MICHIGAN STATE UNIVERSITY

Project Plan Presentation

SmartSat™ AI Acceleration in Space

The Capstone Experience

Team Lockheed Martin Space

Susanne Constantakis
Benjamin Kavara
Josiah Klann
Kellen Lear

Department of Computer Science and Engineering
Michigan State University

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From Students…
…to Professionals

Project Sponsor Overview

- Lockheed Martin is a leading global aerospace, defense, and security company.
- Operates in four main segments: Aeronautics, Rotary and Mission Systems, Space, Missiles and Fire Control.
- Major Contractor for the U.S. DoD specializing in advanced technology systems, products, and services.

Project Functional Specifications

- SmartSat software integration and functionality for efficient software update and processing.
- Building on the previous capstone project and the developed accelerators for targeted testing.
- Develop test infrastructure for application verification and profiling on target hardware.

Project Design Specifications

- Development of a custom terminal within the PetaLinux environment, optimized for communication with the ZCU102 hardware.
- Creation of specialized script capable of automating the deployment of ML models tailored for benchmarking.
- Development of a script to record output data including performance metrics.
- Manage different models for image recognition and segmentation.

Screen Mockup: PetaLinux Terminal

```
root@xilinx-zcu102-2020_2:~# The XKEYBOARD keymap compiler (xkbcomp) reports:
> Warning:          Unsupported high keycode 372 for name <I372> ignored
>                   X11 cannot support keycodes above 255.
>                   This warning only shows for the first high keycode.
Errors from xkbcomp are not fatal to the X server
D-BUS per-session daemon address is: unix:abstract=/tmp/dbus-LgydUQ6N99,guid=e1b
d81205457d55d2e3f44cf65b81869
matchbox: Cant find a keycode for keysym 269025056
matchbox: ignoring key shortcut XF86Calendar=!$contacts

matchbox: Cant find a keycode for keysym 2809
matchbox: ignoring key shortcut telephone=!$dates

matchbox: Cant find a keycode for keysym 269025050
matchbox: ignoring key shortcut XF86Start=!matchbox-remote -desktop

dbus-daemon[984]: Activating service name='org.a11y.atspi.Registry' requested by
 ':1.0' (uid=0 pid=980 comm="matchbox-panel --start-applets showdesktop,windows"
)
dbus-daemon[984]: Successfully activated service 'org.a11y.atspi.Registry'
SpiRegistry daemon is running with well-known name - org.a11y.atspi.Registry
[settings daemon] Forking. run with -n to prevent fork

root@xilinx-zcu102-2020 2:~#
```

Screen Mockup: Script Execution

```
------------------------------
    Execute All AI Script
------------------------------
Input Folder Name:  FolderName
Input Iteration Count: 3


Running: 100%|████████████████████████| 100/100 [00:06<00:00, 16.27it/s]

Data Collection Complete, please run display.py to see results
```

Screen Mockup: Results Display

```
------------------------------
    Average Model Runtime
------------------------------
                         Time(s)
Model 1 on System 1:      123.4
Model 2 on System 1:      123.4
Model 3 on System 1:      123.4
Model 1 on System 2:      123.4
Model 2 on System 2:      123.4
Model 3 on System 2:      123.4
Model 1 on System 3:      123.4
Model 2 on System 3:      123.4
Model 3 on System 3:      123.4

Do you wish to save these results to a Text File?(y/n): y
Enter Name of Text File you wish to save to: Demo
```

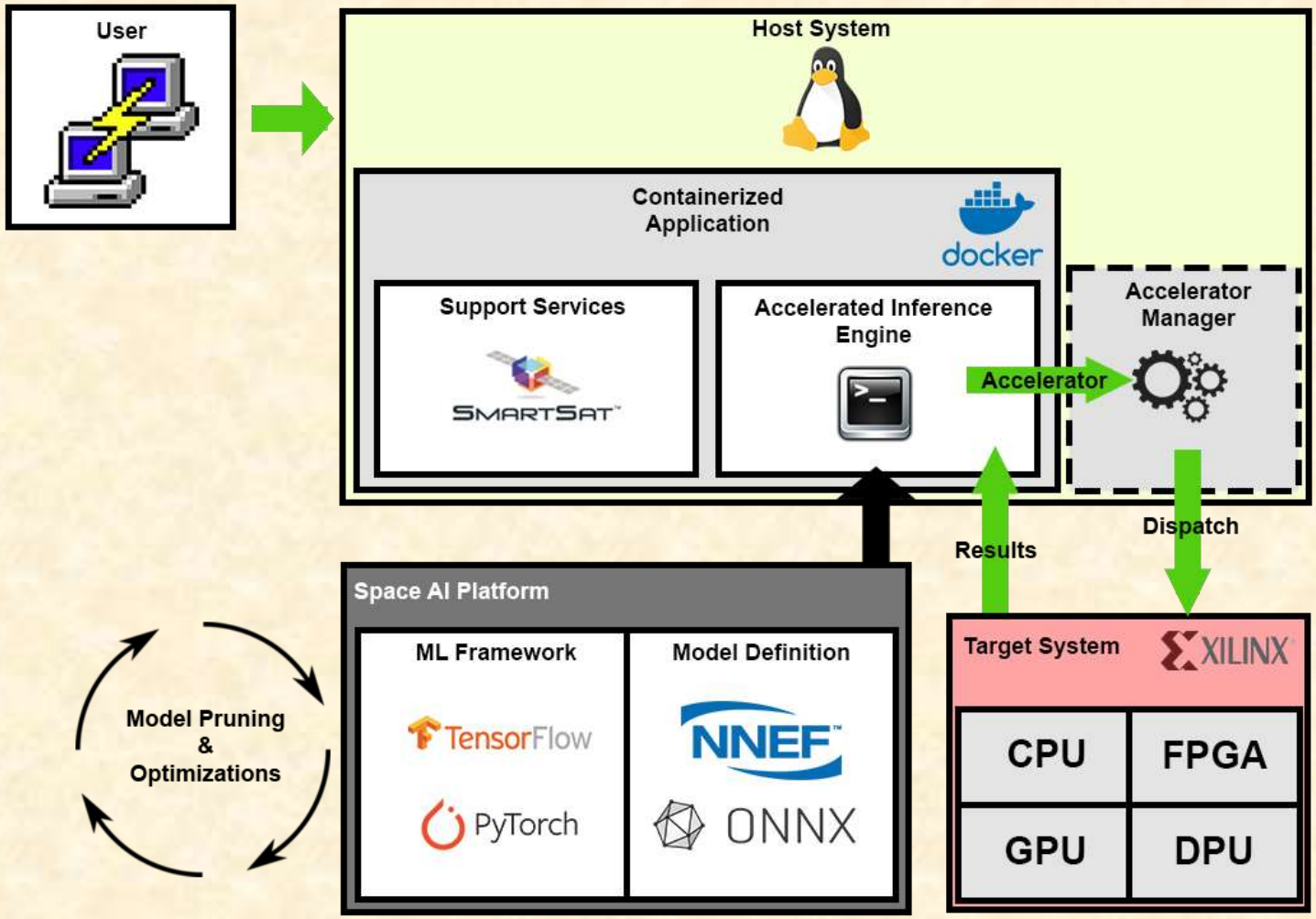
Screen Mockup: Optimal Results Menu

```
-------------------------------------------------
      Optimal Hardware Component per Model
-------------------------------------------------
Input Name of text file:    FileName.txt
Model 1 performs optimally on Hardware X
Model 2 performs optimally on Hardware X
Model 3 performs optimally on Hardware X
Model 4 performs optimally on Hardware X
Model 5 performs optimally on Hardware X
```

Project Technical Specifications

- Integration of TensorFlow models with VitisAI for optimized execution, enabling efficient benchmarking on Xilinx hardware platforms.
- Configuration of a custom PetaLinux system to facilitate communication and operation of AI applications.
- Utilization of the SmartSAT SDK environment, focusing on prototyping and testing.

Project System Architecture



Project System Components

- Hardware Platforms
  - Xilinx ZCU102
  - UDOO Bolt Gear
  - AMD Jetson TX
- Software Platforms / Technologies
  - Vitis AI
  - PetaLinux OS
  - SmartSat DSK

Project Risks

- Xilinx Hardware and non-commodity Embedded Systems
  - Limited, convoluted, sometimes incorrect documentation
  - Mitigation - Frequent communication with sponsors and more frequent team meetings to resolve issues
- Machine Learning
  - No prior experience with ML. Will pose a challenge integrating with FPGA hardware
  - Mitigation – Each develop our own small image recognition model
- Vitis AI
  - Minimal documentation on Vitis, as well as a different workflow than typical software development
  - Mitigation - The team immediately began research on Vitis documentation and will work with sponsors.

Questions?