SOFTWARE
in the ECSEL programme
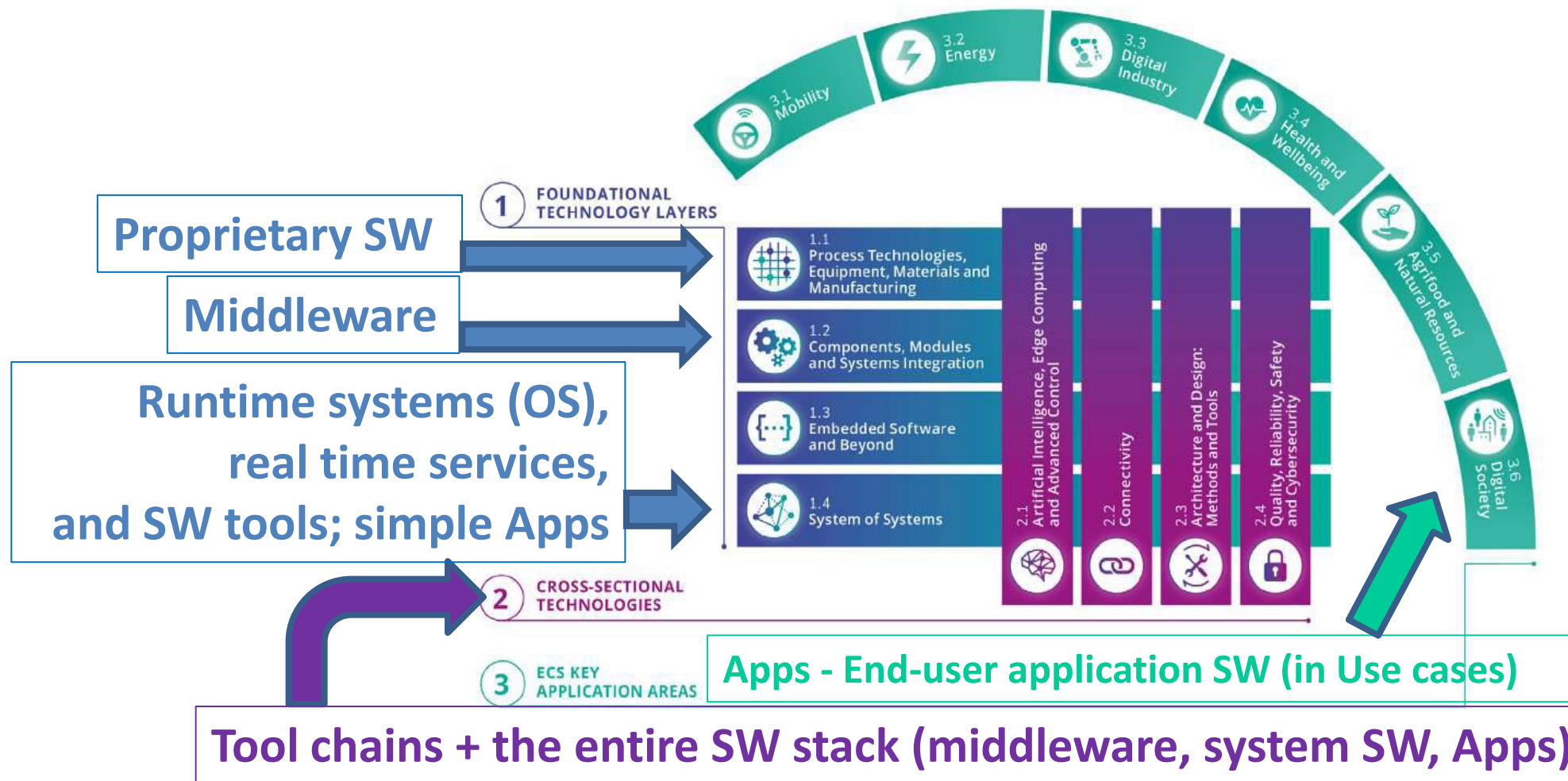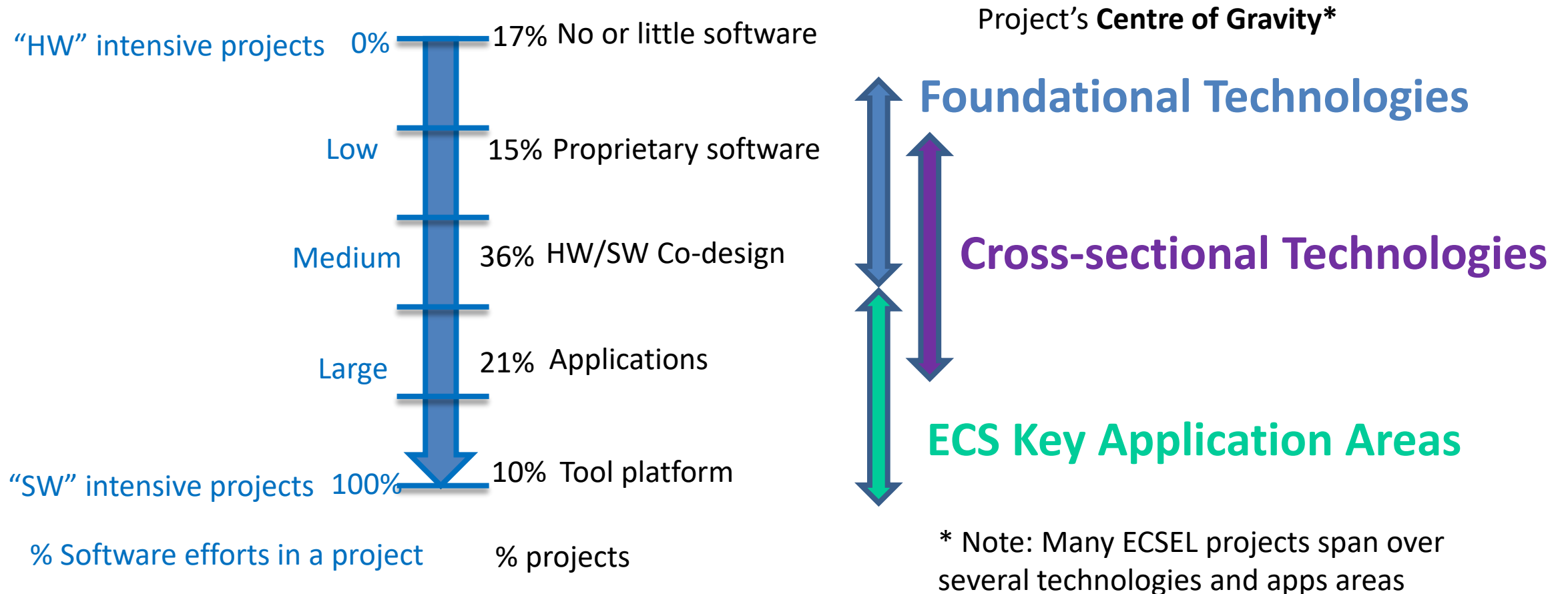
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General considerations

- Different categories of software in the ECSEL projects (to what purpose is the SW developed):
    - **proprietary**: software to support/control/simulate the processes and equipment eventually interlinking different equipment (metrology and process equipment) to improve/control process parameters
    - **HW/SW co-design**: hardware (sensors, MCUs, communication circuits) controlled by software, e.g., middleware, runtime (operating) systems and services;
    - **End-user applications (Apps)** – allow users control and interact with the systems, enable services of the systems;
    - **(Open) tool chains/platforms**: Collaborative development environment of a tool chain that supports design space exploration (DSE), engineering (development, V&V, maintenance), assurance and certification of systems such as CPS. ECSEL Tool Platforms provide services to a community enabling it to pool Intellectual Property, Methodology, Components or Services, in accordance with specific HW architectures, in order to avoid duplicate efforts when developing, maintaining, or using them.
- Different business model: no patents, but copywriting or licensing eventually open-source (eg Eclipse Public License), SW enabled/supported services
- Standardisation

Software in the ECS-SRIA

Proprietary SW

Middleware

Runtime systems (OS), real time services, and SW tools; simple Apps

Apps - End-user application SW (in Use cases)

Tool chains + the entire SW stack (middleware, system SW, Apps)

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Relative Share of Software

"HW" intensive projects — 0% — 17% No or little software

Low — 15% Proprietary software

Medium — 36% HW/SW Co-design

Large — 21% Applications

"SW" intensive projects — 100% — 10% Tool platform

% Software efforts in a project — % projects

Project's **Centre of Gravity***

Foundational Technologies

Cross-sectional Technologies

ECS Key Application Areas

* Note: Many ECSEL projects span over several technologies and apps areas

Tool Chains and Tool Platforms

Arrowhead Tools (2018-1)
Tool chains for IoT and SoS digitalisation/automation engineering and management, adapted to: 1. existing automation and digitalisation engineering methodologies and tools 2. new IoT and SoS automation and digitalisation engineering and management tools 3. security management tools

Productive4.0 (2016-2)
SoS-based system architecture supporting automation and digitalisation for a sustainable production, Data analytics framework and secure communication environment, Development of complex simulation models for digital production (DP), supply chain networks (SCN) and the entire product lifecycle management (PLM), Powerful systems for planning, virtualising, operating and controlling, Influence relevant standards in the Industry , The *Productive4.0* Framework as a cross-domain platform for the Digital Industry , Providing the Industry with IoT-enabling components

CPS4EU (2018-1) (special case: tool chain development for CPS but also HW platform development)
CPS tools and pre-integrated architectures and associated design flows with the aim to support EU industries to easily adopt and integrate CPS technologies,

TRANSACT (2020-1)
develop a universally applicable distributed solution architecture concept, framework and a transition methodology for the transformation of standalone safety-critical CPS into distributed safety-critical CPS solutions

Tool Chains and Tool Platforms

AMASS

developed supporting tools for assurance and certification of CPS by creating European-wide open certification/qualification platform, ecosystem and community spanning the largest CPS vertical markets, resulting in gain for design efficiency of complex CPS by reducing their assurance and certification/qualification effort by 50%; reuse of assurance results; raise of technology innovation and increasing harmonization and interoperability of assurance and certification/qualification tool technologies.

AQUAS

develops a domainflexible framework for Safety/Security/Performance Co-Engineering (CE) using a holistic approach supporting the entire Product Life-cycle (PLC) with strong contribution to Standards Evolution (SE).

AFarCloud

architecture and platform validated in controlled scenarios that contains: a framework for the design, development and testing of robotics and sensors/actuators cooperation; semantic middleware solution to hide the heterogeneity of the low-level environment entities ; distributed platform to provide all the necessary implementation of the concept "farm-as-a-service"; hierarchical mission planning solution ; autonomous and dynamic solution for localization, control and mission execution ; innovative solution for cropping sampling; innovative solution for livestock monitoring and health treatment ; gamification based client-to-farmer business platform

Applications

CPS Connected SCOTT (2016-2) SECREDAS (2017-2) InSecTT (2019-1)
methods for increasing and reference architecture for wireless systems dedicated security and safety in large facilities or industry installations, through a cloud platform using open standards to monitor connectivity inside the smart infrastructures, AI + IoT = AIoT, industrial-grade secure, safe and reliable solutions that can cope with cyberattacks and difficult network conditions, AI-supported Embedded Processing for industrial tasks, ...

CPS Industry 4.0 I-MECH (2016-1) IMOCO4.E (2020-2) SemI40 (2015-2) iDev40 (2017-1) MADEin4 (2018-1) AI4DI (2018-2-ST) iRel40 (2019-1)
Data safety and security in manufacturing environment with special attention on legacy equipment, agile manufacturing including small lot size production, tools and methodologies for automated decision making in manufacturing shop floor based on big data analysis methods, methodologies for large nonlinear Fab virtualization including complexity reduction and material flow, virtualizing the ECS value chain, optimized life cycle and change management along the value chain, enhancing innovation capability by a human-centred design of ECS development processes, developing advanced highly productive and connected metrology cyber physical systems which combine metrology data analysis and design with machine learning methodologies and digital twinning, build a European AI community with European values, AI from the cloud to the edge while making it resilient, safe & secure for the manufacturing and process technology of the future, Dedicated sensors with hardware integrated AI functions as well as dedicated CPUs with hardware integrated AI functions can transform the way people as well as the industry perceives computational power since these devices offer the chance to integrate intelligence for enhanced sensing, improved collaboration and complex self-organizing control systems which can react more flexible than today's deterministic systems,...

Applications

CPS General SafeCOP (2015-1) ENABLE-S3 (2015-2) MegaMaRt2 (2016-1) VALU3S (2019-2) AIDOaRt (2020-2)
"Runtime Manager" to ensure safe cooperation at runtime for building distributed applications for cooperative and autonomous service multi-robot systems, establish cost-efficient cross-domain virtual and semi-virtual Validation & Verification platforms and methods for Autonomous Cyber Physical Systems, enhancing the DevOps tool chain by employing AI techniques to significantly improved productivity, quality and predictability of large and complex industrial systems

NextPerception (2019-2)
Accurate and unobtrusive sensing of human behaviour and physiological parameters, support proactive decision making in traffic by means of predictive analytics and explainable AI,

MANTIS (2014-1)
proactive & collaborative maintenance, through maintenance service platform architecture, providing distributed decision making, gathering most of maintenance relevant information automatically through smart sensors and CPS,

HW/SW Co-design

Mobility: 3Ccar (2014-1) AutoDrive (2016-1) NewControl (2018-2) ArchitectECA2030 (2019-2-ST1) AI4CSM (2020-2) RobustSENSE (2014-1) DENSE (2015-1) PRYSTINE (2017-2)

Software for: reduction of vehicle's maintenance costs; trustworthiness of active safety systems in emergency situations; fail-operable components & architectures, standardized fail-aware, fail-safe, and fail-operational automated vehicles; increase performance, power, reliability, and reduce cost of the on-board computing platforms used for perception, cognition and control generalized hardware abstraction layer for efficient, adaptive fail-operational control of propulsion systems; development real-world test data into the virtual V&V process, in combination with test data derived from a knowledge base, to develop, certify and re-certify automated vehicles with reasonable costs and efforts; develop standardized safety, security and privacy metrics; requirements, specifications and design software architecture solutions to alleviate the effect of sensor degradation, ...

CPS Autonomous systems: SWARMs (2014-1) FITOPTIVIS (2017-2) COMP4DRONES (2018-2) ADACORSA (2019-2)
design and develop an integrated HW/SW platform, incorporated into underwater vehicles in order to improve autonomy, cooperation, robustness, cost-effectiveness, and reliability of the offshore operations;

HW/SW Co-design

More Than Moore for MEMS and packaging: ADMONT (2014-2) IoSense (2015-2) EuroPAT-MASIP (2016-2) CHARM (2019-1)
Software for MtM pilot lines, effective design technologies to improve and streamline the complete design and verification flow

Power Smart Grid: CONNECT (2016-1) PROGRESSUS (2019-2) Energy ECS (2020-1)
Software for smart grid, DC-DC, microgrids, charging infrastructure,

Lighting: DELPHI4LED (2015-1) AI-TWILIGHT (2020-2)
simultaneous simulation of the LED behaviour in all operating domains to be used to develop "first time right" products.

Computing: ANDANTE (2019-2) StorAIge (2020-1) BRAINE (2019-2-ST2) FRACTAL (2019-2-ST2) DAIS (2020-2)
Software for AI systems based on neuromorphic HW, edge AI software that is self-organizing, energy efficient and private, securely integrate edge components to cloud and fog,...

More Moore: WAYTOGO FAST (2014-2) REFERENCE (2015-1) OCEAN12 (2017-1) WAKeMeUP (2017-1) BEYOND5 (2019-1)
CAD tools, modelling software, ...

Proprietary software

More Moore SeNaTe (2014-2) 3DAM (2015-1) TAKE5 (2015-2) TAKEMI5 (2016-2) TAPES3 (2017-1) PIN3S (2018-1) IT2 (2019-1) ID2PPAC (2020-1)
Software that allows integrating and automating the functions of correctors and detectors within the metrology and analysis applications,...

Medtech: ASTONISH (2015-1) POSITION-II (2017-1) Moore4Medical (2019-1)
Software for medical smart systems for: smart data processing algorithms and real time implementations to process the acquired data, novel clinical user interfaces, new modeling and simulation software, platforms that use light for instrument tracking, platform that uses state-of-the-art sensors to monitor people during their sleep that transfer data to cloud and develop advanced algorithms based on AI to detect anomalies, assistance in image acquisition and interpretation without the need for a skilled practician using closed loop configuration with AI algorithms

More than Moore – Imaging: EXIST (2014-1) VIZTA (2018-1) HELIAUS (2018-2)
Software for imagers and other optical technology,...

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Conclusions

- The ECSEL portfolio covers a variety of software aspects, around 1/3 of the projects have no or little software development while 1/3 are mainly software.
- Europe's strength: distributed systems, middleware,...
- Software as the glue that makes the value chain approach possible