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Toy OBDH system

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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

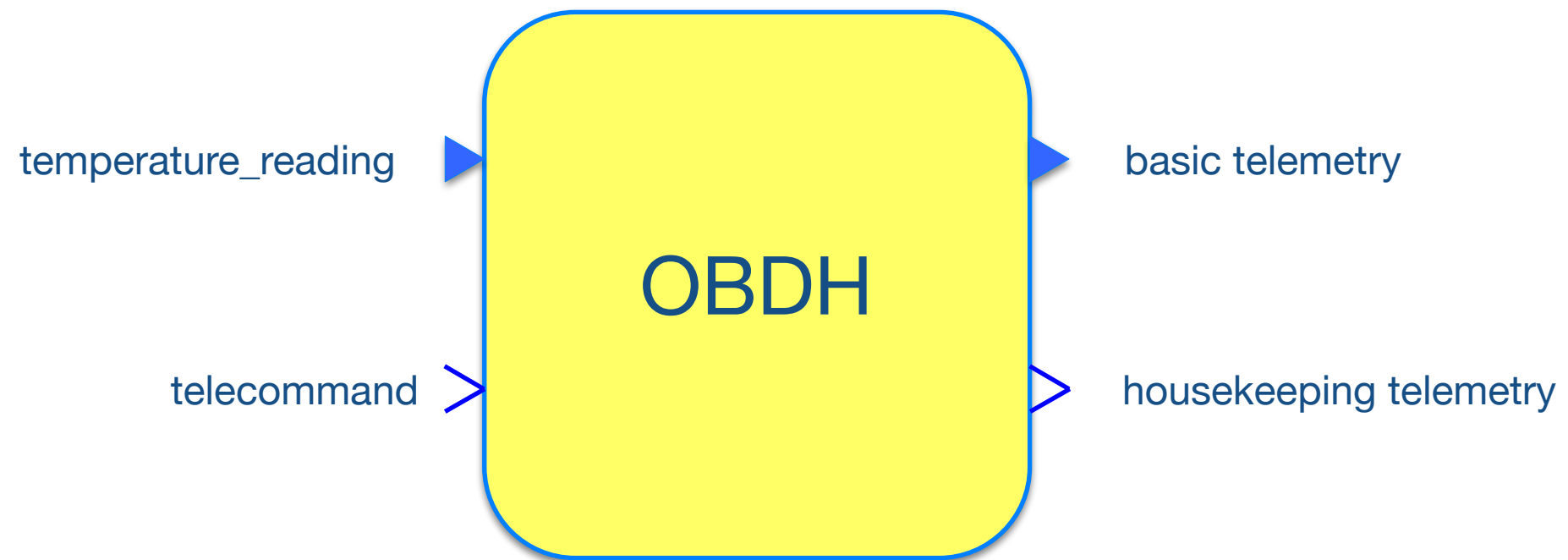
Functional requirements

- 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.

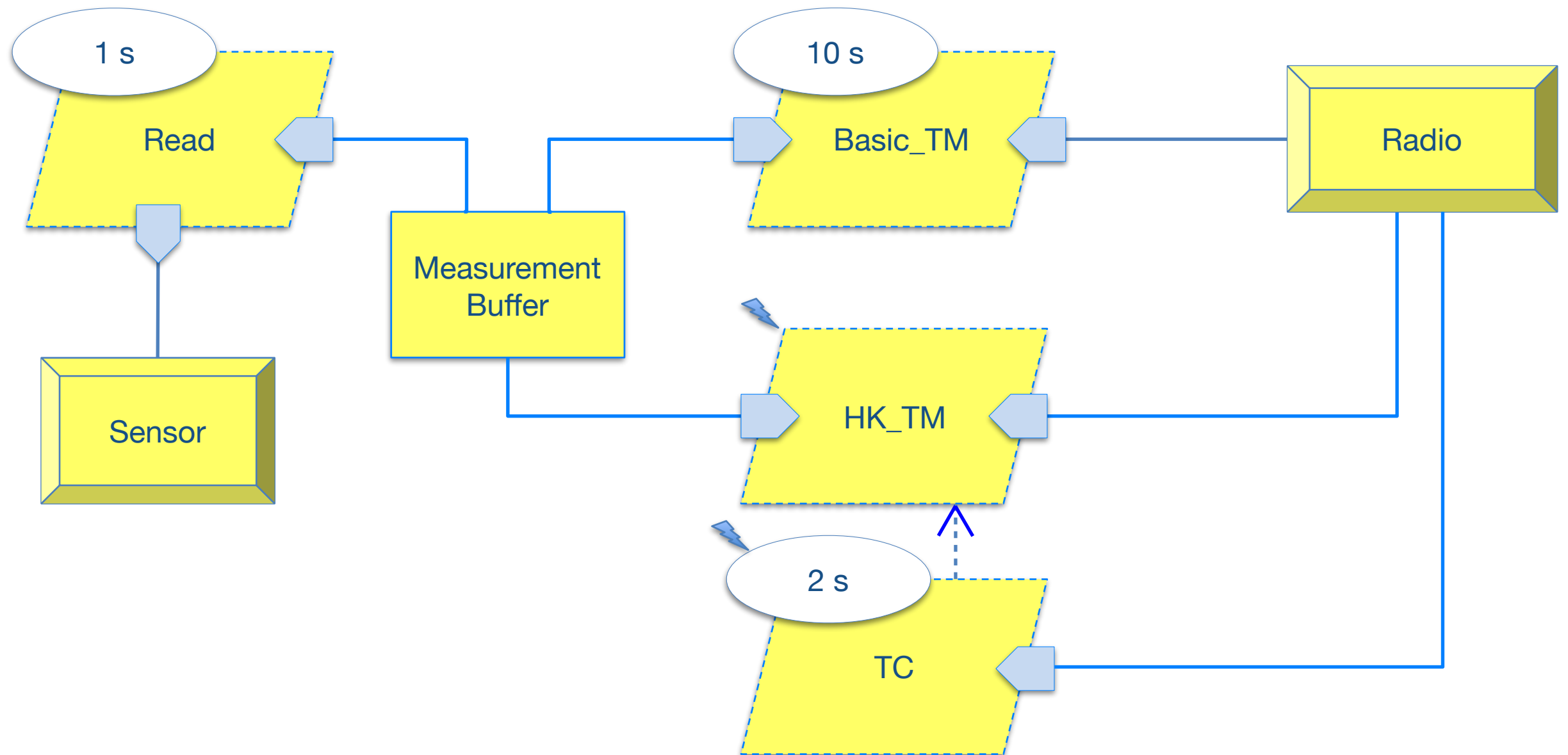
Temporal requirements

- 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

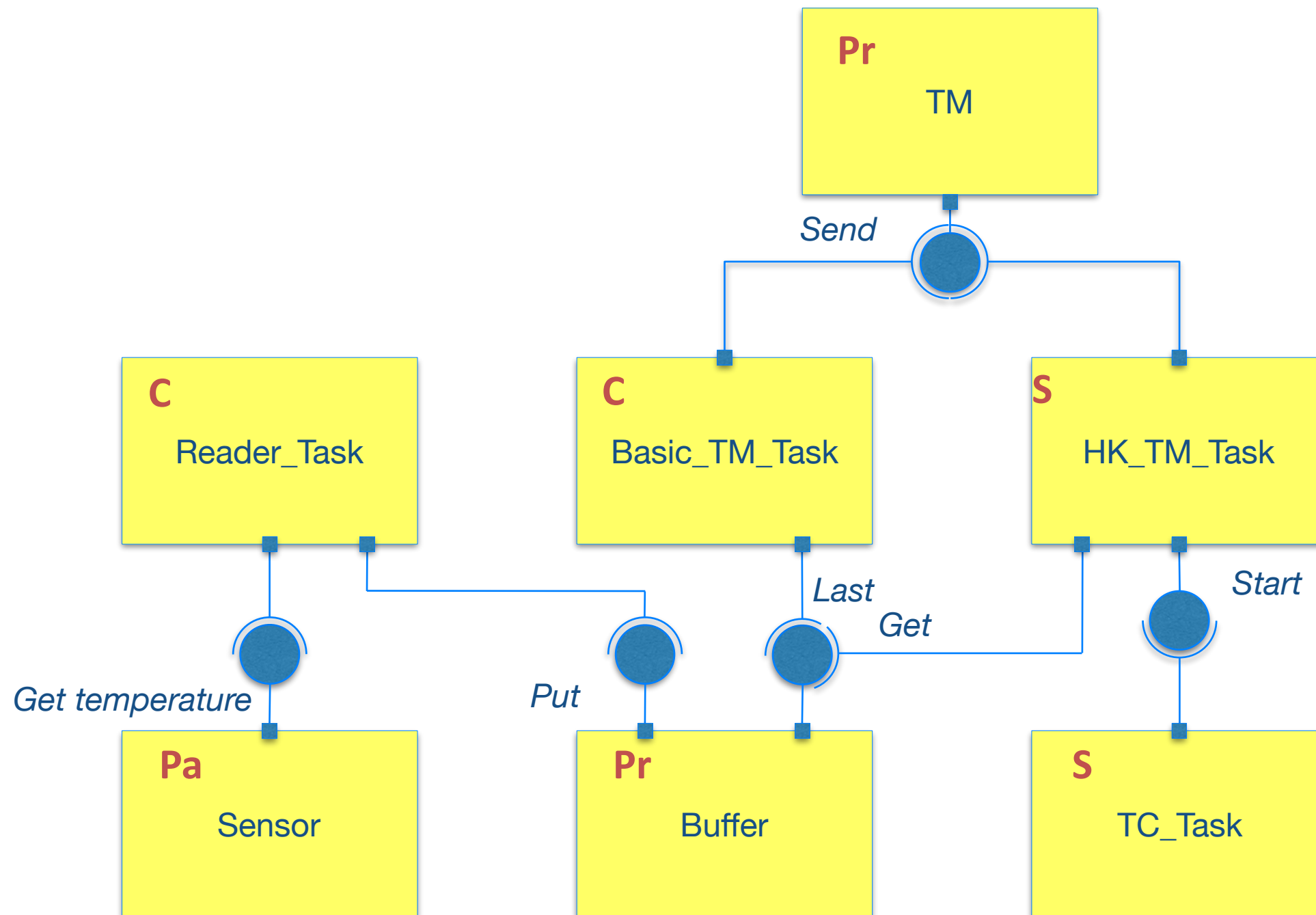
Context diagram



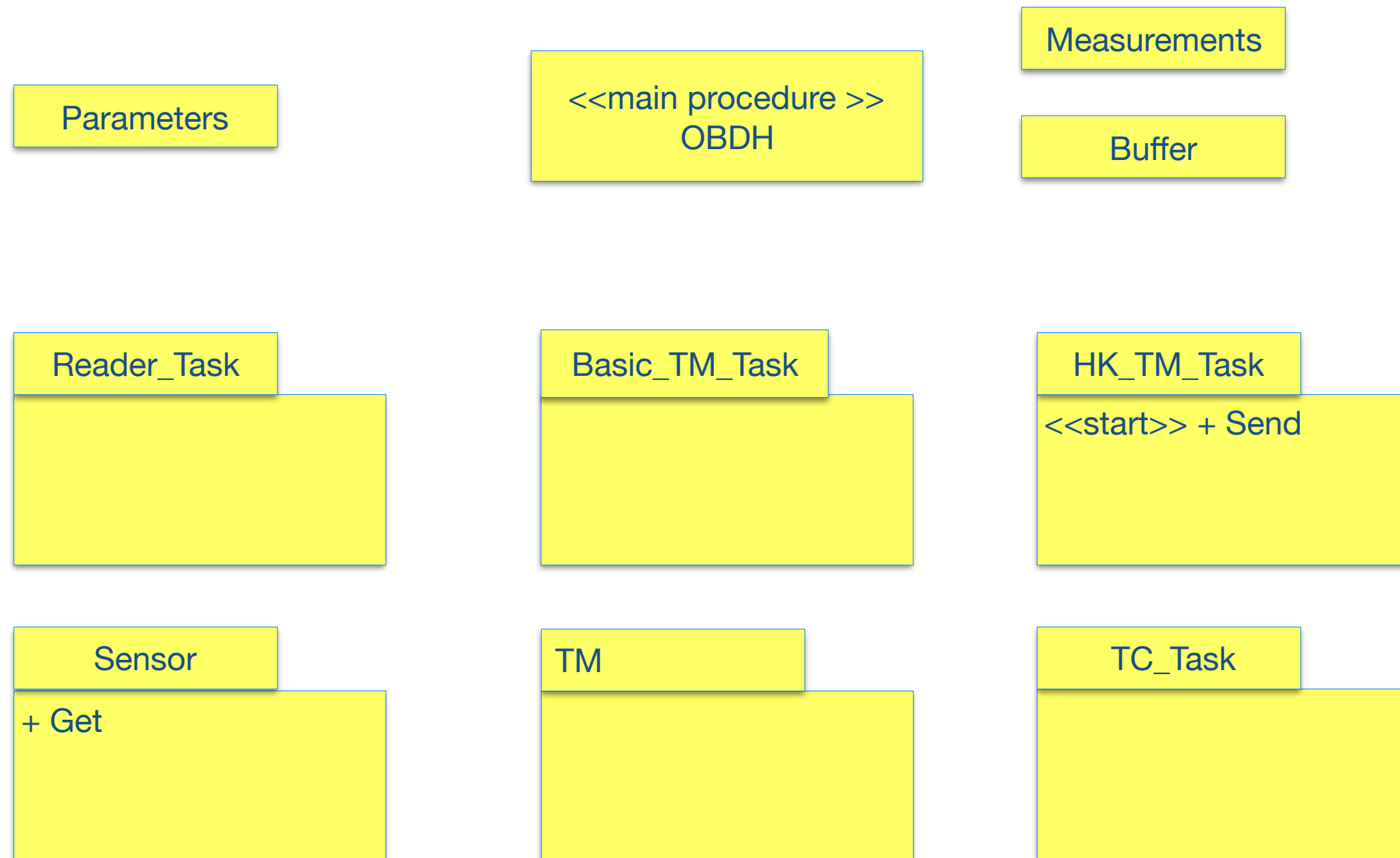
Architectural design (AADL)



Architectural design (UML)



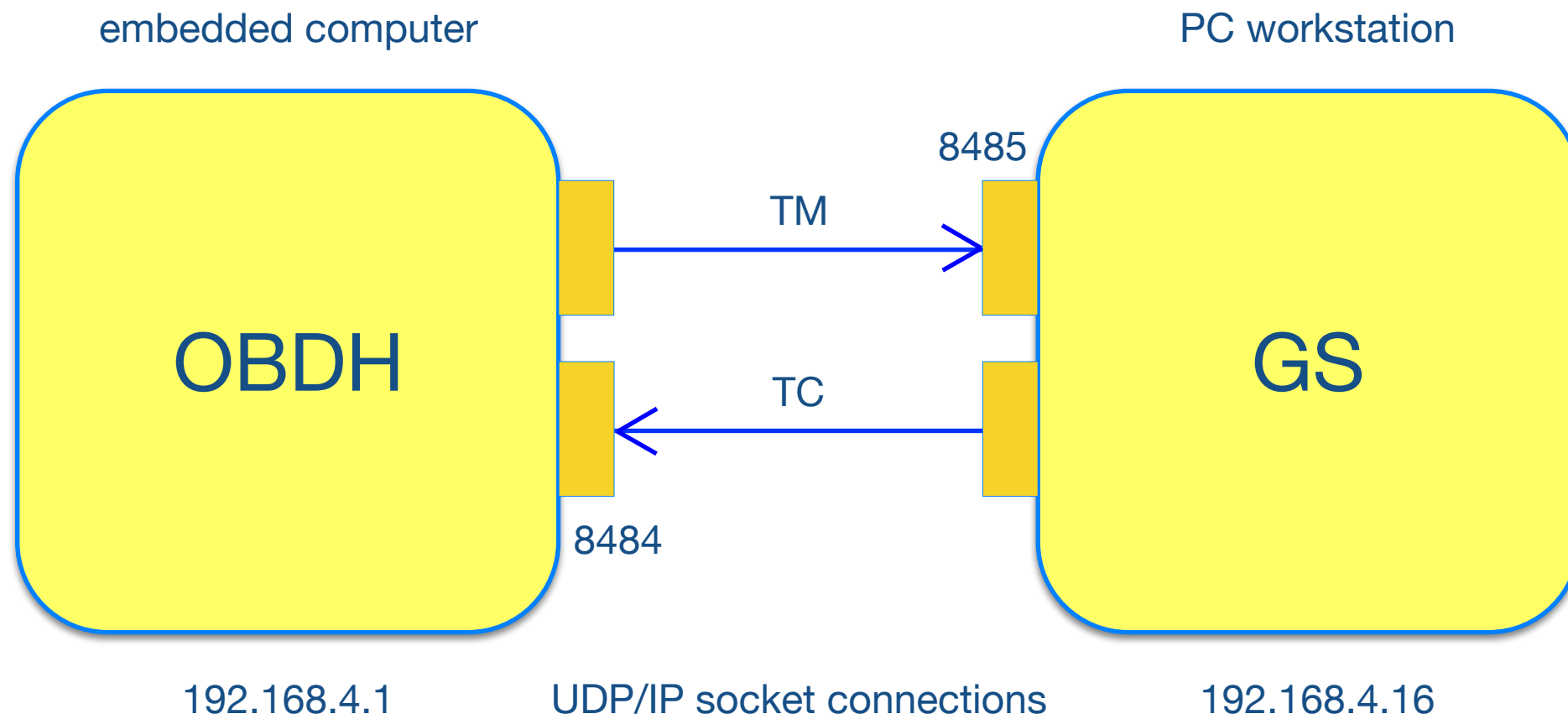
Detailed design



RT Analysis

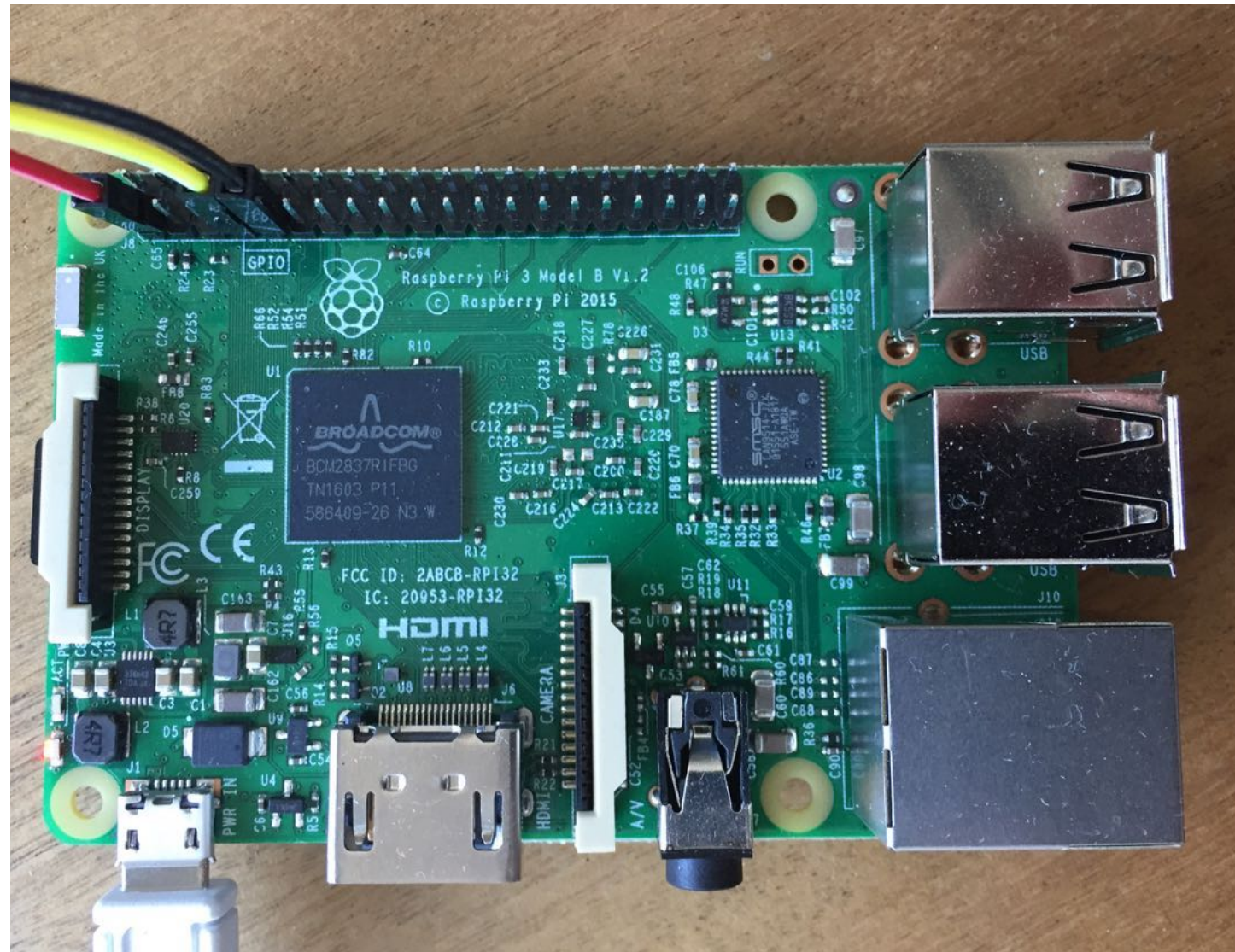
Task		P	T	C	B	R	D
TC	S	4	2,0	0,020	0,001	0,021	0,050
Reader	P	3	0,1	0,010	0,002	0,032	0,100
HK_TM	S	2	2,0	0,12	0,005	0,165	0,200
Basic_TM	P	1	10,0	0,050	0,000	0,210	0,500
PO							
HK event		4		0,001			
TC event		4		0,001			
Buffer		3		0,002			
TM		2		0,005			

Ground station



Embedded computer

RaspberryPi 3B



Ground station

The image displays two side-by-side screenshots of a software application titled "Toy Satellite Ground Station". Each window is divided into two main sections: "Telemetry" on the left and "Telecommands" on the right.

Left Window Telemetry Data:

Time	Type	ID	Value
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

Right Window Telemetry Data:

Time	Type	ID	Value
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

Both windows feature a "Request HK" button in the "Telecommands" section. In the right window, this button is circled in red. Additionally, a red oval highlights a group of telemetry entries in the right window, specifically those with IDs 1523947990 through 1523947994.

runs on Ubuntu, MacOS, Windows

Implementation

- **obdh**: compile on development platform (linux)
 - ▶ download code from the [STR-UPM ToyOBDH](#) 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