Position Paper of the Working Group under the Aegis of the Romanian Academy on the Important Project of Common European Interest in Microelectronics "IPCEI-ME-2"

European Context

On 7 December 2020, in the Council of EU, ministers of the Member States including Romania signed a Joint Declaration: "***The signatory Member States agree to work together in order to bolster Europe's electronics and embedded systems***[1] *value chain… to establish advanced European chip design capabilities and production facilities… This will require investments from the EU budget, national budgets (including if feasible through the national Recovery and Resilience plans) and the private sector. Microelectronics…are already among the key areas identified for investment for the Recovery and Resilience Facility. 20% of the European Recovery and Resilience plans should go to digital transition; this is up to 145B€ over the next 2 to 3 years*."[2]

The "Recovery and Resilience Facility (RRF)" of the European Union introduced a **major novelty** in the guidance for the Member States: the „Flagship Area SCALE-UP" lists the hardware as the **first priority** in a sustainable digital transition, highlighting the **special importance of microelectronic components**: they "*capture, generate, process, transfer and act upon data, and are the basic building blocks for digitalisation in all sectors*."[3] The *specific objectives* list under No. 1: "*Strengthen Europe's design and production capabilities in **microelectronics technologies***", while the development of services is listed under No. 2. Under ***A. Microelectronics with focus on processors***, the first *Example of investments* is "*A5. – Support a large-scale innovative industrial project, possibly in the form of an Important Project of Common European Interest (IPCEI) aiming at the development of cutting-edge capabilities and first industrial deployment in critical parts of the value chain. (Footnote: Notably processor technologies, digital design, advanced packaging and wafer-level fabrication at leading-edge nodes)*".

Several very recent press releases announced that European Commissioners and the German Minister of Economy are actively seeking to form a European consortium, and/or to attract semiconductor leaders (IBM, Taiwanese companies) as foreign investors in Europe.[4]

Status in Romania

The Working Group considers that Romania is well positioned to become an effective contributor to these ambitious proposals. Romania has a tradition in microelectronics continued in several centres of excellence; it already hosts significant investments in industries important to Europe, such as automotive, including both manufacturing and R&D units; can access important European funding (over 60B€ in the current framework programme); is attractive economically, with costs below the European average; has some highly qualified human resources with strong track records both nationally and

[1] A computer system—a combination of a computer processor, computer memory, and input/output peripheral devices—that has a dedicated function within a larger mechanical or electronic system. (Wikipedia)

[2] https://digital-strategy.ec.europa.eu/en/library/joint-declaration-processors-and-semiconductor-technologies

[3] https://ec.europa.eu/info/files/examples-component-reforms-and-investment-scale_en, p. 19

[4] https://www.politico.eu/article/europe-microchip-conundrum-go-big-or-go-home/

internationally; and last but not least, has a considerable demographic reserve that can be oriented towards this industry through an aggressive education programme.[5]

The Ministry of Economy, Entrepreneurship and Tourism (MEAT), and the Ministry of Research, Innovation and Digitalisation (MCID) received expressions of interests in view of a possible Romanian participation in IPCEI-ME-2 and reviewed the submissions in March 2021. The proposals can now be used as building blocks in formulating a national participation scenario.

MEAT invited representatives of the Working Group in the video conference from 26 April 2021 set up by the European coordinators for IPCEI-ME-2, during which Romania reconfirmed its engagement, and showed the footprint of the microelectronics ecosystem in the country (Fig. 1).

Participating Scenarios

Considering the capabilities shown, the interests expressed, and the proposals received so far, the Working Group potentially identified building blocks for a national ecosystem in microelectronics, with actors from the academic and institutional research, from SMEs and from the large industry. The points below follow the headlines from RRF, Focus Area SCALE-UP:

- *digital design*

Romania has significant activities in this area, including cutting edge research in processor architectures, including for Artificial Intelligence; design groups in academic and institutional research collaborating with the private sector; SMEs and subsidiaries of the important international companies; and in addition, the user community, including the automotive companies – expressed their interest to contribute to the definition of the next processor generations and related components. These activities can be supported through existing mechanisms for projects, with public contributions (possibly from PNRR or other European funding sources) of **about 10 M€ per year**.

- *advanced packaging*

In Romania there are centres of excellence in specific unit processes; there is an SME performing low pin-count packaging; hybrid and heterogenous integration of chips and other components are performed both in research and in industrial settings. Under IPCEI, it can be envisioned a consolidation of the resources, upgraded with additional investments, as a network of distributed Digital Innovation Hubs ("digital" defined as above), centrally coordinated to fill gaps and avoid duplications, established where relevant industry, Universities, and research coexist, as an essential element of the Smart Specialization policy of the Regional Development Agencies. About 4—6 Hubs could be anticipated, with up-to-date infrastructure to perform technology innovation; building, validating and qualifying prototypes; and potentially small series manufacturing. They would require (including funding from European programmes) a **total investment of about 500-600 M€**, followed by an annual allocation for the running costs.

- *wafer-level fabrication*

Romanian researchers take part in European project consortia preparing the transition to the 3 nm and 2 nm CMOS generations, collaborating with world leaders (e.g. in

[5] See RRF, Flagship Area 3 Reskill and Upskill, https://ec.europa.eu/info/files/examples-component-reforms-and-investment-reskill-and-upskill_en; also, see the European programme „Pact for Skills".

photolithography). Academic and institutional research groups got internationally recognized results in relevant areas like novel materials, innovative nanotechnologies, specific manufacturing processing steps, novel devices in existing processes etc., supported by an experimental infrastructure including white rooms and newest equipment items. Several possibilities can be envisioned:

- low involvement: point contributions upon requests from project running abroad;
- establishing a national centre for advanced technologies specializing in specific processes or processing steps in collaboration with one or more commercially successful industrial partners who could contribute not only to the starting up investments but also to the subsequent running costs;
- Romania hosts a major semiconductor foreign investor.

These possibilities will be actively explored in preparation for a Romanian proposal within IPCEI-ME-2; the results, of course, cannot be anticipated at this point in time.

Some rough estimations: a centre for useful, yet not most advanced technologies, would require a minimum investment **around 500 M€** (from PNRR, POR[6], etc.) - below this level it would be able to perform some steps, but not the whole process. Private investors could help build a balanced manufacturing line requiring **more than 1 B€** (partially supported by public grants). An economically viable line for cutting edge technology would need much more investments, essentially private.

Next Steps

The Working Group is of the opinion that a Romanian engagement in IPCEI-ME-2 would have an immediate economic impact, and a medium-term one on the general progress in the country. The Working Group will continue exploring the following topics:

- consolidating proposals and including actors in a scenario maximizing participation, contributions, benefits for the national economy, and European impact;
- identification of and engagement with external partner in collaborative actions.
- refining the rough estimations on investments as required for an IPCEI proposal;

The Romanian authorities could structure the national strategies to be supportive of the participation in IPCEI-ME-2, to connect the country to the European efforts:

- In all national strategic plans, DIGITALIZATION must be aligned with the newest EU definition with MICROELECTRONICS in the leading position;
- This ambitious programme requires contributions from various funding sources with different management procedures. It is necessary that the relevant ministries, specifically MEAT, Ministry of Investments and European Projects (MIPE), MCID, Ministry of Education (ME) and potentially the Ministry of National defence (MApN) for “dual use” technologies agree upon a joint mechanism to coordinate the national proposal within IPCEI-ME-2 with POCIDIF, POR, PNCDE, “major equipment” programme of MApN etc.;
- If Romania intends to be active in this area, it should get involved in the European explorations regarding investment scenarios.

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[6] Abbreviations: POCIDIF: Operational Programme Smart Growth, Digitalization, and Financial Instruments; POR: Regional Operative Plan; PNCDI: National Research-Development-Innovation Plan.

Table 2: Microelectronics Ecosystem Matrix – ROMANIA footprint

	Materials (substrates, gases)	Tools and Equipment	Chip Design, IP	Tech R&D	Wafer manufacturing	Packaging, Assembly, Test	System-level integration, (HW/SW)
Processor							
Communication (5G/6G)							
AI/ML/DL							
Trustworthy components, Safety & security							
Photonics							
Next generation sensors							
Next generation power							
Spintronics devices							
Superconducting electronics							
Industry 4.0							

Legend	
	Ongoing activities in industrial and R&D units
	Ongoing activities in R&D units (normally, at least one participation in a European project consortium on the topic)
	Ongoing activities in industrial units
	No activities in RO

Fig 1. The Romanian Microelectronics Ecosystem

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