Pre-exascale Architectures: ARM Performance & Usability Assessment for French Scientific community

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GENCI (GRAND EQUIPEMENT NATIONAL DE CALCUL INTENSIF)

Enabling scientific community in France and Europe

- 40PF+
- 5 partners
- 3 national centers Tiers 1
- 1 National center Tiers 0
- 3 supercomputers
- 100PB+ data
- $x^2/y$ computing power
- $>600$ projects/yr

- Provides state-of-the-art, performant and mature computing resources to academic and industrial French Research Community

- Represents France into the European HPC ecosystem through PRACE
THE FUTURE IS, AT LEAST, CONVERGENCE DRIVEN

More complex scientific challenges & discovery dealing with data explosion

Science

Climat/météo
Modèles globaux à 1km
Ensembles multi physiques

Fusion par confinement
Simulation échelle 1 ITER
Dimensionnement, fonctionnement, sécurité, performances du futur réacteur

Sciences de la vie
Interactions protéines/médicaments & effets des mutations sur systèmes
> 200k atomes simulations sur plusieurs μs

Instrumental data

SKA 4 EB/Y
SWOT 1.5 EB/Y

Genomics
IoT – Edge computing

Our 1st step: Jean Zay, the largest converged machine in Europe production ready

900% oversubscription

Computationnel

Climate
Cosmology
Fusion
Reservoir modelling
A 10 YEARS PATH TO ARM BASED EXASCALE

Strong French involvement

2011
- co-design
  - 11 applications
  - Progammability
  - Define ARM ecosystem to assess maturity of the software ecosystem
  - Energy efficiency

2018
- co-design
  - 5 applications
  - Progammability
  - Vectorisation instruction best support, etc.
  - And even more… *Convergence HCP/AI*

2022-2023
- Exascale
  - Sustained performance driven
  - ARM readiness ecosystem
  - ARM EPI anticipated technology
ARM TECHNOLOGY WATCH

Enabling Future production

X86 Intel Skylake
KNL Intel
X86 AMD Rome (HDR)
NVIDIA V100 (HDR)

Ouessant – IDRIS - 2017
OPA – Power8 – GPU
P100
12 nodes bi-sockets
254 Tflops GPU only
Lead Jean Zay acquisition

Frioul – CINES - 2017
IB EDR - KNL based
48 nodes bi-sockets
146 TFlops
Lead to the first Joliot-Curie KNL deployment

MARVELL Thx3 (BXI)

Inti – CEA - 2019
IB EDR – ThX2
30 nodes bi-sockets
Lead to the acquisition of 2nd phase of Joliot-curie 2 ThX3 based

X86 Intel Cascade Lake
NVIDIA V100
OPA

X86 Intel Haswell
X86 Intel Broadwell
IB FDR

H2 2020
March 2019
APPLICATIONS DRIVEN PROCESS

When application owners, chip designer & maker and solution suppliers work together

- **2 hackatons (09/18 & 06/19)**
  - Single node performance
  - Comparison between ARM and x86 architecture
  - Application scalability

- **3rd hackaton (TBD – Dec.?)**
  - Software ecosystem (Gem5, ArmIE comp. etc.)
  - Feed EPI WP1
  - Attendees: Expert applications owners

- **GENCI open to higher involvement with similar initiatives**
  - Understand respective target(s)
  - Share best practises
  - Define topics to focus on per user’s groups
  - Hackaton all together
  - Regular synchronisation
SINGLE NODE PERFORMANCE

ThunderX2 speed-up versus Intel top bin SKU

- 2xCavium ThunderX2 (32cores@2.2GHz) vs 2xIntel Xeon Platinum 8168 (24cores@2.7GHz)

- 4 white boxes
- Marvell ThX2 – 32c/2.2Ghz
- Compiler ARM 18.4.2
- 15 diverse scientific applications
- Smooth code portability
- +25% increase performance for memory bound applications NEMO, Meso-NH, HYDRO compare to Intel SKL SP

AVBP | Dynamico | GROMACS | Hydro | MesoNH | NAMD | NEMO | PATMOS | PPKMHD | SMILEI | Specfem3D | Tokam3X | TRUST | Yale32 | Mean
---|---|---|---|---|---|---|---|---|---|---|---|---|---|---
0.65 | 0.89 | 0.55 | 1.25 | 1.28 | 0.96 | 1.00 | 0.43 | 0.88 | 0.34 | 0.85 | 0.49 | 0.42 | 0.80 | 0.77

15/09/2019
ARM RESEARCH SUMMIT
MULTI NODES PERDFORMANCE

Strong scalability efficiency for NEMO, SPECFEM3D, GROMACS, AVBP, YALES2

- Results aligned with user’s expectations
- Conditions
  - ARM 19.2
    - NEMO (2 test cases)
    - SPECFEM3D
    - AVBP
  - ARM 18.4.2
    - NAMD
    - GROMACS
    - YALES2

Applications Scalability OpenMPI 2.0.4

- Gromacs
- Specfem3D-Globe
- NAMD
- AVBP
- NEMO (BENCH_1)
- NEMO (GYRO_PISCES_25)
- YALES2
- NEMO (BENCH_1) (110Mcells)
ARM COMPILERS IMPACT@SCALE

Specfem3D performance improvement due to arm compiler enhancement

- **ARM 18.X**
  - Better results than 19.0
  - Lower results than 19.2

- **ARM 19.2**
  - Single node
    - SPECFEM3D: +2%
    - AVBP: +11%
  - @Scale
    - SPECFM3D: +50%
  - NEMO benefits from 19.2

- **Next step**
  - ARM 19.3 (30/08)
  - ARM 20.0 later
Slighty better efficiency openMPI 4.0.1

![Scalability using OpenMPI 4.0.1 (green) and 2.0.4 (yellow)](image)

- **SPECFEM3D**
  - 4% improvement

- **GROMACS Test case B**
  - Prace UEABS
  - Slight improvement
STRENGTHENING & FASTENING A FUTURE MASSIVE ARM ADOPTION

ARM capabilities & plans

❑ Understanding the whole ecosystem
  ▪ Compute is important, Data & IO processing is even as important as compute

❑ HPC, AI -> HPC/AI convergence
  ▪ ARM+X ? Support NVIDIA and/or AMD GPU
  ▪ Ensure memory coherency between CPU and accelerators and beyond
  ▪ ARM involvement in CXL standard ?
  ▪ Understand HBM support programmability: Tiering & memory hierarchy

❑ SVE capabilities
  ▪ 3rd hackaton
  ▪ ArmIE
  ▪ GEM5 simulator (vector length, instructions nb, etc.)
SPECIAL danke merci gracias grazie thanks arigato...
Vector length influence

- compilation
  - Add -mcpu=native+sve
- run
  - srun armie -msve-vector-bits=512 -i libinscount_emulated.so -- xspecfem3D

- >512 bits
  - High overhead
  - Investigation in next hackaton