ICOS

International Cooperation on Semiconductors

SIE Meeting

Francis Balestra (*CNRS/Grenoble INP-UGA/Sinano Institute*)

Naples, June 25, 2025

INTRODUCTION

- ICOS Project started in January 2023 for three years, it is funded by the Horizon Europe research program.

Coordinator

Technical co-Coordinator

- An ambitious project in the framework of the European strategy for semiconductors

PARTNERS & ADVISORY BOARDS

ACADEMICS

GRENOBLE INP UGA

UNIVERSITEIT GENT

TU Delft
Delft University of Technology

POLITECHNIKA WARSZAWSKA
WARSAW UNIVERSITY OF TECHNOLOGY

U.NET

RTOS

leti cea tech

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imec

VTT

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Motivation & Objectives

- **Semiconductors & Semiconductor-based photonics** are pivotal technologies for almost all existing industrial sectors, as demonstrated by the recent chips shortages
- **International cooperation** is key for **speeding up** technological innovation (e.g. ITRS/IRDS, IPSR-I, ECS-SRIA, NEREID), reducing **cost** by avoiding duplicated research, strengthening complex supply and value chains, and is encouraged by the new **strategies** of leading semiconductor countries

=> To build **balanced semiconductor partnerships** with like-minded countries

=> To set out cooperative framework on *initiatives of mutual interest*

=> To identify and support the establishment of the **most promising scientific international collaborations**

=> To support the growth of the European Semiconductor industry through **focused research alliances** based on awareness of advanced research activities

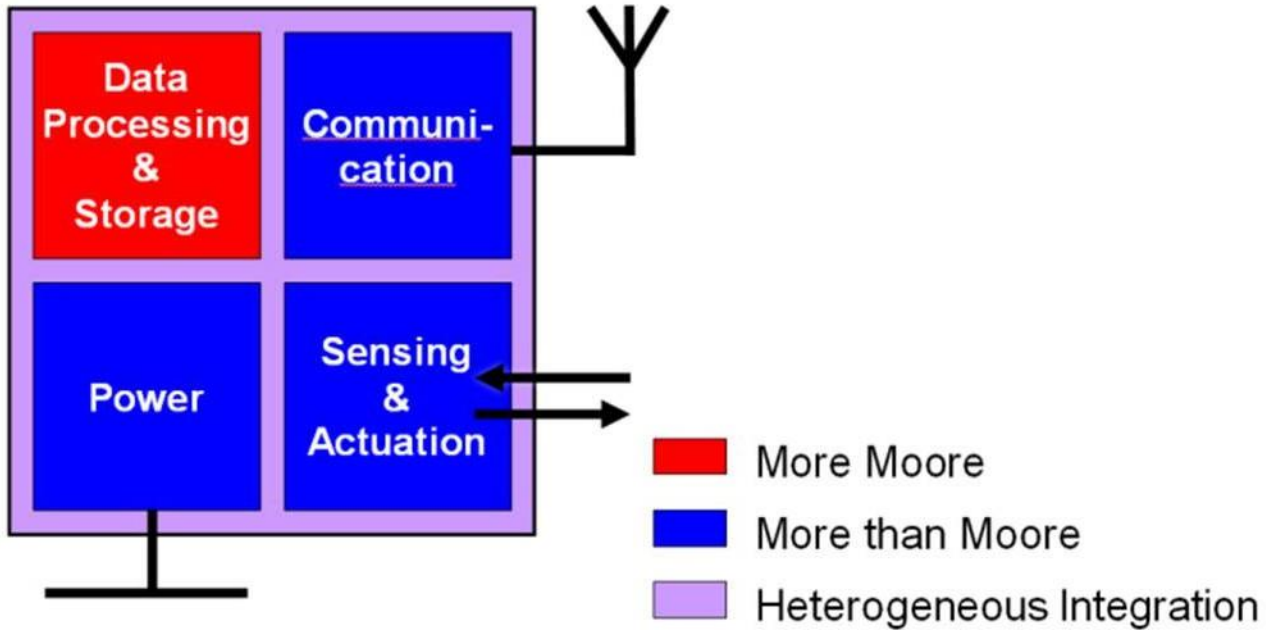
=> To strengthen **Europe's and partner Country's positions** in global value chains in this area and to contribute to the **EU Chips Act, Green deal and Digital Agenda**

Objectives

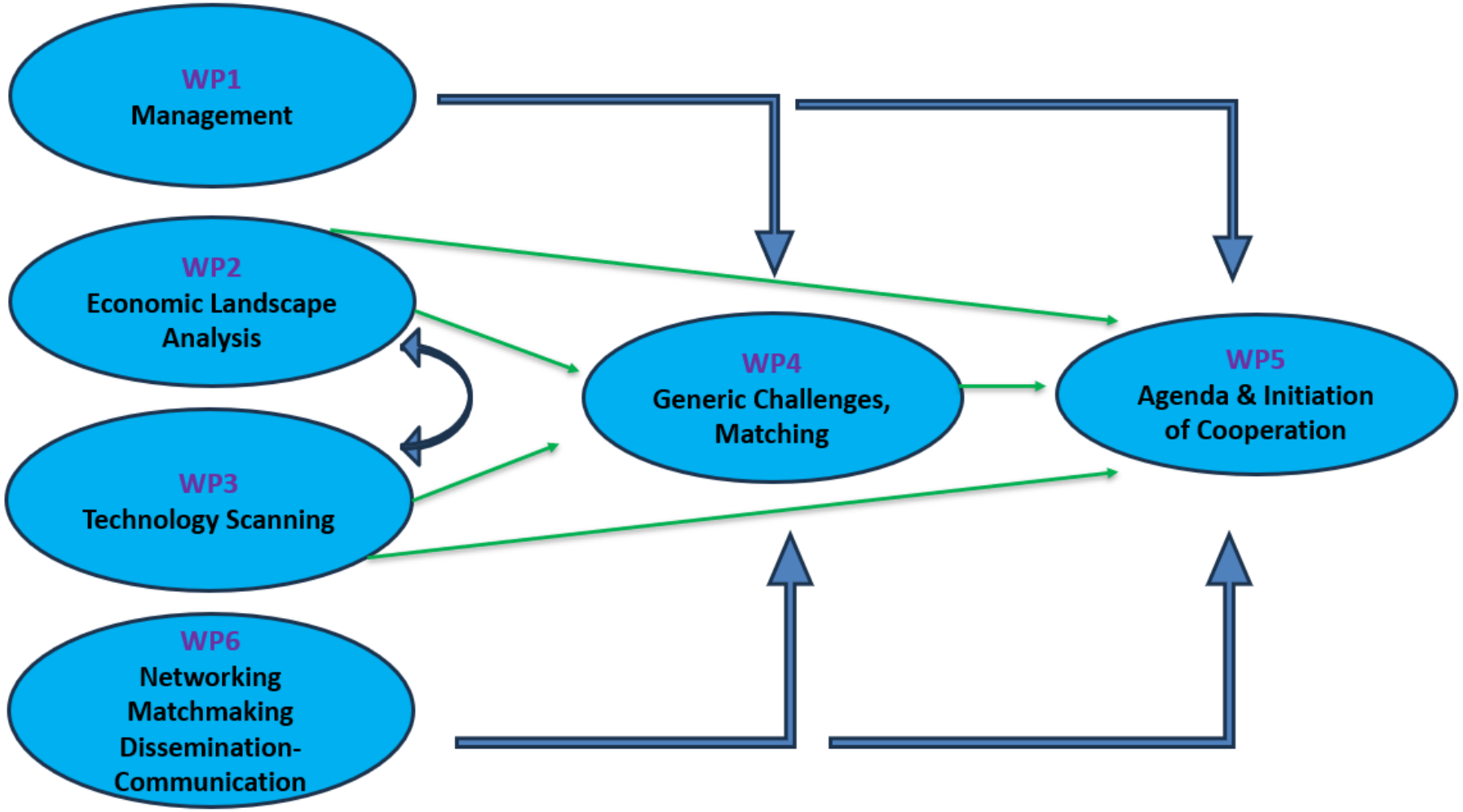

Canada
USA
China
Republic of Korea
Japan
India
Taiwan
Singapore
Investigated countries

Main Scientific Topics

- Advanced computing & Advanced functionalities: sensing, RF & optical communications, optical devices, energy harvesting, power devices, …



ICOS Concept



ICOS
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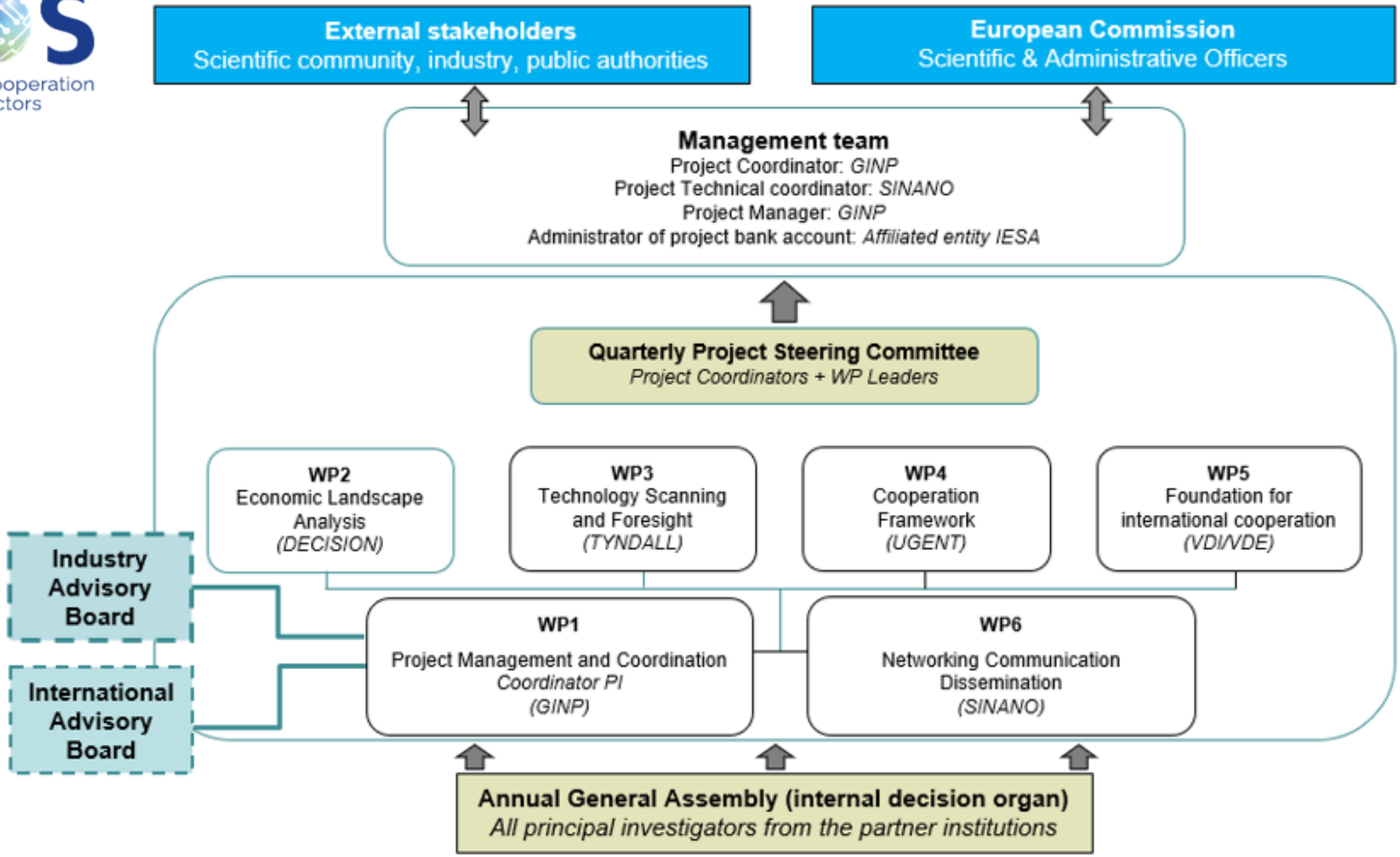

Structure of ICOS project & stakeholders

Funded by the European Union

IMPLEMENTATION

IMPLEMENTATION

EXHAUSTIVE ANALYSIS OF SEMICONDUCTORS' VALUE CHAINS, FOR ELECTRONICS & PHOTONICS

Identification of :

- EU's economic and industrial strengths & weaknesses
- Strategic dependencies
- Market and cooperation opportunities

IDENTIFICATION OF RESEARCH AREAS FOR INTERNATIONAL COOPERATION

Identification of next generation & emerging technologies, especially in advanced computation and functionalities.

DETERMINATION OF MOST INTERESTING COUNTRIES FOR INTERNATIONAL COOPERATION

Identification of challenges for which international cooperation is critically important.

AGENDA FOR AND INITIATION OF INTERNATIONAL COOPERATIONS

- Dialogue with actors of existing cooperation
- International collaboration with non-EU national authorities
- Define standardisation needs and activities
- Support the European Commission

Challenges, possibles solutions & Collaboration opportunities: “Advanced Computing”

- Classical’ Logic Scaling Roadmap beyond FinFET technology that extends devices structures through **sub nm nodes** (e.g., **GAA and CFET architectures**)
- Exploration of ‘**Fully Depleted SOI**’ technology for Power Efficient Analog and RF applications
- Exploration of **alternative channel materials** (e.g., **2D** materials)
- Extension of the **scaling of BEOL technologies**, through the use of Ru, Airgap or Graphene-based metallization, by reducing the associated RC network
- **Added BEOL functionality** through the introduction of new materials such as 2D, oxide semiconductors and ferroics
- Exploration of the use of BEOL **Non-Volatile Memories** (using for example resistive RAM such as FeRAM, MRAM, PCRAM) to supplement/replace charge-based memories, for **in-memory computing** (eNVM), and for Power Efficient **Neuromorphic-based architectures**
- **Photonic chips for optical interconnects and quantum information processing**
- Demonstration of the capability of the ‘**Buried Power Rail delivery**’ to decongest the interconnection density that is becoming the most limiting factor for the **scaling at 2nm and below**
- Enablement of the **High-NA EUV lithography** for the patterning of 2nm nodes and beyond
- **Usage of 3D integration** to desegregate the classical large area chips into **chiplets that will be much more power efficient** when reconstruct using 3D integration design flow and associated toolbox
- **Cryogenic electronics** for power saving and quantum computing

Challenges & possible solutions & collaborations opportunities: “Advanced functionalities”

- Innovation in new, **highly sensitive and more versatile sensors** requiring more advanced sustainable (bio)materials innovation and integration
- **For energy harvesters the improvement of the performance**/ efficiency is as important as the development of “**green” materials**
- **Wide band gap** (e.g. SiC, GaN) and **ultrawide band gap materials** (e.g. AlN, GaOx, diamond) for power
- **Flexible, Printable, Wearable Electronics:** Future Hybridization of Flexible & Si-based electronics
- **Heterogeneous integration** of best materials for target application
- **Advanced design tools**, including multi-physics simulation for first-time-right modelling capabilities
- **Rapid prototyping** to bypass long chip iteration cycles (e.g. PDK, ADK availability)
- **Packaging that meets multiple design requirements** such as optical, electrical, mechanical, thermal, RF, (bio-)fouling etc.

Joint activities

- Webinars
- Workshops
- Contribution to Regional & International Technology Roadmaps (IRDS)
- International R&D&I cooperation on topics of mutual interests
- Exchange of researchers
- Access to Research Infrastructures
- Standardisation needs for emerging technologies

Recent events (July 2024-July 2025)

- **Online Discussion** on **EU-Japan Semiconductor Research Cooperation** (July 5, 2024): Coordination and writing of the 1 page-paper per topic and selection of sub-**topics for EU-Japan cooperation**
- **ICOS Workshop** "Emerging technologies in Advanced Computation, Advanced Functionalities, Ground-breaking Technologies: Impact on International Cooperation", **ESSERC 2024, Bruges**, Sept 9, 2024
- **Joint EU-India semiconductors researchers Forum, Brussels,** (October 9, 2024)
- **ICOS presentation** "EU and non-EU strengths, weaknesses, dependencies, opportunities for international collaboration, **Semicon Europa, Munich**, Nov. 12, 2024
- **ICOS presentation «** Horizon Europe ICOS - International Cooperation on Semiconductors", **EFECS, Ghent**, Dec. 5, 2024
- **ICOS Workshop** "Key emerging technologies for future industrial applications", **EUROSOI-ULIS, Warsaw**, May 12-13, 2025
- **2nd Semiconductor joint EU-ROK Researcher Forum, Jeju**, South Korea, June 16, 2025
- **1st Joint EU-Singapore Researchers Workshop on Semiconductors, Brussels**, July 8-9, 2025

Impact

In regards to:

- the complexity of the global value chains in the semiconductor area
- the high interdependencies between the different regions of the globe
- consortium partners representing the main European stakeholders and to their International Networks

ICOS is a central instrument to generate impact for the European ecosystems and to support the EC for international cooperation

=> **Provide advice to the European Commission** on joint research and other cooperation initiatives on specific topics with selected leading semiconductor countries

=> **Offer support in their implementation**, based on well documented analysis of value chains, important technologies and mutual advantages of potential collaboration

=> **Implement EU policy** by organizing joint international workshops on defined topics

=> **Strengthen European capacities** in key parts of digital and future supply and value chains

=> **Allow to invest in early discovery and industrial uptake** of new technologies

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Thank you for your attention

Acknowledgements: *All ICOS Partners*

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