H2020 Space Robotic SRC- OG4

2nd PERASPERA workshop

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Presentation outline

- I3DS general presentation
  - Project description
  - Consortium
  - Activities
- On-going activities
  - Use-case definition
- Interactions with the other OGs
  - Interfaces
- Conclusion

SRC Objective and Context

- The objective: enhance EU industry competitiveness for future robotic missions by preparing key building blocks for operation in space environments

- OG4 mission: realise a suite of perception sensors that will allow localisation and map-making for robotic inspection of orbital assets and for planetary surface exploration

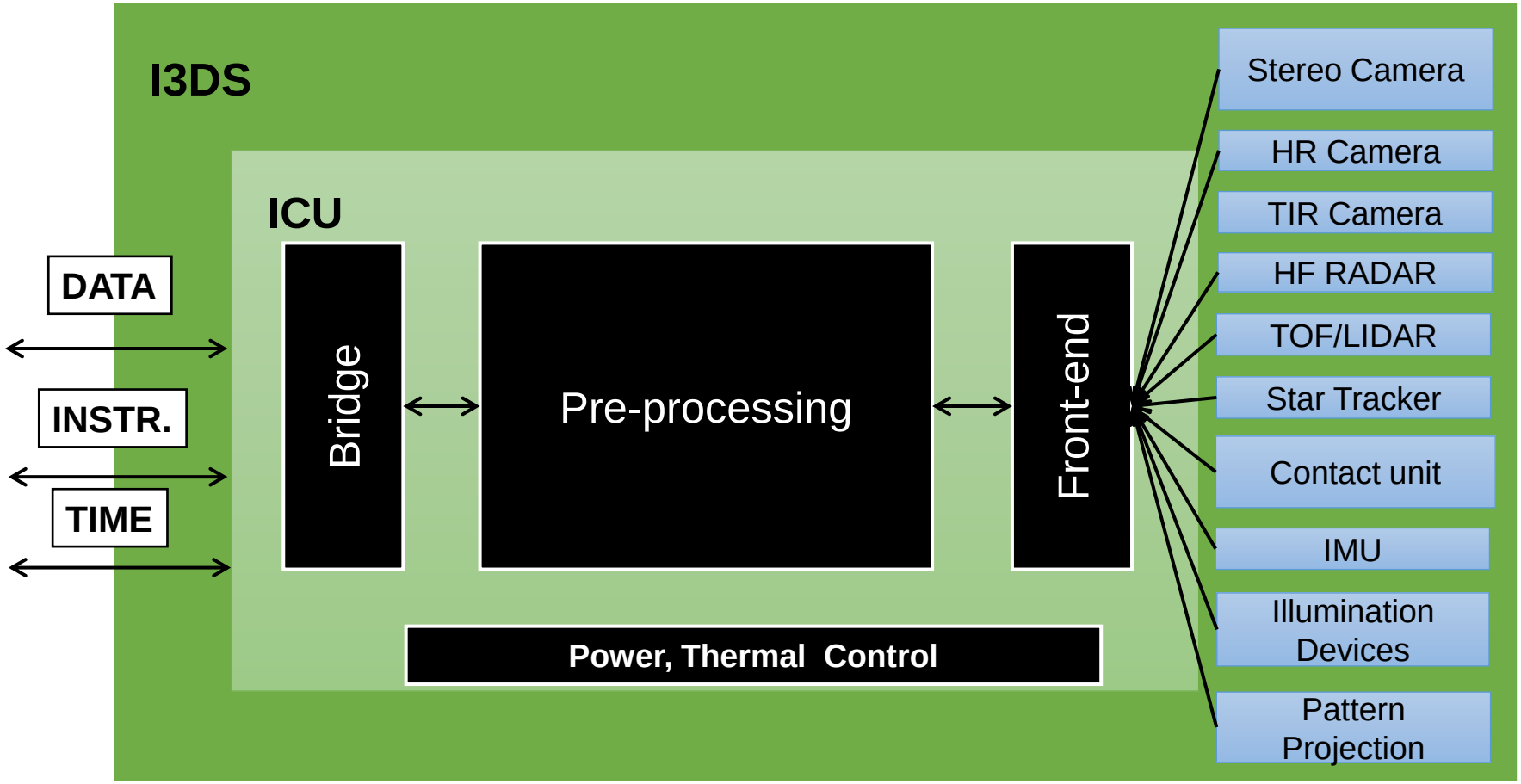
Harmonised and modular suite of sensors with common interface

What is I3DS? « Integrated 3D Sensors Suite »
A smart collection of building blocks

- Set of exteroceptive & proprioceptive sensors organised as modular building blocks
- Design of a generic platform able to implement multiple sensors building blocks
- Modular approach:
  - inter-changeable items
  - scalable design
  - standard I/F vs satellite/rover platform
- Subsets to be defined according to the application:
  - Planetary mission: rover
  - Non-cooperative target capture: debris removal
  - Cooperative rendezvous: servicing, spacetug
- Connected to the satellite platform through an ICU for data concentration & pre-processing

What is inside I3DS?

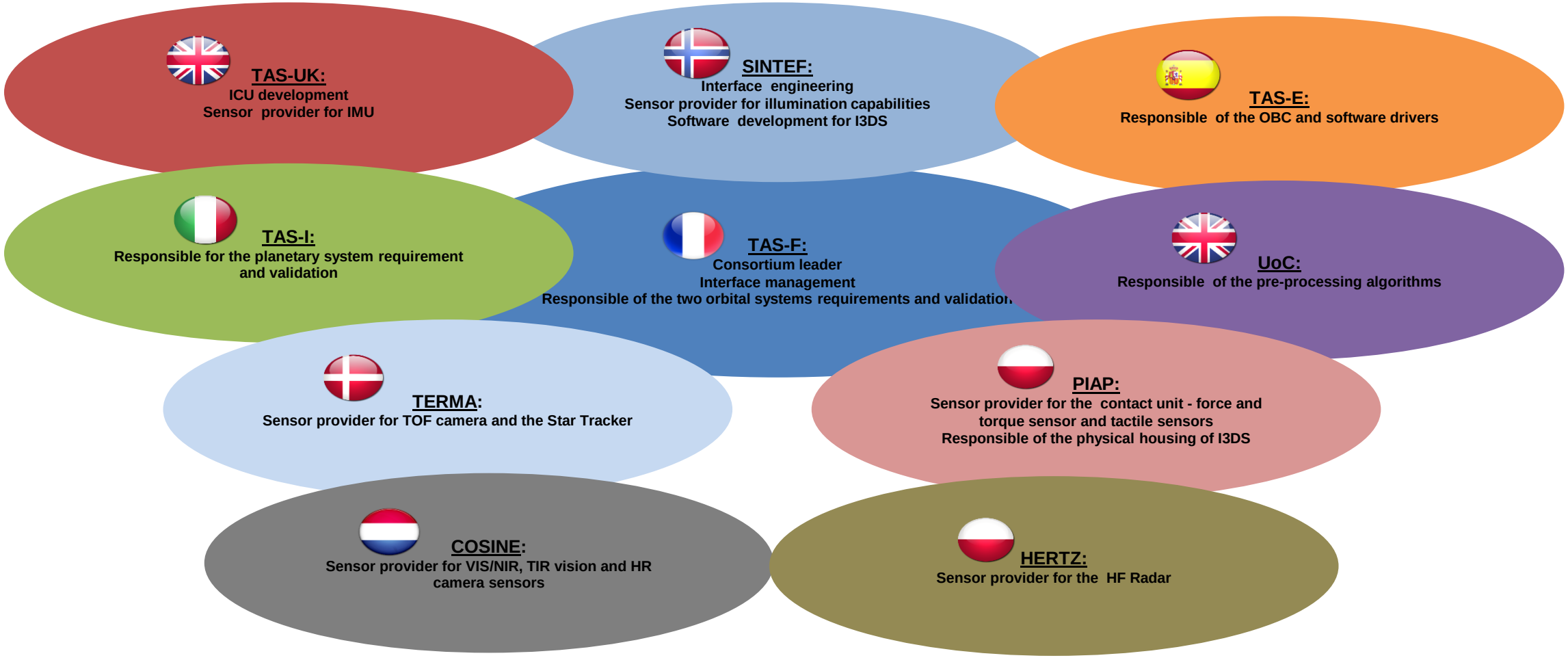
A common set of various sensors



- A stereoscopic camera working in visual & near infrared bands
- A high resolution camera with zoom capabilities
- A thermal infrared micro bolometer camera
- A very high frequency radar
- A laser TOF (Time Of Flight) camera (LIDAR)
- A star-tracker
- A contact unit (with force & torque sensor and tactile sensor)
- An IMU (Inertial Measurement Unit)
- A wide angle and a focused illumination devices
- A pattern projection device

- An ICU (Instrument Control Unit) consisting in a collection of interface boards and pre-processing boards
- A new generation On-Board Computer consisting in a LEON processor upgraded with multiple DSPs, designed for rad-hard applications

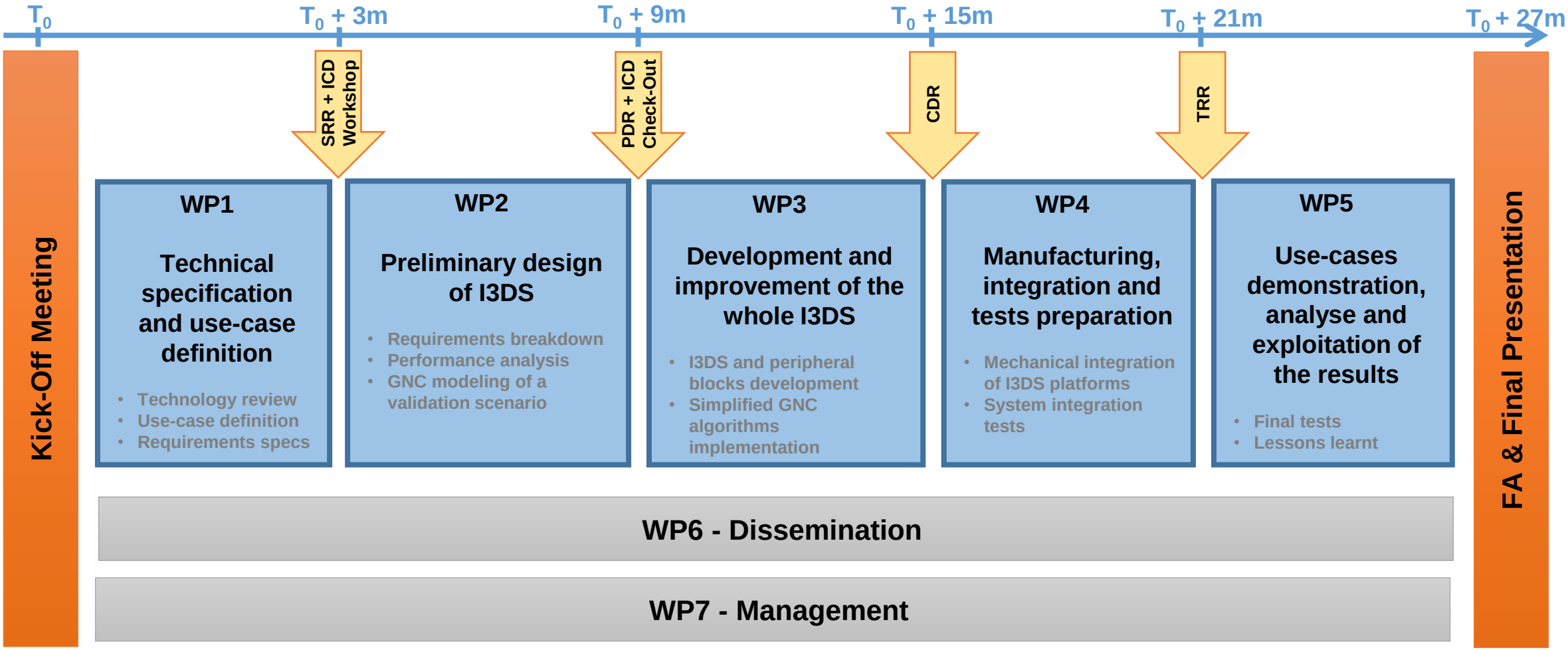
OG4 Consortium



OG4 interface key people

- Project Coordinator (TAS-F): Brice DELLANDREA
- Interface Manager (TAS-F): Sabrina ANDIAPPANE
- Interface Engineer (SINTEF): Kristoffer NYBORG GREGERTSEN

Work packages



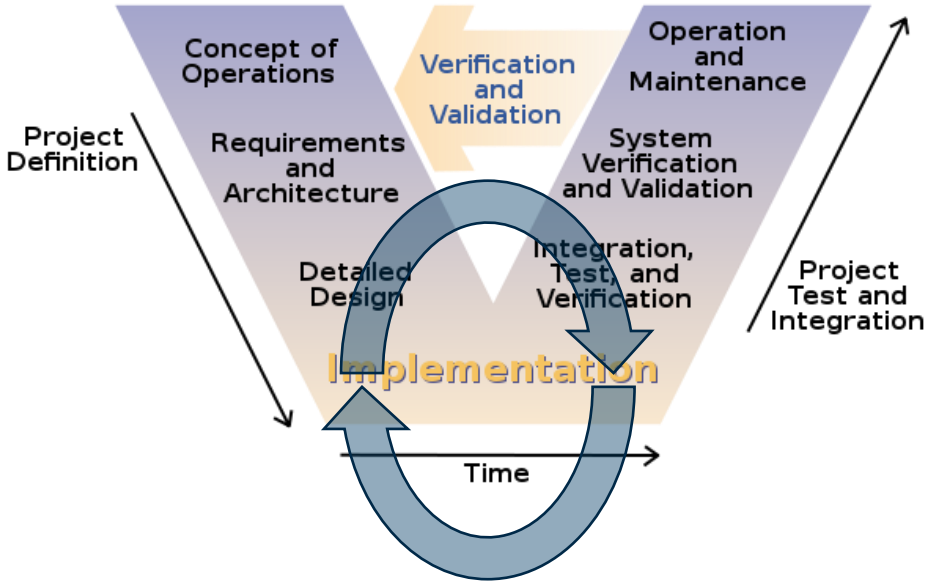
Work logic

To have a top down approach for design:

- System requirements
- Functional requirements
- Sensors requirements

To have a bottom up approach for validation

- Test each sensor individually
- Test at system level for one selected scenario to validate the coherence of the sensor suite



Use-case definition

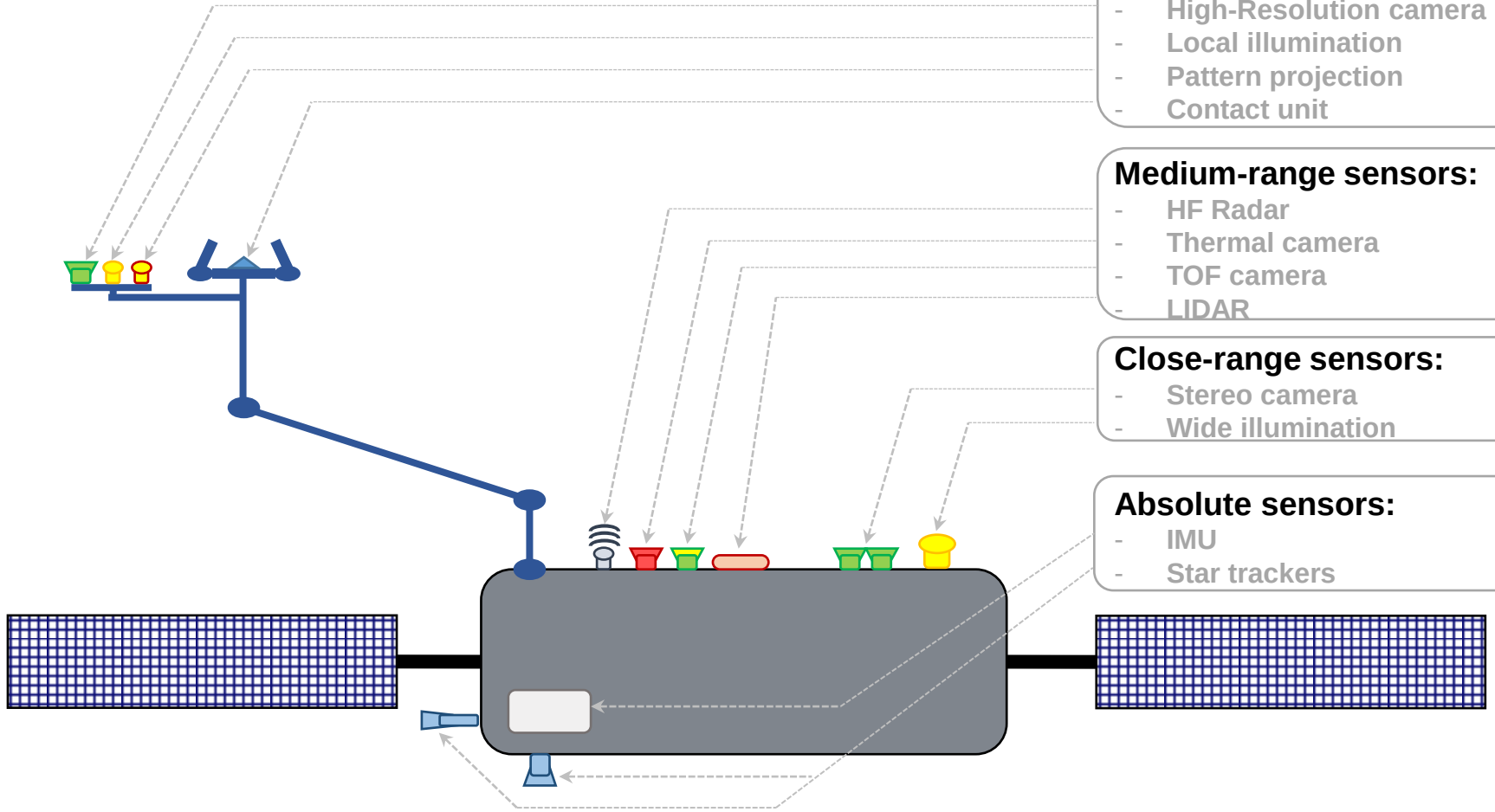
- Answer to two main scenarios:
  - Orbital robotics applications
  - Planetary robotics applications
- Analyse of the potential use-case for space
- In parallel of this activity: the technology review by sensors

Orbital Use-Case – General mission steps

Close-range Rendezvous and Capture

- Phasing: reach a lower orbit to catch up the target
  ground control
- **Far-range Approach:** reach a fly-by position to have the target in the FoV
  absolute navigation
- **Medium-range Approach:** reach a safe position close to the target (<100m)
  relative navigation
- **Inspection:** near-circular trajectory around the target for inspection and estimation
  observation
- **Close-range Approach:** relative motion toward the target along the capture axis
  high precision relative navigation
- **Capture:** grasping and docking with the target
  robotic arm motion

Orbital Use-Case – General sensors configuration



Capture sensors:
- High-Resolution camera
- Local illumination
- Pattern projection
- Contact unit

Medium-range sensors:
- HF Radar
- Thermal camera
- TOF camera
- LIDAR

Close-range sensors:
- Stereo camera
- Wide illumination

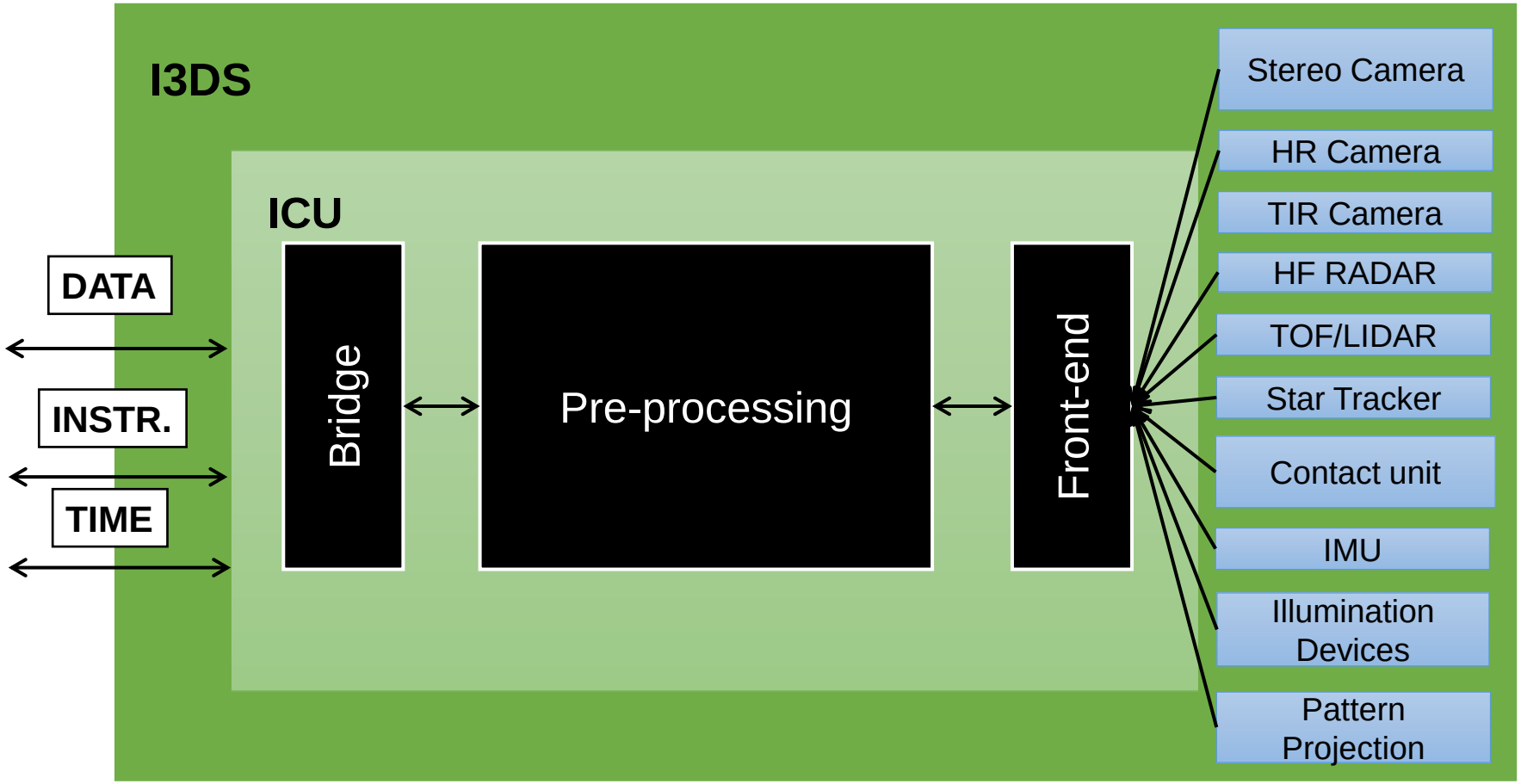
Absolute sensors:
- IMU
- Star trackers

Orbital Use-Case – Different validation scenarios/sub-cases

- Validation scenarios including a servicer spacecraft
  - Cooperative rendezvous and capture
    - On-orbit servicing
      - Module replacement
      - Refueling
      - Life extension module
    - Structure assembly
      - Space station
      - Interplanetary vehicle
    - De-orbitation of end-of-life satellite
  - Non-cooperative rendezvous and capture
    - Space debris
      - Drifting satellite/launcher stage
      - Medium and small debris
    - Celestial bodies
      - Asteroid
      - Comet
      - Planet

Each scenario requires a different set of sensors among the I3DS suite !

I3DS for orbital use-case



- A stereoscopic camera for visual recognition
- A high resolution camera when up close
- A thermal infrared camera for shape recognition
- A very high frequency radar for relative distance measurement
- A laser TOF (Time Of Flight) camera for relative distance measurement
- A star-tracker
- A contact unit for docking or capture
- An IMU
- A wide angle illumination device
- A pattern projection device for debris

Planetary use-case – two main scenarios

Exploration on Mars

≠ Illumination conditions

Exploration on Moon South Pole

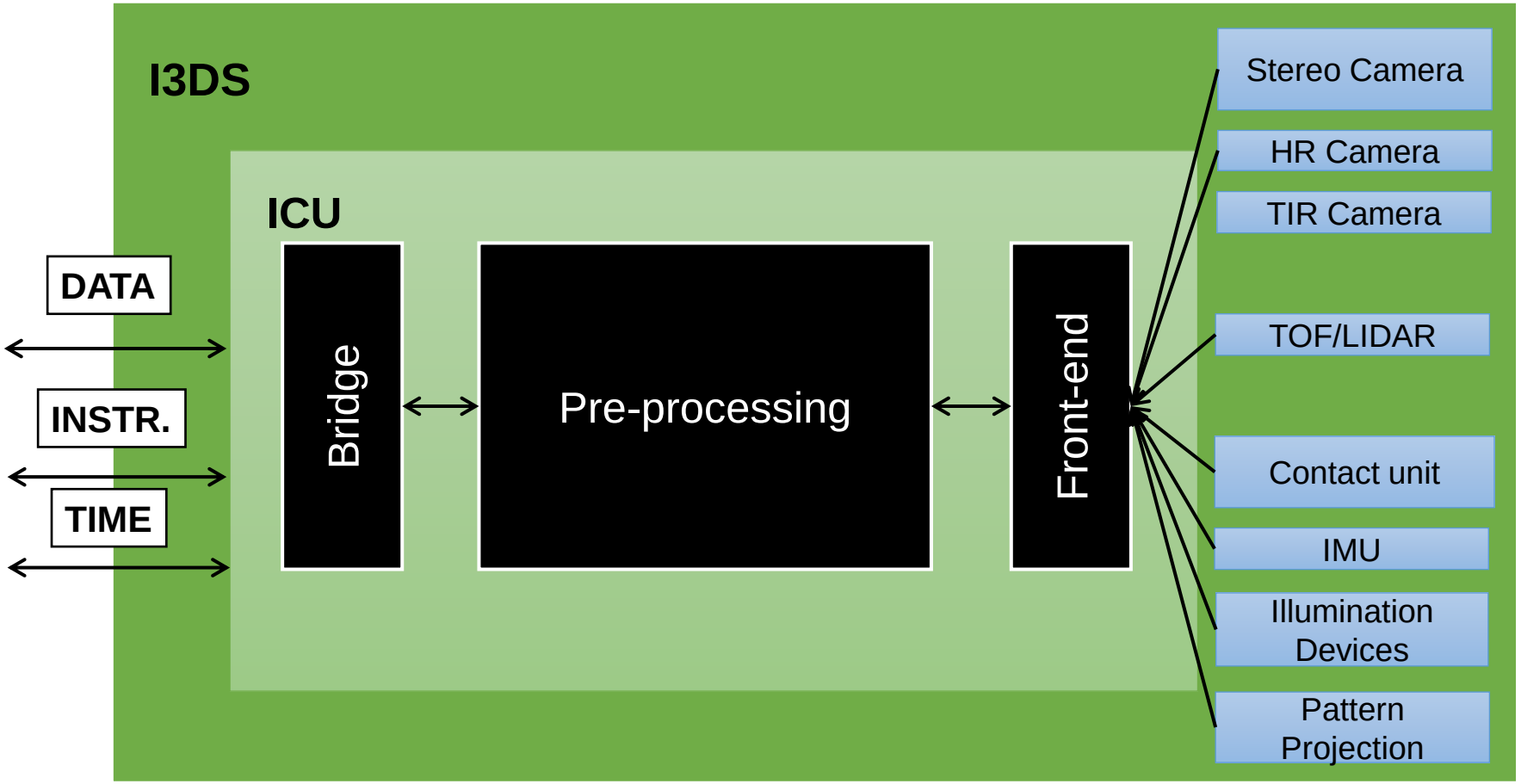
Planetary Use-Case – General missions steps

❑ Different phases of the mission have been identified with functions assessment with the constraints and sensors identifications

❖ Rendezvous with other planetary asset/s	➢ Localisation w.r.t. planetary asset	❑ Accurate estimation ❑ Robustness to loss of sight	✓ Stereo Camera ✓ ToF ✓ Lidar
❖ Sample / Canister Transfer *(i.e. from ground to rover, from rover to lander)* or Interfaces Mating	➢ Fine arm positioning	❑ Precision, accuracy	✓ Stereo Camera on robotic arm ✓ Short Range ToF ✓ F/T Sensor
❖ Autonomous science while traversing	➢ Imagery and video acquisition while traversing ➢ Relative localisation	❑ Relative localisation precision and accuracy	✓ Stereo Camera ✓ NIR Camera ✓ TIR Camera ✓ HR Camera ✓ Pattern projector ✓ ToF

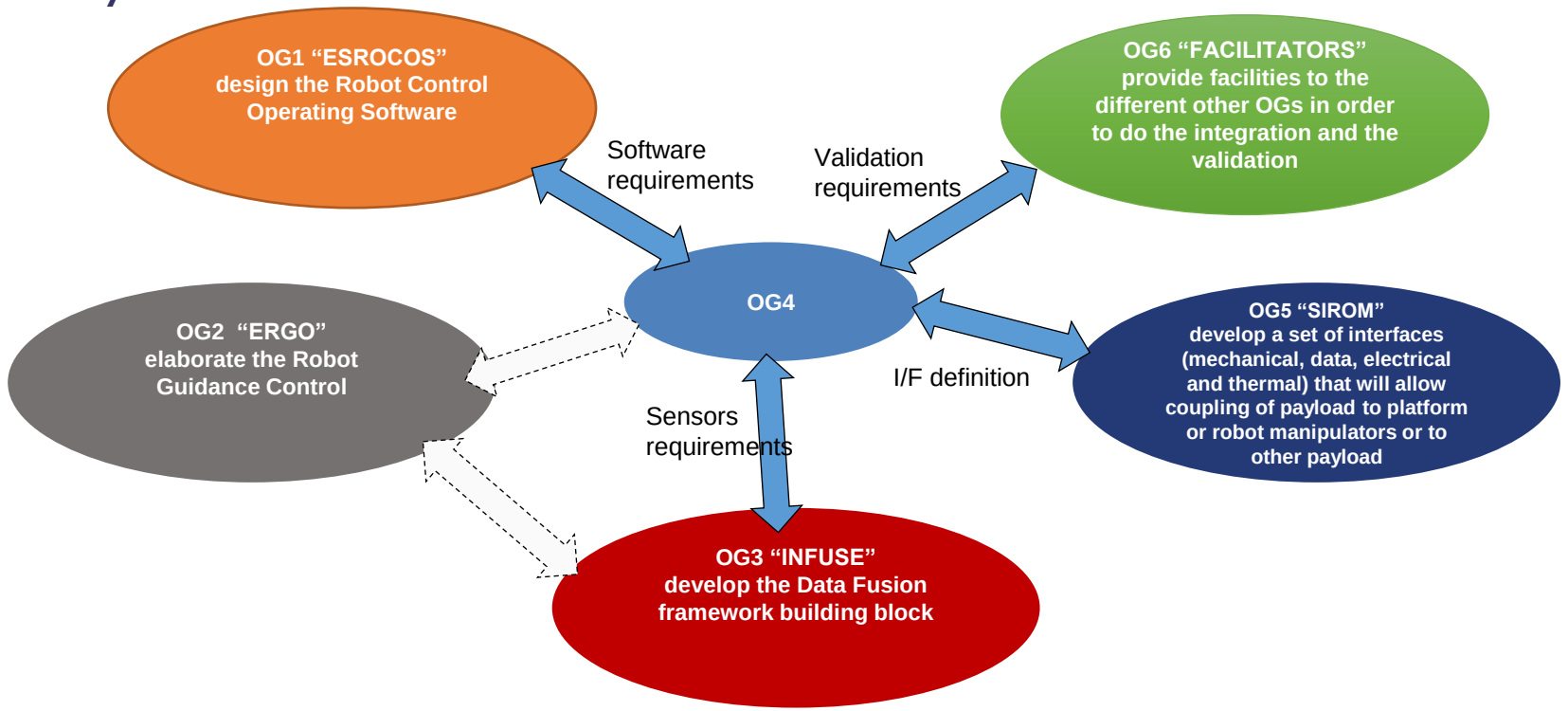
* Not the exhaustive list only a few examples

I3DS for planetary use-case



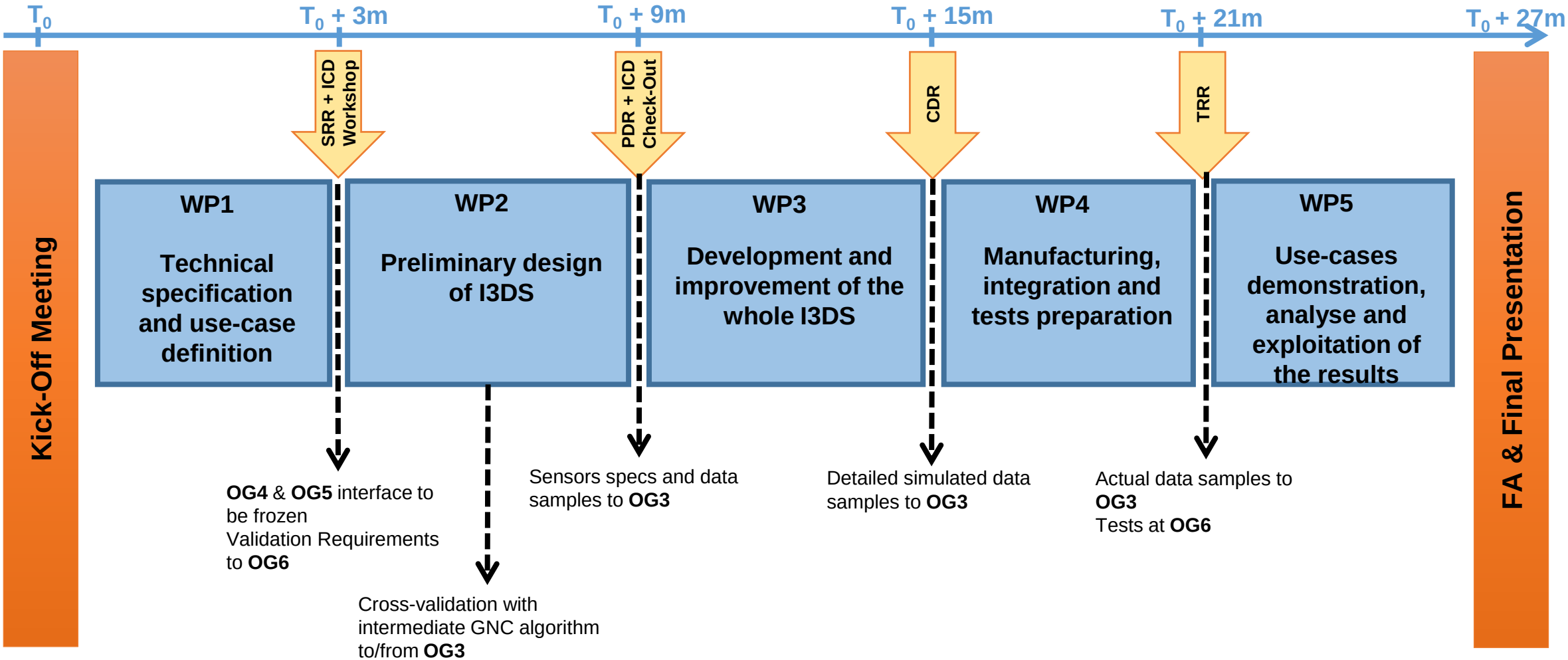
I3DS = Operational Grant n°4

- Operational Grant 4 among 6 other OGs in the frame of H2020 Strategic Research Cluster on Space Robotics Technologies
  - Each OG deals with different aspects of a robot systems
  - Each OG has a defined scope and set of deliverables
  - Each OG is part of an overall system



No integration of all the OGs foreseen at the end of this H2020 but all interfacing shall be planned ahead

Work packages interactions



Conclusion

- Excellent opportunity for high-scale system integration and roadmap convergence between prime & suppliers given by this H2020
- Unique opportunity to have so many entities working together towards a same goal

Thank you !