# ADCSS 2019

# High QoS Communication Networks: TSN?

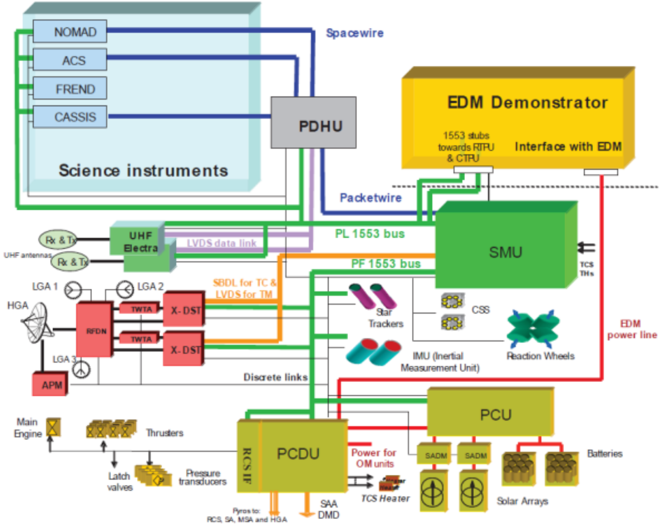
13th of Novembre 2019

# Needs for High QoS Communication Technologies (*ADCSS 2018*)

## Non-functional needs:

- **Cheap, small IP footprint, simple OBSW drivers, low power consumption, standardized, multi-sourcing, large community, easy configuration, FDIR & testability**

## Quality of Service & data rates:




- **Deterministic data deliveries for Command/Control packets: Bounded latency, Acknowledgements of critical data transfer**

- **Flexible data rates & number of connected units**
  - In current missions: <1Mbps & less than 30 connected units
  - In future missions: often the same as for current missions, sometimes improved with 10-100Mbps (STR, future RW, vision-based nav, others); sometimes > 40 units; sometimes very lengthy connexions requiring decentralization

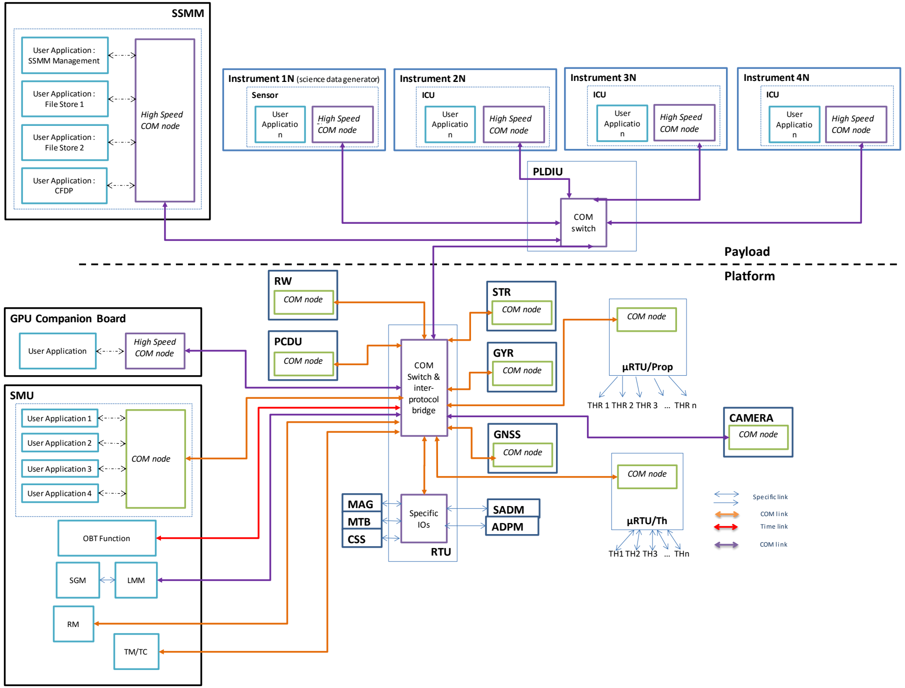
# Needs for High QoS Communication Technologies (*OSRA-NET*)

## OSRA-NET: Performance?

- **OSRA-NET analysed current & near-future needs in communication systems and performed a grouping of need in 7 classes, including Command/Control and payload telemetries**

- **Command/Control is preferably implemented through classes 2 or 6, but can be implemented through point-to-point links using other classes**

| Class | Freq of data exchange scale (Hz) | | QoS | | | Data Rate scale | | Jitter | Latence | Level of determism | | | Timestamp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | 0 | 1 | 2 | Min | Max | ms | ms | None | guaranteed bounded latency | deterministic | Mandatory / Optional |
| 1 | 0,1 | 1 | X | X | | 100 bits/s | 10 kbits/s | 10 | 10 | | X | | Optional |
| 2-a | 4 | 32 | | X | X | | 1 Mbits /s | 5-10 | 10 | | | X | Optional |
| 2-b | 4 | 32 | | X | X | | 1 Mbits /s | 5-10 | 10 | | X | | Mandatory |
| 3 | 8 | 10 | | | X | | 250 kbits /s | 5 | 10 | | | X | Optional |
| 4 | 0,1 | 1 | X | X | | 100 Mbits/s | | up to 100 | up to 100 | X | X | | Optional |
| 5-a | 10 | 1000 | | X | X | | 3 Mbits/s | 0,5 -1 | 0,5 | | | X | Optional |
| 5-b | 10 | 1000 | | X | X | | 3 Mbits/s | 0,5 -1 | 0,5 | | X | | Mandatory |
| 6 | 1 | 10 | | X | X | 100 Mbits/s | | 2 | 10 | | | X | Mandatory |
| 7 | 1 | 10 | X | X | | 100 bits/s | 1 kbits/s | 1 | 2 | | | X | Optional |





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# Focus on Time-Sensitive Network technology

- **Defined through a set of multiple open standards:**
  - *IEEE 802.1AS-Rev Timing and Synchronization for Time-Sensitive Applications – Precision Time Protocol (PTP)*
  - *IEEE 802.1Qbv: scheduled traffic*
  - *IEEE 802.1Qca: path control & reservation*
  - *IEEE 802.1Qcc: central configuration*
  - *IEEE 802.1CB: seamless redundancy*
  - *IEEE 802.1Qci: time-based ingress policing*
  - *IEEE 802.1Qbu & IEEE 802.3br (preemption)*
  - *IEEE 802.1Qch: Cyclic Queuing and Forwarding*
- **Under investigation from many industries: automotive, aeronautics**
- **Leveraging on Ethernet transceivers development for space applications**
- **Testbench units available from many suppliers at relatively cheap prices**
  - NXP, Microchip, Kontron, CISCO, TTTe, NI, Ethercal, Relyum, …

→ *Good opportunities for actual proof testing over representative scenarios !*

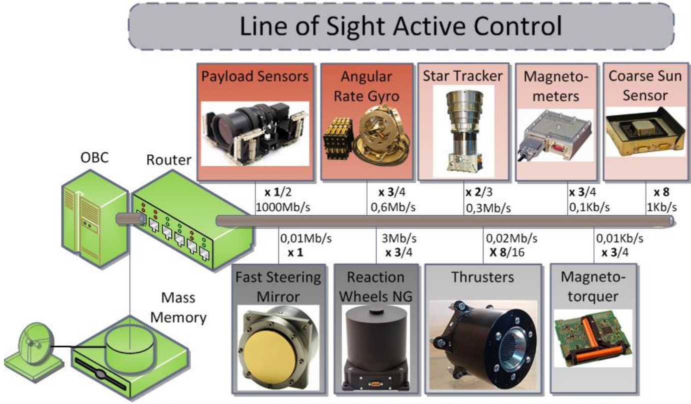
# TSN: test cases

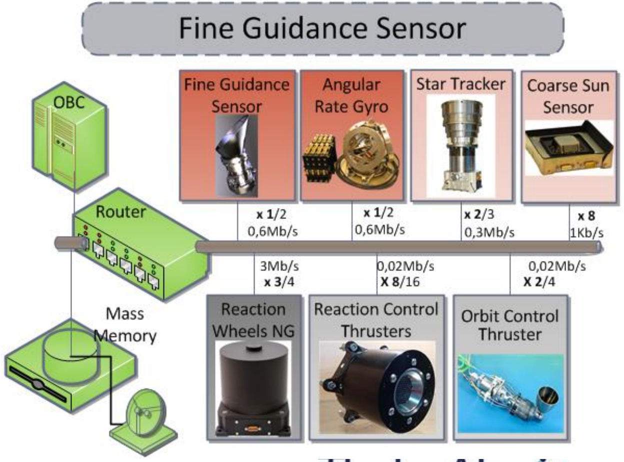
**The use cases target the verification of bandwidth allocation and timing characteristics for mixed-criticality traffic in different configurations, considering:**

- Avionic equipment: On-Board Computer (OBC), Remote Terminal Unit (RTU) for: Guidance, Navigation and Control (GNC), Data Handling and Power Management.
- AOCS Sensors: Global Navigation Satellite System (GNSS), Coarse Sun Sensors (CSS), magnetometer (MGM), momentum wheel (MW), Gyroscope (GYR), Star-Tracker (STR)
- AOCS Actuators: magneto-torque (MGT)/magneto-torque bar (MTB), Reaction Wheel (RW), Reaction Control System (RCS), Solar Array Drive Mechanism (SADM), Antenna Deployment and Pointing Mechanism (ADPM), most of them being centralized through a Remote Terminal Unit (RTU)
- Power Conditioning & Distribution Unit (PCDU)
- Storage like Solid State Mass Memory (SSMM)

**Several points can be raised regarding the payloads:**

- Standard payloads with only command/control interactions with the platform: this use-case require low PF/PL coupling and is not the most suited for testing TSN capabilities
- High accuracy payload units in-the-loop: Cameras, FGS: payloads where are encountered both signals for the active AOCS/GNC loops in high QoS mode and signals for Ground post-processing without realtime constraints

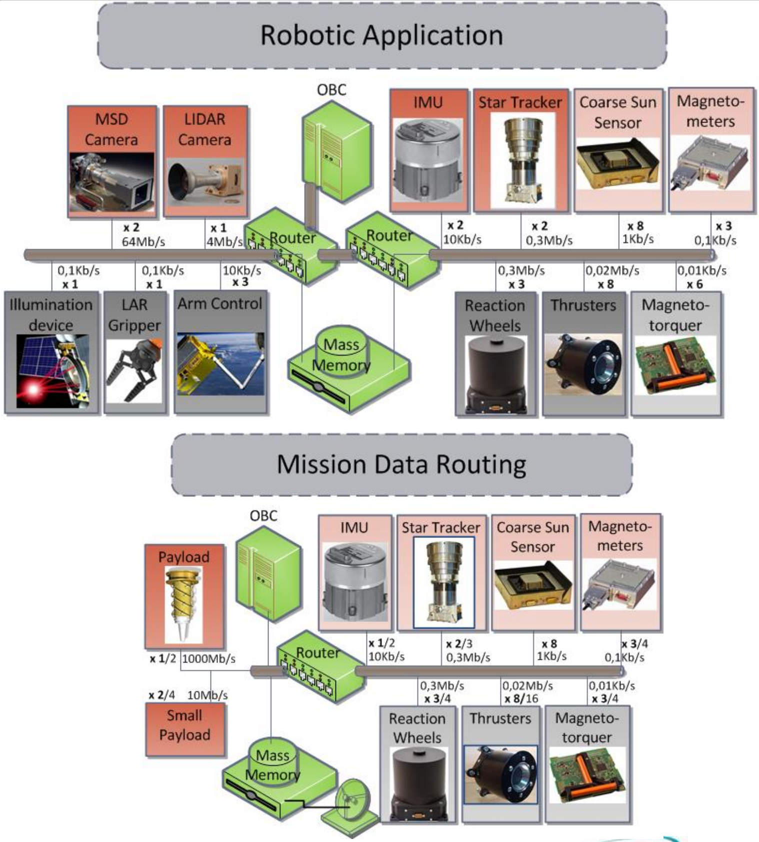


# TSN: test cases (cont'd)

## The minimal configuration to represent those use-cases would be as follows:

- One router for the platform network,
- One router for the payload network,
- One node for the OBC,
- One node for an instrument data generator, potentially up to ~kHz frequency
- One node for an instrument-in-the-loop command & controlling emulation,
- One node for an RTU emulation
- At least one node for AOCS units (at least the Star Tracker with raw data generation at 10Hz)

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# TSN: test targets

## The demonstrators will enable testing:

- *Network latency & jitter*
- *Network synchronisation*
- *Network mixed-criticality response*
- *Deterministic service timing characteristics*
- *QoS management*
- *Configuration & management of modes transitions*
- *Network time stamping*
- *Failre isolation*
- *Failure impact*
- *Configuration change duration*
- *Available health status & monitoring parameters*
- *Effective data rate*
- *Congestion isolation*
- *Packet retransmission*
- …






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# Thanks for your attention

# Questions?