

MICHIGAN STATE

U N I V E R S I T Y

Beta Presentation

SmartSat™ Heterogeneous Computing in Space

The Capstone Experience

Team Lockheed Martin Space

Gorman, Thomas

Kurkowski, Jacob

Langer, Nolan

Mondol, Shawn

Pargan, Bilal

Department of Computer Science and Engineering
Michigan State University

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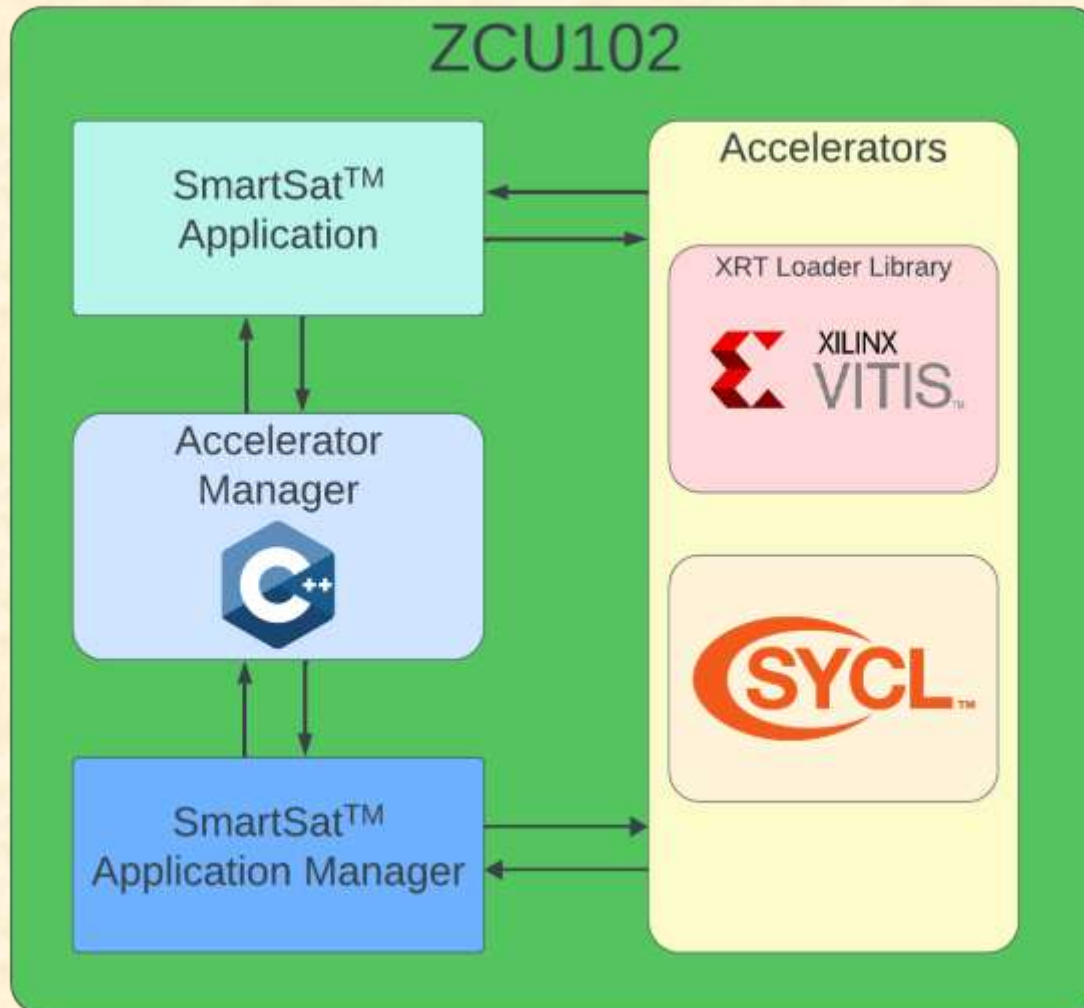
*From Students...
...to Professionals*

Project Overview

- Enable data to be processed faster by distributing algorithms across dissimilar and workload optimized processing devices.
- Minimize processing delays by determining which hardware component to use based on status of the satellite and resource utilization.
- Reduce hardware knowledge required to develop with XRT



System Architecture



Accelerator Manager

```
2023-11-14T00:02:49.888816Z INFO [AcceleratorManager] ORCA: Instantiating ModuleLoader to provide orca::Module for ORCA
2023-11-14T00:02:49.898662Z NOTICE [AcceleratorManager] ORCA: AcceleratorManager starting.
2023-11-14T00:02:49.888948Z INFO [AcceleratorManager] ORCA: Instantiating LifecycleClient to provide sds::Lifecycle::ILifecycle for ORCA
2023-11-14T00:02:49.889980Z INFO [AcceleratorManager] LifecycleClient: Using qualified name (com.lmco.smartat.AcceleratorManager/0.1.0/AcceleratorManager) from $SDS_APP_NAME environment variable
2023-11-14T00:02:49.891881Z INFO [AcceleratorManager] Messaging: Defaulting 'max_concurrent_req_resp' value to '1' for connection 'LifecycleClient'
2023-11-14T00:02:49.891826Z INFO [AcceleratorManager] Messaging: Defaulting receive_timeout to value: 1s for LifecycleClient
2023-11-14T00:02:49.891683Z INFO [AcceleratorManager] ORCA: Instantiating TCP-Mech to provide sds::Messaging::IMechanismFactory::TCP for messaging
2023-11-14T00:02:49.891123Z INFO [AcceleratorManager] TCP-Mech: Connection LifecycleClient, Mechanism LifecycleClientSource: Cannot find 'max_messages' in config; Defaulting value to 8
2023-11-14T00:02:49.891149Z INFO [AcceleratorManager] TCP-Mech: Connection LifecycleClient, Mechanism LifecycleClientSource: Cannot find 'destination_addr' in config; Defaulting value to 127.0.0.1.
2023-11-14T00:02:49.891196Z INFO [AcceleratorManager] TCP-Mech: Defaulting discovery_dwell to value: 3ms for LifecycleClientSource
2023-11-14T00:02:49.891254Z INFO [AcceleratorManager] LifecycleClient: Connection "LifecycleClient" to ApplicationManager established.
2023-11-14T00:02:49.891339Z INFO [AcceleratorManager] ORCA: Instantiating SteadyClock to provide orca::nt::IClock for Scheduler
2023-11-14T00:02:49.891423Z INFO [AcceleratorManager] ORCA: Instantiating AcceleratorManagerCore to provide orca::int::IPeriodic::AcceleratorManagerCore for Scheduler
2023-11-14T00:02:49.891469Z INFO [AcceleratorManager] Messaging: Defaulting 'max_concurrent_req_resp' value to '8' for connection 'AppManagerConnection'
2023-11-14T00:02:49.891497Z INFO [AcceleratorManager] Messaging: Defaulting receive_timeout to value: 1s for AppManagerConnection
2023-11-14T00:02:49.891523Z ERROR [AcceleratorManager] ERROR: Connection AppManagerConnection Cannot load Mechanism AppManagerTransmission: configuration cannot be found
2023-11-14T00:02:49.891547Z ERROR [AcceleratorManager] AcceleratorManagerCore: failed to connect to app manager command
2023-11-14T00:02:49.891572Z INFO [AcceleratorManager] Messaging: Defaulting 'max_concurrent_req_resp' value to '8' for connection 'AcceleratorManager'
2023-11-14T00:02:49.891595Z INFO [AcceleratorManager] Messaging: Defaulting receive_timeout to value: 1s for AcceleratorManager
2023-11-14T00:02:49.891619Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerTransmitResponse: Cannot find 'max_messages' in config; Defaulting value to 8
2023-11-14T00:02:49.891641Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerTransmitResponse: Cannot find 'destination_addr' in config; Defaulting value to 127.0.0.1.
2023-11-14T00:02:49.891674Z INFO [AcceleratorManager] TCP-Mech: Defaulting discovery_dwell to value: 3ms for AcceleratorManagerTransmitResponse
2023-11-14T00:02:49.891729Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerReceiveCommand: Cannot find 'max_messages' in config; Defaulting value to 8
2023-11-14T00:02:49.891757Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerReceiveCommand: Cannot find 'receive_addr' in config; Defaulting value to 0.0.0.0.
2023-11-14T00:02:49.891789Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerReceiveCommand: Cannot find 'max_concurrent_req_resp' in config; Defaulting value to 8
2023-11-14T00:02:49.891816Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerReceiveCommand: Cannot find 'max_client_connections' in config; Defaulting value to 8
2023-11-14T00:02:49.891846Z INFO [AcceleratorManager] TCP-Mech: Connection AcceleratorManager, Mechanism AcceleratorManagerReceiveCommand: Cannot find 'thread_name' in config; Defaulting value to AcceleratorManagerAcceleratorManagerReceiveCommand
2023-11-14T00:02:49.892004Z INFO [AcceleratorManager] AcceleratorManagerCore: Successfully set up command connection
2023-11-14T00:02:49.892048Z INFO [AcceleratorManager] AcceleratorManagerCore: AcceleratorManager initialized
2023-11-14T00:02:49.892129Z INFO [AcceleratorManager] Scheduler: Scheduled IPeriodic 'AcceleratorManagerCore' in thread 'AcceleratorManager_thread' (period:1.000000, delay:0.000000)
2023-11-14T00:02:49.892157Z NOTICE [AcceleratorManager] ORCA: AcceleratorManager initialized.
2023-11-14T00:02:50.671701Z NOTICE [AppManager] sds::app_manager::ApplicationManager: LifecycleServer: Application com.lmco.sds.centralLogger/1.1.0-b7817/CentralLogger reported initialization complete 878.531060ms after start
2023-11-14T00:02:50.671829Z NOTICE [AppManager] sds::app_manager::ApplicationManager: LifecycleServer: Application com.lmco.smartat.AcceleratorManager/0.1.0/AcceleratorManager reported initialization complete 877.752252ms after start
2023-11-14T00:02:50.794483Z NOTICE [AppManager] sds::app_manager::ApplicationManager: AutoStart: Apps have all finished initialization, proceeding to activate all...
2023-11-14T00:02:50.794678Z INFO [AppManager] sds::app_manager::ApplicationManager: LifecycleServer: Sent ACTIVATE command to com.lmco.sds.centralLogger/1.1.0-b7817/CentralLogger
2023-11-14T00:02:50.794833Z INFO [AppManager] sds::app_manager::ApplicationManager: LifecycleServer: Sent ACTIVATE command to com.lmco.smartat.AcceleratorManager/0.1.0/AcceleratorManager
2023-11-14T00:02:50.794930Z NOTICE [AppManager] sds::app_manager::ApplicationManager: AutoStart complete: sent activation command to 2 out of 2 total applications
2023-11-14T00:02:50.794953Z INFO [AcceleratorManager] LifecycleClient: AcceleratorManager [id 1] got the ACTIVATE command
2023-11-14T00:02:50.815891Z NOTICE [centralLogger] ORCA: central_logger activated.
2023-11-14T00:02:50.815902Z INFO [AcceleratorManager] Scheduler: AcceleratorManager_thread: Activated with 1 pre-scheduled job(s).
2023-11-14T00:02:50.815972Z NOTICE [AcceleratorManager] ORCA: AcceleratorManager activated.
```



XRT Loader Library

```
xilinx-zcu102-20231:/mnt# ls
Image          boot.scr      enconfig.json vadd.xclbin  xrt_kernel
xilinx-zcu102-20231:/mnt# ./xrt_kernel vadd.xclbin/xrt_kernel vadd.xclbin
Initializing Bitstream
Opening Device
[ 1268.937981] zocl-drm amba_pl0@:zyxc1nn_drm: zocl_create_client: created KDS client for pl0
[ 1261.062782] zocl-drm amba_pl0@:zyxc1nn_drm: zocl_destroy_client: client exits pid(783)
[ 1261.124113] zocl-drm amba_pl0@:zyxc1nn_drm: zocl_create_client: created KDS client for pl0
Loading Bitstream
[ 1261.857730] [drm] Loading xclbin 02d5b2ac-cef6-4090-87ad-9167f6f0df36 to slot 0
[ 1261.881642] [drm] skip kind 29(AIE_RESOURCES) return code: -22
[ 1261.784595] [drm] found kind 8(IP_LAYOUT)
[ 1261.787903] [drm] found kind 9(DEBUG_IP_LAYOUT)
[ 1261.788271] [drm] skip kind 25(AIE_METADATA) return code: -22
[ 1261.717467] [drm] found kind 7(CONNECTIVITY)
[ 1261.717908] [drm] found kind 6(MEM_TOPOLOGY)
[ 1261.719132] [drm] Memory 0 is not reserved in device tree. Will allocate memory from CMA
[ 1261.719599] [drm] Memory 1 is not reserved in device tree. Will allocate memory from CMA
[ 1261.719905] [drm] Memory 2 is not reserved in device tree. Will allocate memory from CMA
[ 1261.720206] [drm] Memory 3 is not reserved in device tree. Will allocate memory from CMA
[ 1261.720502] [drm] Memory 4 is not reserved in device tree. Will allocate memory from CMA
[ 1261.720820] [drm] Memory 5 is not reserved in device tree. Will allocate memory from CMA
[ 1261.721150] [drm] Memory 6 is not reserved in device tree. Will allocate memory from CMA
[ 1261.822690] zocl_irq_intc ZOCL_CU_INTC_2.auto: zocl_irq_intc_add: managing IRQ 57
[ 1261.840261] cu_drv CU:3.auto: cu_probe: CU[0] created
[ 1261.895512] [drm] zocl_xclbin_read_axiF 02d5b2ac-cef6-4090-87ad-9167f6f0df36 ret: 0
[ 1261.901958] cu_drv CU:3.auto: ffff000005886c10 xrt_cu_intr_thread: CU[0] start
[ 1263.131151] [drm] bitstream 02d5b2ac-cef6-4090-87ad-9167f6f0df36 locked, ref=1
[ 1263.169427] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 kds_add_context: client pid
x7fff) shared(true)
[ 1263.563560] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 kds_del_context: client pid
x7fff)
Bitstream load Successful.
```

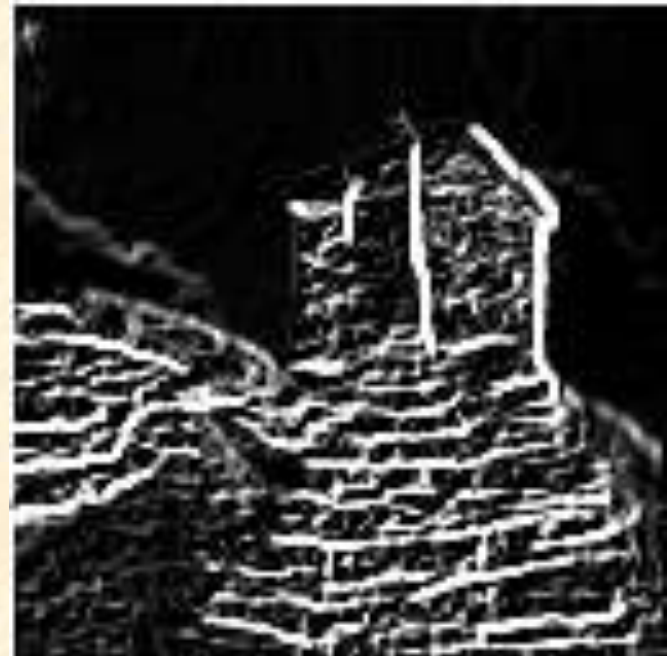
```
Bitstream Load Successful
[ 1263.623006] [drm] bitstream 02d5b2ac-cef6-4090-87ad-9167f6f0df36 unlocked, ref=
[ 1264.354198] [drm] bitstream 02d5b2ac-cef6-4090-87ad-9167f6f0df36 locked, ref=1
[ 1264.400202] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 kds_add_context:
shared(true)
Creating Buffer
Creating Buffer
Buffer created and mapped
Creating Buffer
Creating Buffer
Buffer created and mapped
Creating Buffer
Creating Buffer
Buffer created and mapped
Syncing buffer
Finished syncing buffer
Syncing buffer
Finished syncing buffer
New
Completed
Syncing buffer
Finished syncing buffer
[ 1267.751595] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 _kds_fini_client:
[ 1267.820100] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 _kds_fini_client:
[ 1267.821090] zocl-drm amba_pl0@:zyxc1nn_drm: ffff000001ba7010 kds_del_context:
[ 1267.821965] [drm] bitstream 02d5b2ac-cef6-4090-87ad-9167f6f0df36 unlocked, ref=
[ 1267.822039] zocl-drm amba_pl0@:zyxc1nn_drm: zocl_destroy_client: client exits p
xilinx-zcu102-20231:/mnt#
```



Visioncpp Accelerator



Vitis Vision Accelerator



What's left to do?

- Features
- Stretch Goals
 - XRT Monitor
 - Aesthetically pleasing GUI
 - Priority/Preferred device Shuffle
- Other Tasks
 - Optimize code
 - Make XRT library output more descriptive



Questions?

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