FRAMEWORK PARTNERSHIP AGREEMENT IN EUROPEAN LOW-POWER MICROPROCESSOR TECHNOLOGIES

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 826647

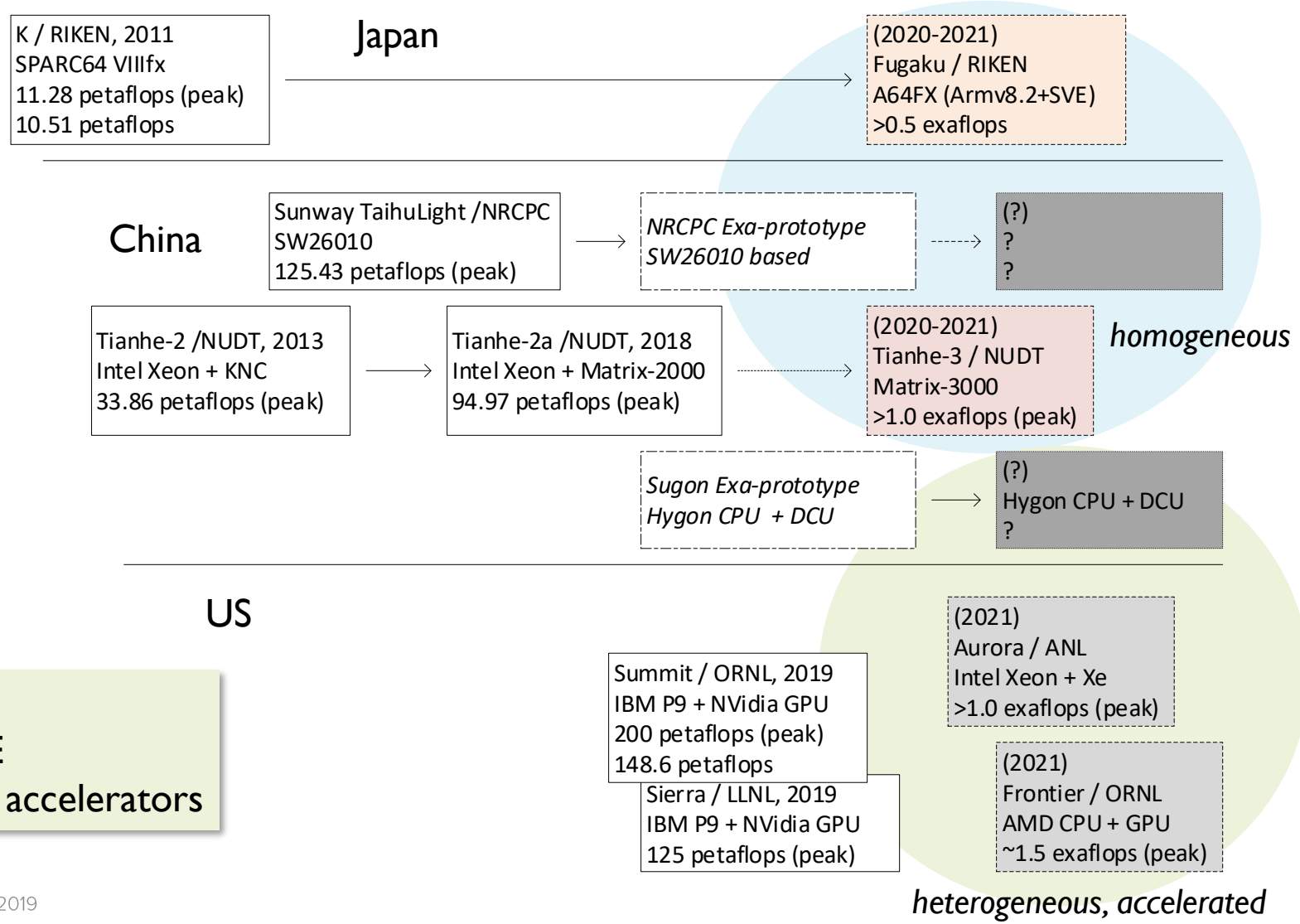
European Processor Initiative

EPI INTRODUCTION

ANDREA BARTOLINI (WP3 LEADER)

RACE TO EXASCALE

- CPU architecture choice
  - x86 + accelerator (heterogeneous)
  - Arm/SVE (homogeneous)
  - Others



EPI takes 2-step approach
step#1 : homogeneous with Arm core+SVE
step#2 : heterogeneous with additional EPI accelerators

53RD EDITION OF THE TOP500 LIST (JUNE 2019)

- Top#1 today:
  - 0.2 10^{18} Flop/s Peak
  - It is 1/5 of Exascale level of performance
- Users:

  #1-#2: US

  #3-#4: China
- Processor design & technology:

Chip	Design	Manuf.
IBM POWER9		
NVIDIA Volta GV100		
Sunway SW26010		
Intel Xeon E5		

Rank	Site	System
1	DOE/SC/Oak Ridge National Laboratory United States	**Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM
2	DOE/NNSA/LLNL United States	**Sierra** - IBM Power System S922LC, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM / NVIDIA / Mellanox
3	National Supercomputing Center in Wuxi China	**Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway NRCPC
4	National Super Computer Center in Guangzhou China	**Tianhe-2A** - TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000 NUDT

53RD EDITION OF THE TOP500 LIST (JUNE 2019)

- Top#1 today:
  - 0.2 10^{18} Flop/s Peak
  - It is 1/5 of Exascale level of performance
- Users:

  #1-#2: US

  #3-#4: China
- Processor design & technology:

Chip	Design	Manuf.
IBM POWER9		
NVIDIA Volta GV100		
Sunway SW26010		
Intel Xeon E5		

WHY EUROPE NEEDS ITS OWN PROCESSORS

- Processors now control almost every aspect of our lives
- **Security** (back doors etc.)
- Possible **future restrictions on exports to EU** due to increasing protectionism
- **A competitive EU supply chain** for HPC technologies will create jobs and growth in Europe
- Sovereignty (data, economical, embargo)

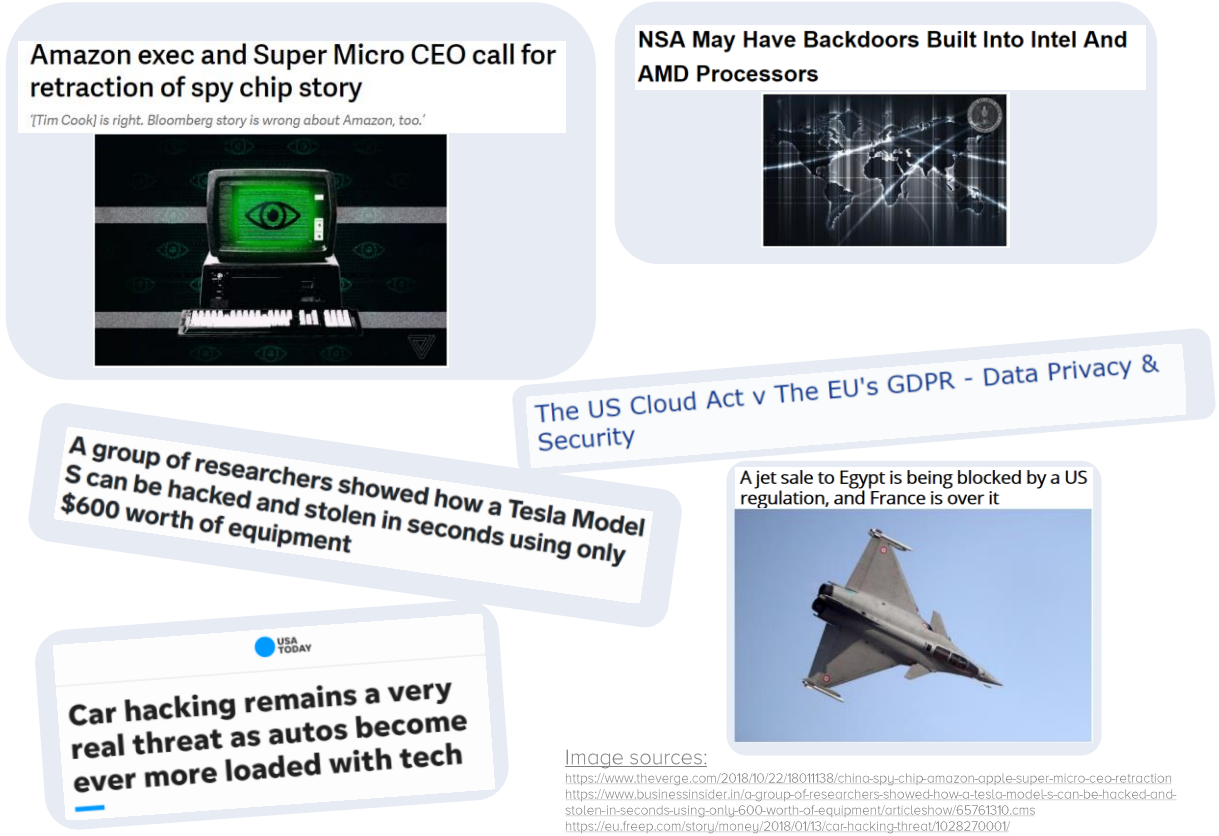


Image sources:

https://www.theverge.com/2018/10/22/18011138/china-spy-chip-amazon-apple-super-micro-ceo-retraction
https://www.businessinsider.in/a-group-of-researchers-showed-how-a-tesla-model-s-can-be-hacked-and-stolen-in-seconds-using-only-600-worth-of-equipment/articleshow/65761310.cms
https://eu.freep.com/story/money/2018/01/13/car-hacking-threat/1028270001/
https://www.eteknix.com/nsa-may-backdoors-built-intel-amd-processors/
https://www.pearse-trust.ie/blog/the-us-cloud-act-v-the-eus-gdpr-data-privacy-security
https://www.defensenews.com/global/europe/2018/08/01/a-jet-sale-to-egypt-is-being-blocked-by-a-us-regulation-and-france-is-over-it/

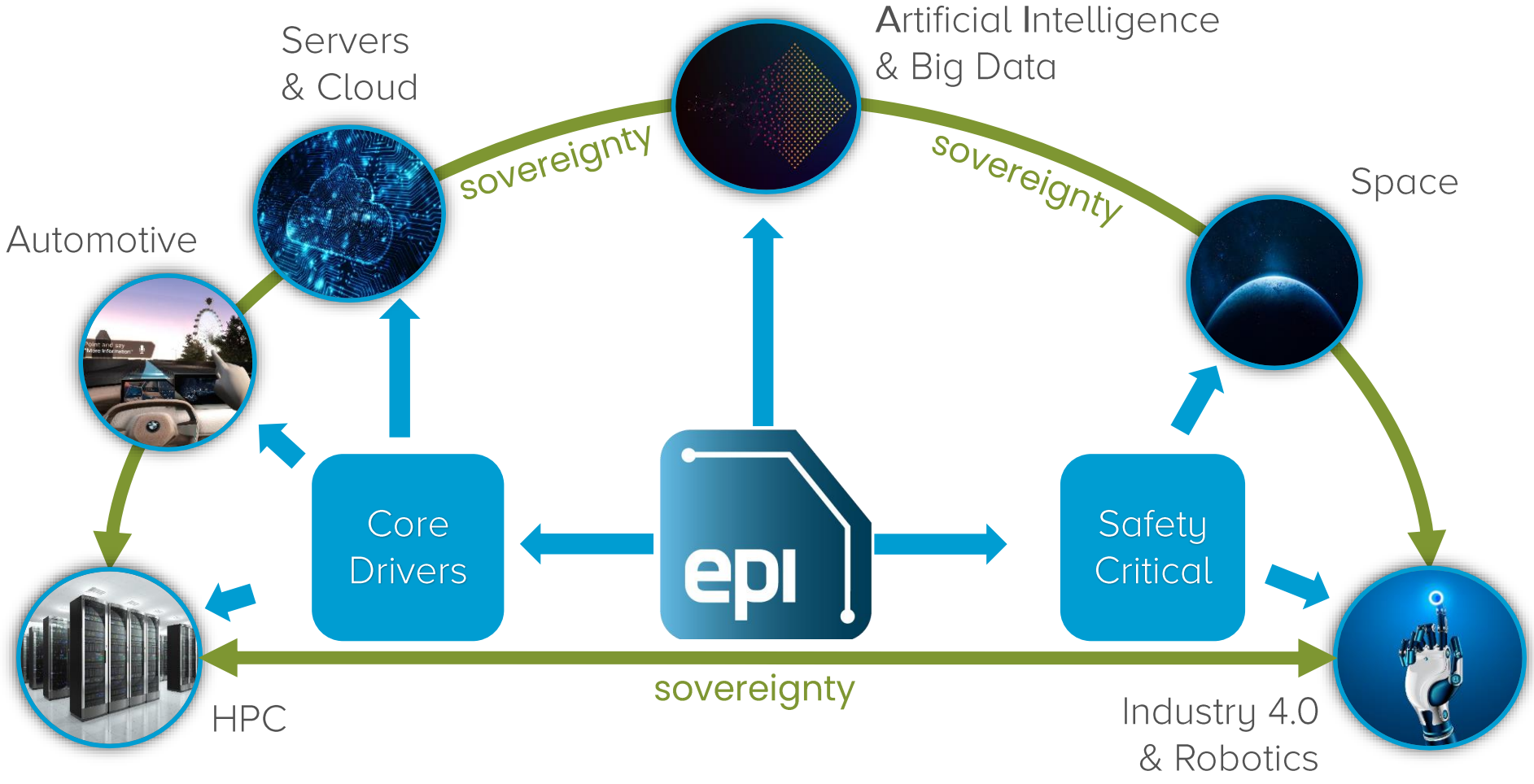
EUROPEAN PROCESSOR INITIATIVE

- High Performance General Purpose Processor for HPC
- High-performance RISC-V based accelerator
- Computing platform for edge and autonomous cars
- Will also target the AI, Big Data and other markets in order to be economically sustainable

Overall objective

Develop a complete EU designed high-end microprocessor, protecting our continent from embargos and external data control

SCALABILITY ALLOWS WIDE MARKET POTENTIAL COVERAGE



EPI TODAY

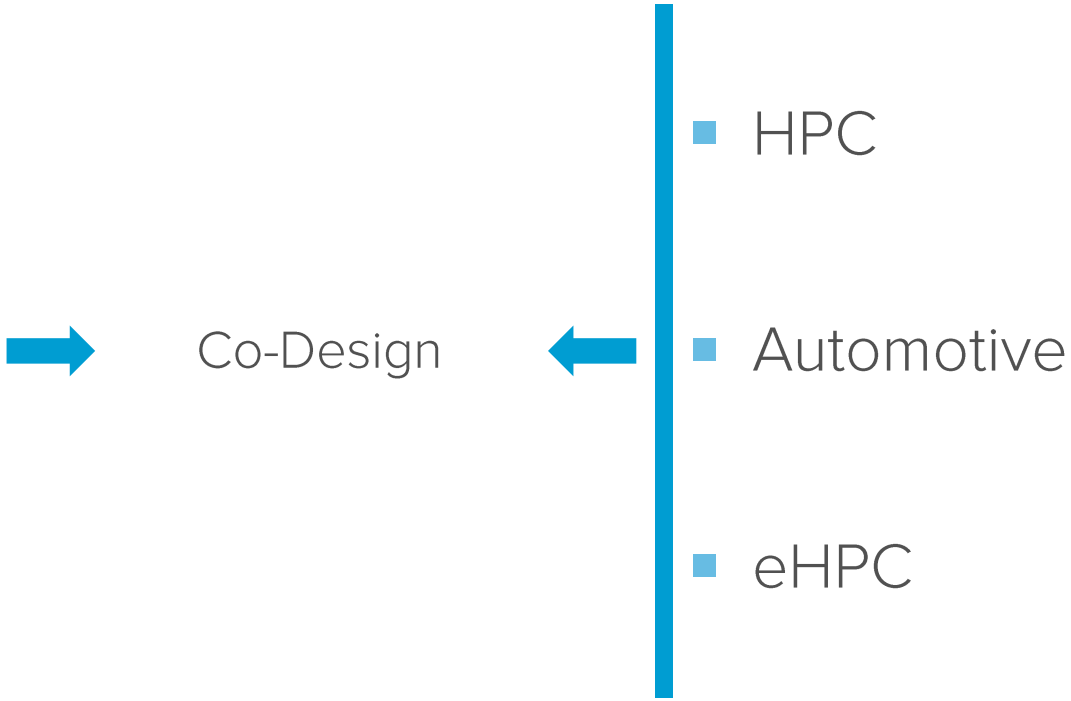
- Official kick off on Dec-2018
- Our Story is known on a WW basis with keynotes and requests from all EU countries, USA, Japan, Singapore and China

- Further Market analysis and business exploration have confirmed 2 compelling interests on top of the high-End processor for HPC and automotive markets
  - EPI End2End Security
  - EPI Common Platform for AI, Crypto and Quantum startups acceleration

EPI: 27 PARTNERS FROM 10 EU COUNTRIES

EPI KEY ELEMENTS

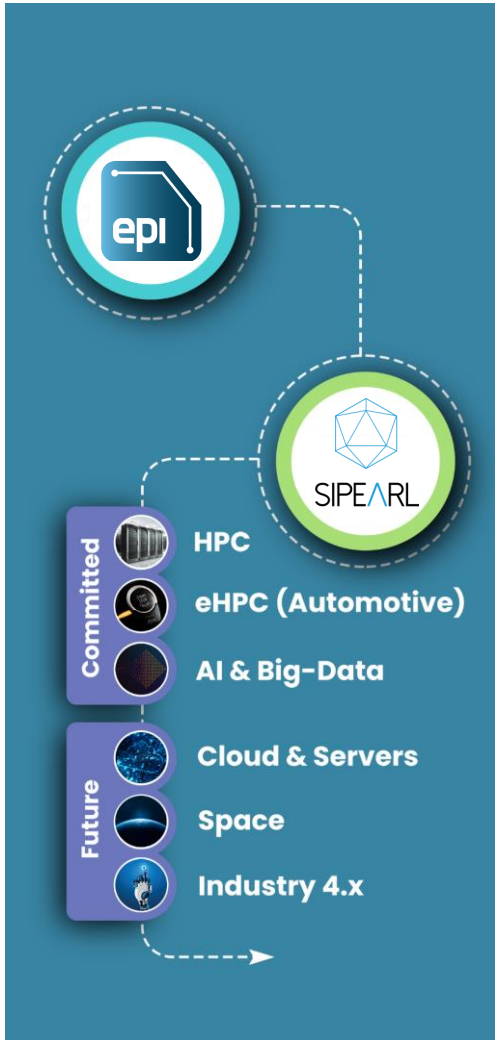
- Hardware
  - Silicon
  - IP's
- Software
  - Firmware
  - To Applications
- Security
  - Everywhere



- HPC
- Automotive
- eHPC

FROM **IPR** TO **PRODUCTS**
FROM **EPI** TO **SIPEARL**

- SIPEARL is
  - Incorporated in EU (France)
  - the industrial and business ‘hand’ of EPI
  - the Fabless company
- licence of IPs from the partners
- develop own IPs around it
- licence the missing components from the market
- Raise in equity the missing budget (~100M€)
- generate revenue from both the HPC, IA, server and eHPC markets
- integrate, market, support & sell the chip
- work on the next generations



EPI & SIPEARL ARE THE EUROHPC INDUSTRIAL CORNERSTONE

April 2016

- *« foster an HPC ecosystem capable of developing new European technology such as low power HPC chips »*
- *« …acquisition of two co-design prototype exascale supercomputers in 2020, at least one based on European technology, which will rank in the Top3 of the world »*

ROADMAP & TECHNOLOGY

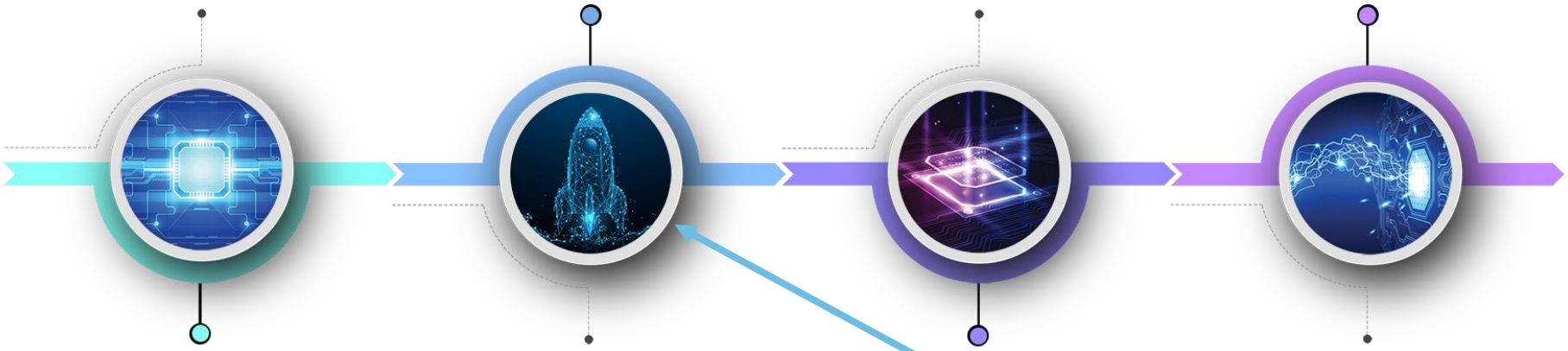
ROADMAP

EPI IP's Launch Pad
&
Pan European Research
Platform for HPC and AI

2021

ZEUS Core
5nm
2022-2023

Gen3 GPP Family



2021-2022
ZEUS Core
6nm

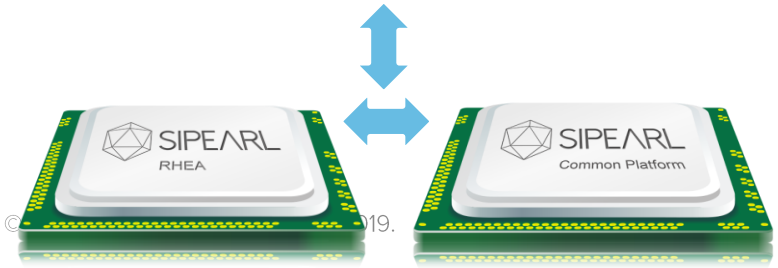
2024-...

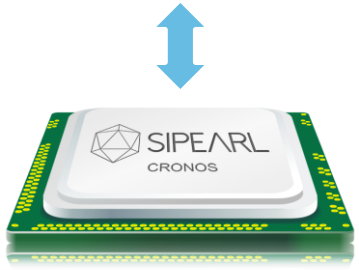
Rhea Family - Gen1 GPP

EPI Common Platform
ARM & RISC-V
External IPs
•
HPC System PreExascale
Automotive PoC

Cronos Family - Gen2 GPP

EPI Common Platform
ARM & RISC-V
•
HPC System Exascale
Automotive CPU



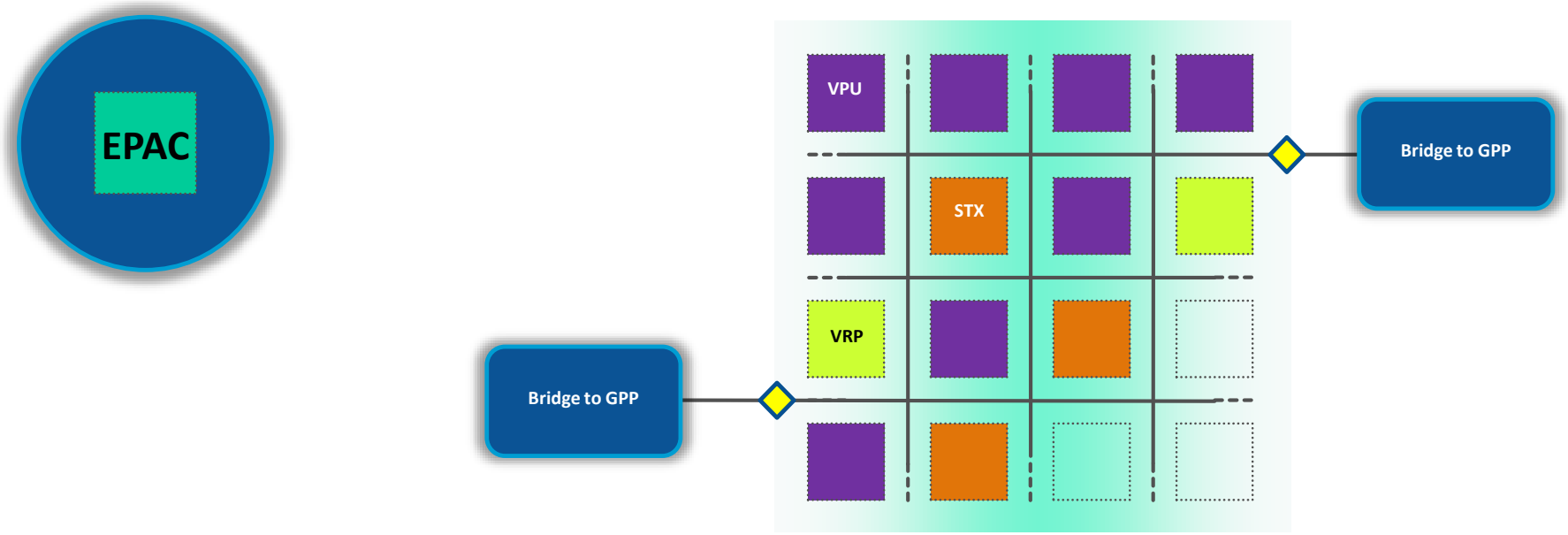


2021 – H2
PCIe board (WS compatible) with < RHEA β version

GPP AND COMMON ARCHITECTURE

- EPAC - EPI Accelerator (TITAN)
- MPPA - Multi-Purpose Processing Array
- eFPGA - embedded FPGA
- Cryptographic ASIC (EU Sovereignty)

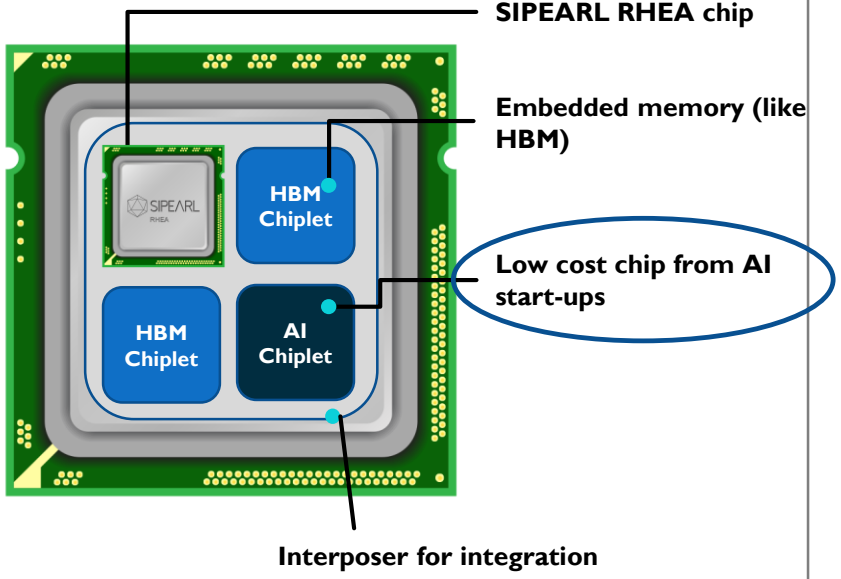
EPAC – RISC-V ACCELERATOR



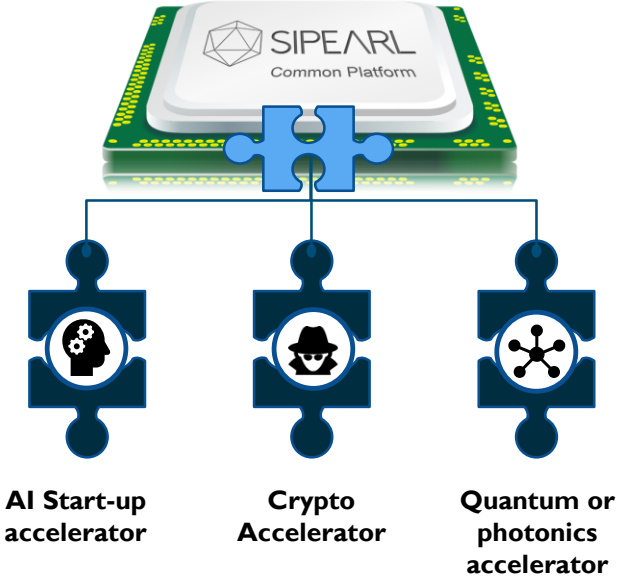
- EPAC – TITAN = EPI Accelerator
- VPU – Vector Processing Unit (plan of record)
- STX – Stencil/Tensor accelerator (PoR)

COMMON PLATFORM VISION: WE ACCELERATE ACCELERATORS

Interposer function



Value proposition



+60 potential customers

GRAPHCORE · LIGHTMATTER · thinci · PEZY Computing · cerebras · Esperanto Technologies · adapteva · DEEPSCALE · WAVE COMPUTING · Think Force · SiFive · AMPERE · TENSTORRENT · KONIKU · groq · BITMAIN · antmicro · GREENWAVE SYSTEMS · KALRAY · Tachyum · SambaNova SYSTEMS · krtkl · TERADEEP · ChipIntelli MAKE AI REAL · KNOWM · AMOTIVE · DEEP VISION · Kneron · LIGHTELLIGENCE · GREENWAVES TECHNOLOGY · MYTHIC · Cambricon · gyrfalcon technology · another brain · NOVUMIND · brainchip

COMMON PLATFORM HAS THE POTENTIAL TO BE COME THE EUROPEAN I/O STANDARD DATA-PROCESSING

European Processor Initiative

SOFTWARE

TECHNOLOGY

HOLISTIC APPROACH

- Build on successful existing approaches
- Node administration ➔ ARM +Open BMC
- Operating system ➔ Linux
- Security by design ➔ protect data (GPRD)
- Compilers ➔ GCC & LLVM
- Libraries (HPC / AI / Edge / Automotive)
- Development environment
- GPP & ACC ➔ OpenMP

Partnership is key

- On EPI own budgets
- EuroHPC RIA (calls 2019)
- Prepare EU Exascale EuroHPC landing

EPI SOFTWARE AMBITIONS IN HPC

- **Complement the already existing software** to supply an entire HPC production stack
- **Deployment/administrative side**
  - Securing the node
  - Power managing the node
  - Booting the node
  - (Remote) controlling the node
  - Running a Linux distribution on the node
  - Managing various nodes in a large system
  - Monitoring & accounting various nodes in a large system
- **End-user side**
  - Compiling software for the General Purpose Processor
  - Compiling software for the Accelerators
  - Combining the use of GPP & Accelerators in a software
  - Leveraging standard libraries tuned for the node
  - Running the software on a node
  - Running the software on multiple nodes in a system
- **Automotive (edge-HPC) requirements**
  - Security, power
  - Predictable performance for autonomous driving
    - Multiple inputs, complex models

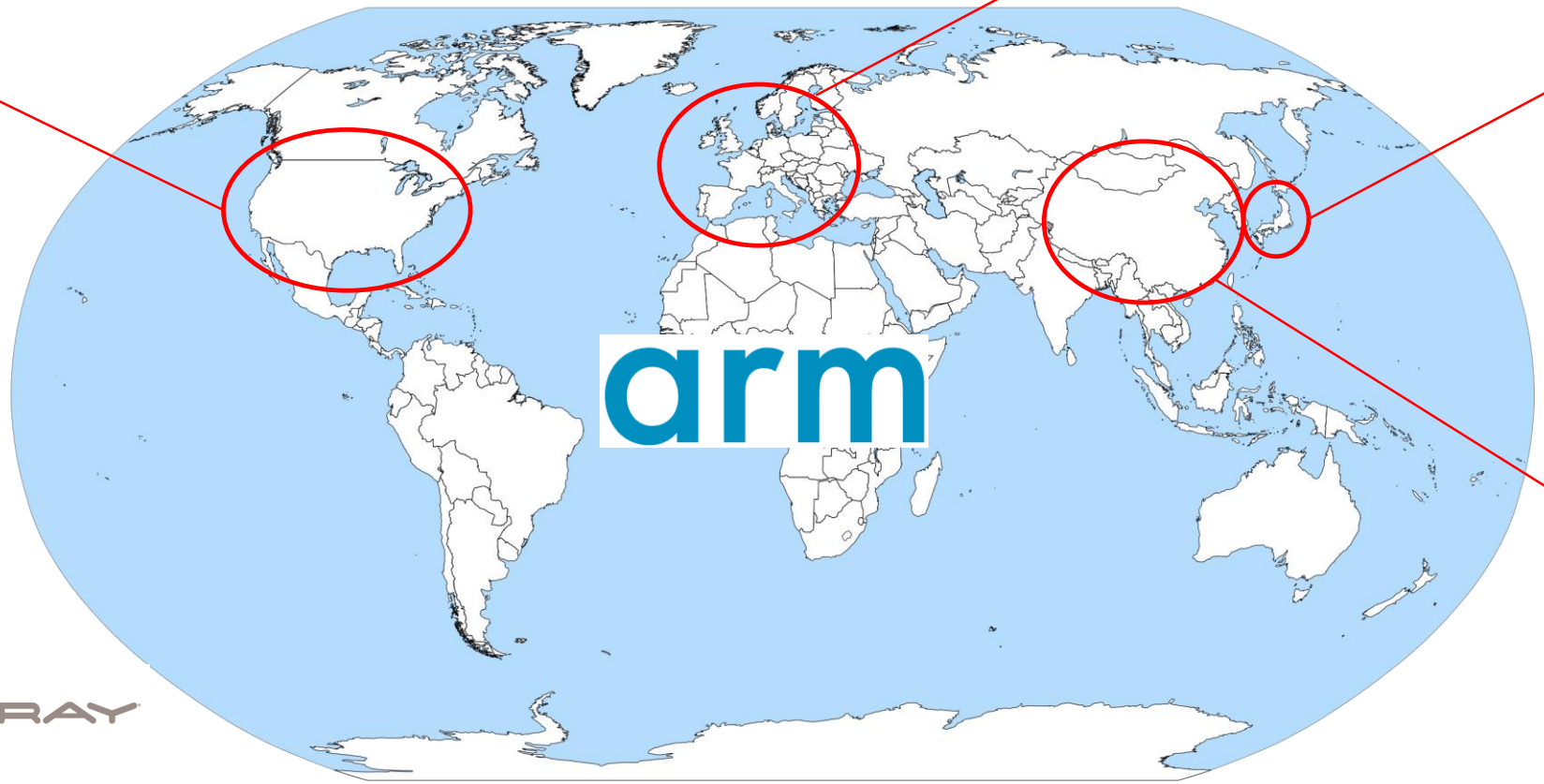
ARM WW HPC

Upcoming CPU manufacturer, Server manufacturer, system at CEA, UK, MontBlanc, EPI

CPU manufacturer, 2 server manufacturers, “Astra” system at Sandia, upcoming system at Stony Brook

CPU & server manufacturer, upcoming “Fugaku” system

CPU & server manufacturer [geopolitical issues regarding the license]

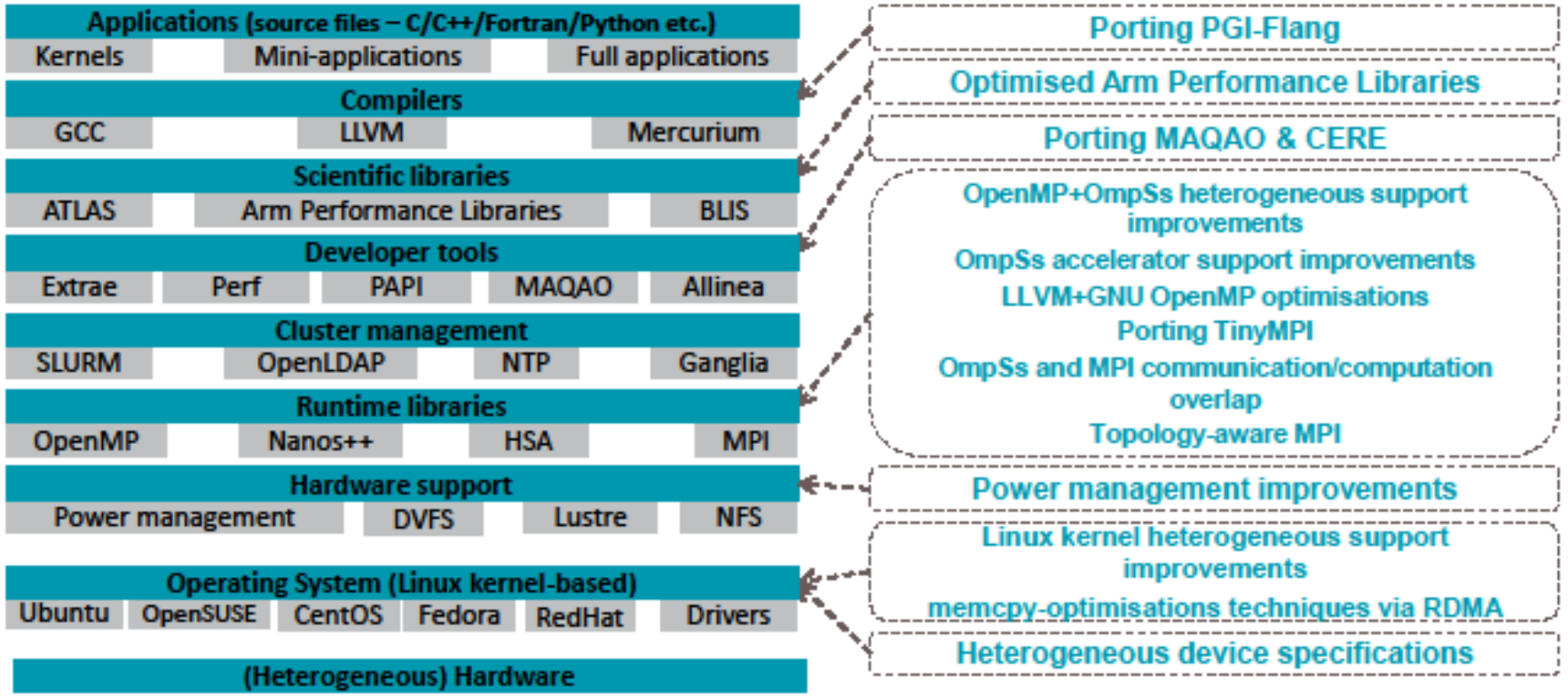


STANDING ON THE SHOULDERS OF SUCCESSFUL EUROPEAN PROJECTS

- Mont-Blanc 3 helped create and stabilize most of the foundations of a full HPC software stack on Arm

arm

HPC Arm Software Stack



+ Contribution to OpenHPC (from 1.2)

EPI ECOSYSTEM
(INCLUDING POTENTIAL OUTSIDE PARTNERS)

Full HPC Environment for the Reference Platform

Co-design exploration space

Automotive eHPC software support

Programming tools & Libraries: LLVM/GCC with OpenMP; OpenMPI; FFTW; BLIS; OpenBLAS, …

Security, Low-level software, power management

Linux Operating System

EPI Processor

EPI Reference Hardware

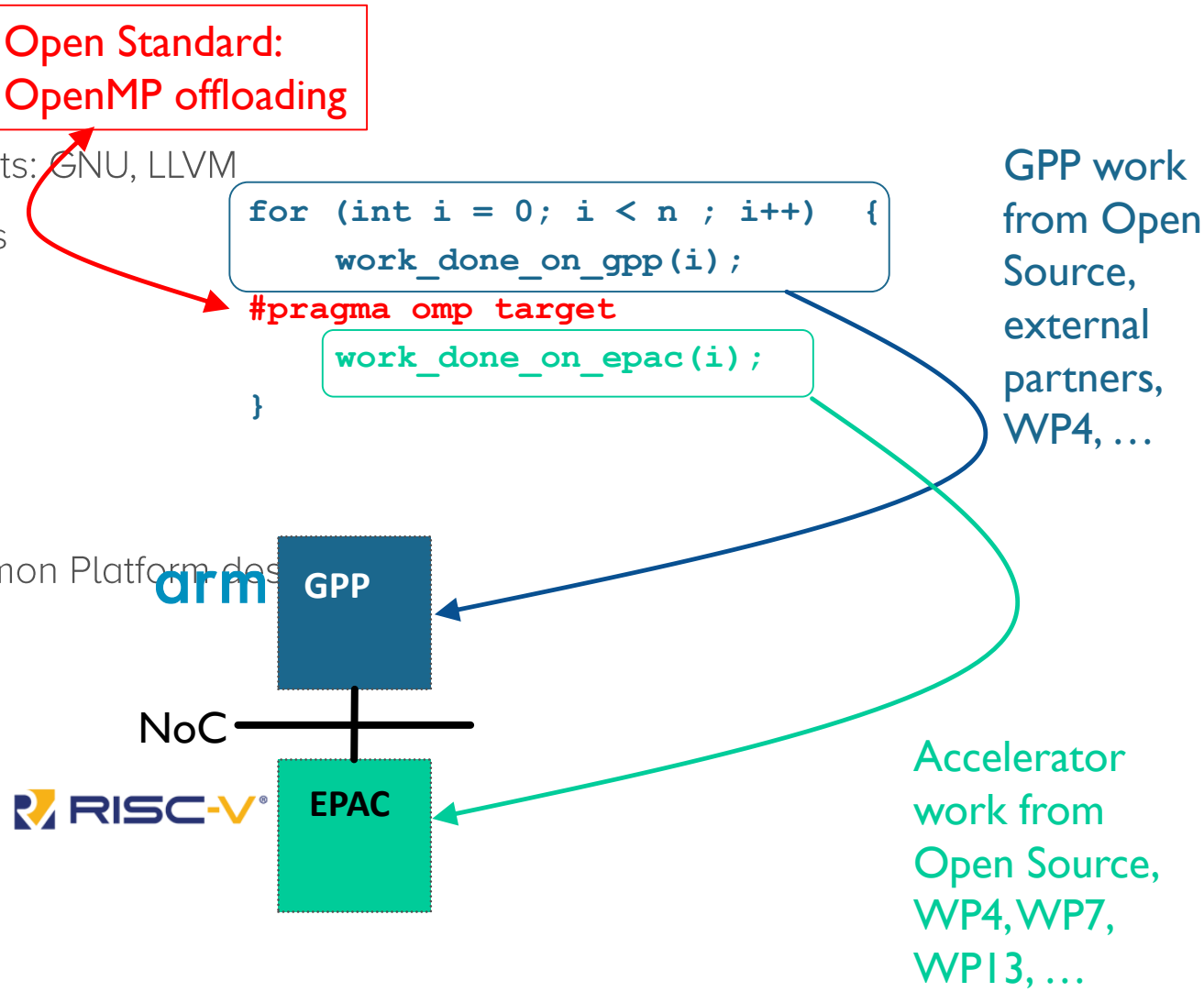
… and those supporting the ecosystem & EPI, including EPI partners, external partners & OpenSource contributors

EXPANDING TO RISC-V

- The RISC-V architecture is used extensively in EPI
  - EPAC accelerator, Power Management, …
- It is fully open and not reliant on one company for its definition
- The software ecosystem is not yet has developed as the Arm one
  - Mont-Blanc projects were instrumental in maturing the Arm ecosystem
- EPI software work includes work to bring RISC-V closer to the need of a production-ready general-purpose processor
- MPI work on RISC-V & hybrid (WP4)
- OpenMP runtime on RISC-V (WP14, WP7)
  - For offloading & native mode
- Compiler work (WP7, WP14)
  - Including OpenMP SIMD
- Using RISC-V in the industrial world as a full-fledged, linux-capable processor and not just a microcontroller
  - Real-life use to strengthen the software

END-USER

- Compiling, combining
  - Leveraging work from existing Open Source projects: GNU, LLVM
  - Choosing open standard over proprietary solutions
    - Emphasis on OpenMP in the project
    - OpenVX for automotive in WP20
  - Working with external partners
    - Arm work in LLVM & libraries for the GPP
  - EPI adding missing pieces to fully exploit the Common Platform des
    - Better vectorization in EPAC (WP14)
    - OpenMP offloading (WP4, WP7, WP14, WP20)
    - OpenMP SIMD (WP14 for R5)



END-USER

- Leveraging, running
  - Tuned libraries to support end-user – optimized FFTs, Linear Algebra, etc. on GPP & EPAC (WP4, WP14)
  - Tuned runtimes for the compiler & the OpenMP support, kernel support (WP4, WP7, WP14)
  - Multi-node support by expanding OpenMPI support for homogeneous & heterogeneous computations (WP4, WP14)
  - Enable PGAS programming model via Global Address Space Programming Interface (GASPI, WP14)
- And also third-party work enabled for EPI, building on the Mont-Blanc work
  - Arm HPC compiler
  - Arm Performance Libraries
  - UVSQ Maqao
  - OpenHPC initiative
  - …

SOFTWARE COMPONENTS

- Full boot code for the processor
  - Fully secure boot, power management, UEFI
- Linux kernel support
  - Linux on GPP
  - Linux on generalist accelerator
  - Drivers for built-in hardware
- Compilers for GPP
  - LLVM and GCC
- Compilers for Accelerators
  - LLVM and/or GCC (accelerator-dependent)
  - eFPGA, MPPA-specific toolchains
- Compilers for offload (GPP + accelerator)
  - LLVM and/or GCC (accelerator-dependent)
  - Integrated in the GPP compilers
- Runtimes & drivers for the supported native and offloaded mode
  - OpenMP target
- Libraries for the supported native and offloaded mode
  - MPI GPP, MPI accelerator
  - Numerical libraries GPP, numerical libraries accelerator
- Automotive-specific components
- And OpenSource software components

CONCLUSION

EPI NEXT CHALLENGES

Build on existing IP and w. communities

- Risk minimized by leveraging existing work
  - Open Source, previous projects, external partners
- Future-proofed by favoring open standards & simpler programming models
- Legacy taken into account to widen the potential user-base

Close the gap between R&I and industrial products

- Have EPI “delivery and product” oriented while fulfilling its needs for Research and Innovation
  - We need to be ready for production end of 2021
- Face a WW class competition
  - We will not be used because we are “engineered” in EU but because we have the best and cost effective solution
- Re-create a real ecosystem for deep node microelectronics:
  - Engineers
  - IP’s
  - …factories…

WE NEED YOU!

- EPI needs your help
- EPI will be successful through collaborations
- EPI will be successful through partnership
- EPI needs your expertise

- Key areas of collaboration / partnership
  - Development tools
  - Libraries
  - Applications

- DG-CNECT & EUROHPC want to see more collaboration between EPI and RIA calls

- Contact us!

European Processor Initiative

- www.european-processor-initiative.eu
- @EuProcessor
- European Processor Initiative
- European Processor Initiative