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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

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

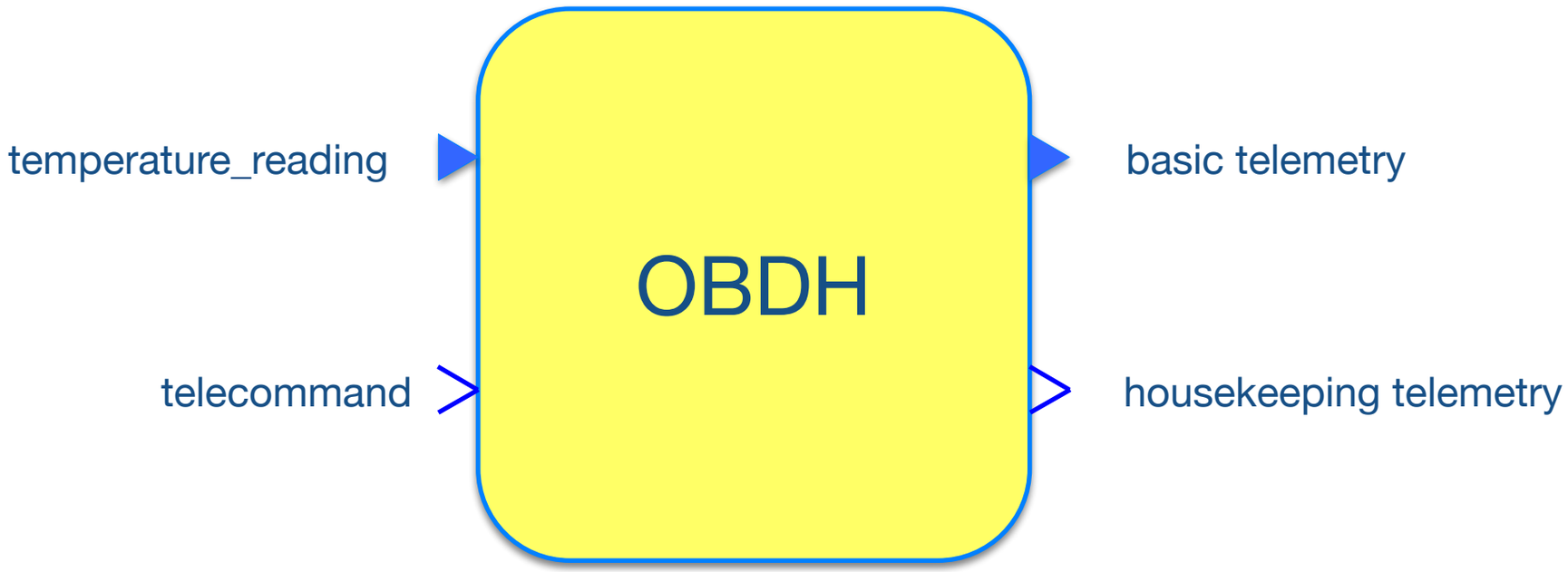
# Functional requirements

- 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.

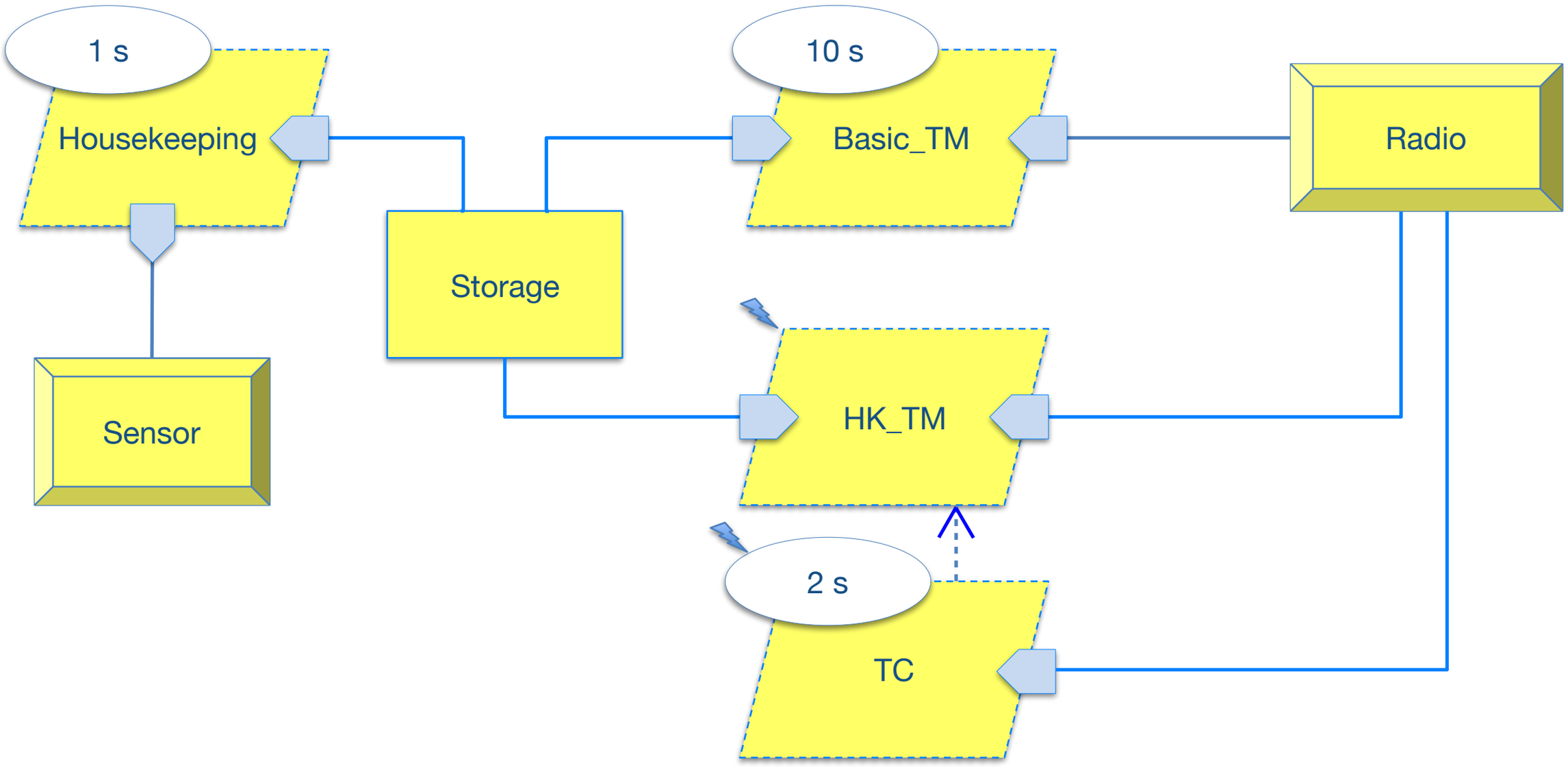
# Temporal requirements

- 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

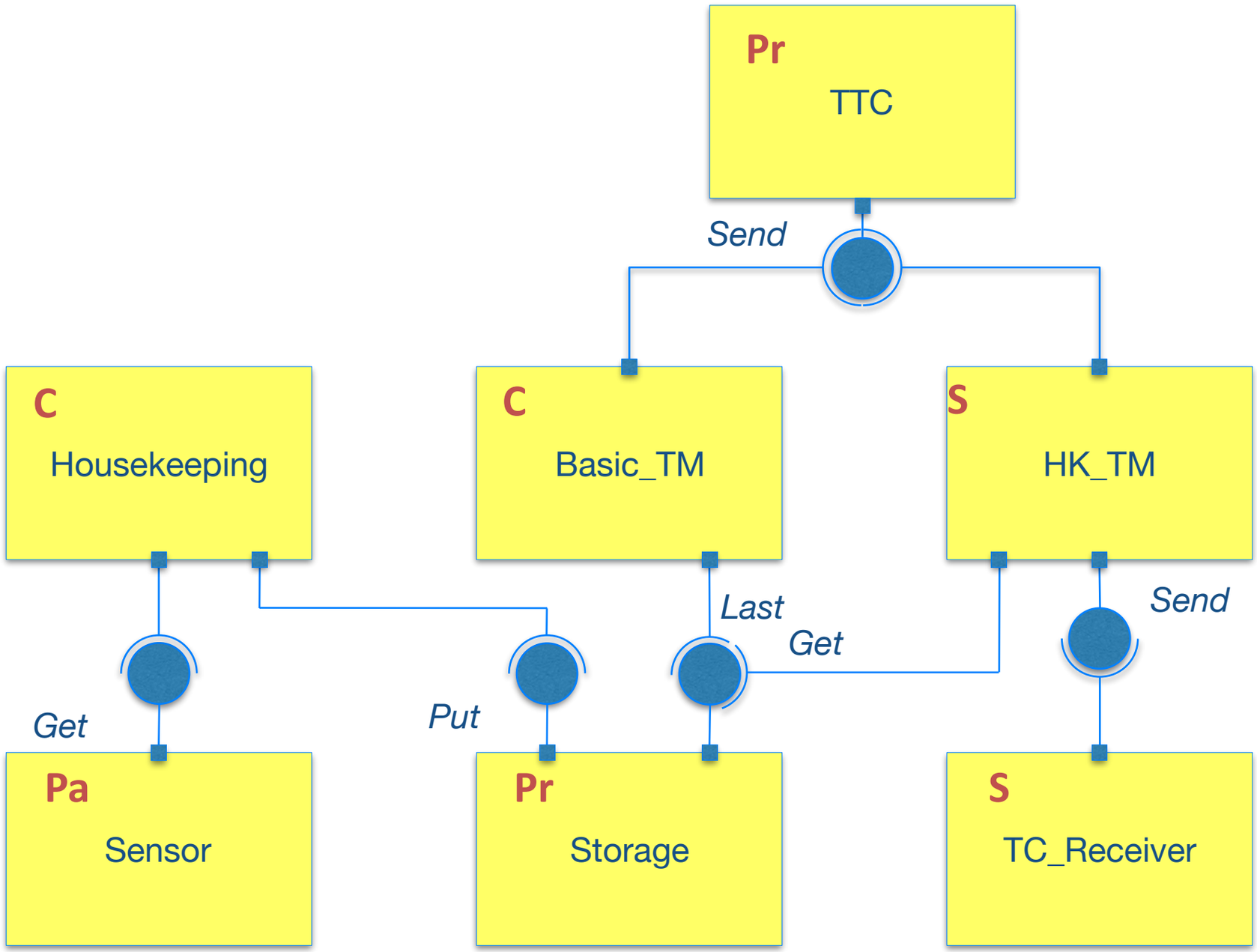
# Context diagram



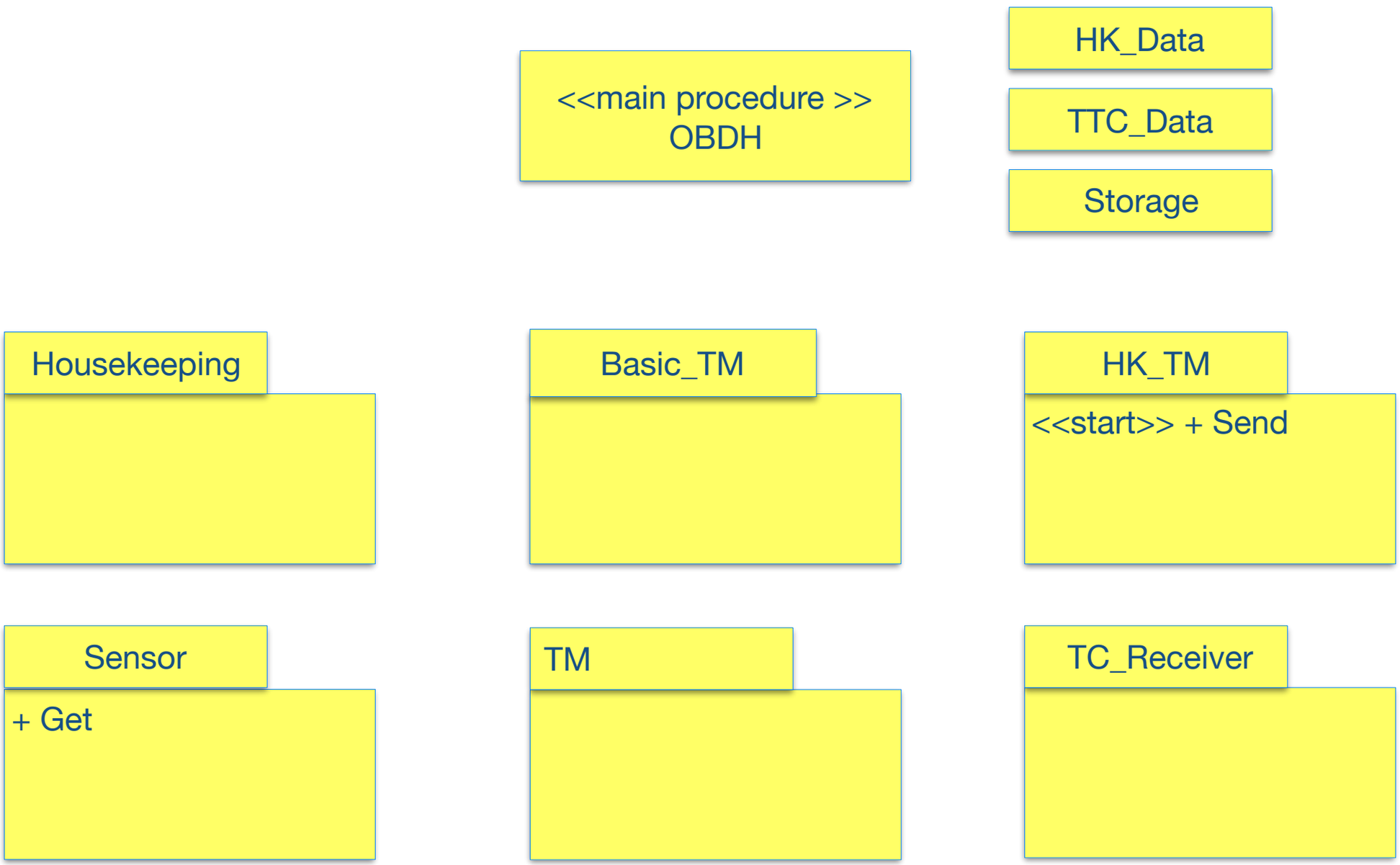
# Architectural design (AADL)



# Architectural design (UML)



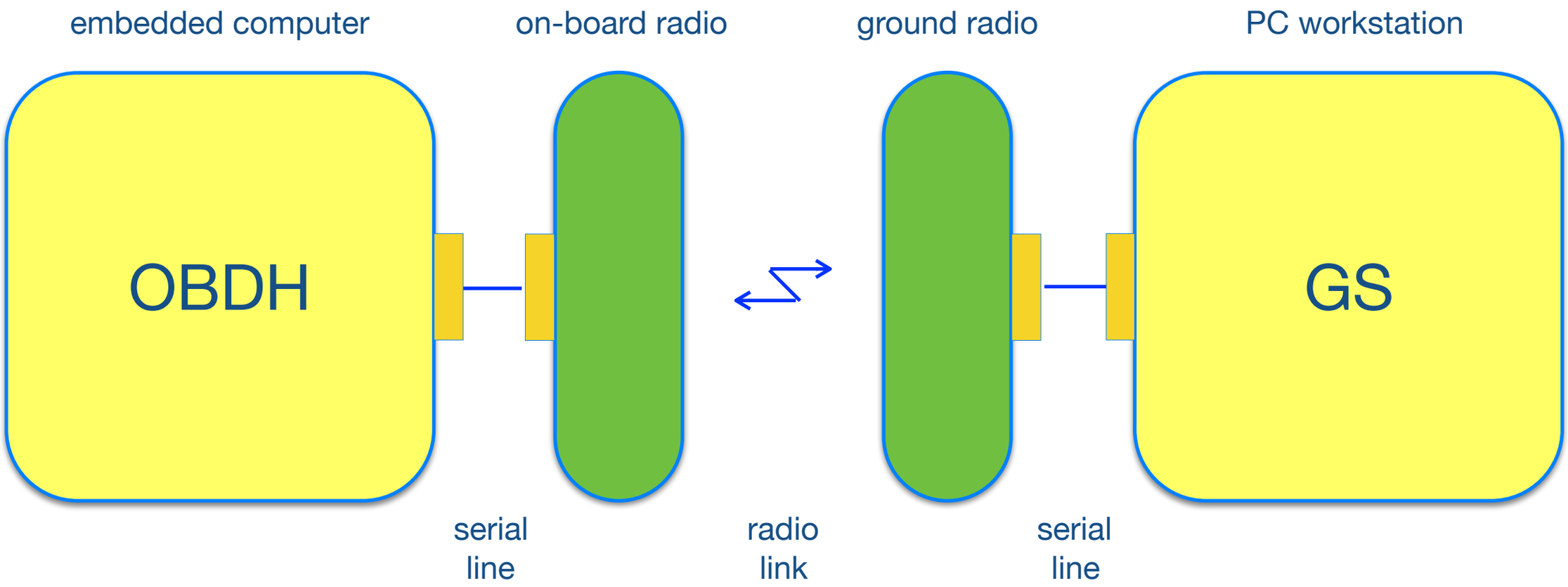
# Detailed design



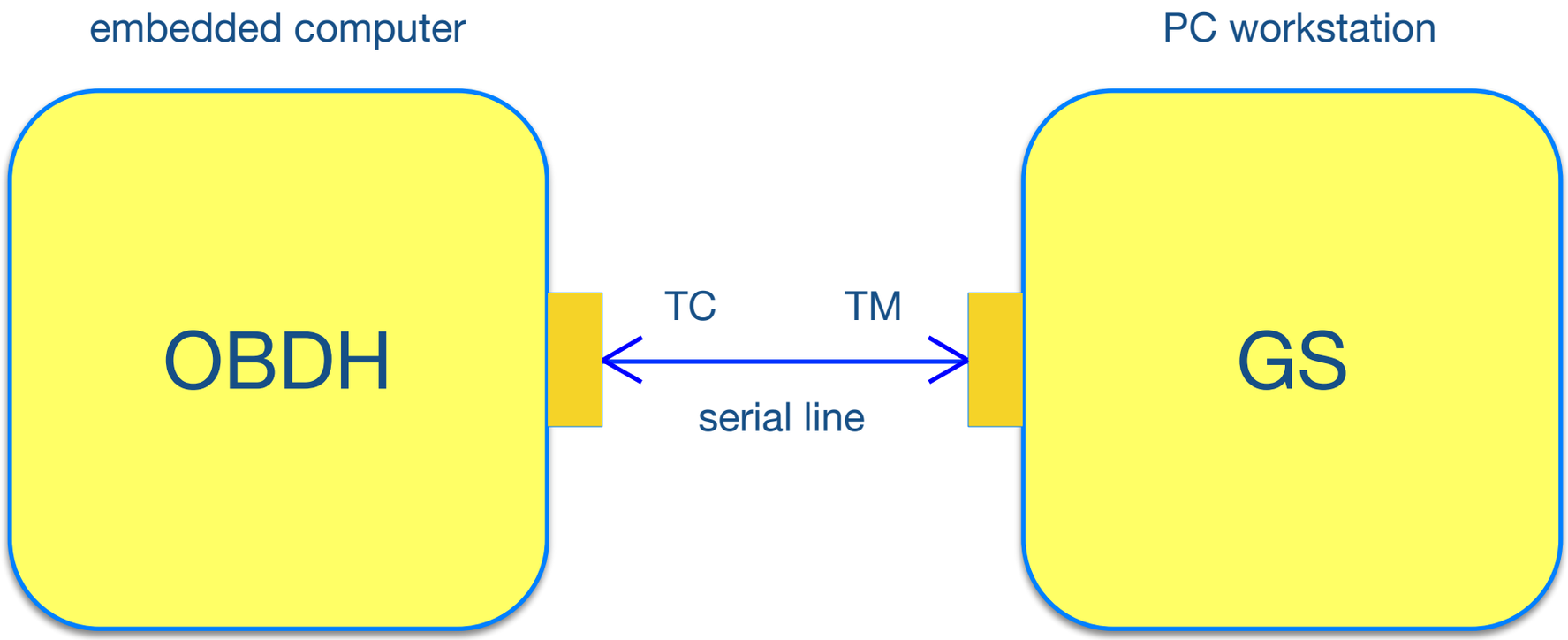
# RT Analysis

| Task | | P | T | C | B | R | D |
|---|---|---|---|---|---|---|---|
| TC | S | 4 | 2,0 | 0,020 | 0,001 | 0,021 | 0,050 |
| 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



# Ground station test arrangement



# Embedded computer

## STM32F4 - discovery


temperature sensor TMP36 (ADC)

pin 1 (violet) -> + 3V
pin2 (orange) -> PA5 (V out)
pin3 (black) -> GND

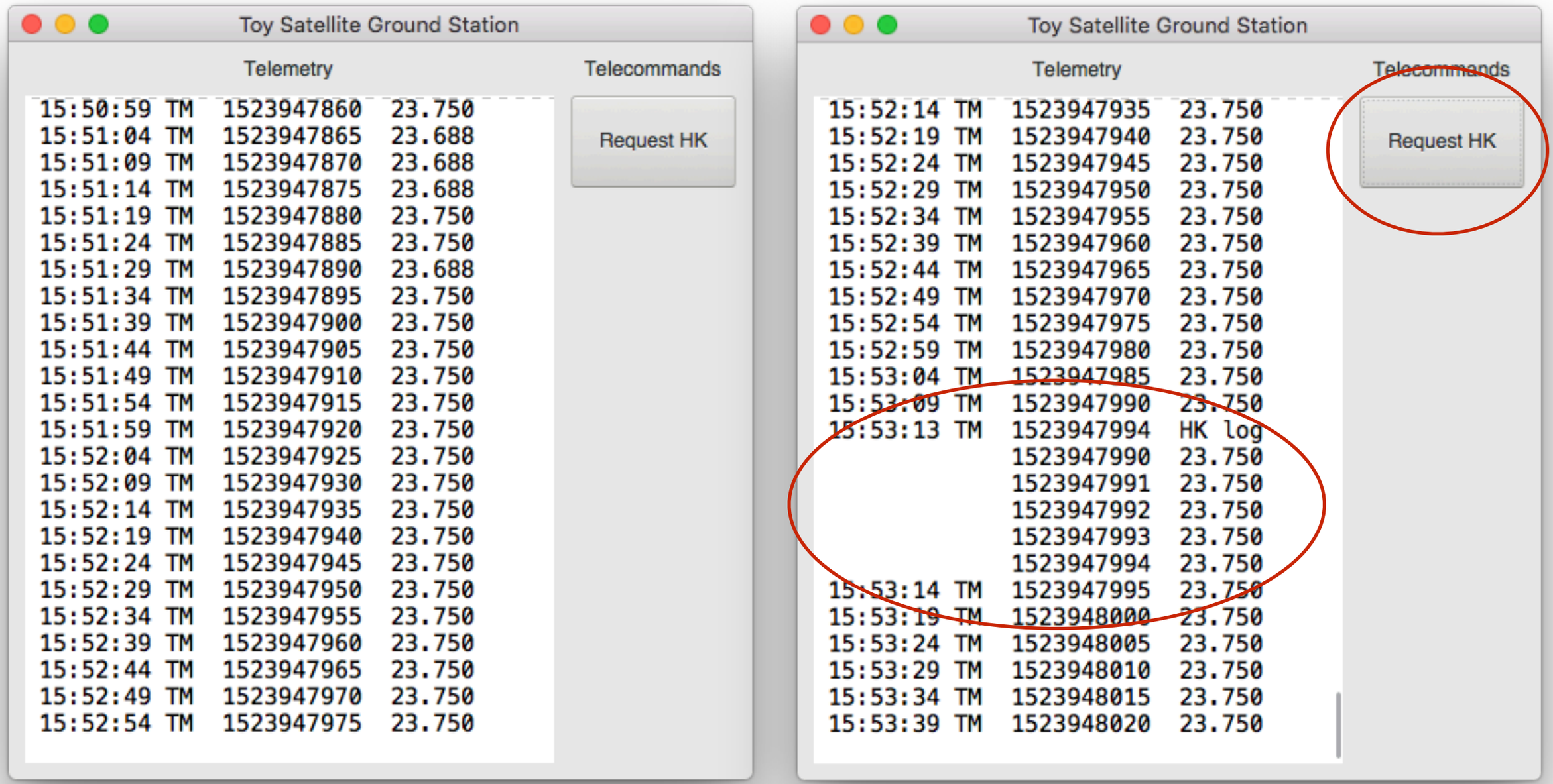

USB serial cable — IEEE 1394
e.g. FTDI TTL-232R-5V

serial port

pin 1 (black) -> GND
pin 4 (orange) -> PB7 RX
pin 5 (yellow) -> PB6 TX

115200 bps 8N1

# Ground station




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 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

- Github repositories
  - https://github.com/STR-UPM
    - ToyOBDH 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