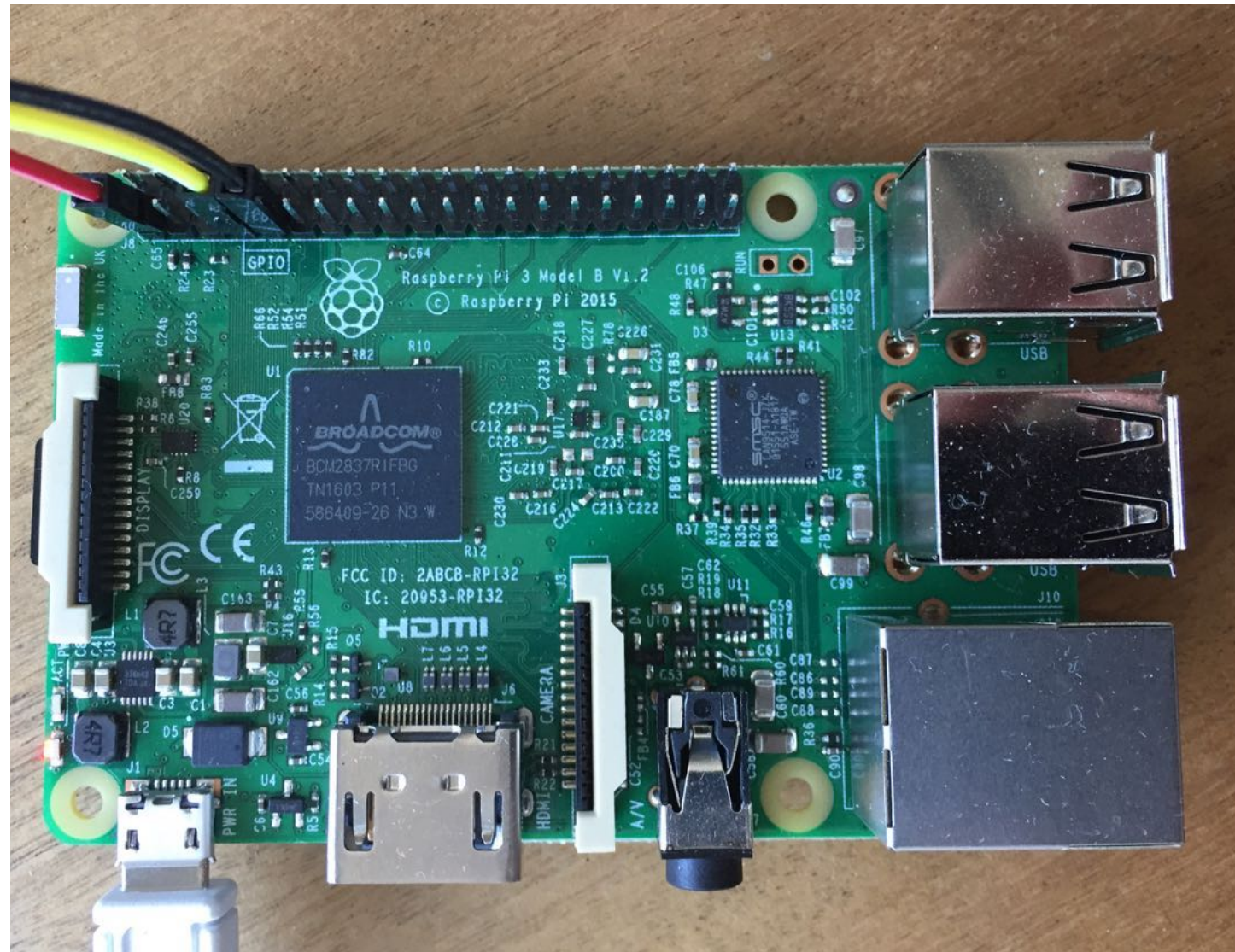
---



# Embedded computer

## RaspberryPi 3B

---



# Ground station

Toy Satellite Ground Station

Telemetry

15:50:59	TM	1523947860	23.750
15:51:04	TM	1523947865	23.688
15:51:09	TM	1523947870	23.688
15:51:14	TM	1523947875	23.688
15:51:19	TM	1523947880	23.750
15:51:24	TM	1523947885	23.750
15:51:29	TM	1523947890	23.688
15:51:34	TM	1523947895	23.750
15:51:39	TM	1523947900	23.750
15:51:44	TM	1523947905	23.750
15:51:49	TM	1523947910	23.750
15:51:54	TM	1523947915	23.750
15:51:59	TM	1523947920	23.750
15:52:04	TM	1523947925	23.750
15:52:09	TM	1523947930	23.750
15:52:14	TM	1523947935	23.750
15:52:19	TM	1523947940	23.750
15:52:24	TM	1523947945	23.750
15:52:29	TM	1523947950	23.750
15:52:34	TM	1523947955	23.750
15:52:39	TM	1523947960	23.750
15:52:44	TM	1523947965	23.750
15:52:49	TM	1523947970	23.750
15:52:54	TM	1523947975	23.750

Telecommands

Request HK

Toy Satellite Ground Station

Telemetry

15:52:14	TM	1523947935	23.750
15:52:19	TM	1523947940	23.750
15:52:24	TM	1523947945	23.750
15:52:29	TM	1523947950	23.750
15:52:34	TM	1523947955	23.750
15:52:39	TM	1523947960	23.750
15:52:44	TM	1523947965	23.750
15:52:49	TM	1523947970	23.750
15:52:54	TM	1523947975	23.750
15:52:59	TM	1523947980	23.750
15:53:04	TM	1523947985	23.750
15:53:09	TM	1523947990	23.750
15:53:13	TM	1523947994	HK log
		1523947990	23.750
		1523947991	23.750
		1523947992	23.750
		1523947993	23.750
		1523947994	23.750
15:53:14	TM	1523947995	23.750
15:53:19	TM	1523948000	23.750
15:53:24	TM	1523948005	23.750
15:53:29	TM	1523948010	23.750
15:53:34	TM	1523948015	23.750
15:53:39	TM	1523948020	23.750

Telecommands

Request HK

runs on Ubuntu, MacOS, Windows

# Implementation

---

- **obdh**: compile on development platform (linux)
  - ▶ download code from the [STR-UPM ToyOBDAH](#) GitHub repository
  - ▶ compile and build with the raspberrypi-linux compiler
  - ▶ upload to the board through wifi connection

```
scp obdh pi@192.168.4.1:bin
pi@192.168.4.1's password:
obdh                                100% 799KB 799.2KB/s 00:00
```

- **gs**: compile on linux/Mac/Windows workstation
  - ▶ requires a native GNAT compiler and the GtkAda library



# References

---

- Github repositories
  - ▶ <https://github.com/STR-UPM>
    - ToyOBDAH and ToyGS sources
- AdaCore Community site
  - ▶ <https://www.adacore.com/community>
    - native GNAT compilation system for the development platform
      - ✓ download also gtkada libraries
    - cross compilation system for Raspberry Pi with linux, hosted on linux