Gray Scott 2026 - 2027 : Computing on heterogeneous hardware

Pierre Aubert

Reprises

Reprises

IN2P3 transverse project

~ **20** people

Reprises

IN2P3 transverse project

~ **20** people

Reprises

IN2P3 transverse project

~ **20** people

Performance tests

Valgrind MAQAO Perf

Precision

Cadna

Container

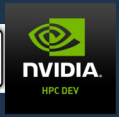
apptainer.org docker

C++ Fortran

Reprises

IN2P3 transverse project

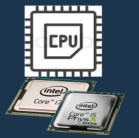
~ **20** people

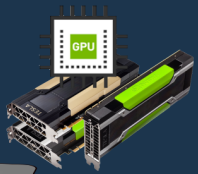


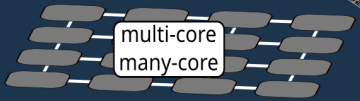
Reprises

IN2P3 transverse project

~ **20** people







TERATEC / EuroCC / EuroHPC

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- **Association**
- **Valorisation** / **Dissemination** of Knowledge :
  Schools / **Seminars** / **Interviews**
- **Bridge** between **Academy** and **Industry**

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EuroCC (Catalog of HPC/HTC/HPDA formations)

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+33 Countries

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+33 Countries

Gray Scott School 2024 : Reloaded

A free High Performance Computing Summer School
(1-12 july 2024)

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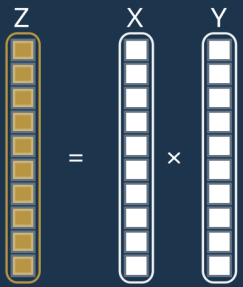
Simple Examples

Simple Examples

Hadamard Product



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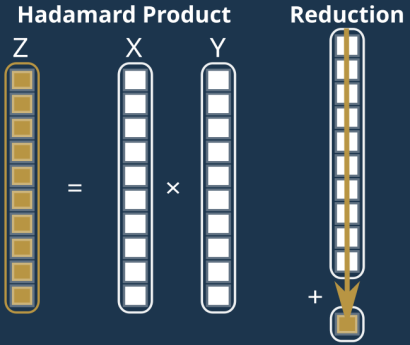

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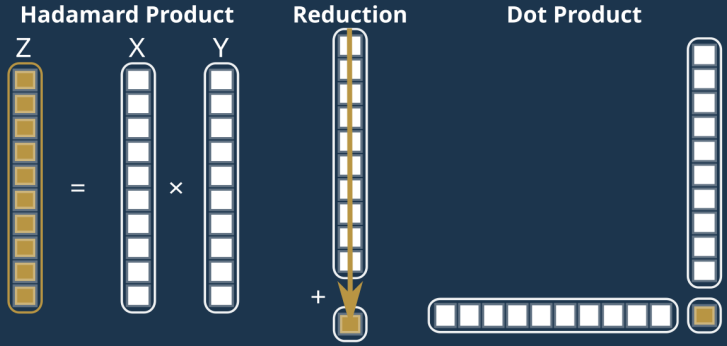

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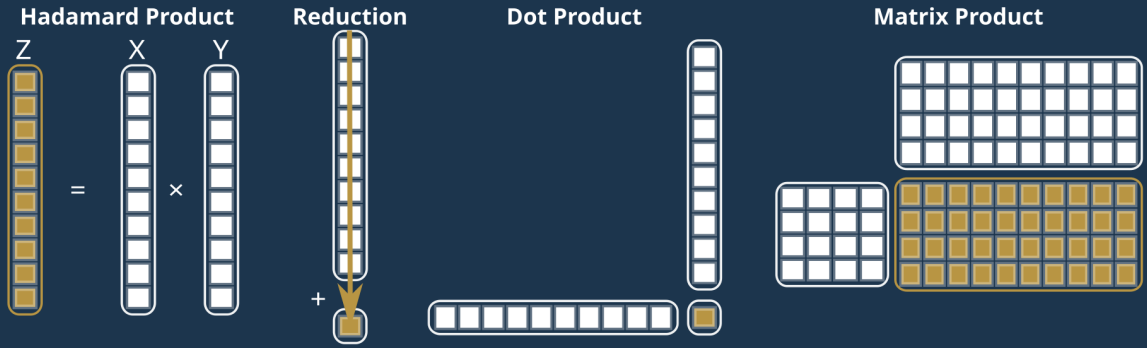

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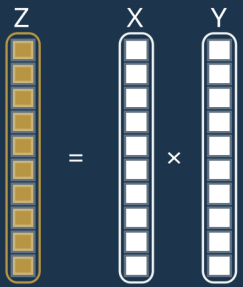
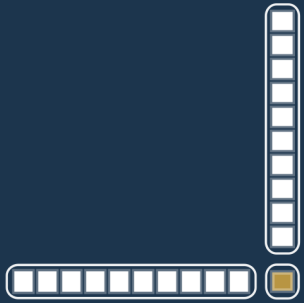
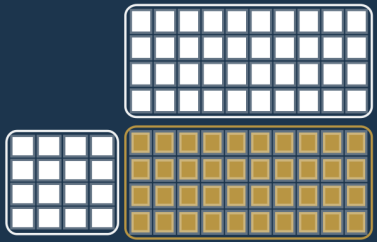


Reduction

Dot Product



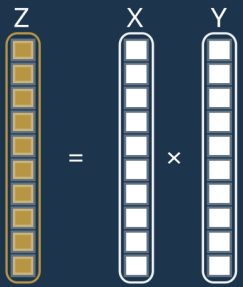
Matrix Product



MKL

Simple Examples

Hadamard Product



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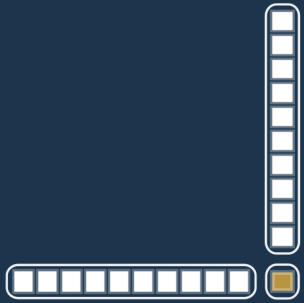

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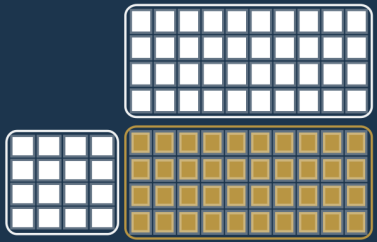
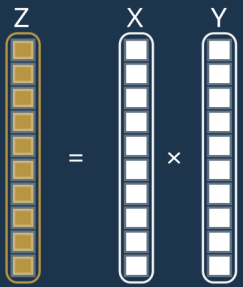


MKL

Eigen

Simple Examples

Hadamard Product



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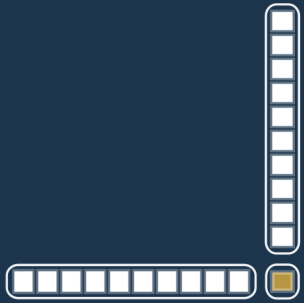

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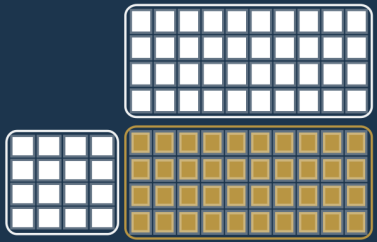

MKL

Eigen

Armadillo

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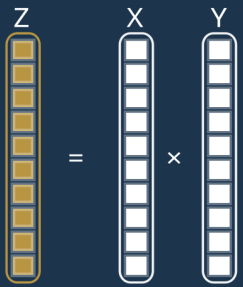

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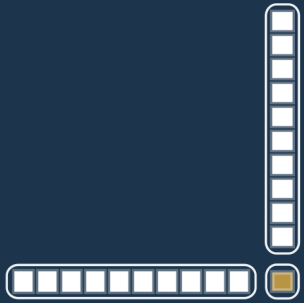

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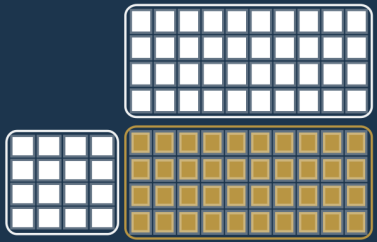

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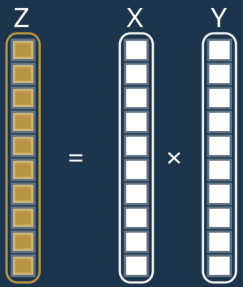

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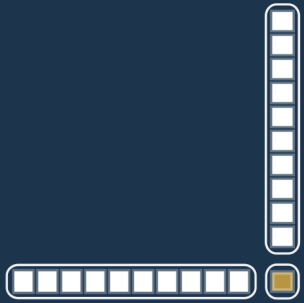

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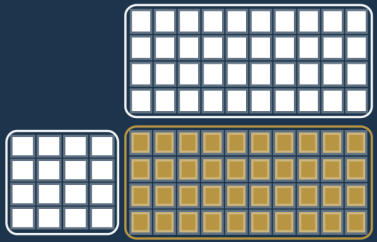

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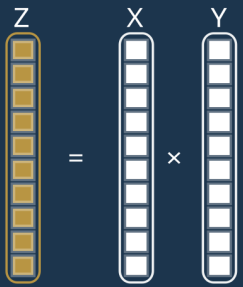

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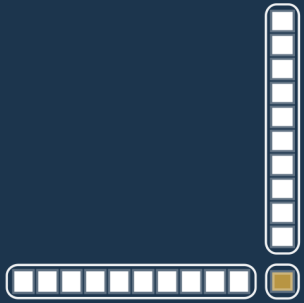

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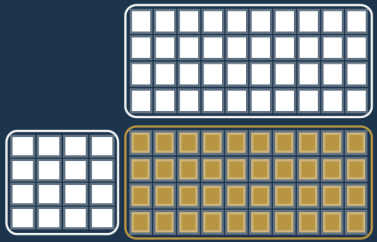

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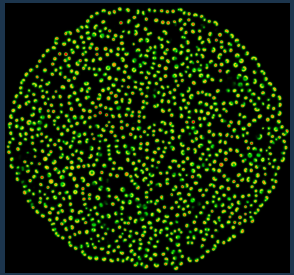
School computing example

Gray Scott reaction (a chemistry game of life)



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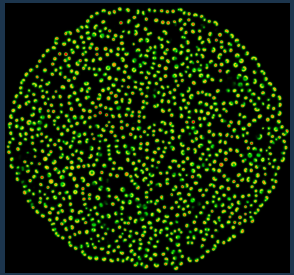
$$
\begin{aligned}
U + 2V &\longrightarrow 3V \\
V &\longrightarrow P
\end{aligned}
$$



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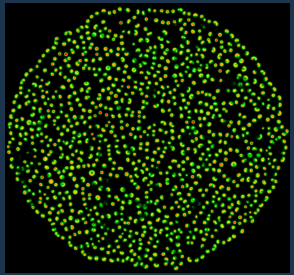
Gray Scott reaction (a chemistry game of life)

Computing :

$$\begin{aligned} U + 2V &\longrightarrow 3V \\ V &\longrightarrow P \end{aligned}$$

$$\begin{aligned} \frac{\partial u}{\partial t} &= r_u \nabla^2 u - uv^2 + f_r \times (1 - u) \\ \frac{\partial v}{\partial t} &= r_v \nabla^2 v + uv^2 - (f_r + k_r) \times v \end{aligned}$$



- u and v are concentration of product **U** and **V**
- r_u and r_v diffusion rate of **U** and **V**
- k_r (**Kill Rate**), conversion rate from **V** to **P**
- f_r (**Feed Rate**), speed of process which feed **U** and kills **V** and **P**
- $\nabla^2 u$ and $\nabla^2 v$ are différence of space concentration between current cell and its neighbours

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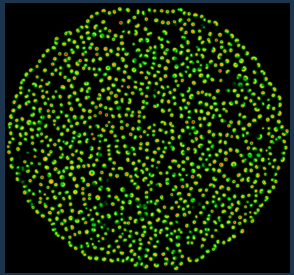

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- Easy to understand
- Not so easy for the compiler
- Possibility of high speed up

Languages / Technos

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Fortran

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Fortran

(NUMA)

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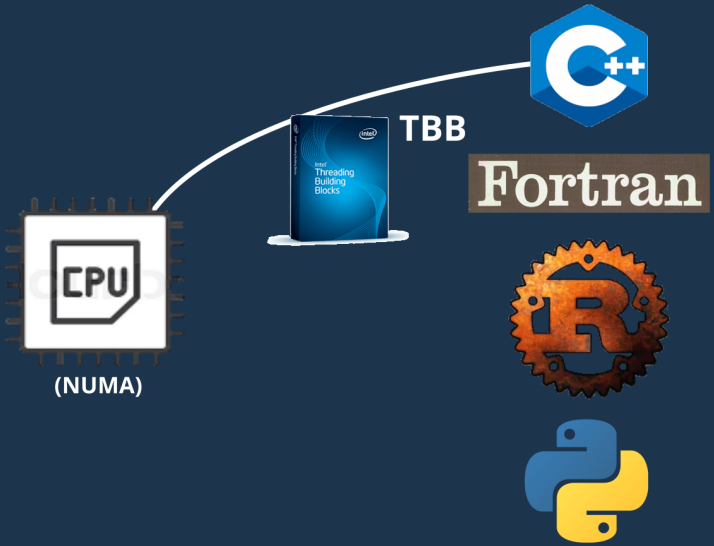
Fortran

Languages / Technos



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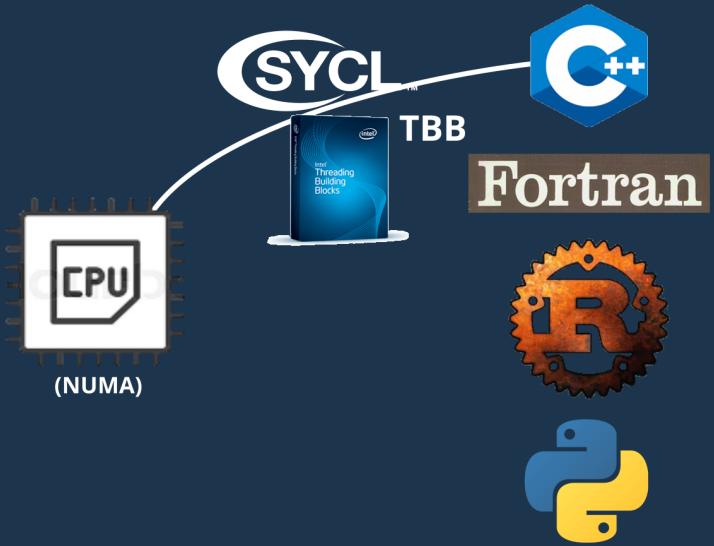

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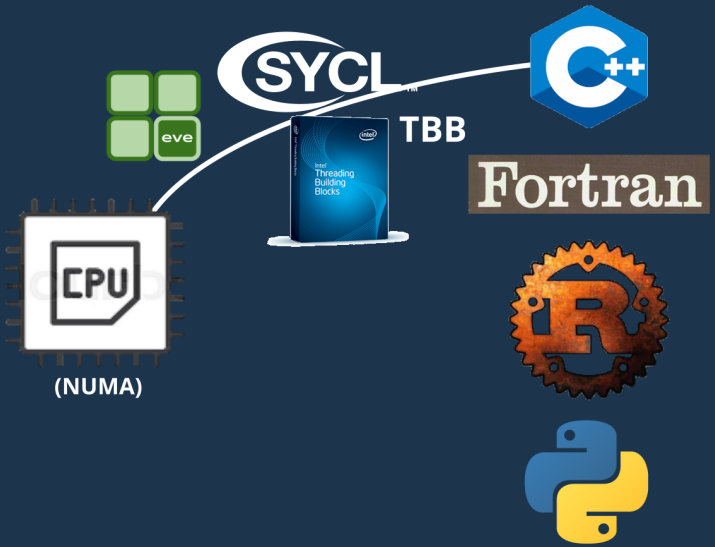

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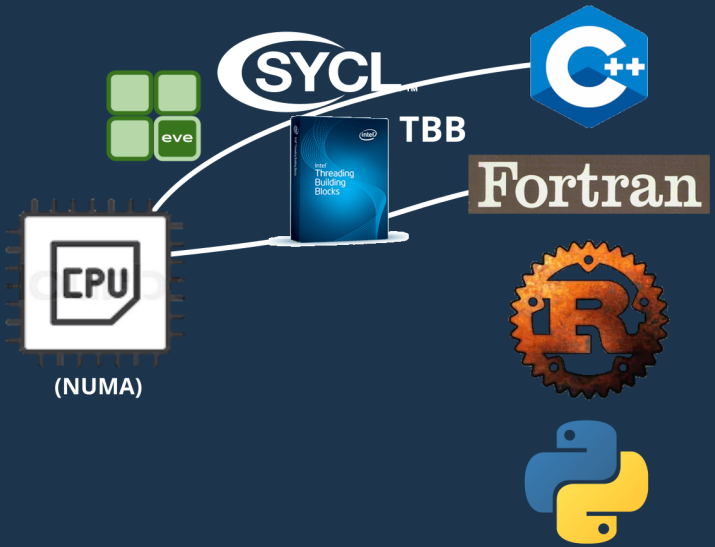

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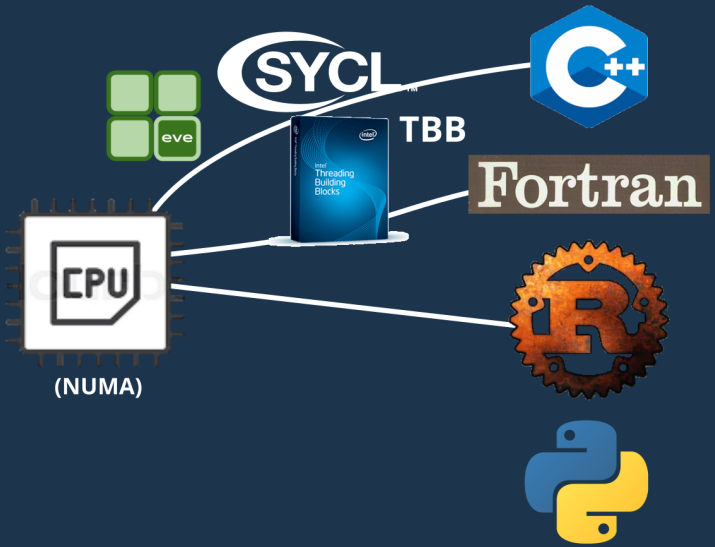

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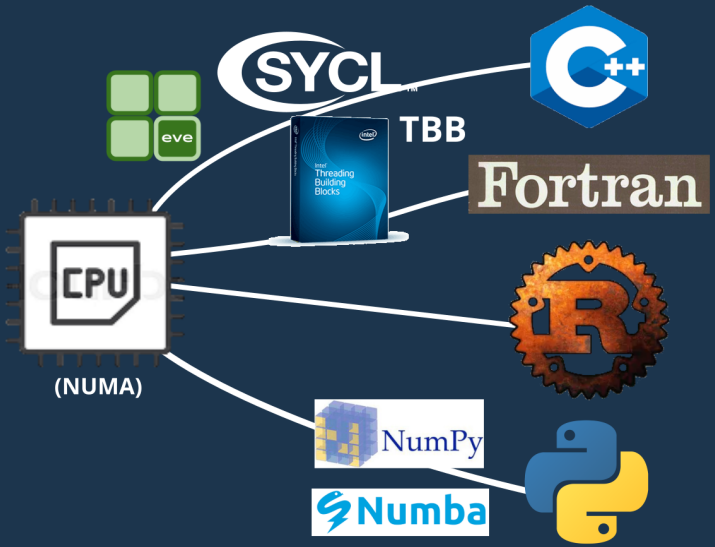

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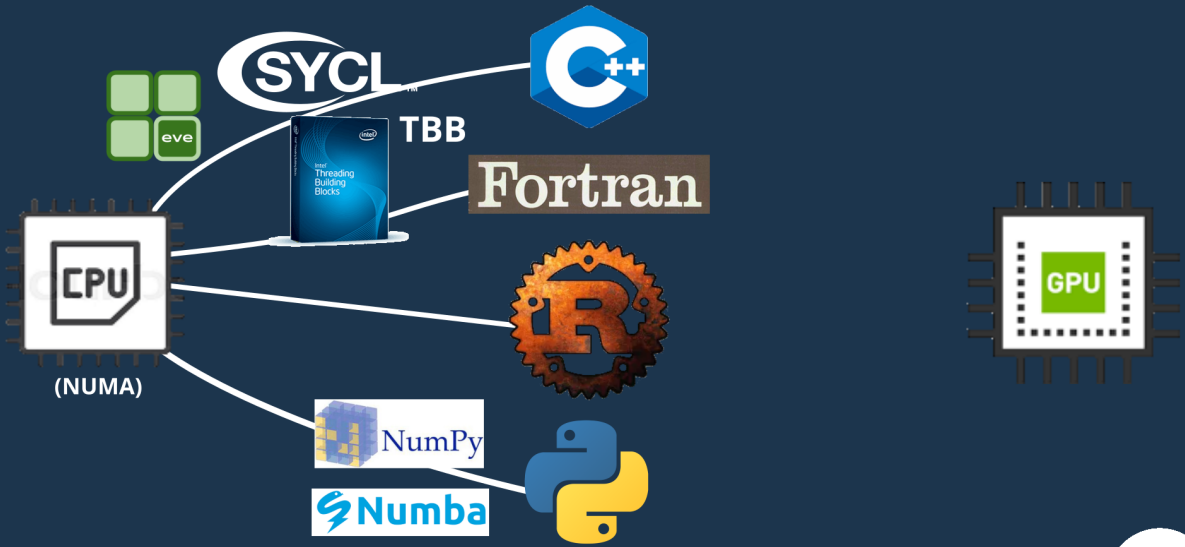

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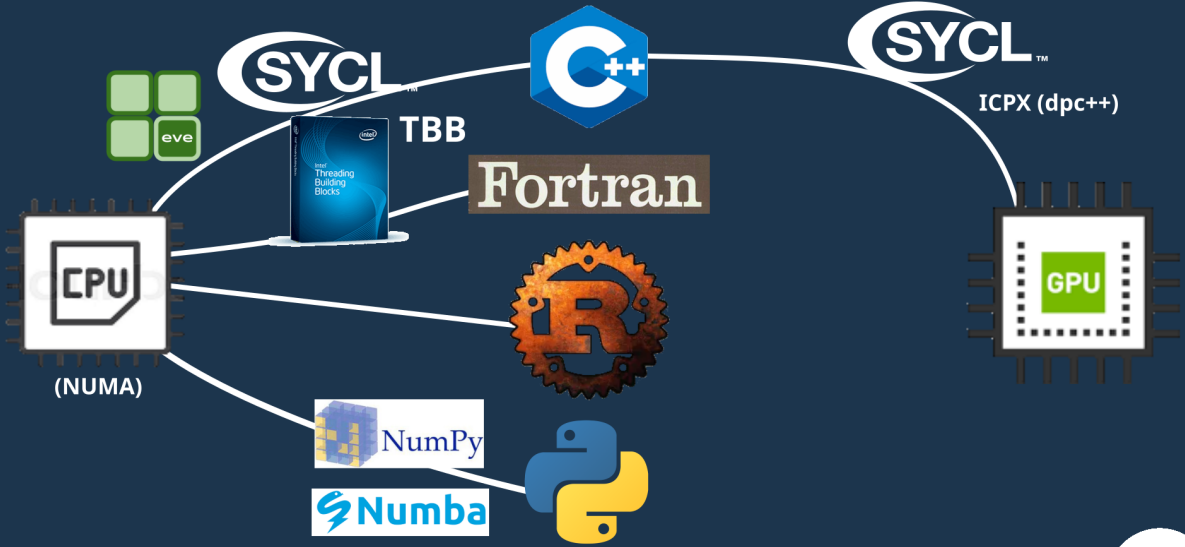

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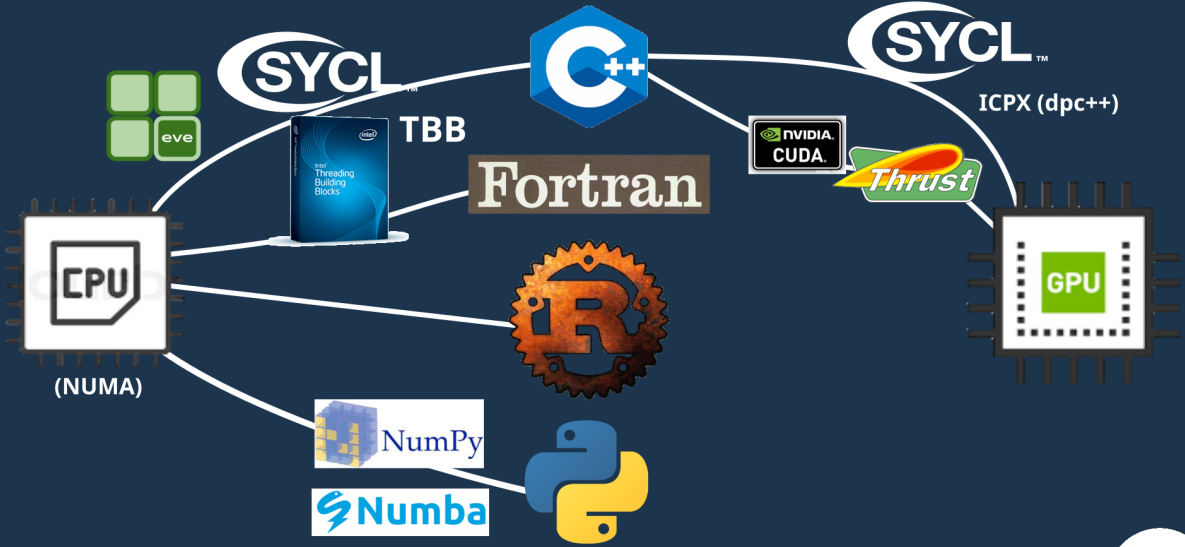

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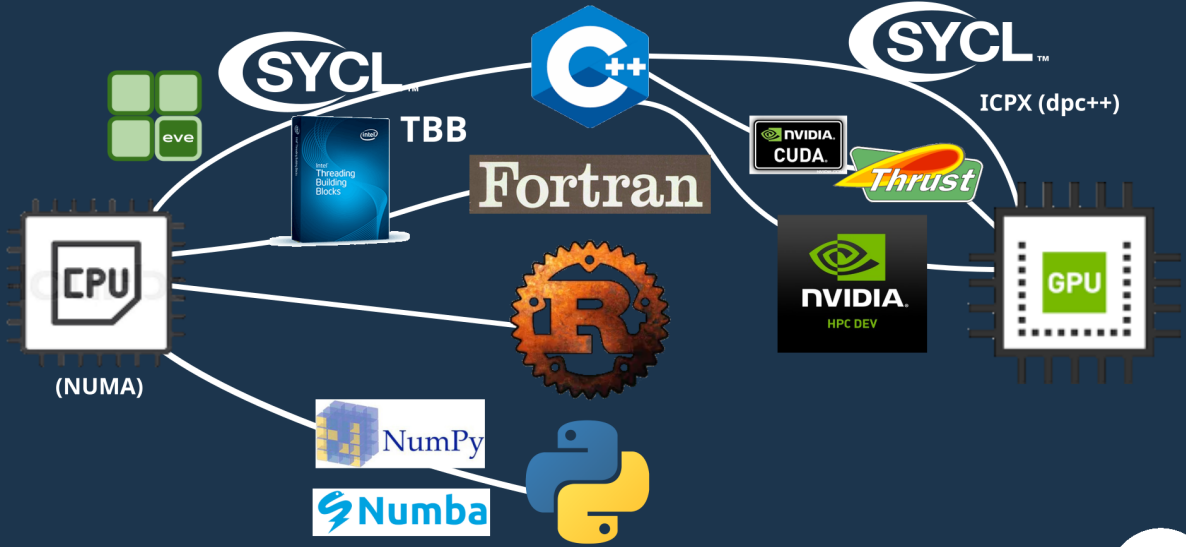

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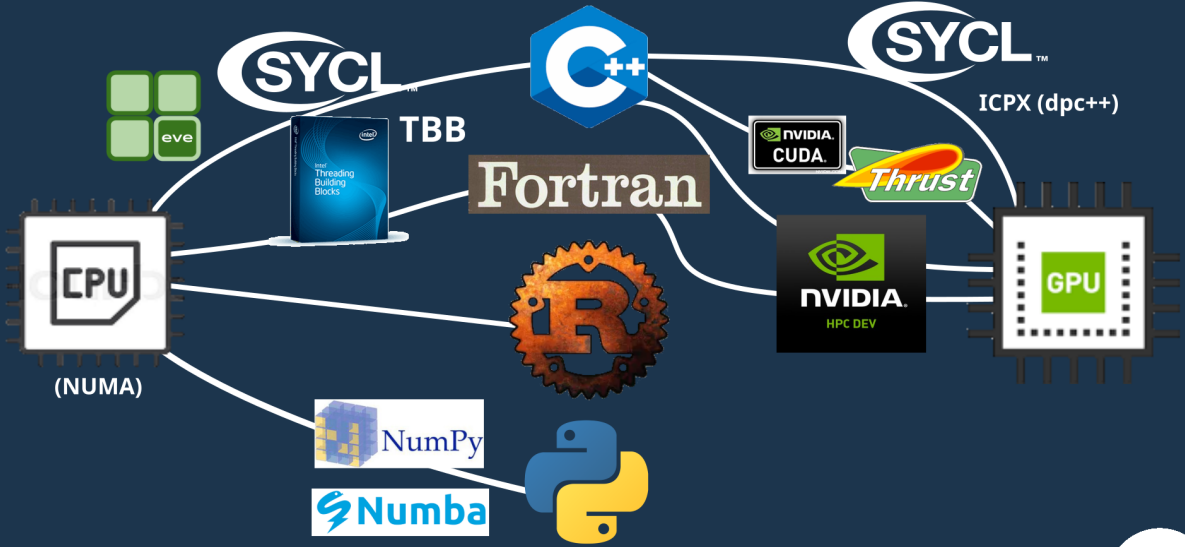

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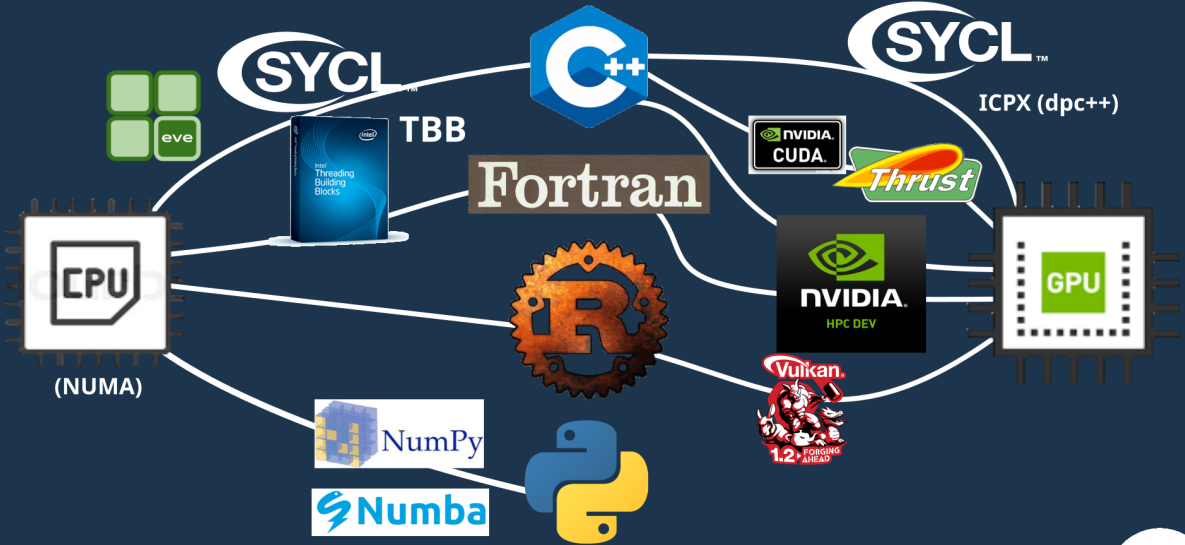

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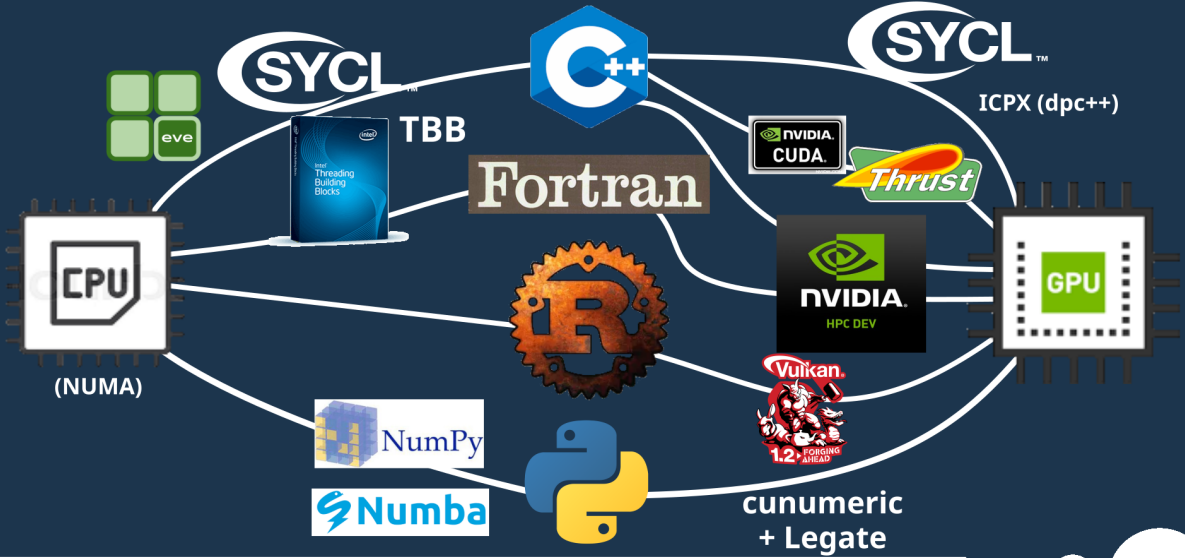

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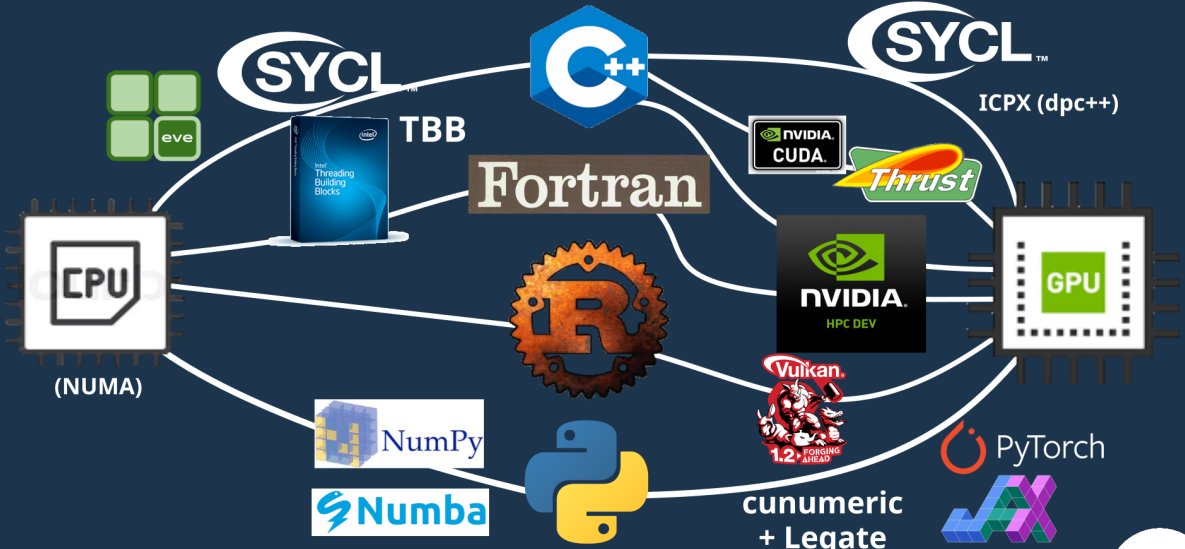


Tools

Tools

Performance tests

Perf

MAQAO

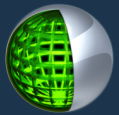
NSight

Tools

Performance tests

Perf

MAQAO



NSight

Memory Profiler

MATL

NUMA Prof

Tools

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Perf

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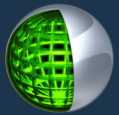

NSight

Compilers

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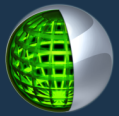

NSight

Compilers

LLVM : CLang /
CLang ++ / FLang

Memory Profiler

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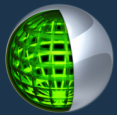

NSight

Compilers

LLVM : CLang / CLang ++ / FLang

GNU : GCC / G++ / GFortran

Memory Profiler

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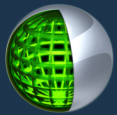
Perf

MAQAO



NSight

Memory Profiler

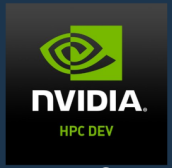
MATL

NUMA Prof

Compilers

LLVM : CLang / CLang ++ / FLang

GNU : GCC / G++ / GFortran



nvc++ / nvfortran

intel

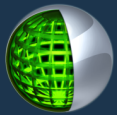
icpx / dpc++

Tools

Performance tests

Perf

MAQAO



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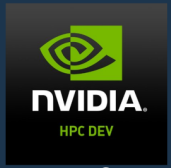


nvc++ / nvfortran

intel

icpx / dpc++

Precision

git

Memory Profiler

MATL

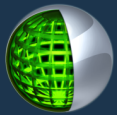
NUMA Prof

Tools

Performance tests

Perf

MAQAO



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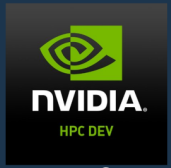

nvc++ / nvfortran

intel

icpx / dpc++

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git

Gitlab

Memory Profiler

MATL

NUMA Prof

Tools

Performance tests

Perf

MAQAO

NSight

Compilers

LLVM : CLang / CLang ++ / FLang

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NVIDIA HPC DEV

nvc++ / nvfortran

intel

icpx / dpc++

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Memory Profiler

MATL

NUMA Prof

git

Gitlab

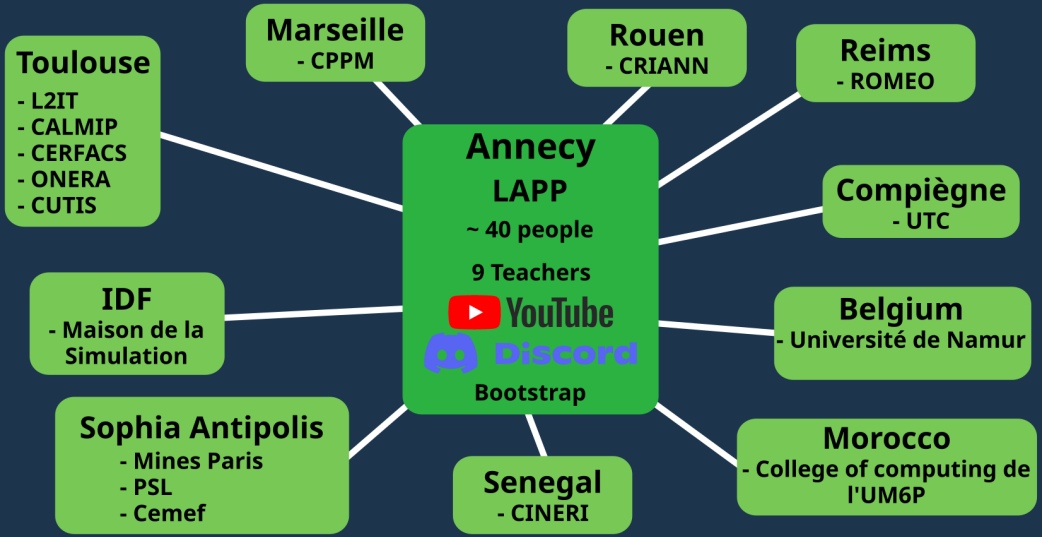
CMake

Cross-platform Make

Multi-site diffusion

Multi-site diffusion

Multi-site diffusion



Following Lectures

Following Lectures

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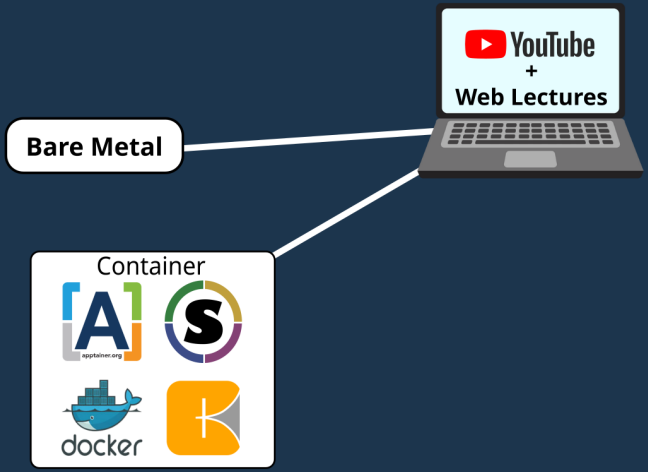
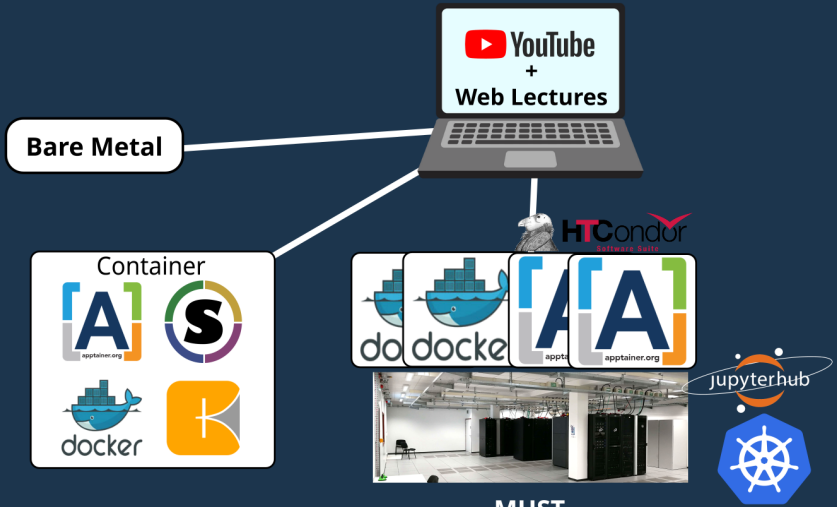


Following Lectures



Following Lectures

YouTube
+
Web Lectures

Bare Metal

Container

CERFACS

ROMEO

CRIANN

HTCondor
Software Suite

MUST

jupyterhub

slurm
workload manager

Following Lectures

Hardware :
- CPU : Intel, AMD
- GPU : NVidia CC >= 6, AMD

Bare Metal

YouTube + Web Lectures

Container

HTCondor Software Suite

MUST

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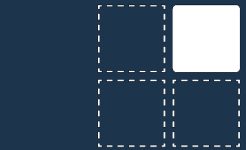
Sponsors



CODE RECKONS

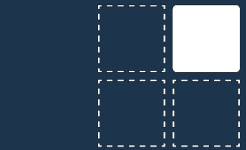
Science to the CORE

intel®

EVIDEN

an atos business

Sponsors



CODE RECKONS

Science to the CORE

intel

EVIDEN

an atos business

Computing center access

Engineers helping at bootstrap day

Statistics : 2024

- **9** teachers
- **18** webinars (almost **weekly** from **January** to **June**)
- **3** connection modes
- **12** Satellitte Sites
- **4** countries (**France**, **Belgium**, **Morocco**, **Senegal**)
- **642** Attendees
  - **~400** people following school on **YouTube**
  - **~200** people following school on **Discord** (**530 Discord accounts** created)
- **~50** Containers-lectures compatible with **Docker**, **Apptainer**, **Podman**, **Kubernetes** and **OpenStack**
- **Lectures available on laptop/remote server/HT condor/slurm (Intel / AMD)**
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Next school : 23 june - 04 July 2025

Gray Scott School 2025 : Revolutions

A free High Performance Computing Summer School
(23rd june - 4th july 2025)

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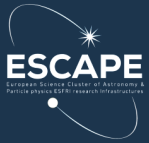

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EURO

ESCAPE
European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures

cnrs

Inria

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cnrs

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L2IT

LAPP

Laboratoire de Physique des 2 infinis Irène Joliot-Curie

LUPM LABORATOIRE MONTPELLIER UNIVERS & PARTICULES

LPNHE PARIS

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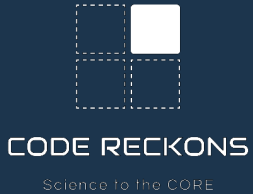
Sponsors 2025



EOLEN (AS+)

DoItNow (HPC as a service)

Carno

Statistics : 2025

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  - **+5400 views** on YouTube
- **3** connection modes
- **16** Satellitte Sites
- **51** countries (basically from **America** to **New-Zeland**)
  - Officially **31** countries (**19** in Europe)
- **~500** unique attendees
  - **80%** Accademia, **17%** Industry, **3%** other
  - **~200** people connected each day
  - **~933** people on **Discord**
- +**50×(~2)** Containers-lectures compatible with **Docker**, **Apptainer**, **Podman**, **Kubernetes** and **OpenStack** for **x86 AMD_64** and also **ARM**
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Next school : 22 june - 03 July 2026

Languages / Technos 2026

Languages / Technos 2026

Languages / Technos 2026

Fortran

Languages / Technos 2026

Fortran

Languages / Technos 2026

(NUMA)

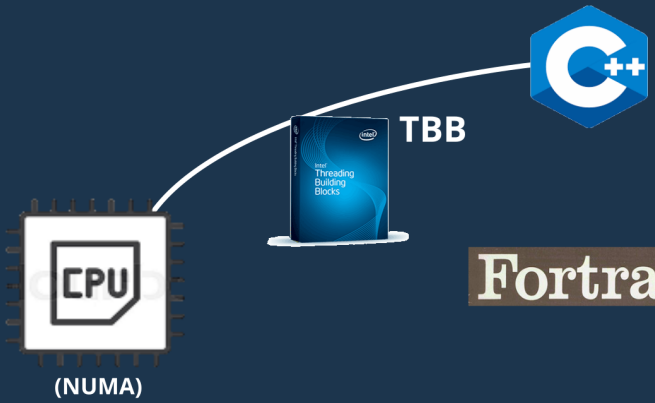
Fortran

Languages / Technos 2026

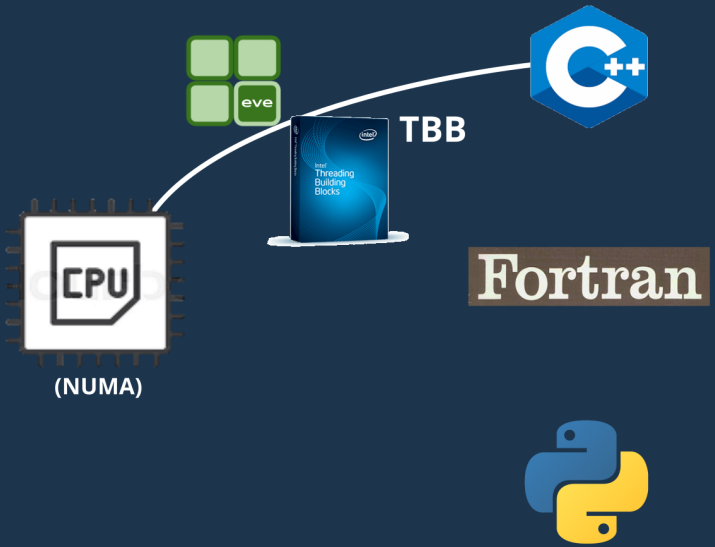
(NUMA)

Fortran

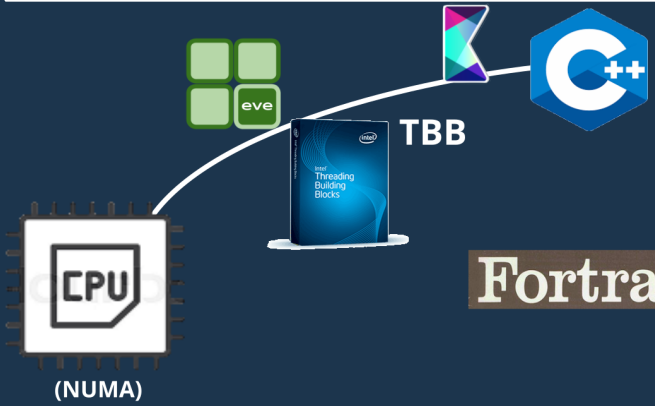
Languages / Technos 2026



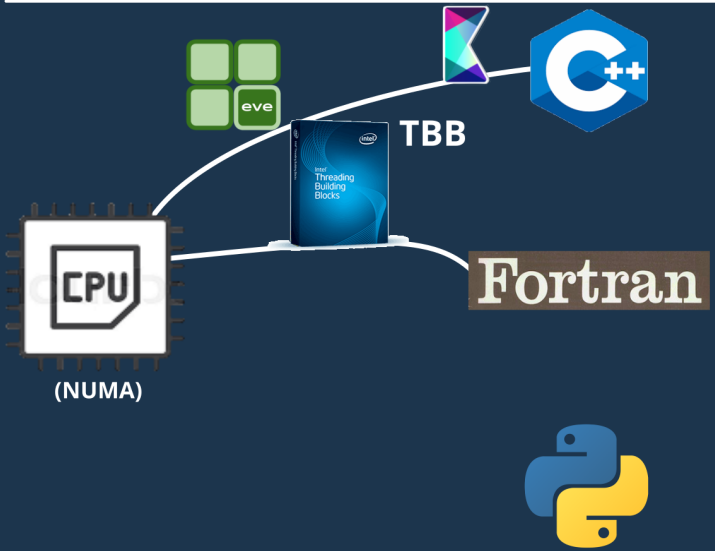
Languages / Technos 2026



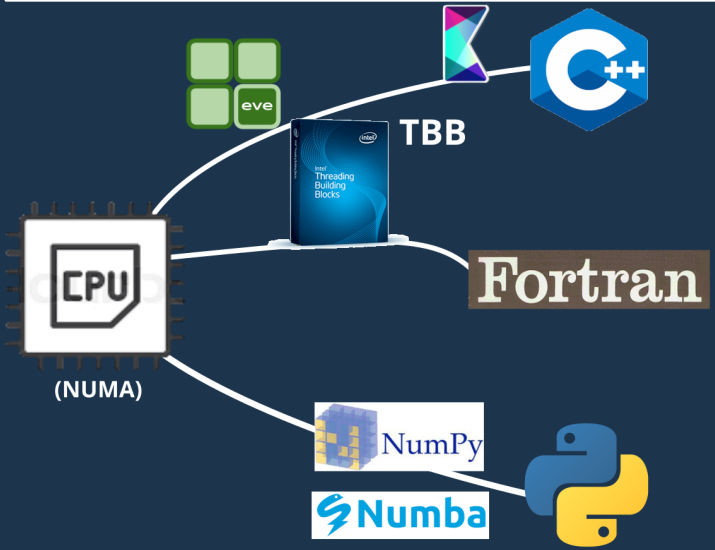
Languages / Technos 2026



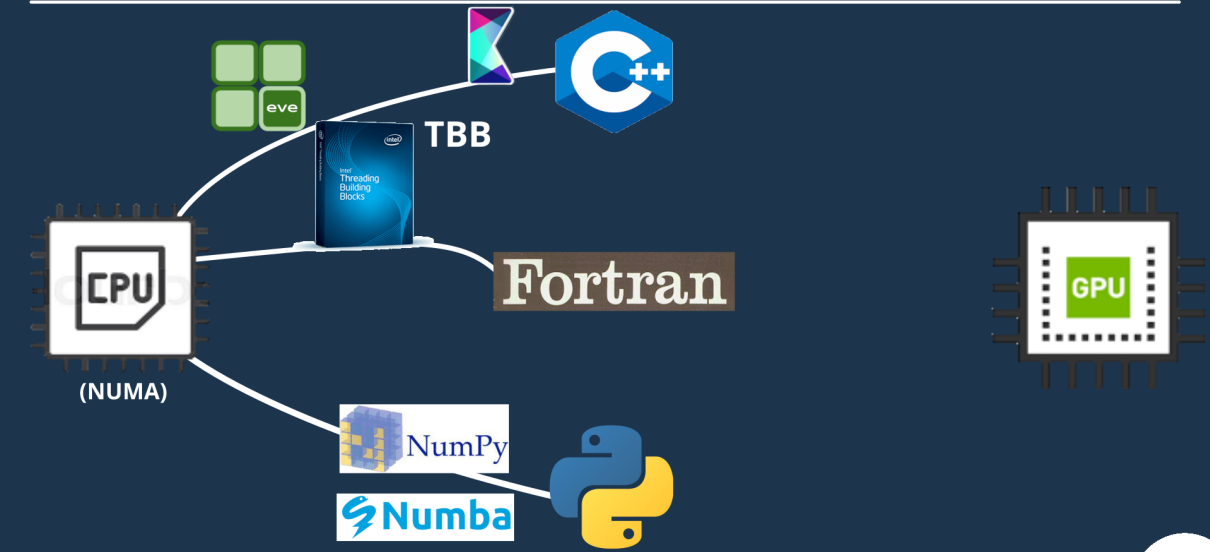
Languages / Technos 2026



Languages / Technos 2026



Languages / Technos 2026



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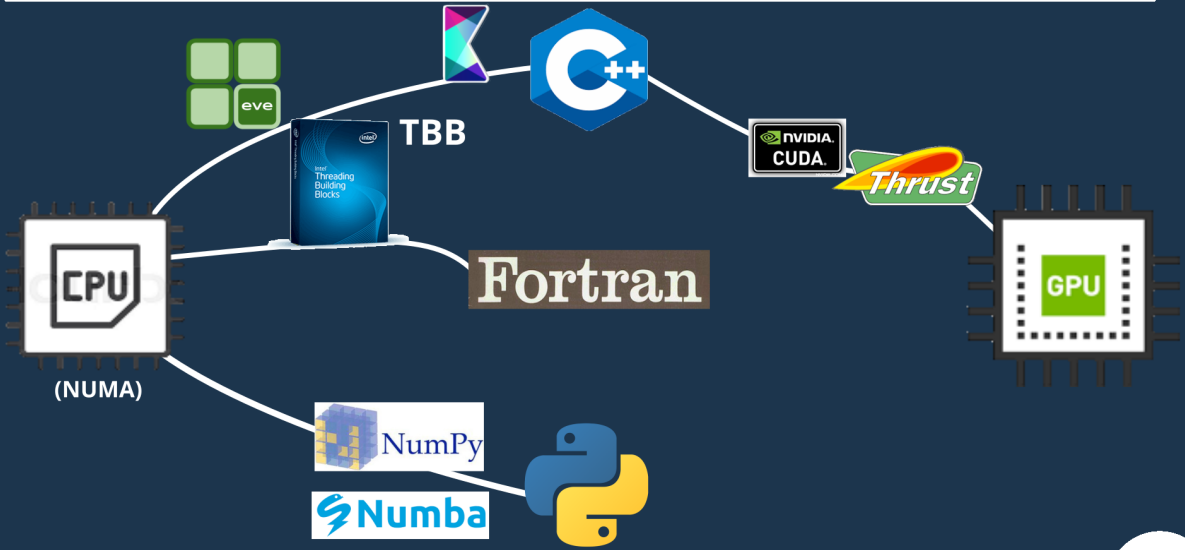

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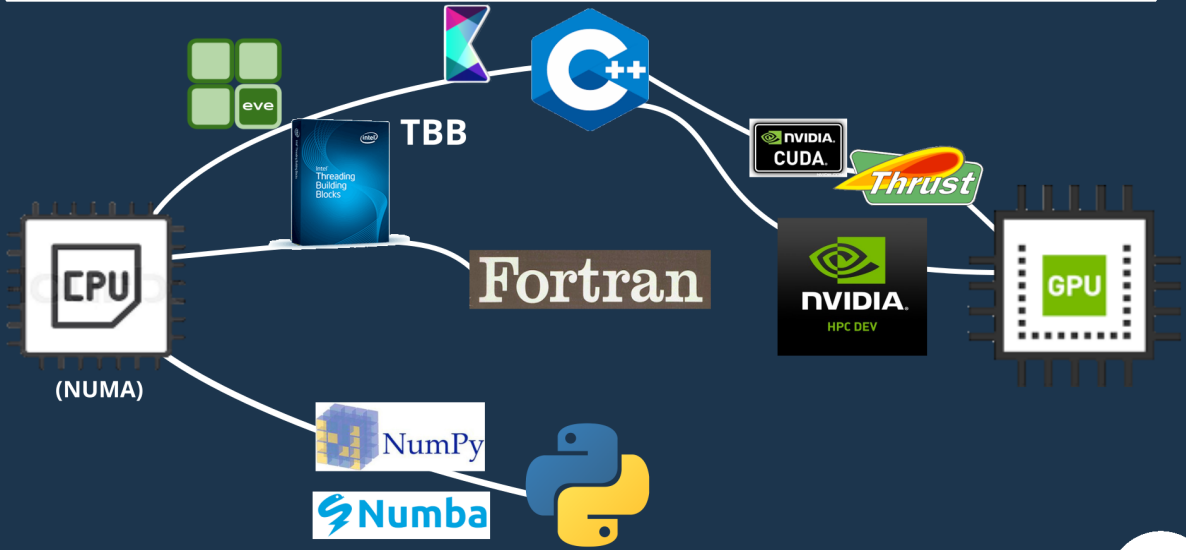

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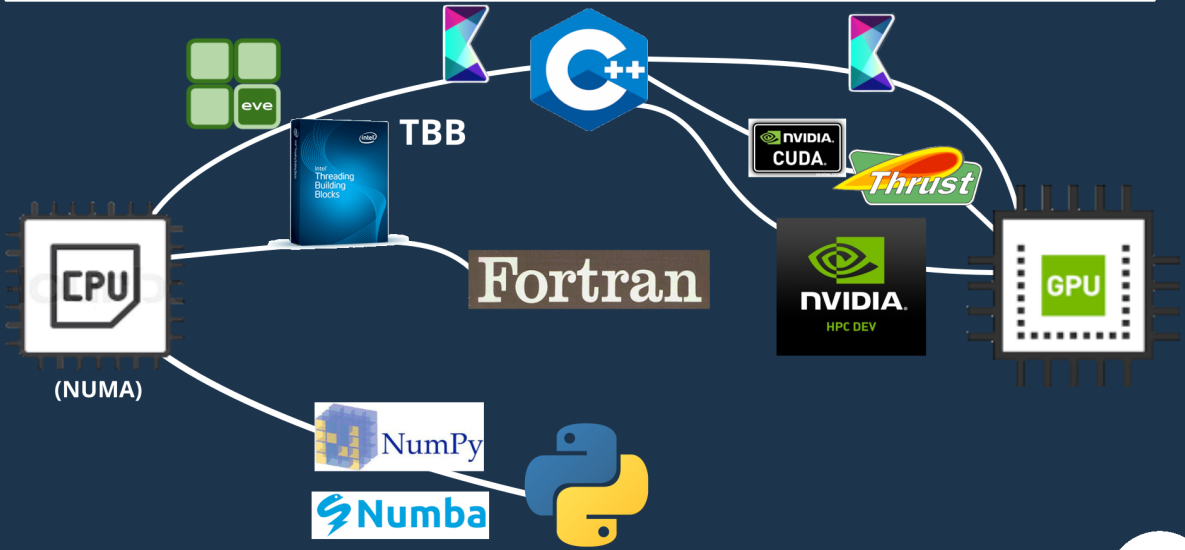

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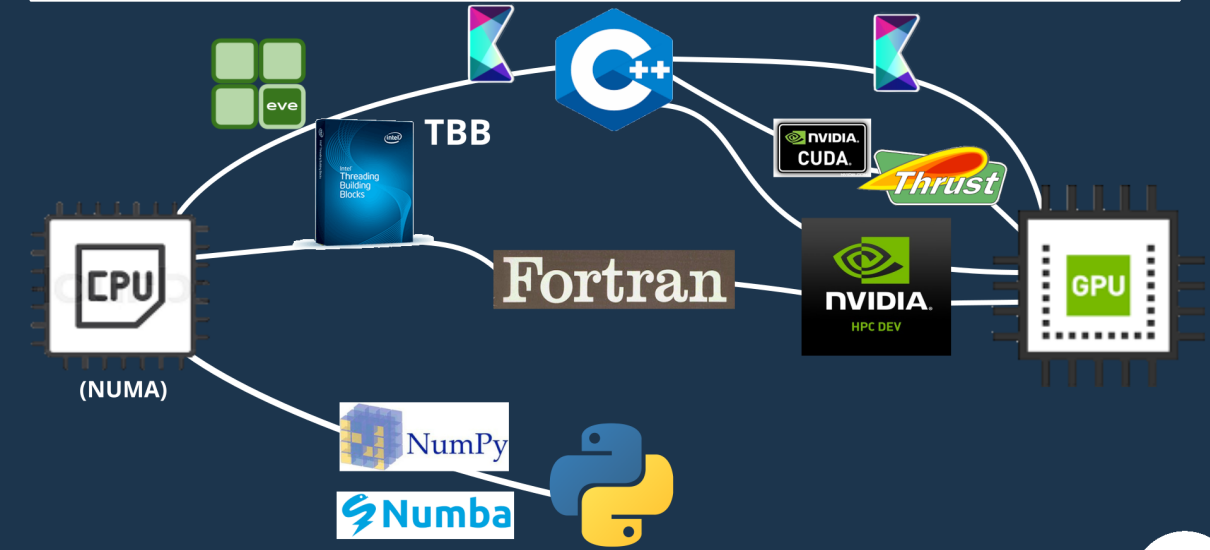

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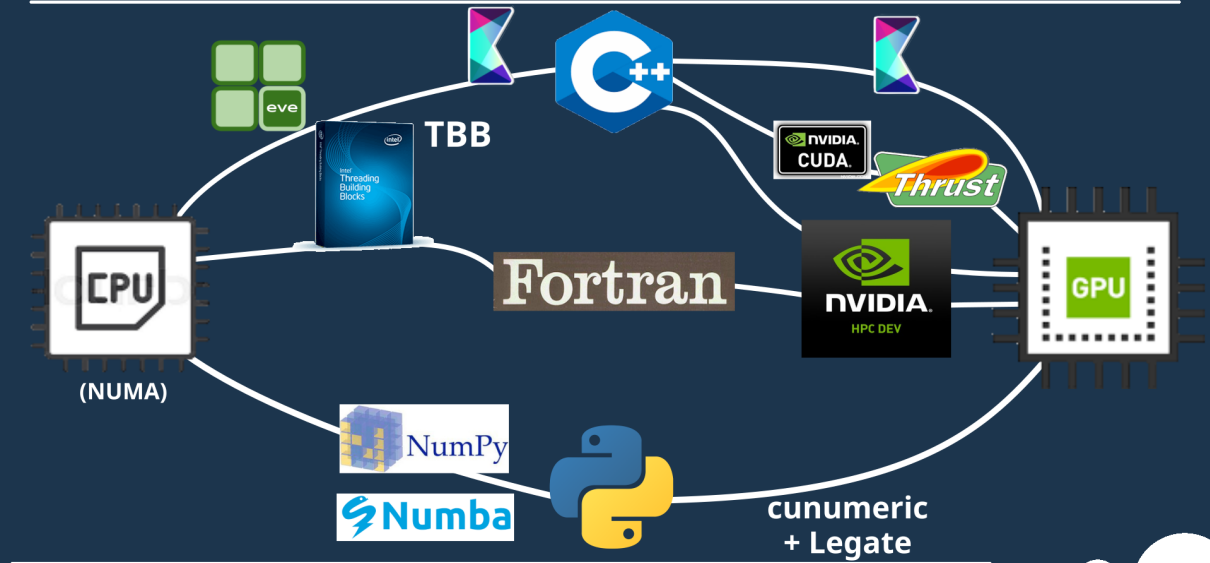

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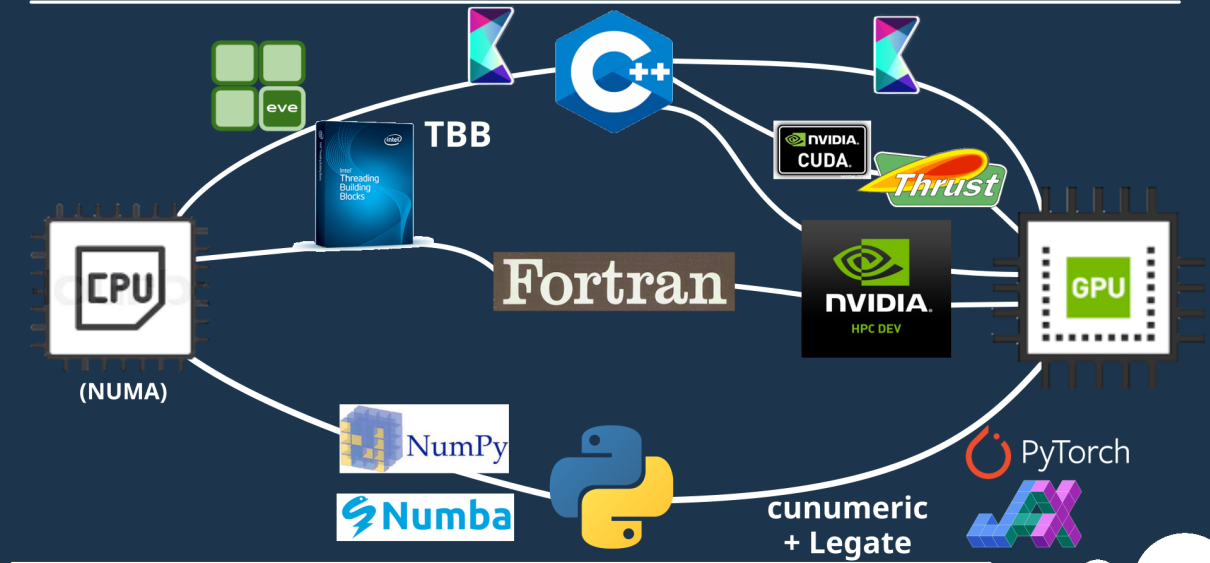


Evolution 2026 - 2027

Evolution 2026 - 2027

2026 - Summer

Evolution 2026 - 2027

2026 - Summer

- Multi-CPU
- Multi-GPU
In a blade server

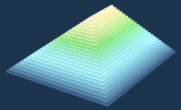
Evolution 2026 - 2027

2026 - Summer

- Multi-CPU
- Multi-GPU

In a blade server

Pyramid Algo
CPU + **GPU**



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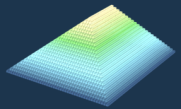

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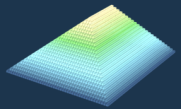

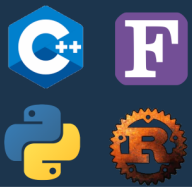

2027 - Summer Gray Scott 40K

Evolution 2026 - 2027

2026 - Summer

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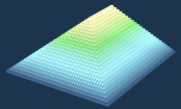
In a blade server

Pyramid Algo
CPU + **GPU**



2027 - Summer Gray Scott 40K

- Multi-CPU
- Multi-GPU
- Multi-Node

In a full rack or full computing center

Evolution 2026 - 2027

2026 - Summer

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- Multi-GPU

In a blade server

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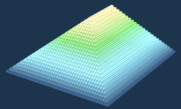

2027 - Summer Gray Scott 40K

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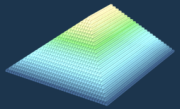
In a full rack or full computing center

Pyramid Algo
Multi-Rack (CPU + **GPU)**



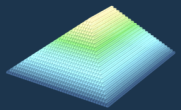
Evolution 2026 - 2027

2026 - Summer

- Multi-CPU
- Multi-GPU

In a blade server

Pyramid Algo
CPU + **GPU**



2027 - Summer Gray Scott 40K

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In a full rack or full computing center

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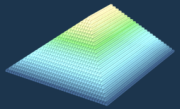

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- With **Mocks** and **Unit Tests**

Evolution 2026 - 2027

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In a blade server

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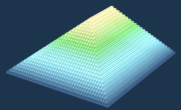

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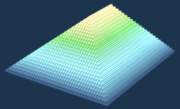

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Strategies by respect to the **network**

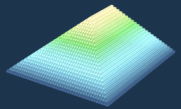
Evolution 2026 - 2027

2026 - Summer

- **Multi-CPU**
- **Multi-GPU**

In a blade server

Pyramid Algo
CPU + **GPU**

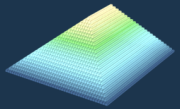


2027 - Summer Gray Scott 40K

- **Multi-CPU**
- **Multi-GPU**
- **Multi-Node**

In a full rack or full computing center

Pyramid Algo
Multi-Rack (CPU + **GPU)**



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- With **Mocks** and **Unit Tests**

Strategies by respect to the **network**

- **Development** with **Minikube**
- **CI** with **Kind**
- How to **deploy** with **Kubernetes (K8s, K3s)**

Evolution 2026 - 2027

2026 - Summer

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In a blade server

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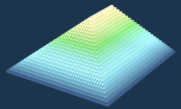
CPU + **GPU**



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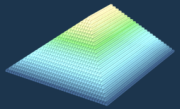

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2027 - Fall Gray OPS

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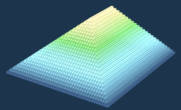

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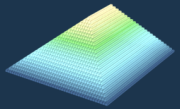

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2027 - Fall Gray OPS

For **IT people** :
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Evolution 2026 - 2027

2026 - Summer

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In a blade server

Pyramid Algo
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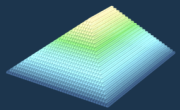

2027 - Summer Gray Scott 40K

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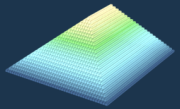

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2027 - Fall Gray OPS

For **IT people** :
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- **CPU** / **GPU** ressources
- **Scalability**
- **Maintainability**

Evolution 2026 - 2027

2026 - Summer

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In a blade server

Pyramid Algo
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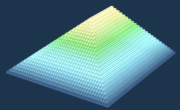

2027 - Summer Gray Scott 40K

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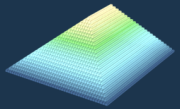

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2027 - Fall Gray OPS

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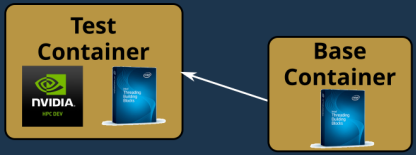
Worker Nodes :
- With **External Network**
- With **Local Network** only

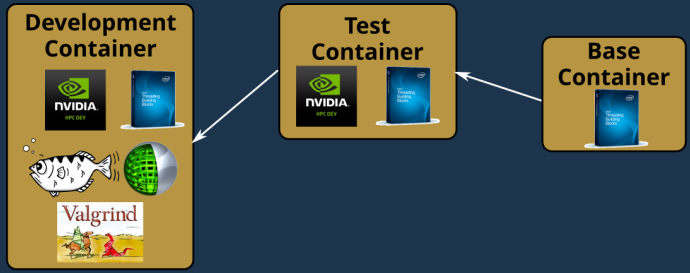
Kubernetes Workflow

Kubernetes Workflow

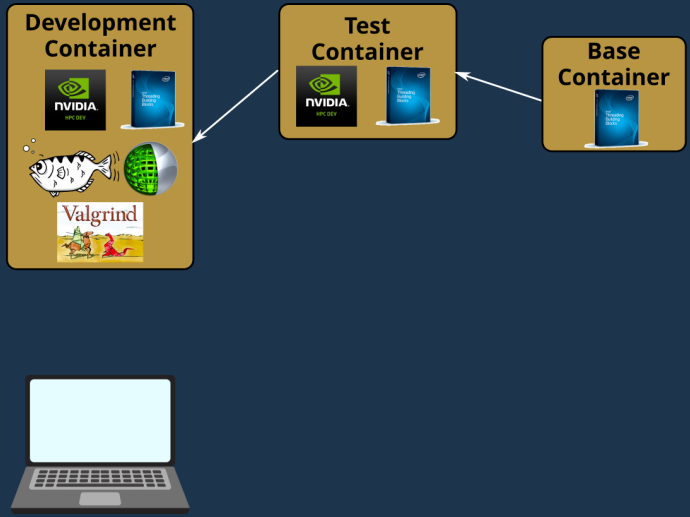
Kubernetes Workflow



Kubernetes Workflow



Kubernetes Workflow



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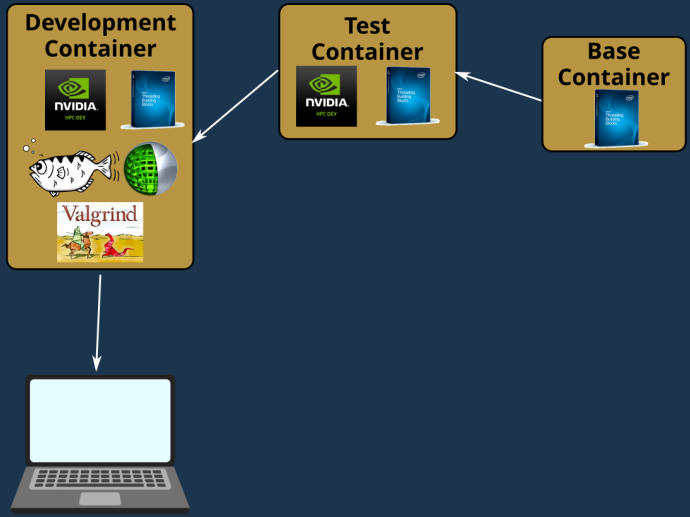

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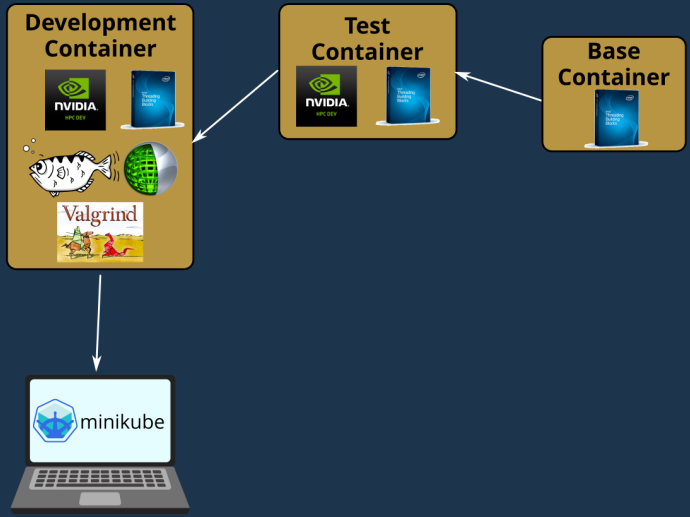

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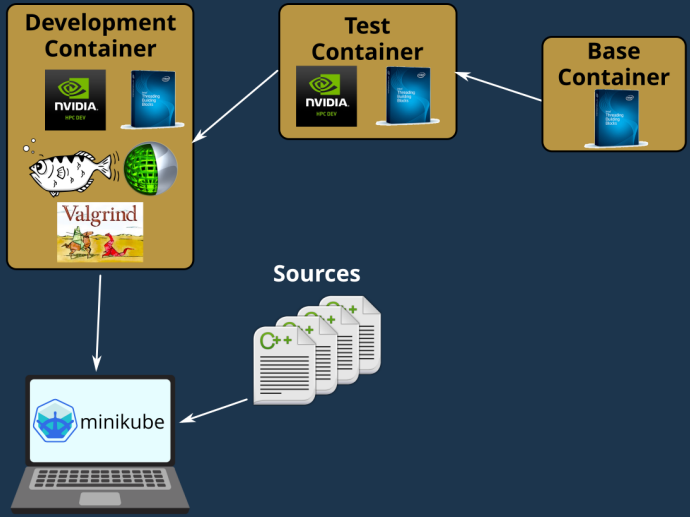

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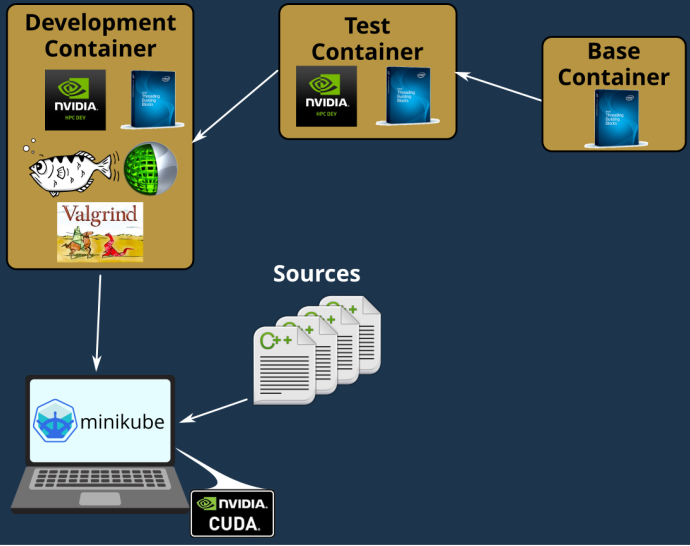

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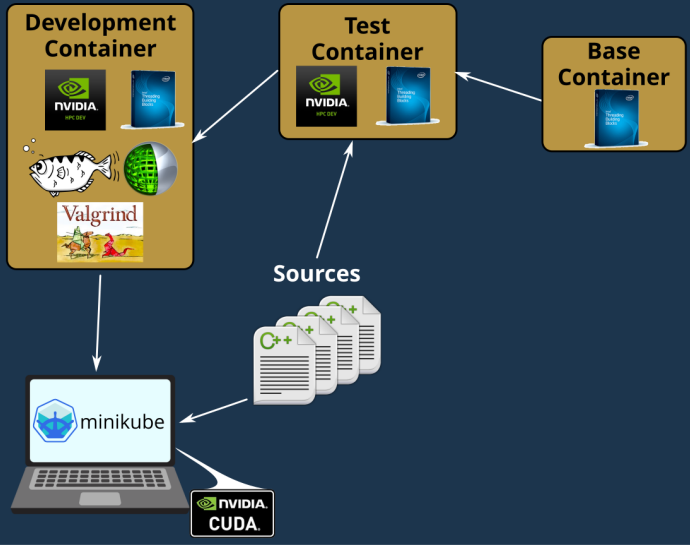

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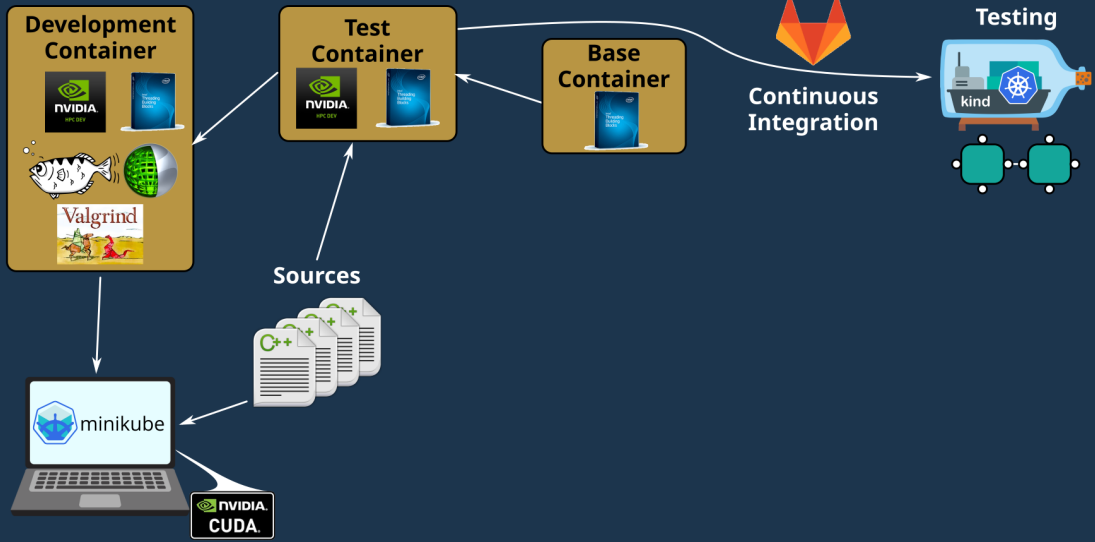

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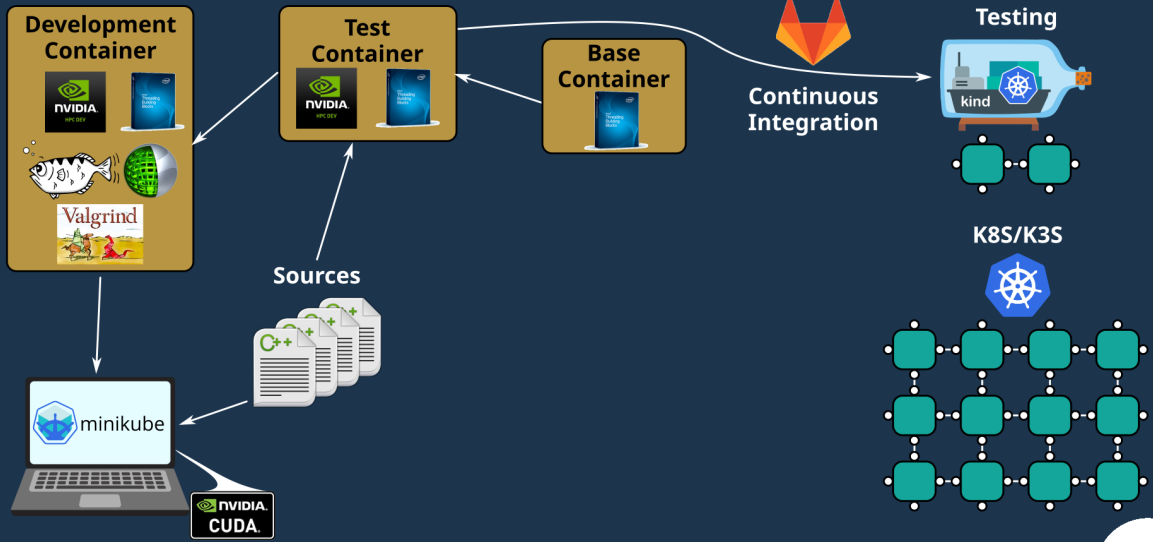

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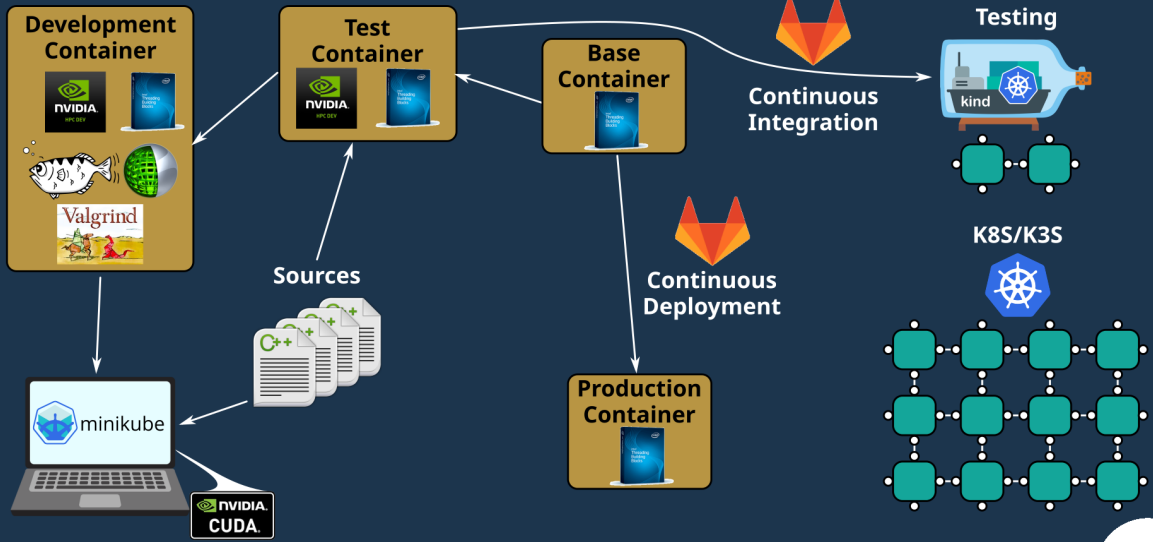

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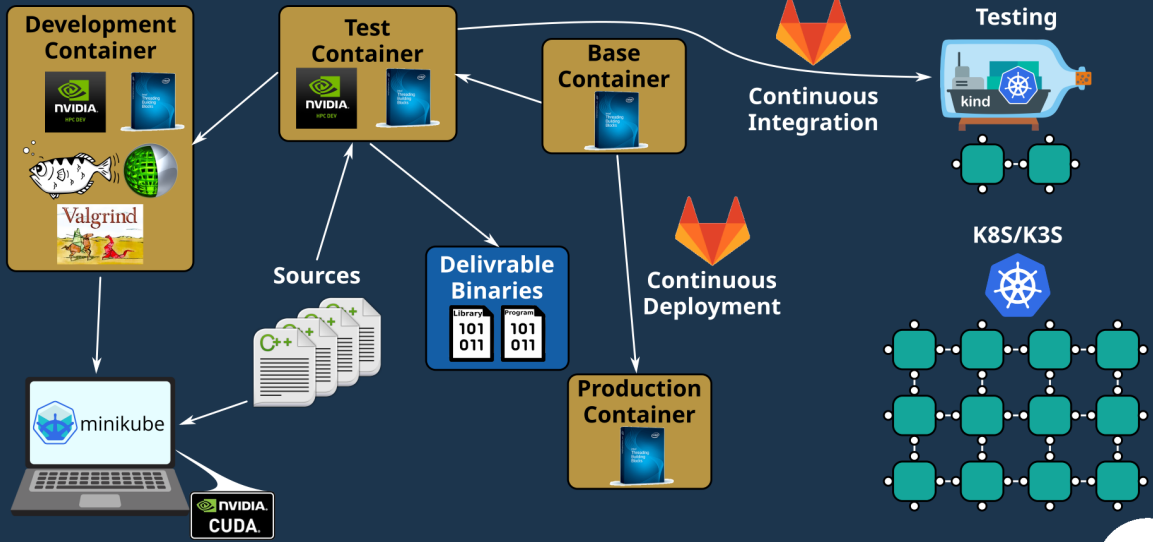

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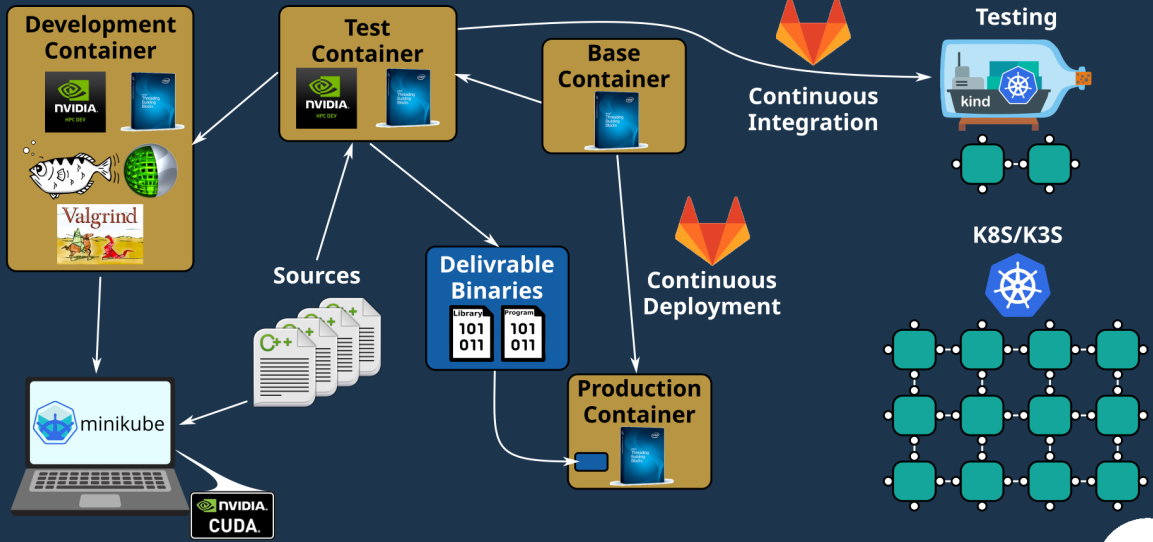

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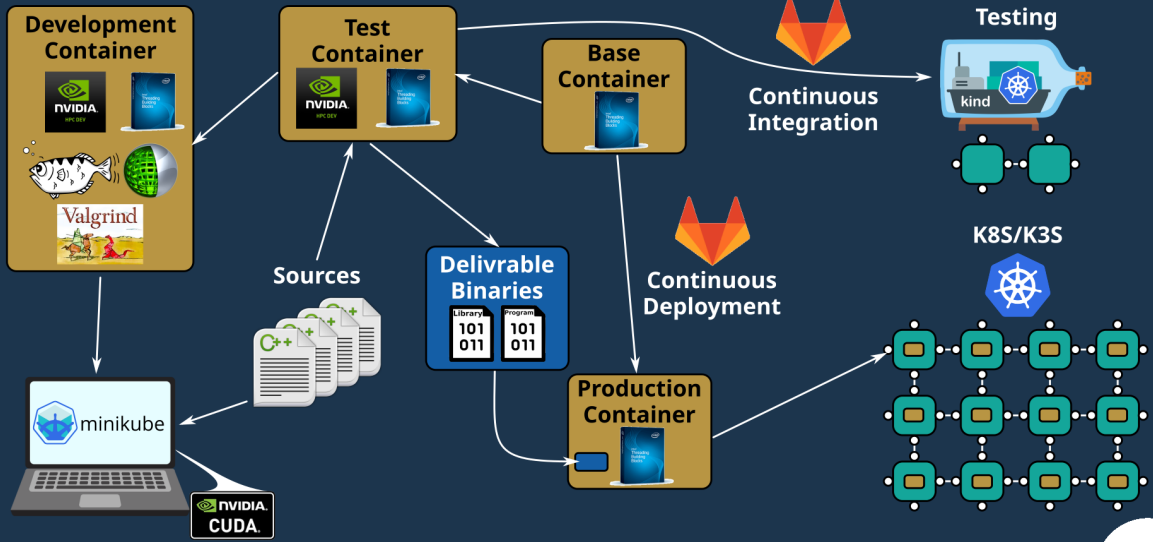

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