Project Plan Presentation
SmartSat™ Heterogeneous Computing in Space

The Capstone Experience
Team Lockheed Martin Space

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Project Sponsor Overview

• The world's largest military contractor
• In 2022, Lockheed Martin generated $66 billion in revenue
• Satellite manufacturing and design, missile defense, space exploration
• Lockheed Martin space systems account for $15 billion per year in revenue
Project Functional Specifications

- Create framework to allow for significant application portability
- Developers can write an application to multiple targets with little regard to hardware present
- Begin development on system-agnostic algorithms to allow cross-compatibility applications
- Doing so allows for faster development workflows
Project Design Specifications

• Receive instructions from the SmartSat system
• Articulate the load, unload start and stop commands to the hardware accelerators
• Manage processes based on priority
• Communicate application data with the application manager
• Log application data and errors
Screen Mockup: Load and Start

xilinx-zcu102-20221: Accelerator Manager Running...

[09/13/2023_1130309UTC] Instruction Received

[09/13/2023_1130310UTC] Process 0 (flySmartOperator#18927)

[09/13/2023_1130314UTC] Preferred accelerator available, loading to accelerator 1 (AMD Radeon 7900s) load 0

[09/13/2023_1130318UTC] Process 1 (flySmartOperator#18927)

[09/13/2023_1130319UTC] Starting process 1 on accelerator 0

[09/13/2023_1130323UTC] load 0 successful, starting process 0 on accelerator 1

[09/13/2023_1130335UTC] Instruction Finished, Sending Status
Screen Mockup: Accelerator Status

xilinx-zcu102-20221: Accelerator Manager Running...
[09/13/2023_1130410UTC] __Instruction Received
[09/13/2023_1130412UTC] __processing accelerator report request
Accelerator: Type : Process
0(AMD Radeon 7900s0): GPU : flySmartProcess#18938
1(AMD Radeon 7900s1): GPU : ConvolutionPro#18873
2(Altera Terasic De5-Net): FPGA : Not in use
[09/13/2023_1130420UTC] __report sent
[09/13/2023_1130421UTC] __Instruction fulfilled, logging status
Screen Mockup: Error Handling

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xilinx-zcu102-20221: Accelerator Manager Running...

[09/13/2023_1130410UTC]__Error occurred while running (flySmartOperator#18973) on accelerator 2 (AMD Radeon 7900s0)

[09/13/2023_1130412UTC]__Logging error in smartSat

[09/13/2023_1130420UTC]__success

[09/13/2023_1130450UTC]__Instruction Received

[09/13/2023_1130452UTC]__Process 0 (flySmartOperator#18973)

[09/13/2023_1130453UTC]__Preferred accelerator available, process loaded, starting process on accelerator 2 (AMD Radeon 7900s0)

[09/13/2023_1130455UTC]__Instruction fulfilled, logging status
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Screen Mockup: Managing Priority

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xilinx-zcu102-20221: Accelerator Manager Running...

[09/13/2023_1130450UTC] ___Instruction Received

[09/13/2023_1130452UTC] ___Process 0(flySmartOperator#18973)

[09/13/2023_1130453UTC] ___Preferred accelerator unavailable, requested process priority level 1, checking priority on preferred targets

[09/13/2023_1130455UTC] ___process(convolutionPro#18973) running on preferred target with priority level 2

[09/13/2023_1130458UTC] ___stop process(convolutionPro#18973) on accelerator 1(AMD Radeon 7900s0)

[09/13/2023_1130462UTC] ___loading process(flySmartOperator#18973) on accelerator 1(AMD Radeon 7900s0) load 0

[09/13/2023_1130467UTC] ___load 0 successful, starting process 0(flySmartOperator#18973) on accelerator 1(AMD Radeon 7900s0)

[09/13/2023_1130468UTC] ___Instruction fulfilled, logging status
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Project Technical Specifications

• Accelerator manager allows deployment of applications on compatible and available machines
• Xilinx Runtime loader library to help manager run algorithms
• Two common algorithms written with different programming techniques to begin creating system-agnostic applications
Project System Architecture

- SmartSat™ Application
  - Accelerator Manager
    - SmartSat™ Application Manager
  - XRT Loader Library
    - XILINX VITIS
    - SYCL

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Project System Components

• Hardware Platforms
  ▪ ZCU102 Evaluation Board
  ▪ UDOO Bolt Gear

• Software Platforms / Technologies
  ▪ PetaLinux
  ▪ Vitis
  ▪ SmartSat™ SDK
  ▪ Xilinx Runtime Library
  ▪ OpenSYCL
Project Risks

• Embedded System Development Workflow
  ▪ No one on the group has experience with embedded systems
  ▪ Xilinx forums and documentation to understand basics

• Frequent PetaLinux builds
  ▪ PetaLinux requires a long time to build on target device
  ▪ Create Linux server in CSE 498 lab to run build process and plan when a team member needs to rebuild

• Testing software
  ▪ Setting up boards is tedious, testing code can be a hassle
  ▪ Lockheed Martin Space is providing a testing environment

• OpenSYCL Framework
  ▪ Parallel programming is new to every member of the team
  ▪ Create simple programs that run across multiple accelerators to understand basics
Questions?