

MICHIGAN STATE

UNIVERSITY

Project Plan
SmartSat™ Heterogenous Computing in Space

The Capstone Experience

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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

```
bash
$ smart-sat DATA

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
```

```
bash
$ smart-sat DATA

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   | 00000000002 | xilinx-ZCU-102-68492
                     GoodProgram | Complete | 000000006845 | nvidia-tx2-42763
                     StillWorking | Running | 00000642873  | intel-i386-23496
                     NoHardware  | Waiting | 00000000000  | 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.
$
```

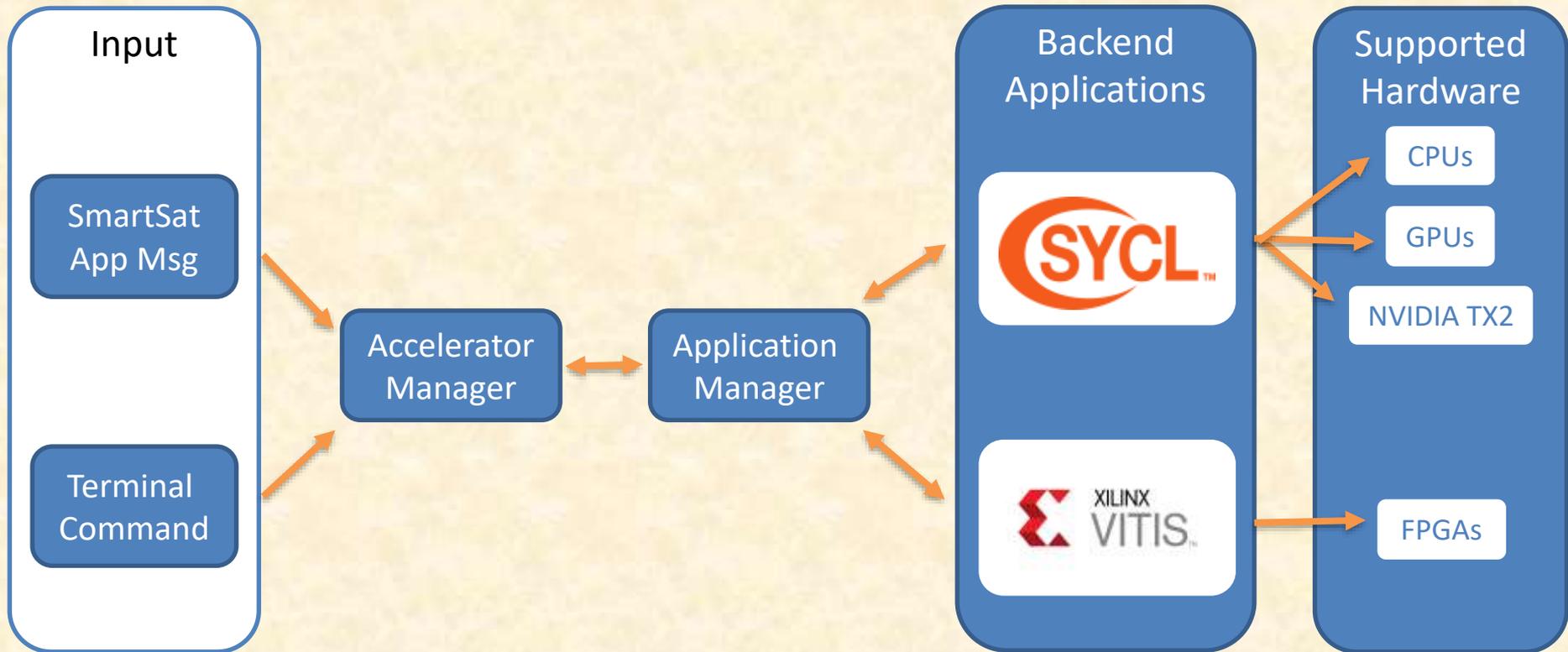


Technical Specifications

- 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?

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