

Foreword

The three Industry Associations, AENEAS, ARTEMIS-IA and EPoSS are in the process of updating the ECS-SRA 2018 and will collect feedback from the Electronics Components and Systems community during EF ECS 2018. The final version of the ECS-SRA 2019 will be available online shortly thereafter.

ECS-SRA 2019 Update – Release Notes

Based on an analysis of the major applications fields where Europe must maintain and/or develop its leadership, and of the current and foreseeable technology capabilities, the ECS-SRA ambitions to identify the main focus points for Research and Innovation in Europe in its field. To fulfil its mission, it must reflect the dynamics of our industry, characterised by technology advances occurring every year, and new applications being invented at an ever-increasing pace. Therefore, it cannot be a static document, and it will continue to evolve, with reviews every year and a major update every 3 years. This continuous process will enable all the ECS stakeholders to be constantly aware of new technologies coming up, of potential game-changers and of the evolving long-term vision.

After the initial 2018 edition, the ECS- SRA has undergone its first minor update. The present document summarises the changes/updates made to the 2018 edition, resulting in the 2019 update.

General

For all chapters 1 to 10, the timelines have been adjusted to span the period 2019-2028.

The importance of the on-going and future breakthroughs of Artificial Intelligence, the technology developments they require, and their impact across all application domains are visible across all chapters of this Strategic Research Agenda and make this a recurring theme of the document.

0. Introductory and Overview Chapter

The section on new technological paradigms was reshuffled to bring the advent of Artificial Intelligence and data analytics in the most prominent place among the game changers.

The long-term vision section has been replaced by an introduction to the new Long -Term Vision chapter (chapter 11). Contents which were initially in that section have been moved into the new chapter and expanded, along with additional topics.

1. Transport and Smart Mobility

The chapter has been expanded to more explicitly include all transportation modes. Maritime transport is covered extensively, reflecting the importance of that industrial sector for Europe. Railroad and multimodal transportation challenges are also addressed in more detail than in the 2018 edition.

2. Health and Wellbeing

The text was aligned with the ECSEL Lighthouse HEALTH.E, resulting in minor updates.

3. Energy

- Added sub-chapter: Digitalisation & Energy – new approaches including artificial intelligence
- Updated graphics and numbers where available
- Added Artificial Intelligence / Machine Learning approaches.

4. Digital Industry

Given the vast economic scale of agricultural industry and current deployment of IoT devices for precision farming, it was felt that this topic deserved to be addressed by the SRA. Since Digital farming is bearing close resemblance to digital industry needs and solutions, it was included in chapter 4. This leads to some expansion and modification of the description of Challenge 3, now worded "Generalising condition monitoring, to pre-damage warning on-line decision-making support and standardisation of communication scenarios to enable big data collection across huge (remote) sites".

5. Digital Life

The only change to this chapter vs. the 2018 edition is a small update of the timeframe diagrams.

6. Systems and Components: Architecture, Design and Integration

- Changes/Updates in the overall text
 - Re-introduction of the definition/meaning of the word 'system' as used within this chapter (text-box next to Figure 33).
 - Extended the text, especially the examples and example applications given, to convey the huge span of technologies and applications covered in this chapter:
 - from (design and integration of) semiconductor device characteristics along chip or block level and from (design and integration of) simple collections of basic software modules via 'components' up to complete application systems and even (Cyber-Physical) Systems of Systems
 - including systems/components realised in hardware only, functions realised in software only, and, most important, systems integrating both.
 - Added resp. strengthened the description of the following topics in the text:

- (Design and Integration of) Systems of Systems, Software running of Systems of Systems
 - (Design and Integration of) Systems using AI methods and learning
- Changes/Updates in Challenges
 - Clarified the different viewpoints of the Challenges (Challenge 1-4: architecture and design prior to fabrication; Challenge 5-7: physical and functional integration during fabrication), and their strong interdependence and interactions. (Chapter 6.3)
 - Challenge 1: Strengthening the role of Software and Systems Engineering, Systems of Systems
 - Challenge 2: Stressed important System Properties: Increased importance of Software, (geographically) distributed components implying the need for distributed control, hierarchical architectures, need to handle big data, etc.
 - Challenge 5-7: Description of the high priority areas revised.
- Editorial changes
 - The complete text of the chapter was streamlined, repetitions were eliminated, and passages with similar meaning combined, resulting in a much more concise version of the text without losing any content.
- Timelines/Topic lists (appendix):
 - There have been only few new topics added, but the topics from above have mostly been added to the existing ones
 - Timelines have been brought up to date.

7. Connectivity and Interoperability

The only change to this chapter vs. the 2018 edition is a small update of the timeframe diagrams.

8. Safety, Security and Reliability

- Executive summary:
 - Addition of disruptive threats linked to cloud, big data and quantum cryptography
- Major Challenges:
 - In Safety, security and privacy by design, added new patterns of processor architecture including security, and new priorities around architecture & design related to security
 - In Reliability and Functional Safety, introduction of Artificial Intelligence in safety design, addition, in the priorities, of AI, and precisions related to reliability assessment up to the 3rd level.
 - Updated Table of major challenges

9. Computing and Storage

Challenges related to energy consumption are discussed, as they require new approaches not only at the component level, but also at the system and even infrastructure level.

Consequences of the on-going revolution of how we now interact with machines, mainly due to the advance in Artificial intelligence, are developed.

Open Hardware initiatives (Open Compute Project, RISC-V, OpenCores, OpenCAPI, etc.) are addressed in this new edition of the SRA. Indeed, while Coprocessors, GPU and Deep

Learning accelerators (and other accelerators) are becoming more and more important in computing architectures, those Open Hardware initiatives (Open Compute Project, RISC-V, OpenCores, OpenCAPI, etc.) are gaining momentum as a way to prevent dependence on non-European companies for the provisioning of these devices.

Software challenges for growing complexity of applications and systems are added and the need for methodologies and tools for application and system design is addressed.

In the “Developing new disruptive technologies” section, some content has been moved into the new Long Term Vision chapter (chapter 11), while other topics have been explicitly linked with the technology development that they require (e.g., quantum computing requirements were linked to quantum technology developments addressed in chapter 10).

10. Process Technology, Equipment, Materials and Manufacturing for Electronic Components & Systems

The title has been reworded, from “ECS Process Technology, Equipment, Materials and Manufacturing” in the 2018 edition, to “Process Technology, Equipment, Materials and Manufacturing for Electronic Components & Systems” in the new one.

The first paragraph of the executive summary was adapted to strengthen link to applications, most importantly Artificial Intelligence.

The impact section has been revised to improve readability without changing content.

Major challenges:

- More elaborate description of major challenge 1, “Develop advanced logic and memory technology for nanoscale integration and application-driven performance”;
- Rewording of major challenge 2, “Develop Technology for heterogeneous System-on-Chip (SoC) Integration”;
- Rewording of major challenge 3, “Develop technology for advanced packaging and smart (heterogeneous) System-in-Package (SiP) applications by combining heterogeneous building blocks in packages”;
- Rewording of major challenge 4, “Extend world leadership in Semiconductor Equipment, Materials and Manufacturing solutions for advanced semiconductors building blocks, for *both* “More-Moore” technologies *and* for “More-than-Moore” technologies for heterogeneous “System on Chip” *and* for “System in Package””

The text regarding major challenge 2 has been significantly restructured, along the following topics:

- Unconventional devices and materials
- Application-specific logic
- Advanced Sensor technologies
- Advanced Power electronics technologies
- Advanced RF and Photonics Communication technologies

The text of major challenge 3 has also undergone a significant revision.

In major challenge 4, additions include the need for specific R&I on equipment and materials required for the development of quantum technologies, and the specific challenges derived from the manufacturing of small batch More-than-Moore products.

Links with other chapters of the SRA like Digital Industry as well as Computing & Storage, where relevant, are now more apparent than in the 2018 edition.

11. Long Term Vision

The long-term vision of the SRA has now developed into a full chapter, which surveys emerging technologies with a significant potential impact on the European ECS landscape 10 years from now and beyond. Rather than attempting to make specific predictions, which could always be disputed, this chapter highlights challenges to be solved, based on probable long-term trends (fossil fuel availability, requirements for personalised medicine, zero-emission environmental norms, to name a few) and identifies which technology or application are the most promising ones, or must be developed, to meet the expected societal needs. It focuses in particular on the expected future requirements which cannot be achieved with the predicted evolution of the current technologies.

By highlighting key research and innovation topics required to maintain the competitiveness of the European ECS industry in the long run, this Long-Term Vision chapter is an essential element to achieve the ECS-SRA mission to generate growth, create value, jobs and prosperity, and safeguard Europe's competitiveness and sovereignty.

Appendices

The appendix on the US Export Control Laws, as an evidence of the rising protectionism and its potential impact on the European ECS industry, is now attached to Chapter 0 (instead of Chapter 9 in the 2018 edition), since it is an issue affecting all the domains covered by the SRA.

The lists of contributors have been updated to reflect the arrival of additional experts.

The list of acronyms has been updated.