MICHIGAN STATE UNIVERSITY

Project Plan
SmartSat™ Heterogenous Computing in Space

The Capstone Experience

Team Lockheed Martin Space

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From Students…
…to Professionals

Functional Specifications

- Downlink time to process satellite data is very slow (can be as slow as ~20 MB per day)
- Processing data on satellite can save time and money
- Software needs to utilize available hardware on the satellite without interfering with flight or other core functions fully autonomously
- Need to use embedded Linux to find program requirements and delegate appropriately

Design Specifications

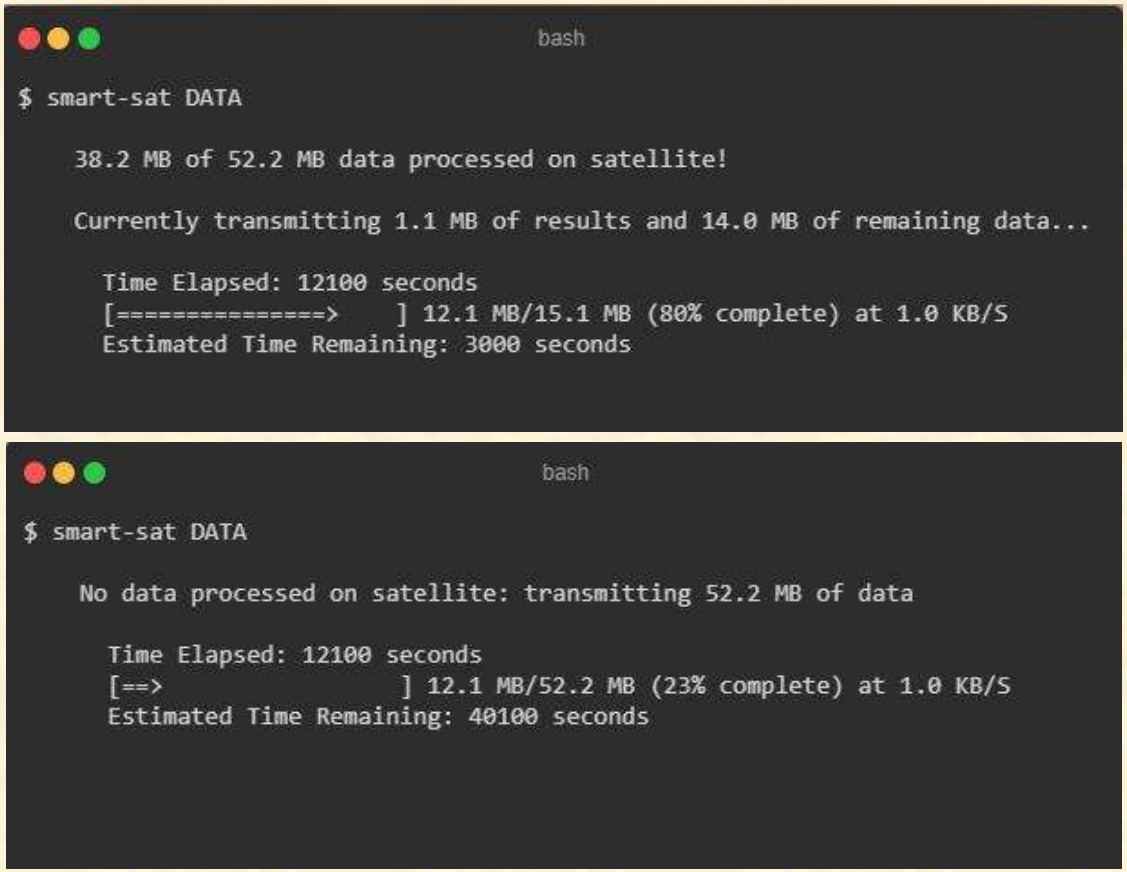
- Accelerator manager app optimizes hardware usage for accelerator apps
- SYCL app backend provides parallel capabilities for Intel/NVIDIA hardware
- Vitis app backend provides parallel capabilities for Xilinx FPGAs
- Accelerator manager provides status updates for hardware usage and accelerator programs

Screen Mockup: Hardware Selection

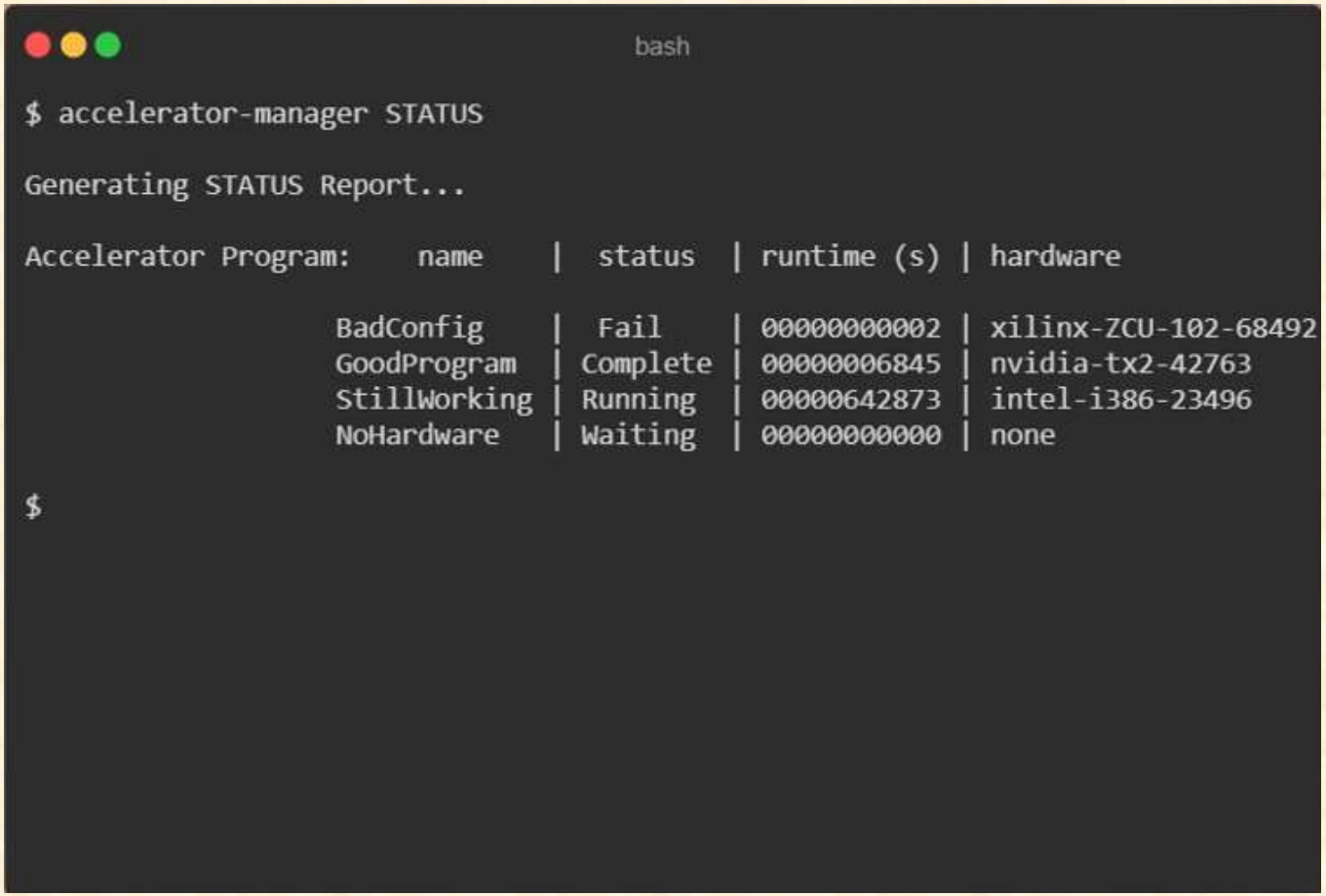
bash

```
$ accelerator-manager {SYCL:../AcceleratorA}

Fetching hardware usage...

    Hardware:       name           | type | use | [compatibility]

             nvidia-tx2-56749     | GPU  | 96% | True
             xilinx-ZCU-102-68492 | FPGA | 13% | False
             nvidia-tx2-42763     | GPU  | 26% | True
             intel-i386-23496     | CPU  |  9% | True
             xilinx-ZCU-102-13467 | FPGA | 45% | False

    Chosen Hardware: nvidia-tx2-42763

    Installing "AcceleratorA" on nvidia-tx2-42763...
    Success! Accelerator program was installed.
    Starting "AcceleratorA" on nvidia-tx2-42763...
    Success! Accelerator program has started.

$
```

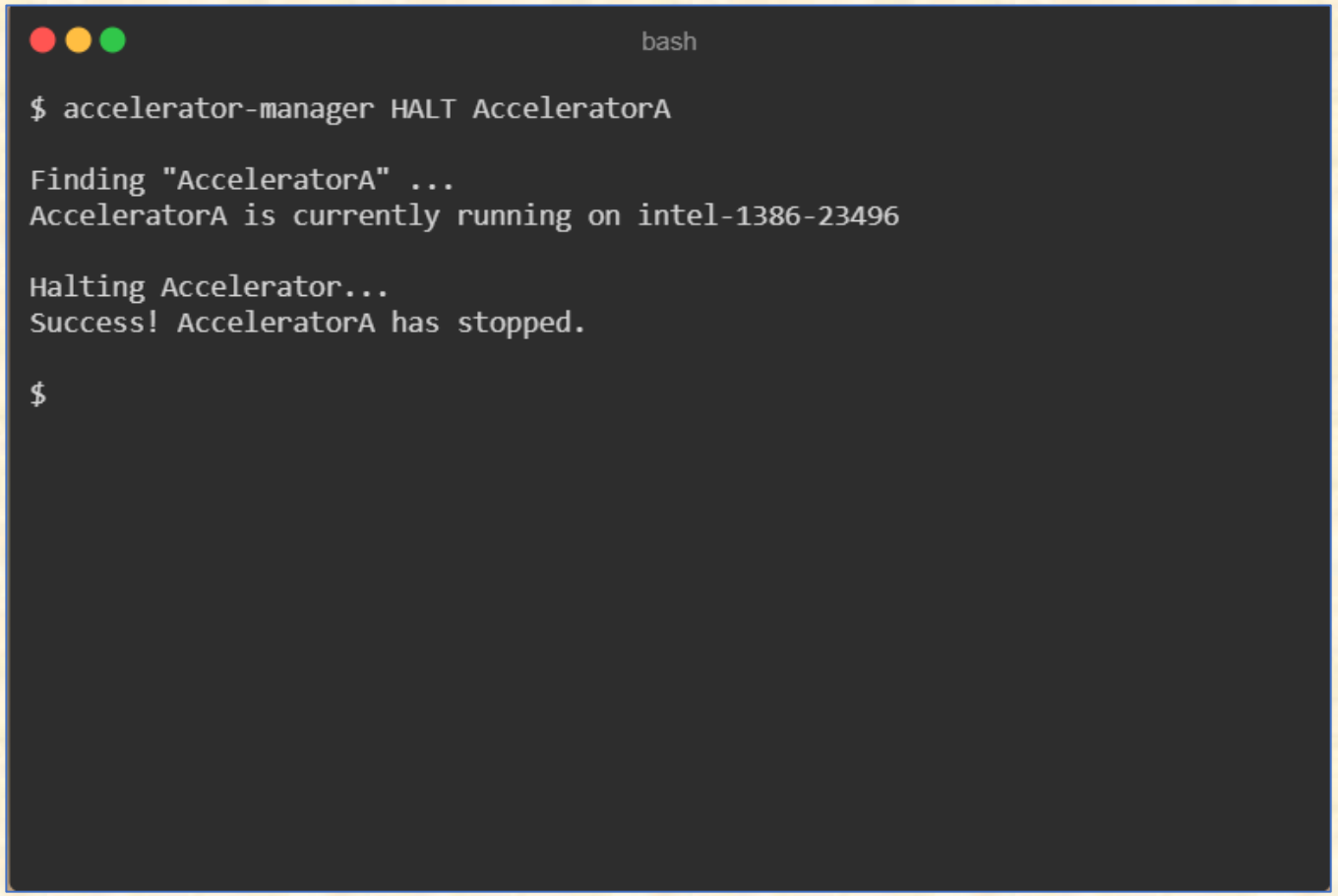
Screen Mockup: Data Transmission



Screen Mockup: Status



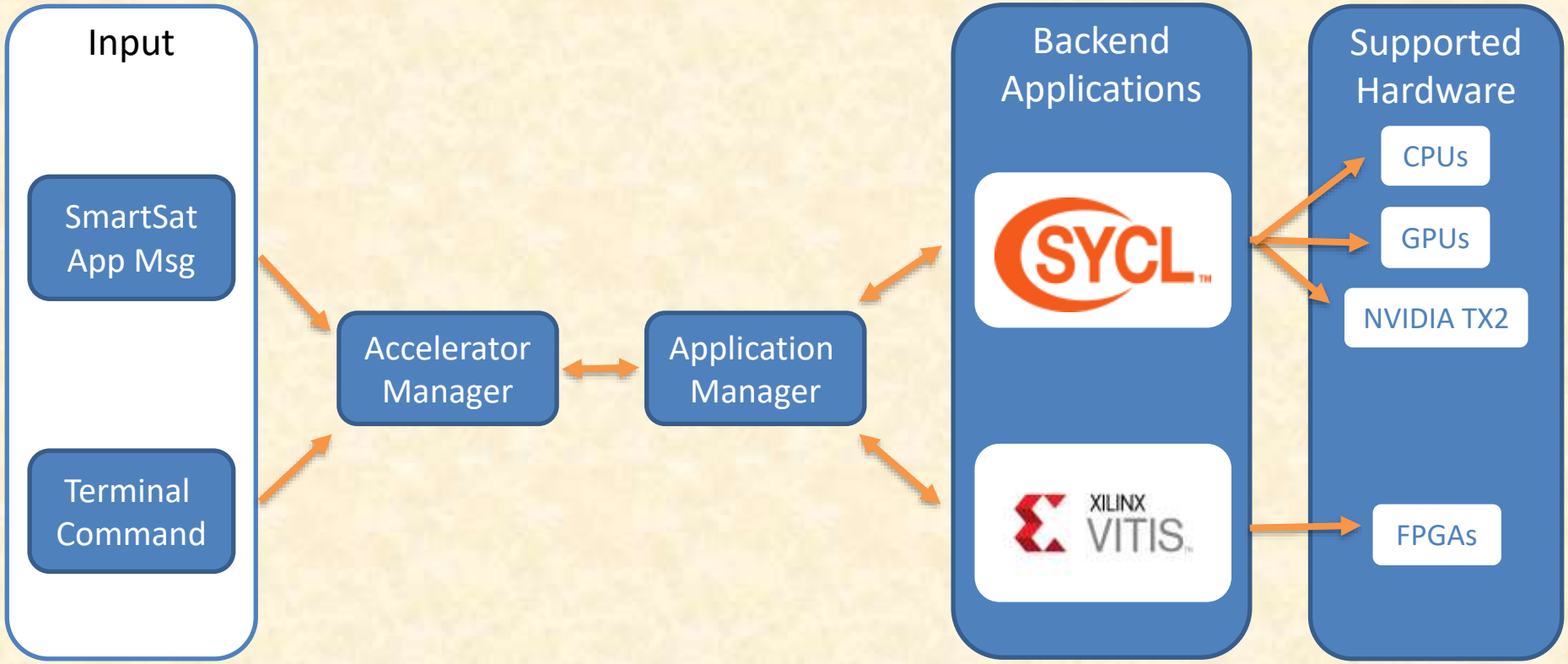
Screen Mockup: Halting Accelerator



Technical Specifications

- Accelerator Manager SmartSat app
  - Communicates with other SmartSat app over TCP connections
- SYCL Backend to optimize with parallel programming
- Vitis Backend to optimize with parallel programming

System Architecture



System Components

- Hardware Platforms
  - NVIDIA TX2
  - Xilinx ZCU-102 FPGA
  - Test Machine CPU-GPU
- Software Platforms / Technologies
  - C/C++/Python
  - SYCL
  - Vitis
  - SmartSat SDK

Risks

- Distance Between Teammates
  - Team members are located all across Michigan and we need to share hardware and securely transfer files
  - Early scheduling for in person meetings and hardware delivery
- Limited Hardware Availability
  - Testing must be done on FPGA/TX2 boards, these are limited
  - Request additional hardware from client or deliver available hardware to teammates as needed
- Hardware Integration
  - SmartSat SDK requires Ubuntu, but all members use PC/Mac
  - Dual boot from partition, virtual machine, or secondary hard drives
- Security
  - SmartSat files cannot be sent over the internet
  - Individual testing and messaging of SIE

Questions?