



# Project Plan

## SmartSat™ Heterogenous Computing in Space

### The Capstone Experience

#### Team Lockheed Martin Space

Nolan Baldwin

Shivang Patel

Austin Declark

Alex Taylor

Joseph Stafford

Department of Computer Science and Engineering

Michigan State University

Fall 2020



*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

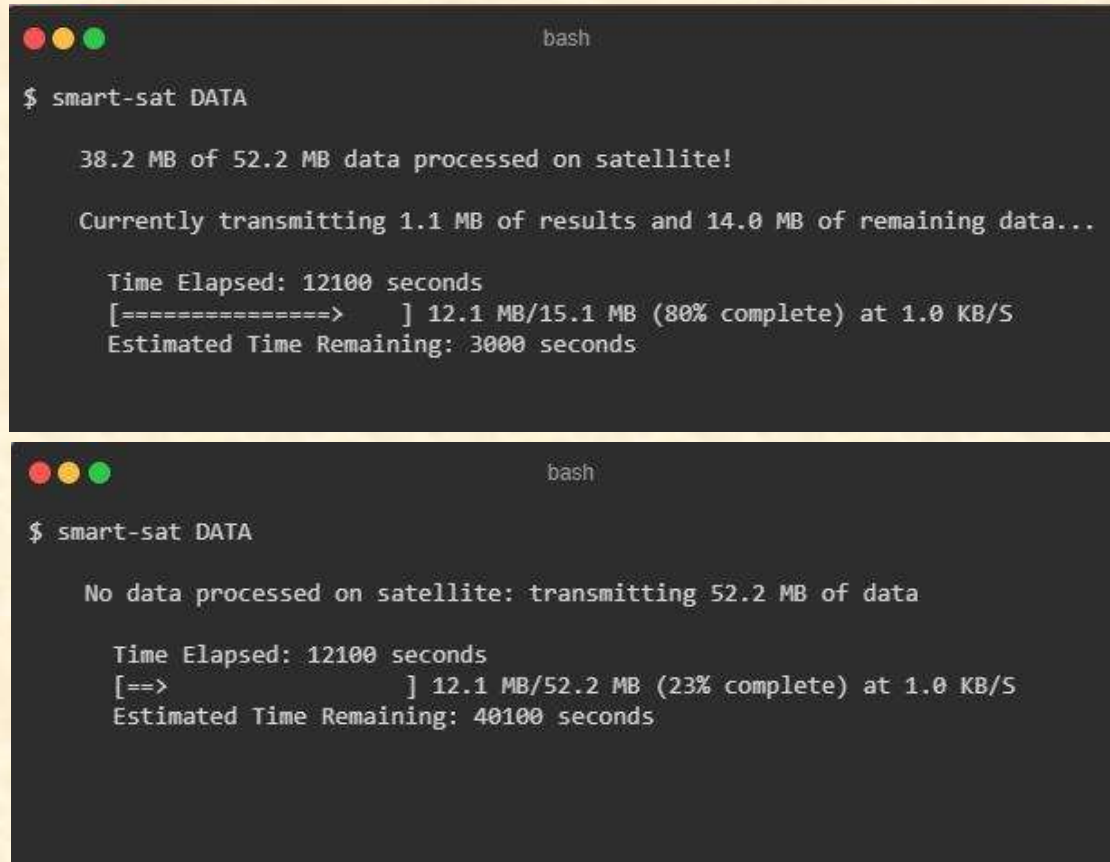
Chosen Hardware: nvidia-tx2-42763

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



The image displays two terminal window mockups, each with a dark background and three colored window control buttons (red, yellow, green) in the top-left corner. The title bar of each window reads "bash".

The top terminal window shows the output of the command `$ smart-sat DATA`. The output text is as follows:

```
38.2 MB of 52.2 MB data processed on satellite!  
  
Currently transmitting 1.1 MB of results and 14.0 MB of remaining data...  
  
Time Elapsed: 12100 seconds  
[=====>      ] 12.1 MB/15.1 MB (80% complete) at 1.0 KB/S  
Estimated Time Remaining: 3000 seconds
```

The bottom terminal window also shows the output of the command `$ smart-sat DATA`. The output text is as follows:

```
No data processed on satellite: transmitting 52.2 MB of data  
  
Time Elapsed: 12100 seconds  
[==>           ] 12.1 MB/52.2 MB (23% complete) at 1.0 KB/S  
Estimated Time Remaining: 40100 seconds
```



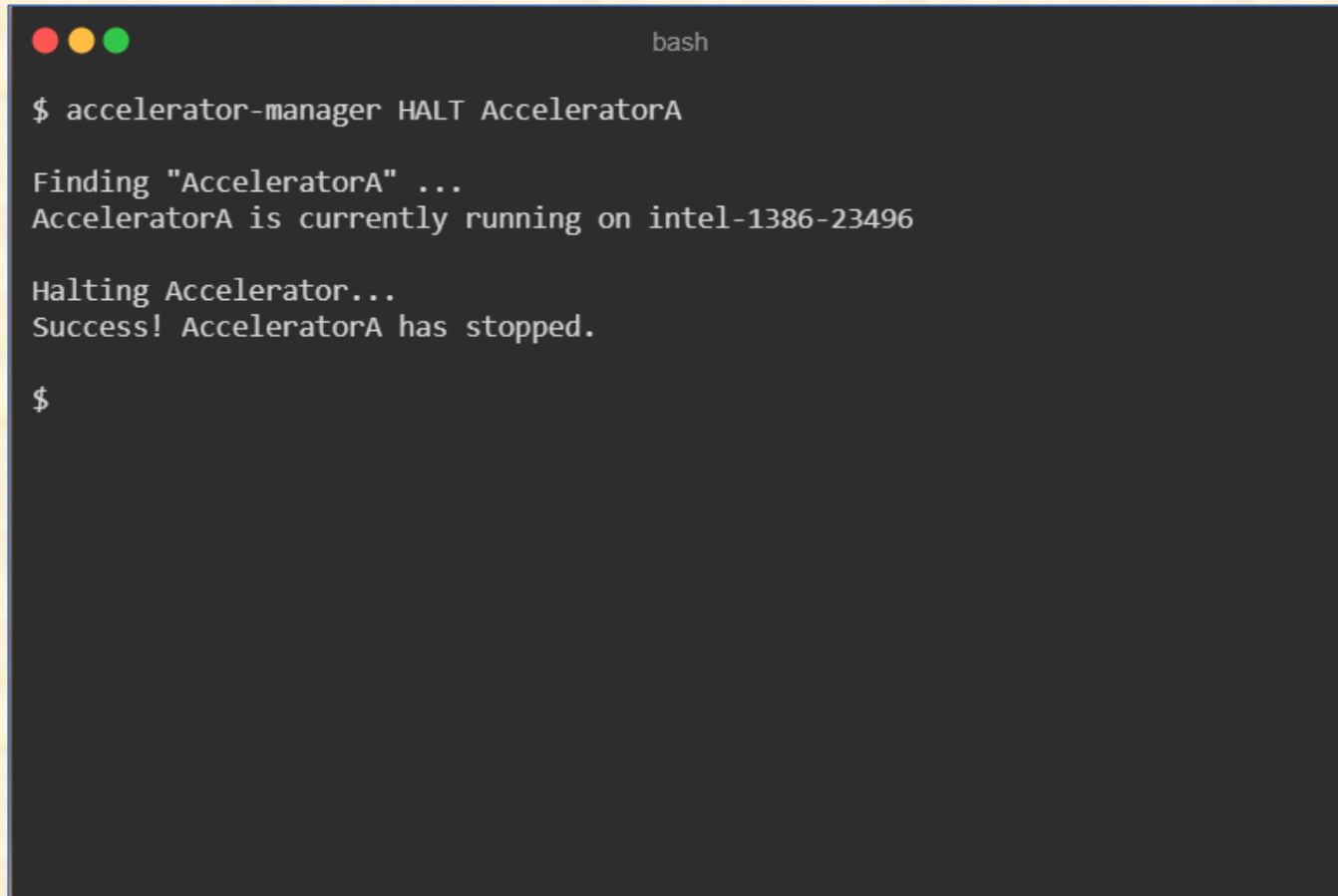
# Screen Mockup: Status

```
bash
$ accelerator-manager STATUS
Generating STATUS Report...

Accelerator Program:   name      | status    | runtime (s) | hardware
                        |          |             | 
        BadConfig     | Fail      | 000000000002 | xilinx-ZCU-102-68492
        GoodProgram    | Complete  | 000000006845 | nvidia-tx2-42763
        StillWorking   | Running   | 00000642873  | intel-i386-23496
        NoHardware     | Waiting   | 000000000000 | none

$
```

# Screen Mockup: Halting Accelerator



```
bash

$ accelerator-manager HALT AcceleratorA

Finding "AcceleratorA" ...
AcceleratorA is currently running on intel-1386-23496

Halting Accelerator...
Success! AcceleratorA has stopped.

$
```





# Technical Specifications

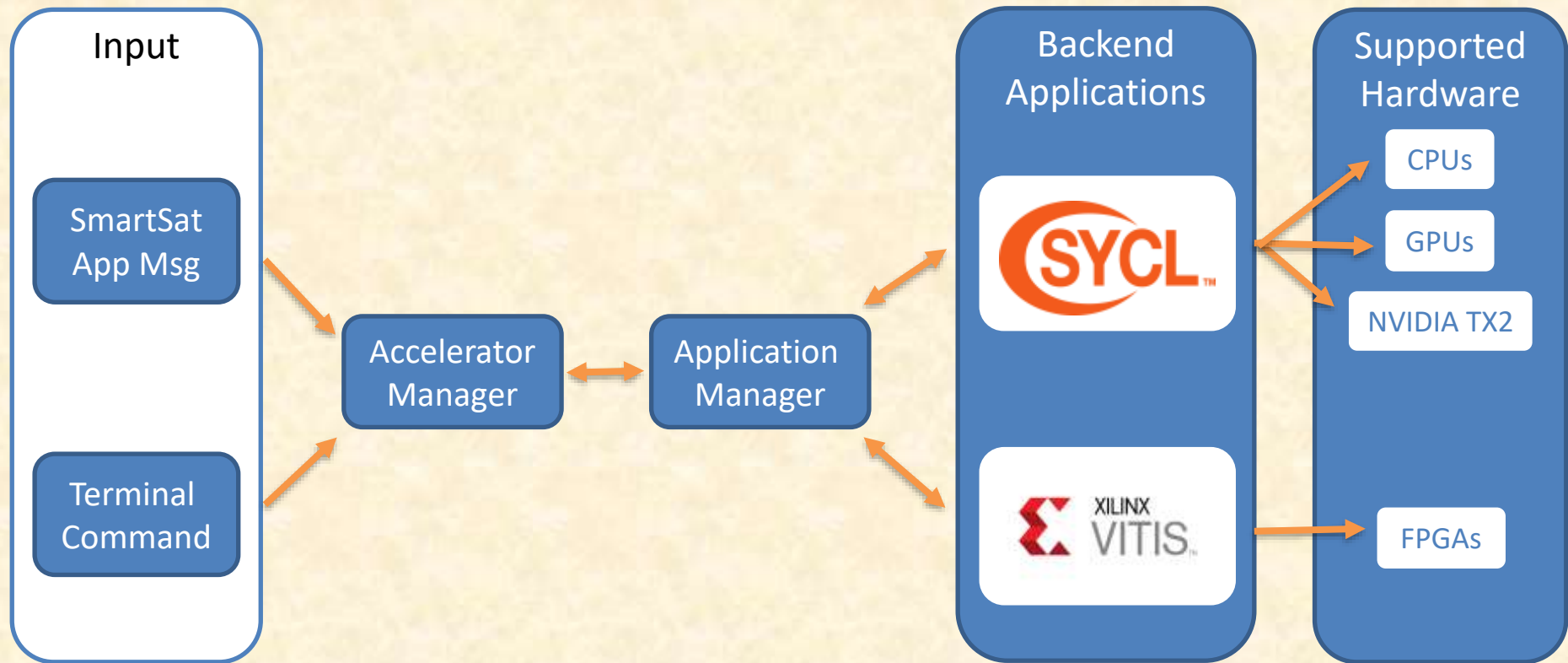
---

- 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?

---

?

?

?

?

?

?

?

?

?

