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# Toy OBDH system

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# Overview

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- 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
- The target platform is an STM32F429 discovery board
- The host platform is a GNU/Linux workstation

# Functional requirements

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- 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.

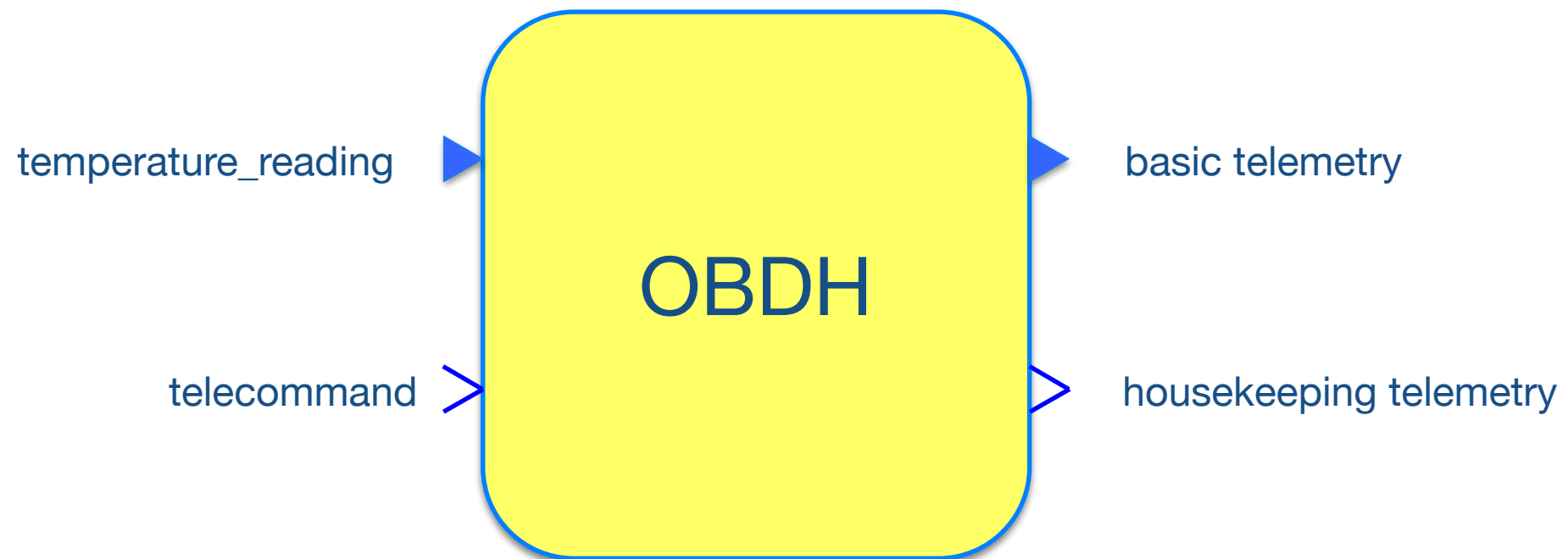
# Temporal requirements

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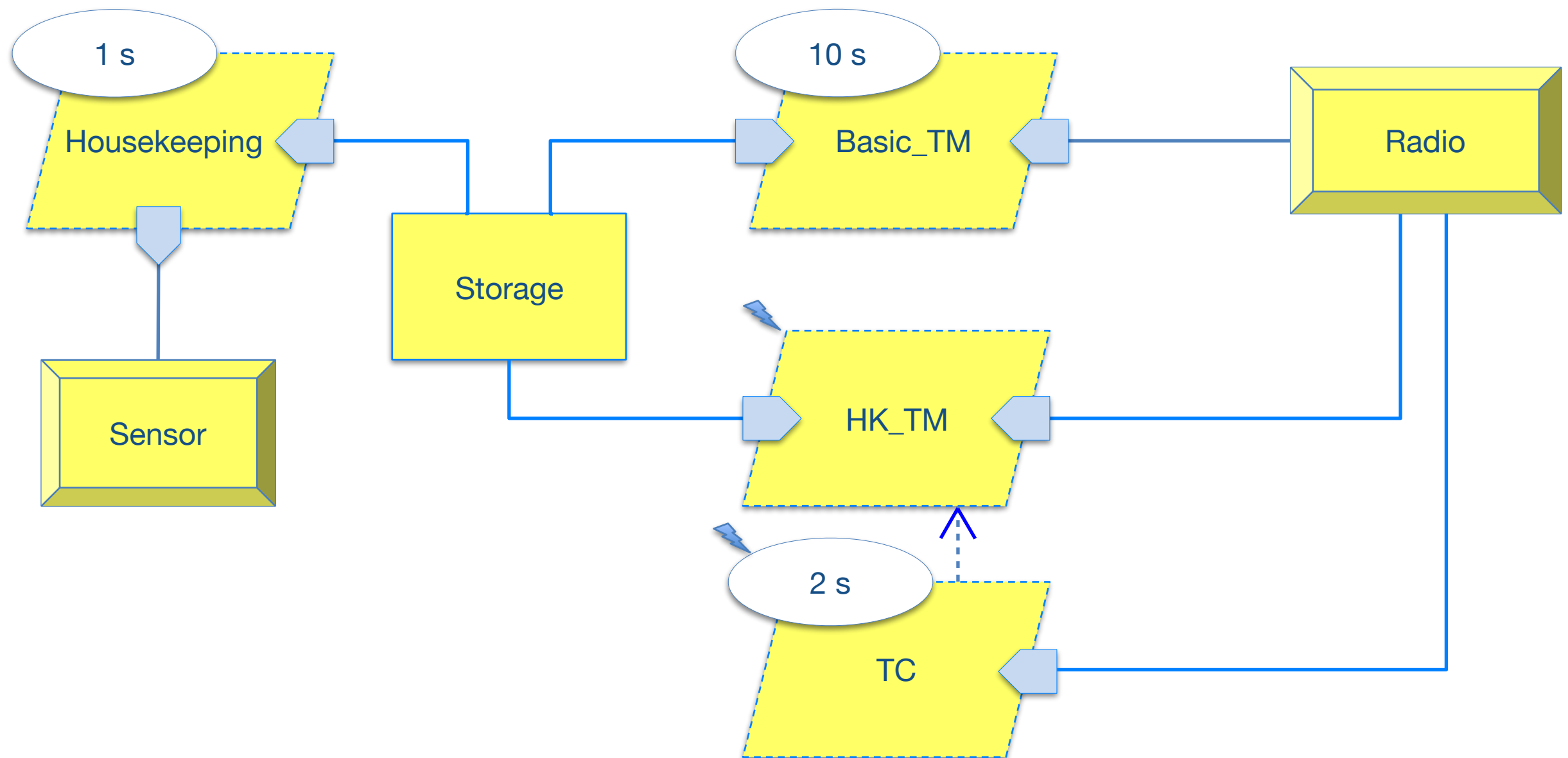
- Temperature must be sampled every  $T_S = 1$  s
  - ▶ reading to be completed before  $D_S = 0.1$  s
- Basic telemetry must be sent every  $T_B = 10$  s
  - ▶ message must be sent before  $D_B = 0.5$  s
- Telecommands are separated by at least  $T_C = 2$  s
  - ▶ processing must be completed before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

# Context diagram

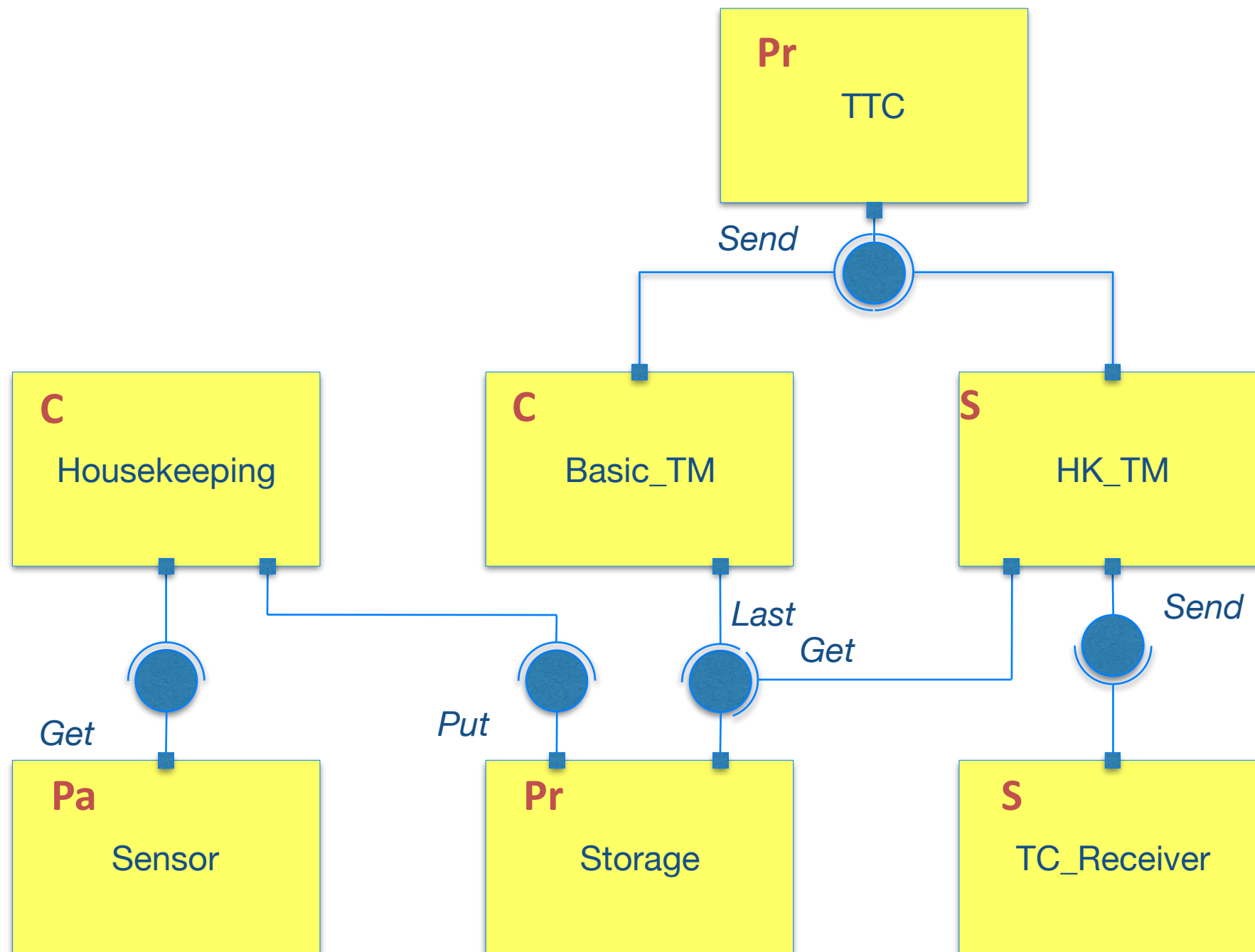
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# Architectural design (AADL)

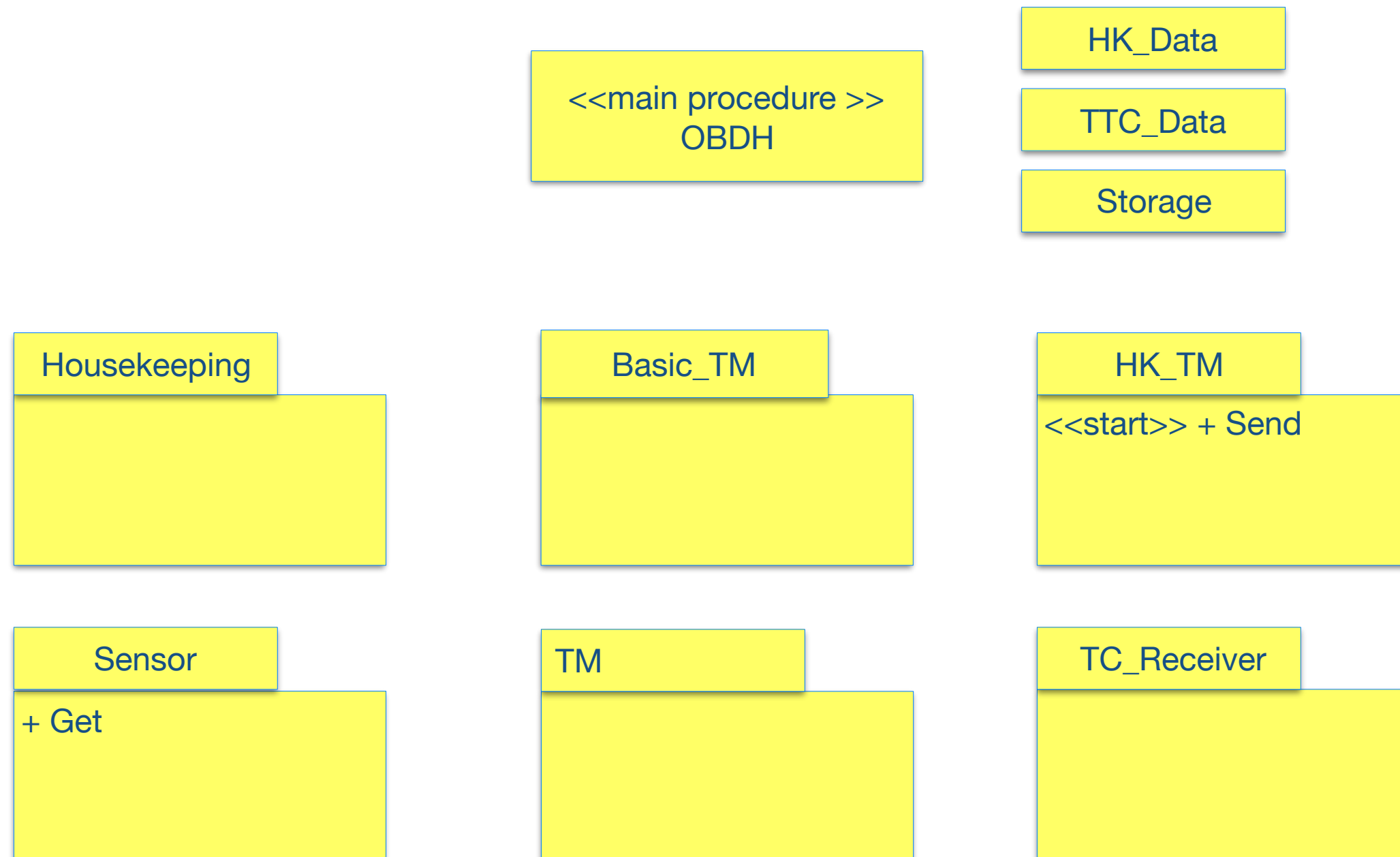


# Architectural design (UML)



# Detailed design

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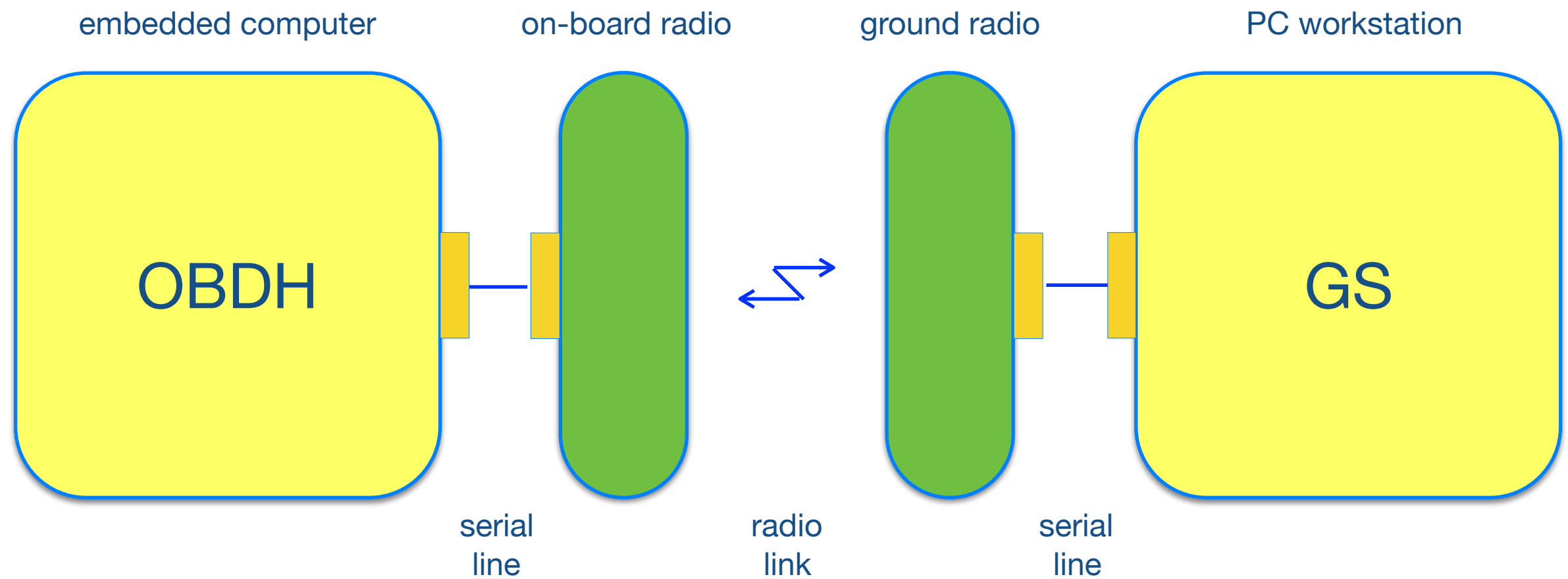


# RT Analysis

Task		P	T	C	B	R	D
TC	S	4	2,0	0,020	0,001	0,021	0,050
Housekeeping	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 request		4			0,001		
TC event		4			0,001		
Buffer		3			0,002		
TM		2			0,005		

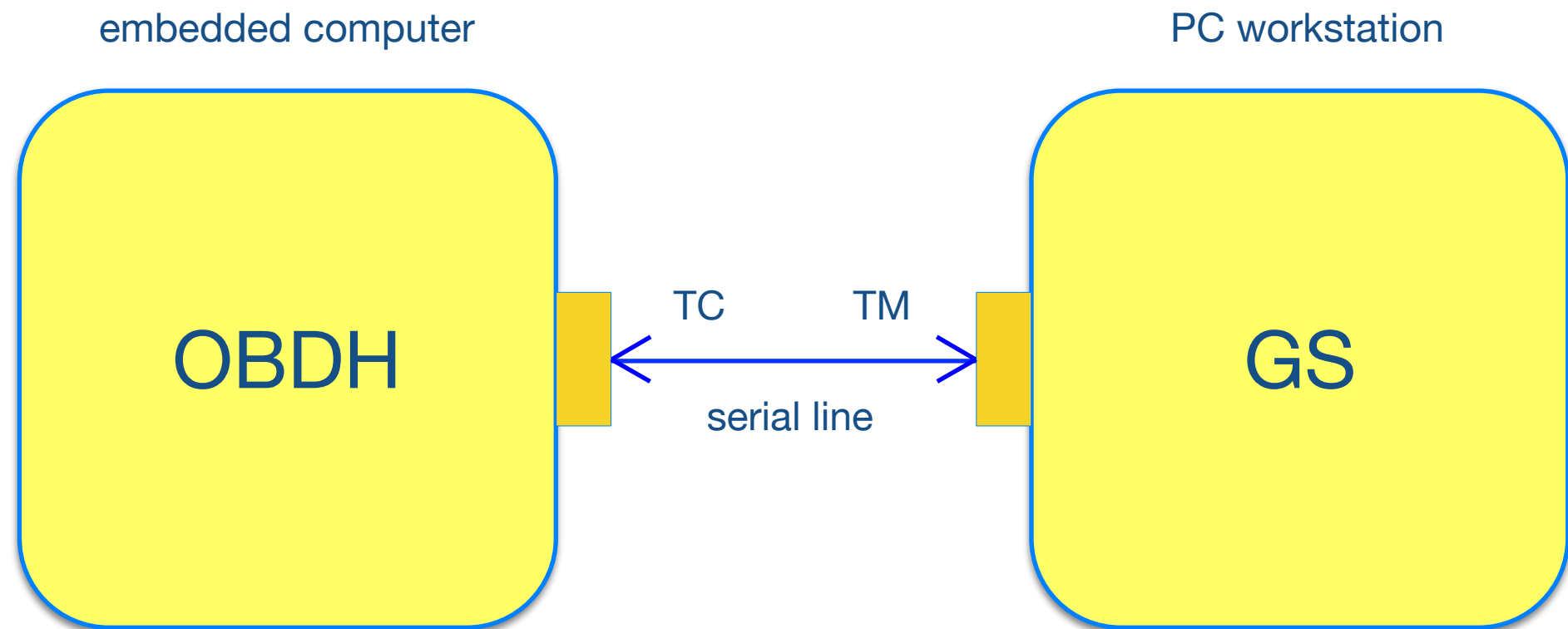
# Ground station

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# Ground station test arrangement

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# Embedded computer

## STM32F4 - discovery

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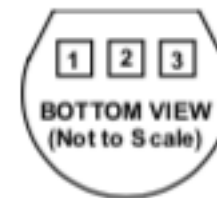


temperature sensor TMP36 (ADC)

pin 1 (violet)      -> + 3V

pin2 (orange)      -> PA5 (V out)

pin3 (black)      -> GND



PIN 1, +V<sub>S</sub>; PIN 2, V<sub>OUT</sub>; PIN 3, GND

USB serial cable — IEEE 1394  
e.g. FTDI TTL-232R-5V

serial port

pin 1 (black)      -> GND

pin 4 (orange)      -> PB7    RX

pin 5 (yellow)      -> PB6    TX

115200 bps 8N1

# Ground station

The image displays two side-by-side windows 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 data rows in the right window's telemetry list, starting from the entry at 15:53:09.

runs on Ubuntu, MacOS, Windows

# Implementation

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- **obdh**: compile on development platform (linux)
  - ▶ download code from the [STR-UPM ToyOBDAH](#) GitHub repository
  - ▶ compile and build with the arm-elf compiler
  - ▶ upload to the board through usb connection
- **gs**: compile on linux/Mac/Windows workstation
  - ▶ requires a native GNAT compiler and the GtkAda library

# References

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- 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