AthXRT: Centralized FPGA Management for Accelerated Algorithms in Athena

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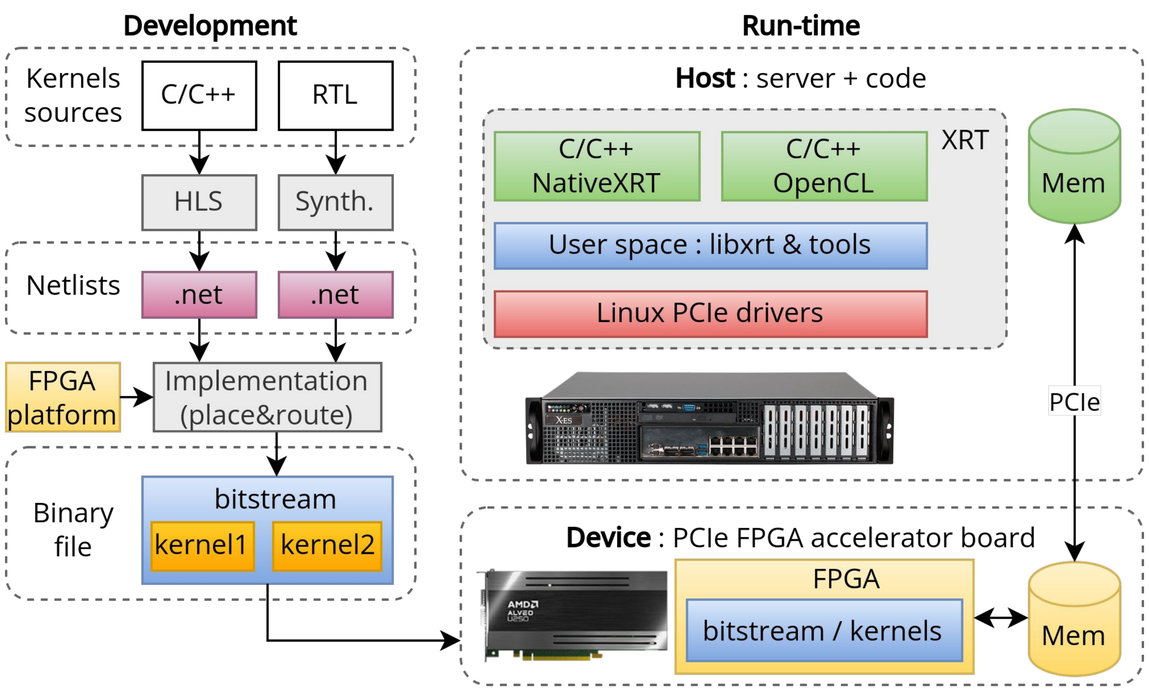
Context & Challenge

- **Multiple teams are exploring the use of FPGAs as heterogeneous accelerators within Athena for applications such as Tracking and Calorimeter Topo-Clustering.**
- **Loading FPGA configuration files is time-consuming and must be completed during Athena's initialization, not during execution.**
- **Managing multiple accelerated algorithms creates a shared FPGA state, which requires careful coordination to prevent conflicts.**

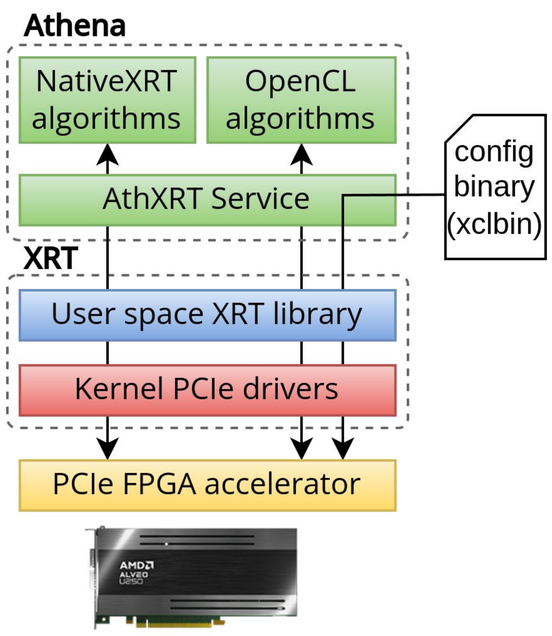


FPGA Development Flow and Communication with Software Accelerators

Solution: AthXRT

AthXRT: A centralized Athena service that simplifies the management of AMD FPGA configuration file loading.

- **Integrate AMD XRT library in Athena to enumerate and configure Alveo class FPGA accelerators.**
- **Configuration files (XCLBIN) can be specified by Python configuration code.**
- **Support both Native XRT API and OpenCL API simultaneously.**
- **Once the service is initialized and the device(s) programmed, user algorithms can request devices list by kernel name.**
- **User algorithms have no constraints on the way they use and communicate with devices and kernels.**
- **AthXRT has the potential for future expansion into Athena's comprehensive FPGA configuration management system.**

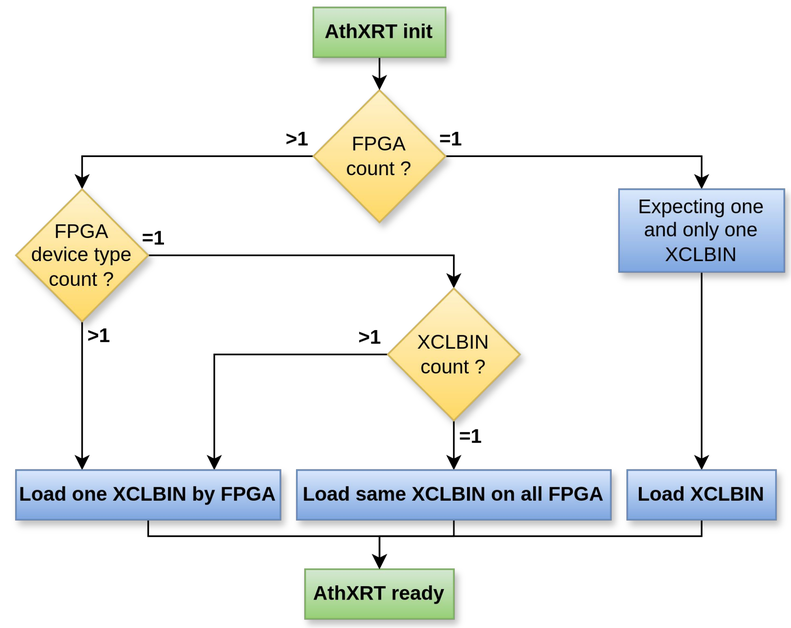


Configuration Loading from AthXRT

FPGA Loading

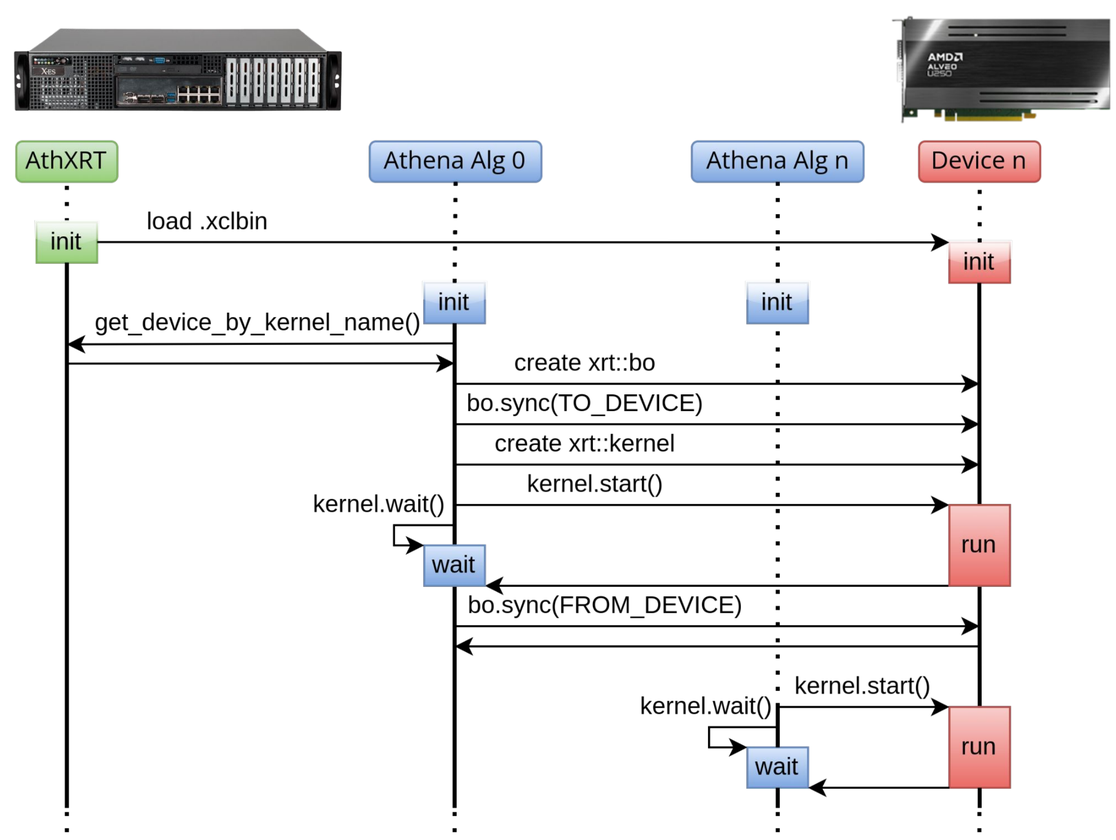
Supported use-cases:

- **Single FPGA**
- **Multiple similar FPGAs, one XCLBIN**
- **Multiple similar FPGAs, multiple XCLBINs**
- **Multiple different FPGAs, multiple XCLBINs**



AthXRT FPGA Configuration File Loading Logic

Interaction with Service & Kernels



Example of Native XRT API Use from Algorithms

Code & Examples

AthXRT is integrated into the Athena framework, accompanied by practical AthExXRT examples to demonstrate functionality with multiple kernels and APIs:

Kernels examples:

- **Simple vector addition & vector multiplication**

Athena algorithms examples:

- **XRT & OpenCL APIs examples for both kernels**

gitlab.cern.ch/atlas/athena/-/tree/main/Control/AthenaExamples/AthExXRT

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