ArmoniK : An Open-Source Solution for Computation Orchestration and Distribution

Jérôme Gurhem -
Wilfried Kirschenmann - Aneo, Boulogne-Billancourt, France

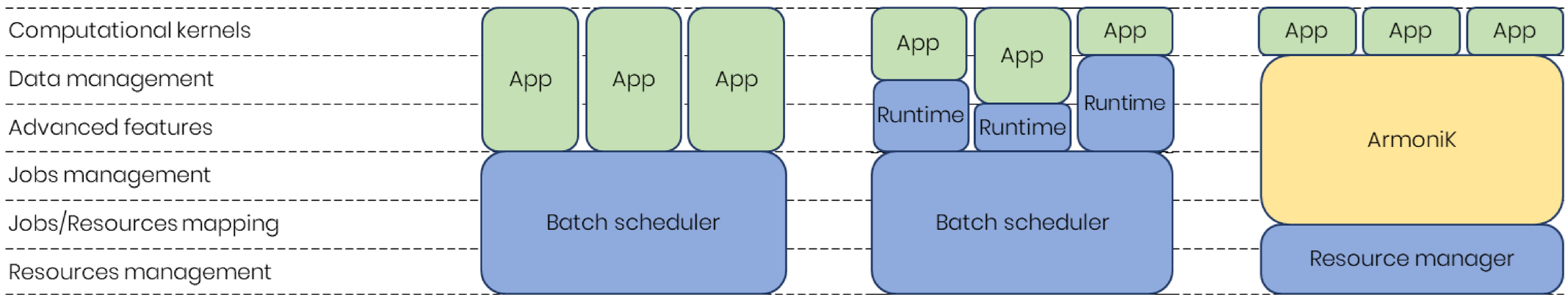
Context

In a world of ever-growing needs for High-Performance Computing (HPC) and massive data processing, **ArmoniK** provides an Open-Source, scalable platform for executing distributed workloads efficiently on heterogeneous infrastructures.

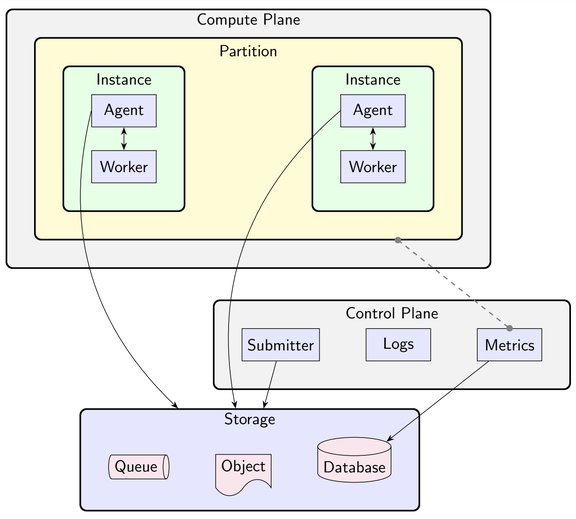
Objectives

- Simplify the development and deployment of distributed computing applications
- Maximize resource utilization across private/public clouds and HPC clusters
- Provide a high-level abstraction for developers

ArmoniK Positionning in HPC

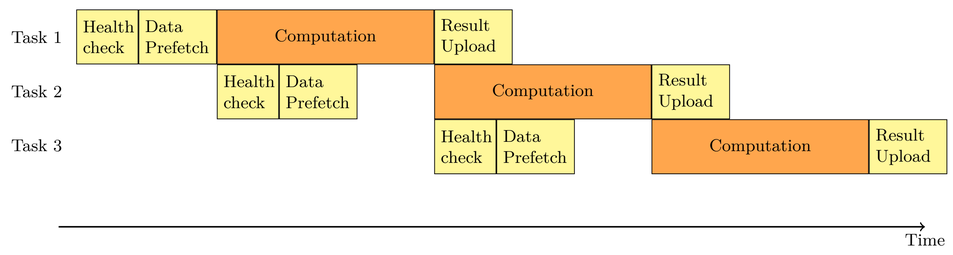


Simplified Architecture



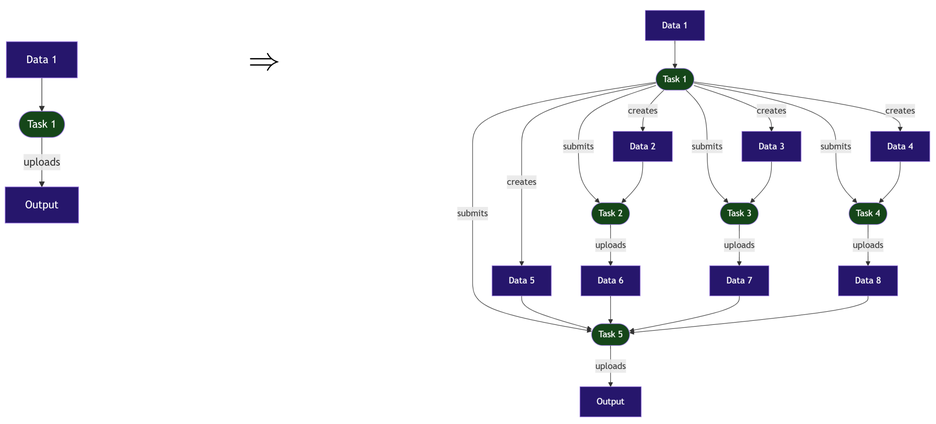
Computations/Comm Overlapping

- ArmoniK is responsible for tasks input and output data management
- Allows for automatic communication + scheduling/task execution overlapping
- Automatic Uncoordinated Checkpointing
- Data communications through global storage



Dynamic Graph

- Dependency graph is not fully known when scheduling starts
- Submissions can happen anytime
- Tasks can submit new tasks
- Tasks can delegate the production of their output to their new tasks

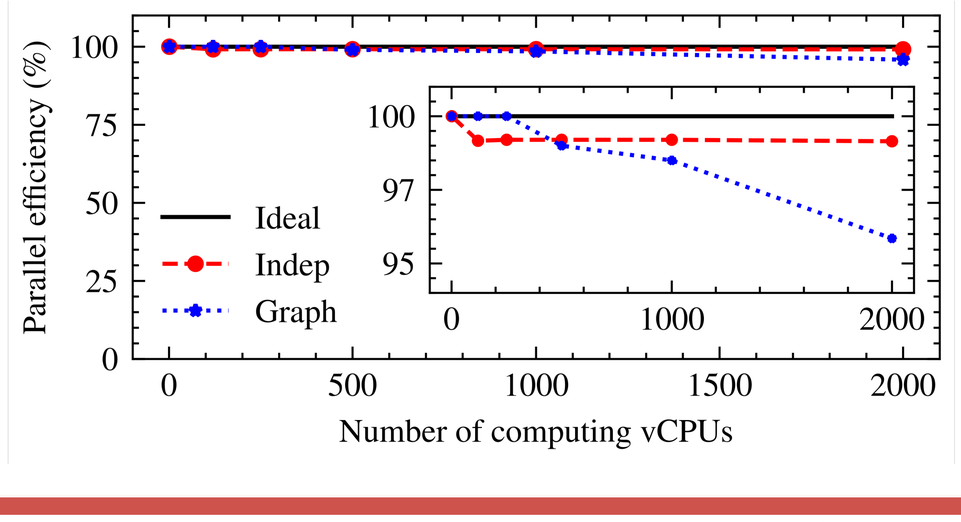


Main features

- **Observability**: GUIs, CLIs, monitoring APIs, metrics, logs, and traces to understand of the state of the system
- **Portability**: Easy to transfer an application from one environment to another
  - Officially supported languages: C#, C++, Python, Rust, Java, and JavaScript
  - Tasks on different architectures (x86, ARM, GPU, Linux, Windows), applications, environments
- **Fault Tolerance**: Functions without interruption even when one or more nodes fail
  - Allow support for preemptible computing resources
  - Error management at the task level
- **Malleability**: Support dynamic reconfiguration of the number of allocated resources during execution without interruption
- **Resource Sharing**: Allows sharing resources between applications to execute as many as possible at the same
- **Modularity**: Modules can be swapped without modifying ArmoniK's code to suit user neeeds and constraints

Performance & Scalability

- Efficient task retry on failure
- Load-aware scheduling
- Linear scalability on real workloads
- Optimal resource usage on hybrid clusters
- Indep : independent tasks workload
- Graph : nested fork-join workload



Use Cases

- Scientific simulation
- Bioinformatics pipelines
- Financial Monte Carlo workloads
- Large-scale data analytics

Conclusion

- ArmoniK simplifies the development of distributed computing applications.
- It ensures efficient execution on clouds and HPC clusters through smart orchestration.
- Developers benefit from a high-level abstraction and multi-language SDKs.
- Its modular, scalable architecture adapts to changing workloads.
- Integrated observability guarantees reliability and performance.
- ArmoniK enables the next generation of high-performance, data-intensive computing.