SURPRISE

SUPER-RESOLVED COMPRESSIVE INSTRUMENT IN THE VISIBLE AND MEDIUM INFRARED FOR EARTH OBSERVATION APPLICATIONS

Summary of Deliverable “Earth observation application analysis, roadmap analysis and user requirements” [D2.1]

Nicolas Lamquin, ACRI-ST

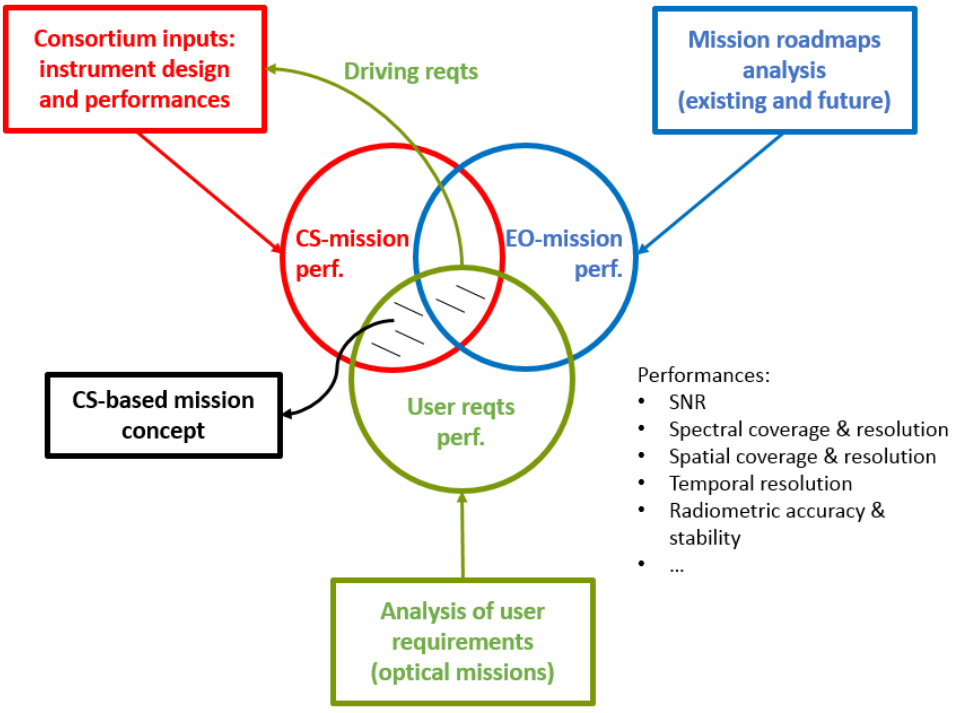
1. Summary of Deliverable content

Based on preliminary design and performance indicators of the SURPRISE sensing system, D2.1 determines applicable Earth Observation (EO) mission concepts and proposes system performances where most efforts should be directed throughout the project and beyond.

The figure below sketches the relationships between the inputs and outputs of the study. Performance indicators (red box) first provide estimations of the expected performances of the SURPRISE concept and constrain the domain of remote sensing applications that can be addressed. In turn, user requirements associated to these domains (green box) constrain the performances that must be achieved to address the user's needs.

A comprehensive roadmaps analysis (blue box) of competitive remote sensing systems (current, planned, and investigated missions from national and international agencies as well as commercial entities) is carried out to spot where SURPRISE could fill requirements that are and/or will not be covered by other missions (e.g. high temporal revisit associated to high spatial resolution), or at least increase performance of such missions (e.g. smaller data volume, better timeliness etc.).

In such a user-driven approach, the intersection between user performance requirements, roadmaps analysis performances, and SURPRISE system performance, pinpoints where to extract a mission concept (black box) and/or drive the investigations to be made for the improvement of the system performance (e.g. higher SNR, better spectral coverage etc.).



2. Main Innovations / New knowledge

In this study, we evaluate the most pertinent EO applications for the SURPRISE sensor/payload concept, which is set to be launched on a Geostationary orbit (GEO). First, we recap the relevant performance indicators for EO passive optical sensors and the SURPRISE concept: spectral, spatial, and temporal coverage and resolution as well as SNR. Applicable user requirements are extracted from the exhaustive Nextspace compendium and consolidated for targeted EO applications: (i) ocean colour monitoring, (ii) land/vegetation monitoring, (iii) active fires monitoring, (iv) clouds and aerosols monitoring. Analyses of miscellaneous requirements provide further potential interest for (v) lunar calibration and (vi) emergency monitoring.

A review of state-of-the-art passive optical sensors, both for LEO and GEO platforms is undertaken to accentuate the reference missions and concept studies that set the bar to which the SURPRISE (GEO) concept is to be held in terms of offering a competitive advantage. It is clear that different prime targets result in different trade-offs in terms of the key performance indicators, and no single mission/sensor is optimal for all of the discussed applications.

Comparing user requirements, EO-mission performances and SURPRISE performances allow us to perform a gap analysis revealing where SURPRISE can provide technology breakthroughs.

We summarise below the feasibility of preliminary concepts addressing each considered thematic separately. Relative technical feasibility expresses how the system design allows (or shall allow) to achieve requirements. Relative data volume workload expresses the amount of computational effort, assumed to be roughly proportional to the data volume that must be generated.

Competing concepts then propose some of the most relevant competitors for SURPRISE restricted to Europe: either launched, planned, or (in parenthesis) investigated through early development phases or with unknown status.

Lastly, potential improvement from SURPRISE expresses the benefit that the SURPRISE concept shall bring to the considered thematic. “+” to “++++” indicates the increasing capacity to address the item.

Concept / target	**Relative technical feasibility**	**Relative data volume workload**	**Competing concepts applying to Europe**	**Potential improvement from SURPRISE**
GEO-Colour (ocean)	+++	+++	(GEOCAPI), (Geo-OCULUS)	High (revisit)
GEO-Veg	++++	+++	Sentinel-2 MSI, Sentinel-3 OLCI, PlanetScope	High (revisit)

(vegetation)				
GEO-Fire **(active fires)**	+++	++	MTG-FCI, (Geo-OCULUS)	High (spatial)
GEO-Met **(clouds and aerosols)**	+++	+	MTG-FCI	High (spatial)
LEO-Moon **(Moon)**	++	++++	CLARREO, ARCSTONE, TRUTH	Low (but high benefit for SURPRISE)
GEOn-demand	+ +++ (no PAN) ++++ (no PAN, no MIR)	++++	All above, except those for LEO-Moon	High (revisit, spatial)

SURPRISE can indeed bring benefits to each of the proposed GEO concepts/acquisitions, where its strengths lie primarily in imaging at medium and somehow flexible spatial resolutions and achieving high SNRs. Flexibility in spatial resolution has to be addressed according to acquisition vs image reconstruction capacities. Depending on the final setting (chosen EO targets), this can be the most important asset.

For the project, we conclude on the versatility of the preliminary concept, however with potential ways of improving each specific target. Further iterations will be necessary throughout the project either to consolidate or to invalidate each option. Operational concepts being prioritised against exploratory concepts for GEO payloads, we will also have to consider the necessity to handle/support operational requirements. Integration times and acquisition strategies (Local Area vs. Full Disk) as well as SNR/GSD goals need to be consolidated and/or strengthened.

For the future, more in-depth mission analyses are also needed. Critical points not yet addressed in this early-phase study are instrument characteristics, such as size, mass, and power consumption, which strongly drive the overall mission cost, a non-negligible selection criterion. Since GEO platforms are generally more expensive, it would indeed be much beneficiary to show that the SURPRISE concept provides large benefits for costs, even from preliminary figures.

More investigations will be drawn over the duration of the project for reporting in the D2.2 deliverable “Impact on application products and synergy”.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870390.