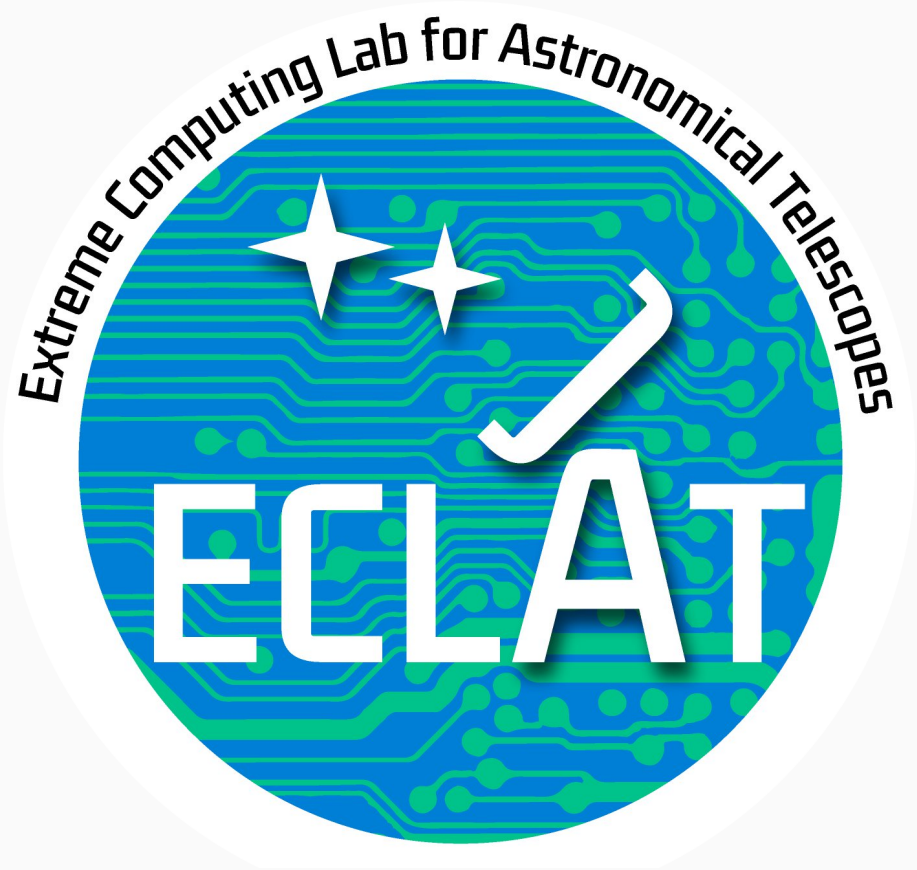
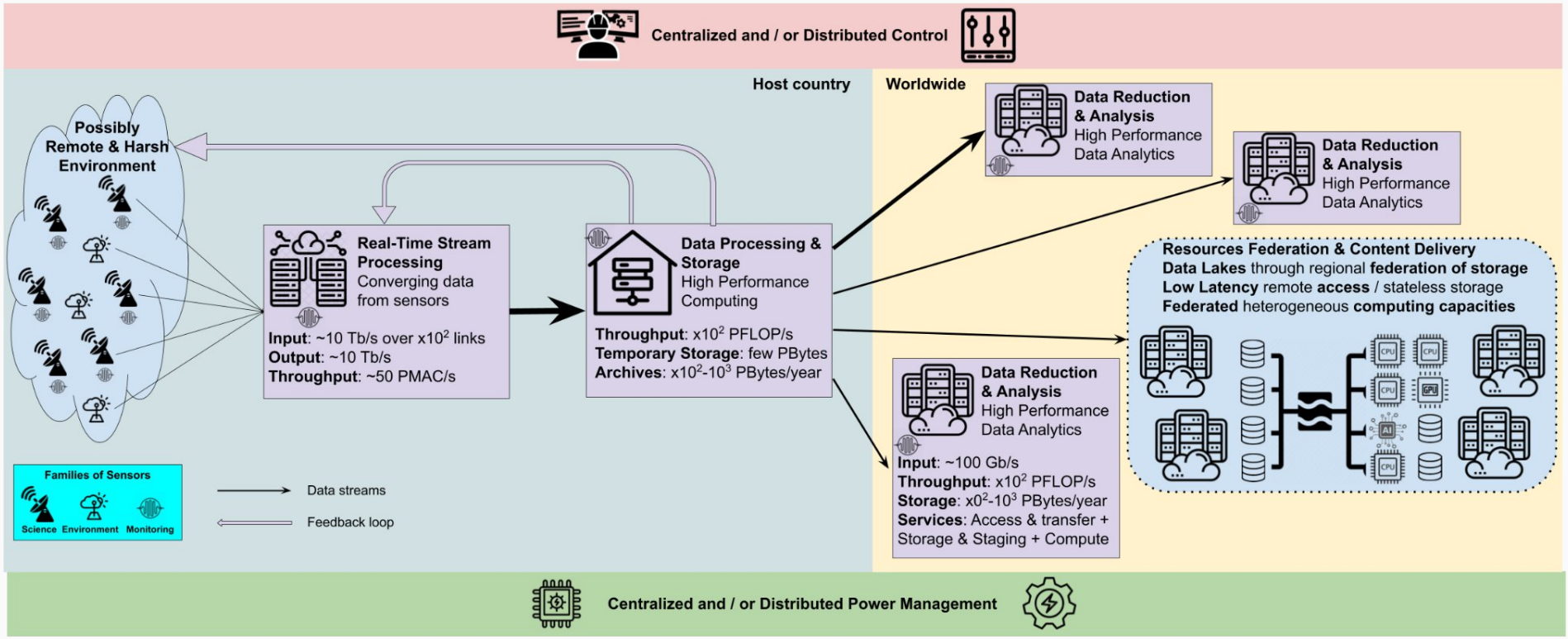


Laboratoire Commun CNRS - Atos - INRIA

SKA computing challenges

Hierarchical architecture: system of systems

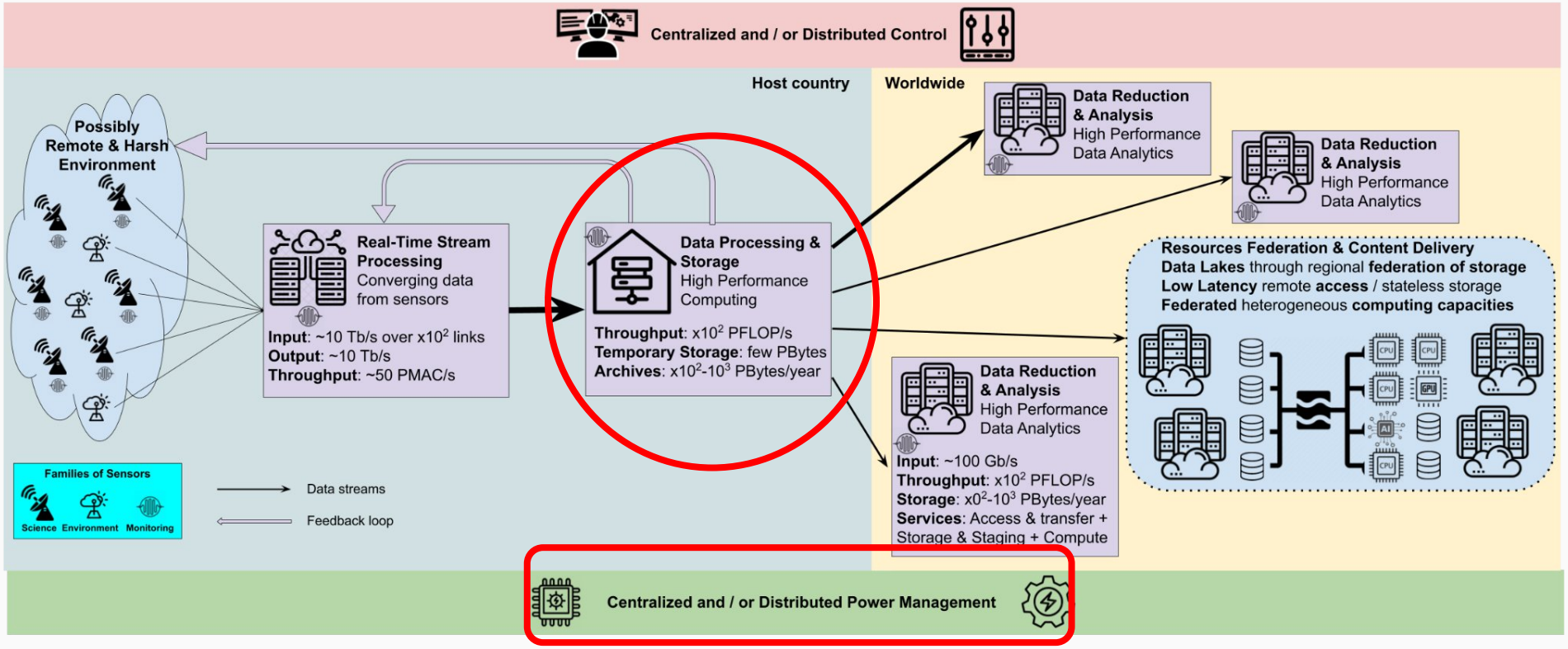
From large amount of distributed & heterogeneous sensors to distributed network of national processing facilities for content delivery to the users



SKA computing challenges

Contribution on Science Data Processor is a core task for France

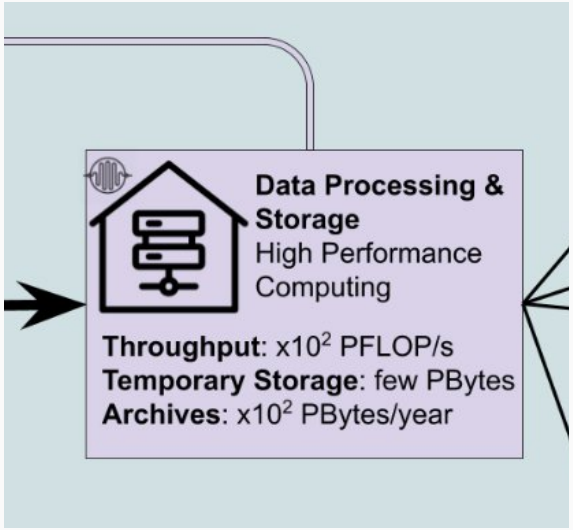
- State-of-the-art datacenter for processing, storage and distribution
- Deeply embedded in the continuum
- Focus on Energy Efficiency & Power Management



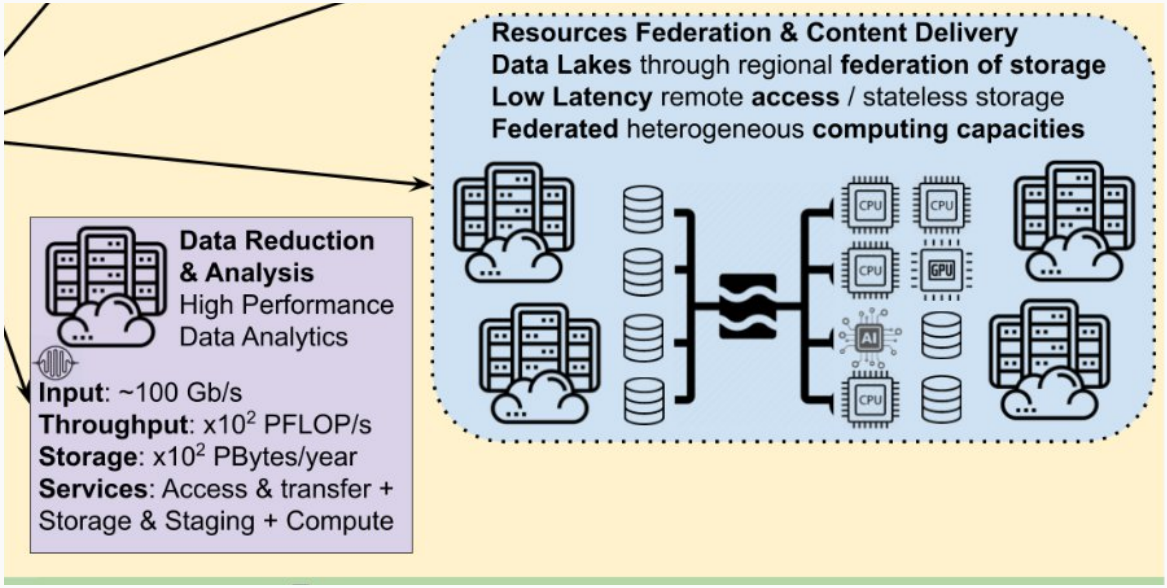
SKA computing challenges

Existing synergies with Regional Centers

- Heterogeneous high performance computing & data distribution



- Resources federation (compute / storage)
- Portability
- Distributed Learning for AI

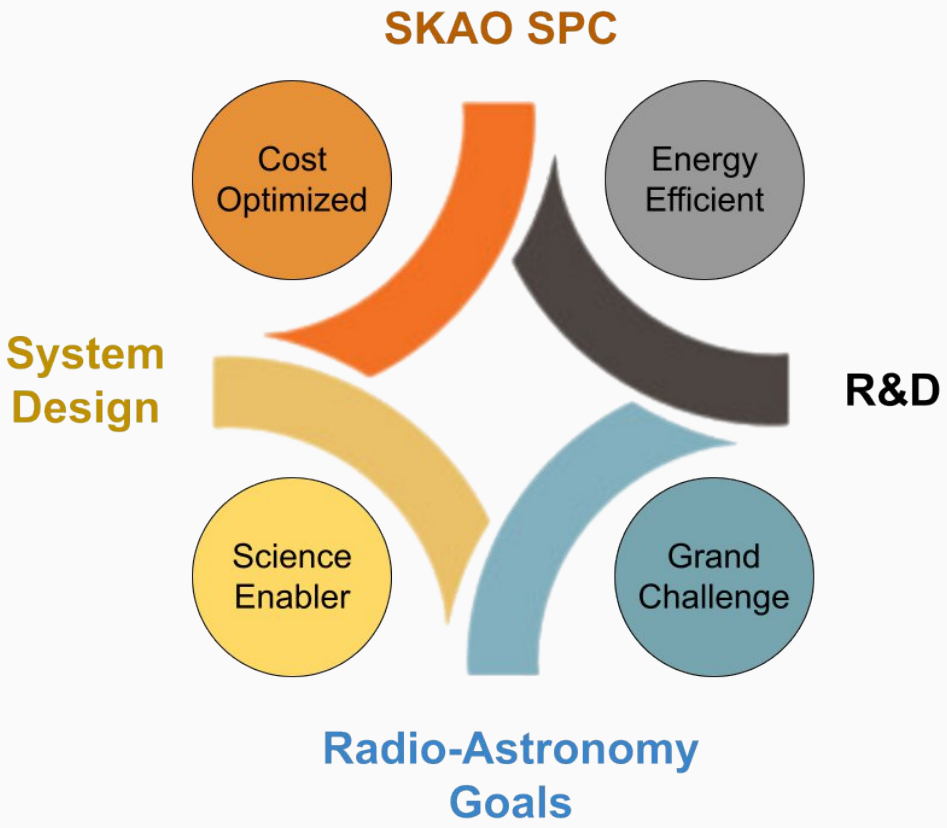


- Energy Efficiency
- Cost Containment
- Heterogeneity / Portability

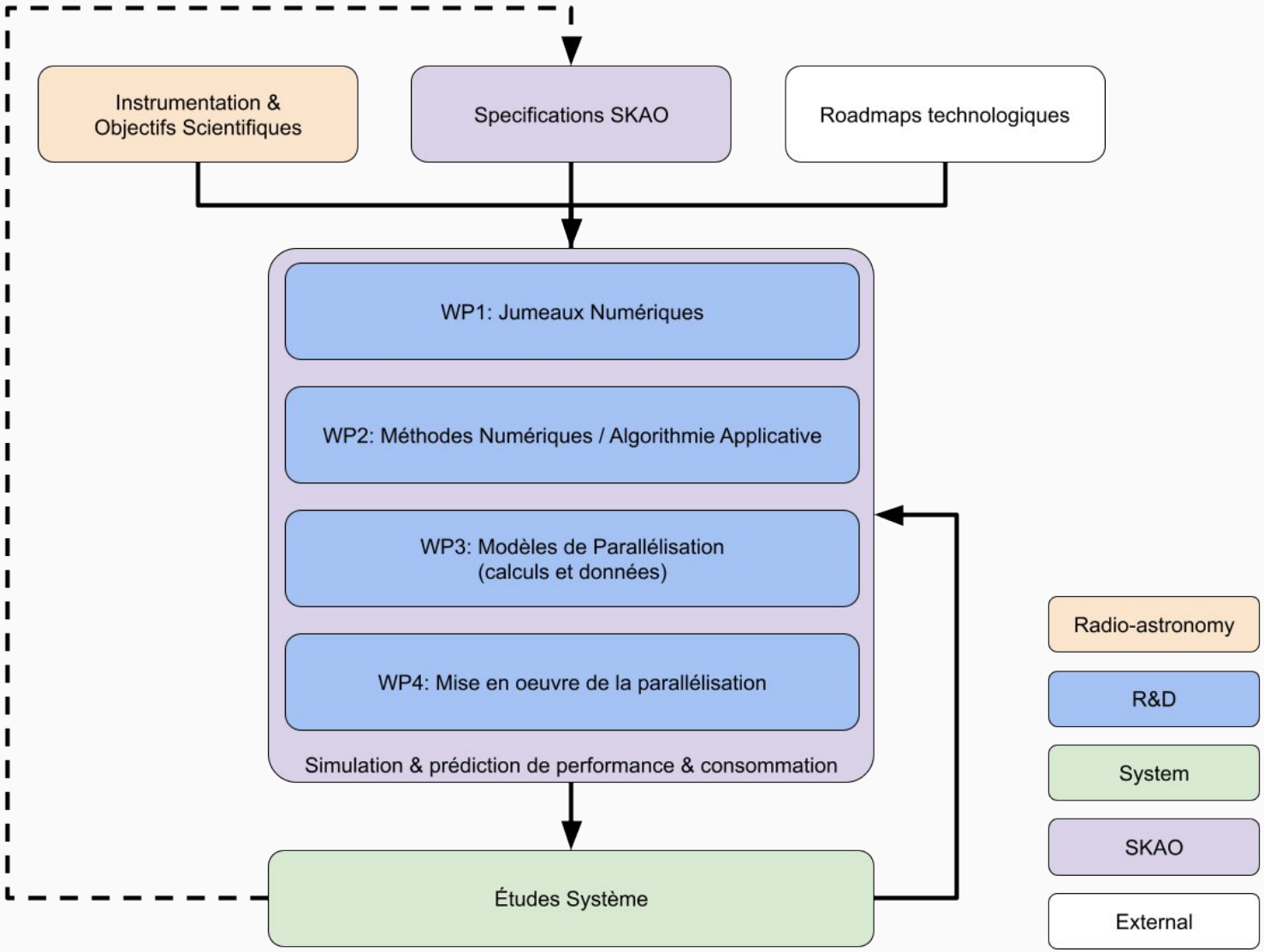
Co-Design SKA Science Processing Centers

Provide solutions for an extremely challenging sub-system under cost and energy efficiency constraints

- **4 main topics**
  - Radio-Astronomy goals
  - System Design
  - R&D
  - SKAO SPC
- **4 main drivers**
  - HPC Grand Challenges
  - Science Enabler
  - Cost Optimization
  - Energy Efficiency



Proposed Implementation



R&D Activities

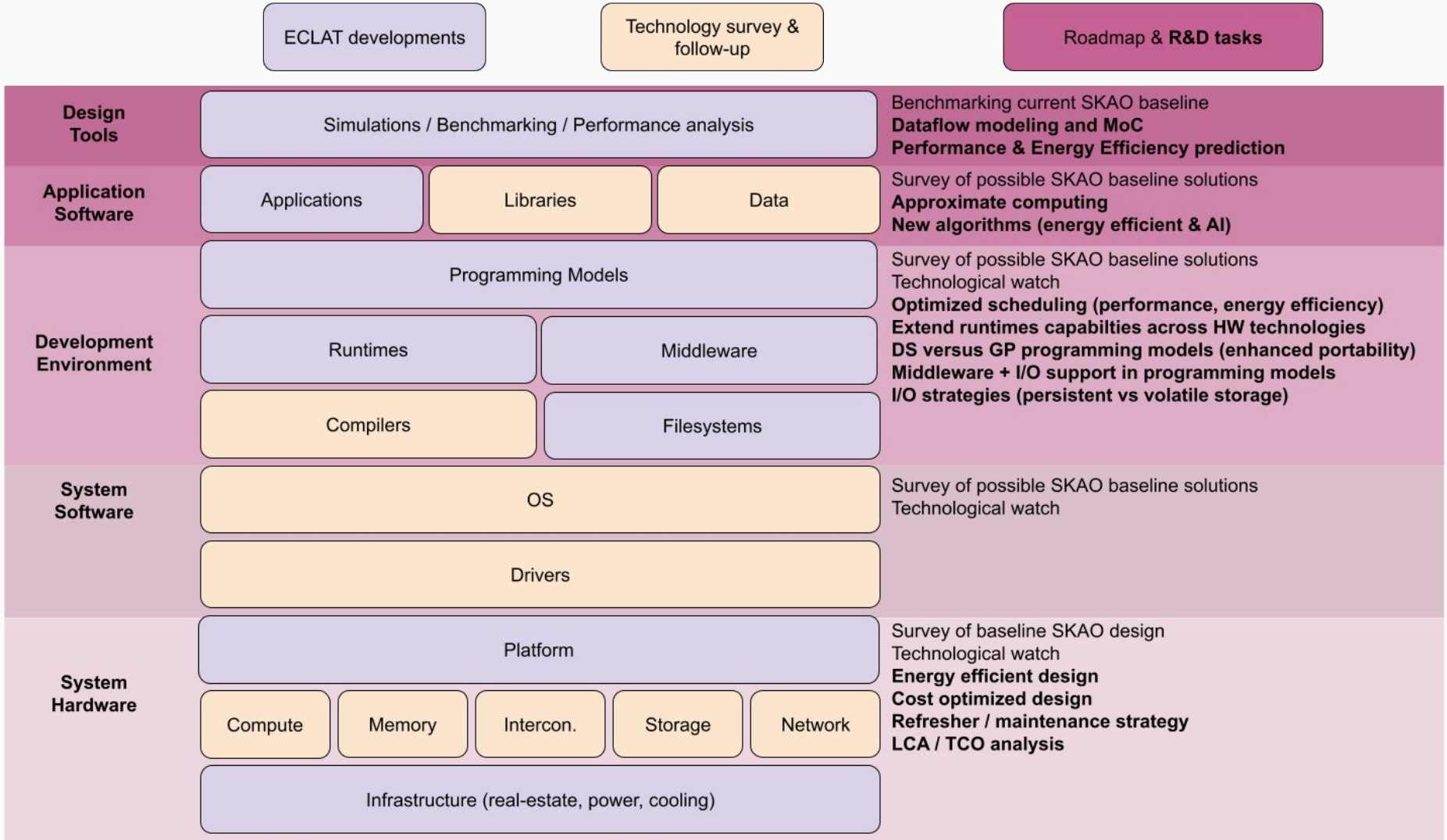
2 transversal topics

- **Artificial Intelligence**
  - New hardware solutions (wide spectrum from “specialized cores” to FPGA)
  - New algorithms (trustworthy AI, energy efficient AI)
  - Energy management of the whole infrastructure to minimize carbon footprint
  - Real-time performance
- **Green Computing**
  - Holistic view: from optimization at the node level to efficient distribution (data, workload) to a global view at the level of the whole infrastructure
  - Adapt power consumption dynamically depending on operating scenario
  - Use models of computing at the core of this strategy

5 main axes of development:

- System architecture
- I/O & interconnect
- Storage management
- Emerging compute technologies
- New algorithms & AI

R&D Activities



Contribute to SKAO SPC roadmap

Incorporate effort in current roadmap

- Benchmarking activities related to current baseline
- Rely on existing hardware / middleware / software solution
- Work on portability using various programming models options

Propose new approaches

- Hardware: emerging solutions with high enough TRL
- Software: new algorithms (better science), new programming models (portability)
- Middleware: enhanced scalability / energy efficiency
- Additional work on infrastructure + deployment strategy
- Couple with science drivers

Progress towards final proposal for SPC delivery

- In sync with SKAO
- Aligned with science objectives

What sustainable means ?

“meeting the demand of current generation without putting the demands of future generations at stake”

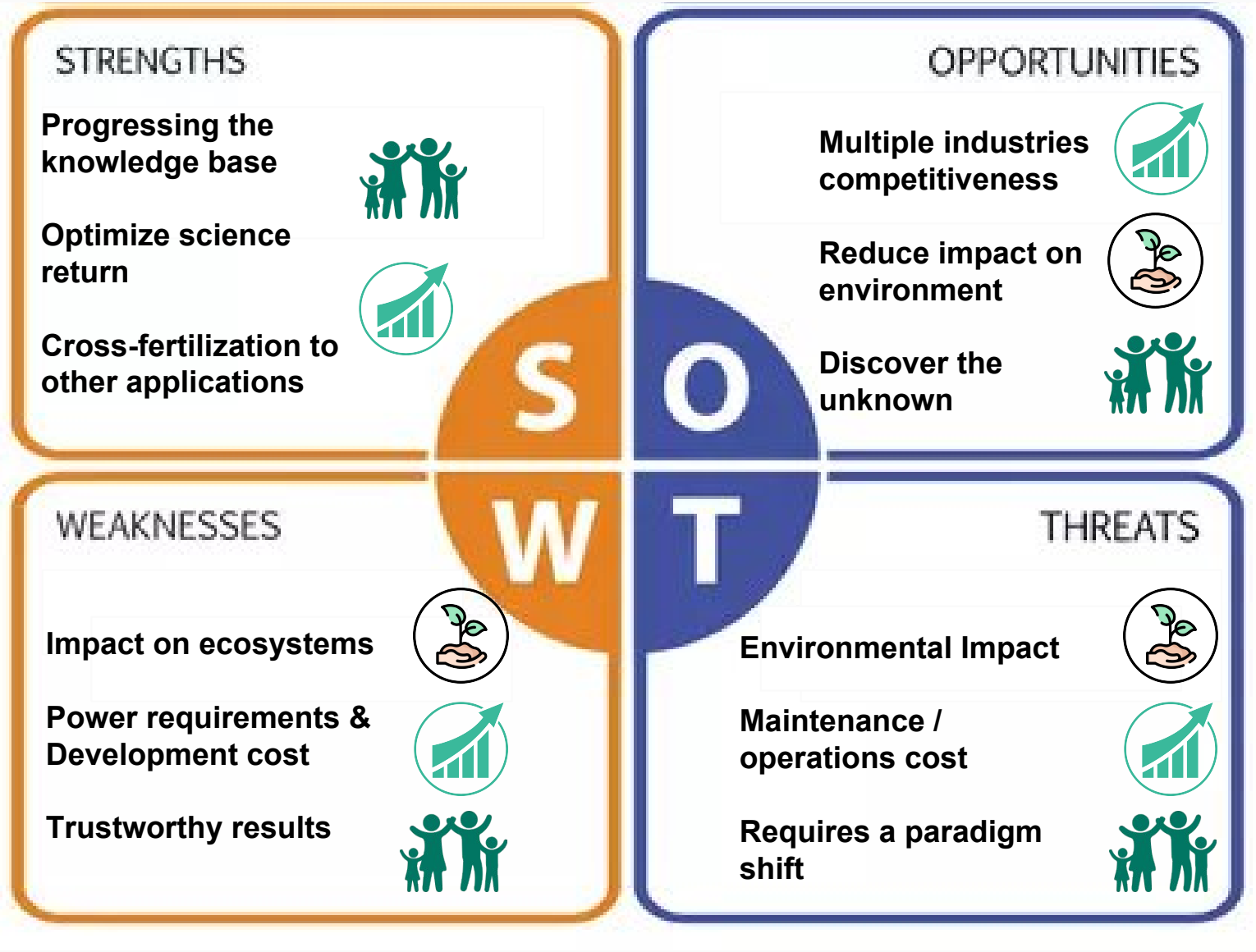
Can be analyzed as the convergence between:

- **Economic**
- **Social**
- **Environmental**

ICT developments can:

- make contributions on all fronts
- come with negative impacts

A SWOT analysis on sustainability



Horizontal challenges, addressed sustainably

Big science requires unprecedented (and exciting !) ICT breakthroughs

- Integrate / leverage emerging HPC / HPDA technologies
  - Across the infrastructure continuum
  - At all scales
  - Maximize science return
  - Converge design and operation / maintenance models: continuous integration
- AI has a key role to play
  - Across the infrastructure and at all scales
  - From producing science to managing the infrastructure
  - Change of paradigm calling for new AI methodologies
- And there are more ...

Let's do it sustainably !

All aspects of sustainability represent both opportunities and challenges

- Close partnerships with industry
- Maximize positive societal impact
- Minimize environmental impact

Supporting Initiatives (I)

Close cooperation with Atos and collaborations with main vendors

- Strategic support from Atos (in-kind)
- Requesting support from vendors (Intel, AMD, NVIDIA, etc..): external funding to the lab (cash + hardware donations) on dedicated sub-projects / sub-tasks

Relying on national initiatives (2023-2027)

- **PEPR NumPEx**: large exploratory R&D project on Exascale computing
  - Strong involvement including core activities (WP co-lead) and dedicated demonstrators
  - Major initiative (~40M€ budget), CNRS + INRIA + CEA
- "**Défis INRIA-Atos**": supporting strategic partnership agreement
  - Ongoing definition of 3 sub-projects with several INRIA teams + Atos R&D
  - Excellent feedback, 3-4 PhD projects to start + equivalent engineering support
- Setting up experimental **STREAMS integration platform**
  - 1M€ hardware budget + donations from main vendors
  - Collaboration with IDRIS, GENCI and other partners (inc. Industry)
  - Integration in national ecosystem (CLUSSTER project, PEPR ORIGINES)

Supporting Initiatives (II)

External partnerships

- Horizon Europe:
  - Rising STARS mobility grant (link with Australia)
  - EXTRACT project (lead BSC), inc. R&D on NenuFAR as pathfinder for SKA
- Ongoing grant request prep.
  - ANR + FNS "international cooperation project" with EPFL
  - ITN GIGANTIC
- **Large EU consortium: DICES**
  - 25 partners, 4 Research Infrastructures
  - Tier 0 supercomputing centers
  - Strong industry engagement
  - INFRATECH proposal unsuccessful
  - looking into options

DICES: **DI**stributed **C**yber-physical systems at **E**xtreme scales for **S**cience

Participant #	Short name	Participant organisation name	Type	Country
1 (Coord.)	CNRS	Centre National de la Recherche Scientifique	Academia	FR
2	OCA	Observatoire de la Cote d'Azur	*affiliated*	FR
3	**CERN**	Organisation Europeene pour la Recherche Nucleaire	R.I.	CH
4	**PRACE**	Partnership for Advanced Computing in Europe	R.I.	BE
5	**SKAO**	The Square Kilometer Array Observatory	R.I.	UK
6	ASTRON	ASTRON the Netherlands Institute for Radio Astronomy	Academia	NL
7	Atos	BULL SAS	Industry	FR
8	BSC	Barcelona Supercomputing Center	Academia	ES
9	CIEMAT	Centro de Investigationes Energeticas Medioembiantales y Technologicas	Academia	ES
10	CINECA	CINECA Consorzio Interuniversitario	Academia	IT
11	CS Group	CS Group	Industry	FR
12	E4	E4 Computer Engineering SpA	Industry	IT
13	EAS	Energy Aware Solutions S.L.	Industry	ES
14	FZJ	Forschungszentrum Julich	Academia	DE
15	INAF	Istituto Nazionale di Astrofisica	Academia	IT
16	INFN	Istituto Nazionale di Fisica Nucleare	Academia	IT
17	INRIA	Institut National de Recherche en Informatique et Automatique (also representing **SLICES-RI**)	Academia	FR
18	NEOVIA	NEOVIA Innovation	Industry	FR
19	Simula	Simula Research Laboratory SA (representing **SLICES-RI**)	Academia	NO
20	SiPearl	SiPearl	Industry	FR
21	SURF	SURF BV	Academia	NL
22	EPFL	Ecole Polytechnique Federale de Lausanne	Associated	CH
23	GENCI	Grand Equipement National de Calcul Intensif	Associated	FR
24	Intel	Intel Corporation Italia SPA	Associated	IT
25	Graphcore	Graphcore AS	Associated	UK

Supporting Initiatives (III)

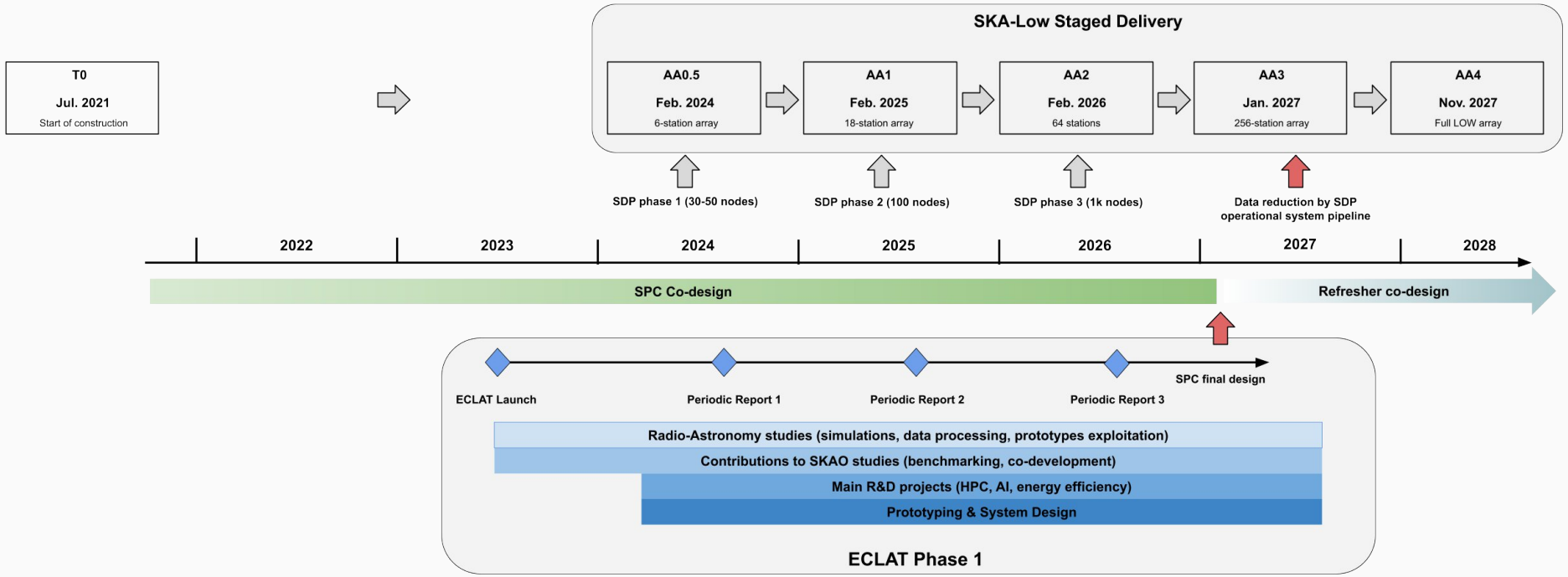
Fostering disruptive R&D in Europe

- TransContinuum initiative (TCI) from ETP4HPC
- 8 associations in Europe covering the whole compute continuum (inc. BDVA, HiPEAC, 5G IA, etc ..)

- Working on white paper with CERN on Big Science Infrastructures
- Contribution to ETP4HPC Strategic Research Agenda
- Working closely with experts and advisers to progress EU roadmap on cyber-infrastructures using **SKA challenges as pilot for future global needs**

Roadmap

Kick-Off expected in the coming weeks !



Partner Labs

Covering 3 institutes at CNRS + INRIA + Atos (BULL)

Partie(s)	Laboratoire(s) / équipe(s)
CNRS / OP	LESIA
	GEPI
	LERMA
CNRS / OCA	Lagrange
	Galilée
CNRS	LAB
CNRS / INSA Rennes / Centrale SupElec / UNIVRENNES	IETR
CNRS / Centrale SupElec / UPSaclay	L2S
CNRS / INSA Rennes / UNIVRENNES	IRISA
INRIA	Avalon
INRIA	KerData
BULL SAS	BDS

Concluding remarks

Ambitious goals to lead the co-design study of one of the main SKA sub-systems

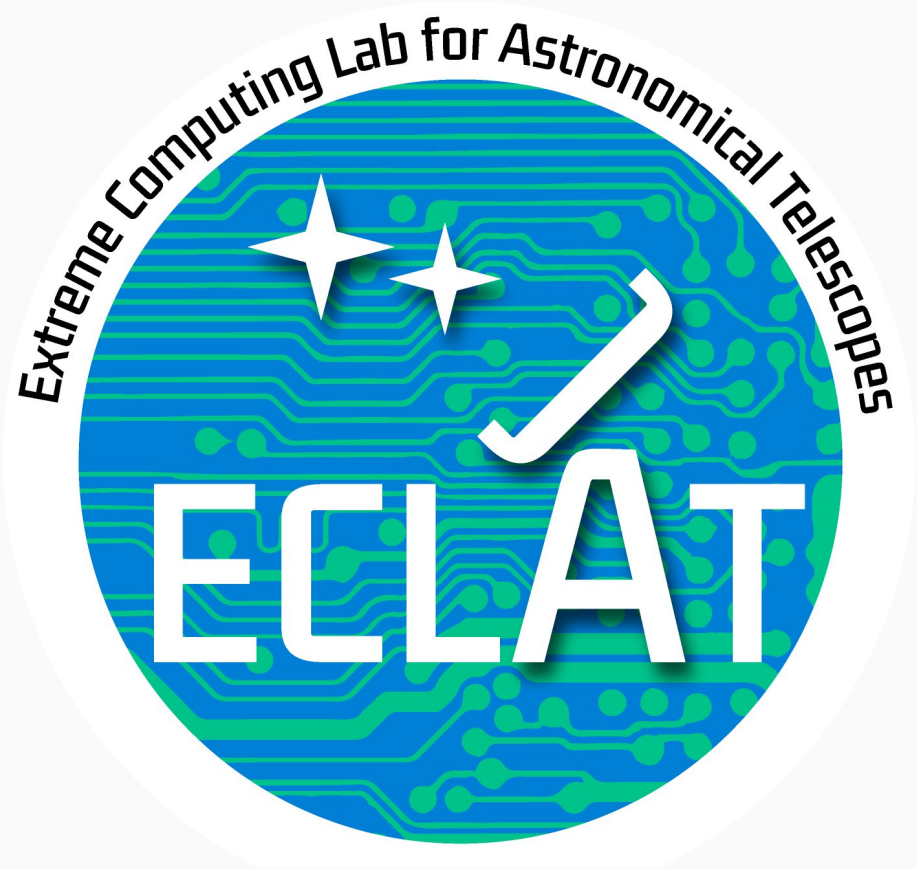
- Enable science while promoting French expertise (science + technology)
- Address Grand Challenges (Astronomy and HPC / HPDA)
- Spin-offs are expected in other domains (optical astronomy, simulations, …)

Multi-disciplinary by nature, core contribution to EU ecosystem

- Working with the community to refine goals and establish milestones
- 3 institutes @ CNRS (INSU, INS2I, INSIS) + INRIA + Atos
- Happy to collaborate widely (providing support / getting associated with other initiatives)

France is getting back onboard while construction is starting

- Co-design and R&D activities starting on the very short term
- Need to ramp up quickly
- Need every good will in the community !



Thanks !