



SNIA DEVELOPER CONFERENCE



BY Developers FOR Developers

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Smart Data Accelerator Interface Use Cases Proof Points v1.1 and beyond

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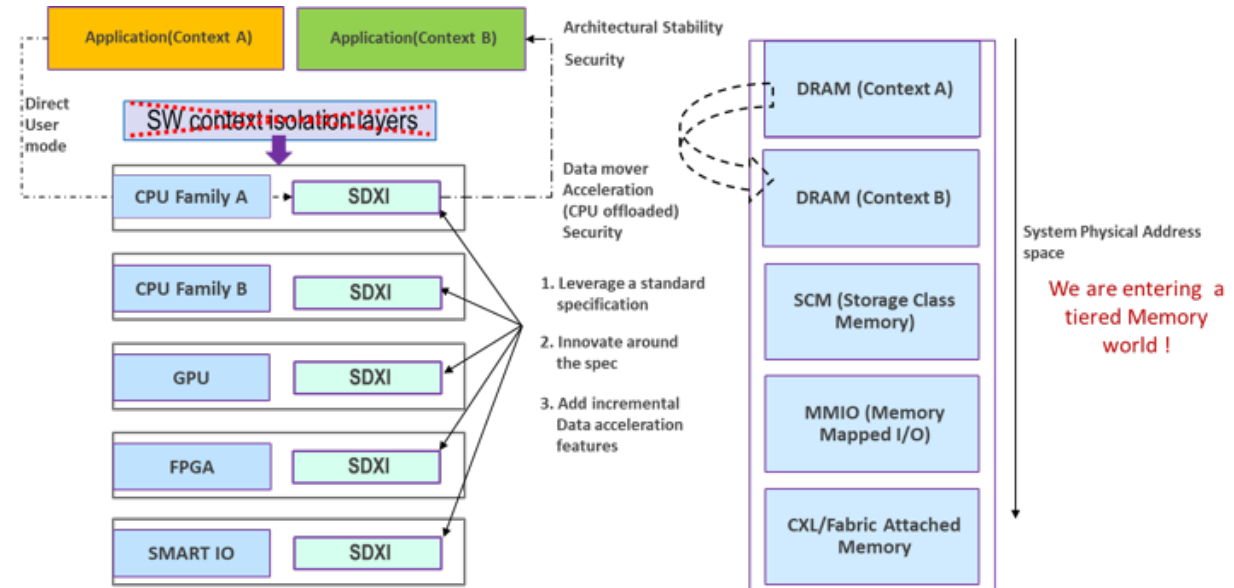
Agenda

- SDXI Intro and brief overview of v1.0
- SDXI v1.1 preview
- Software Enablement
- Proof points
- Summary

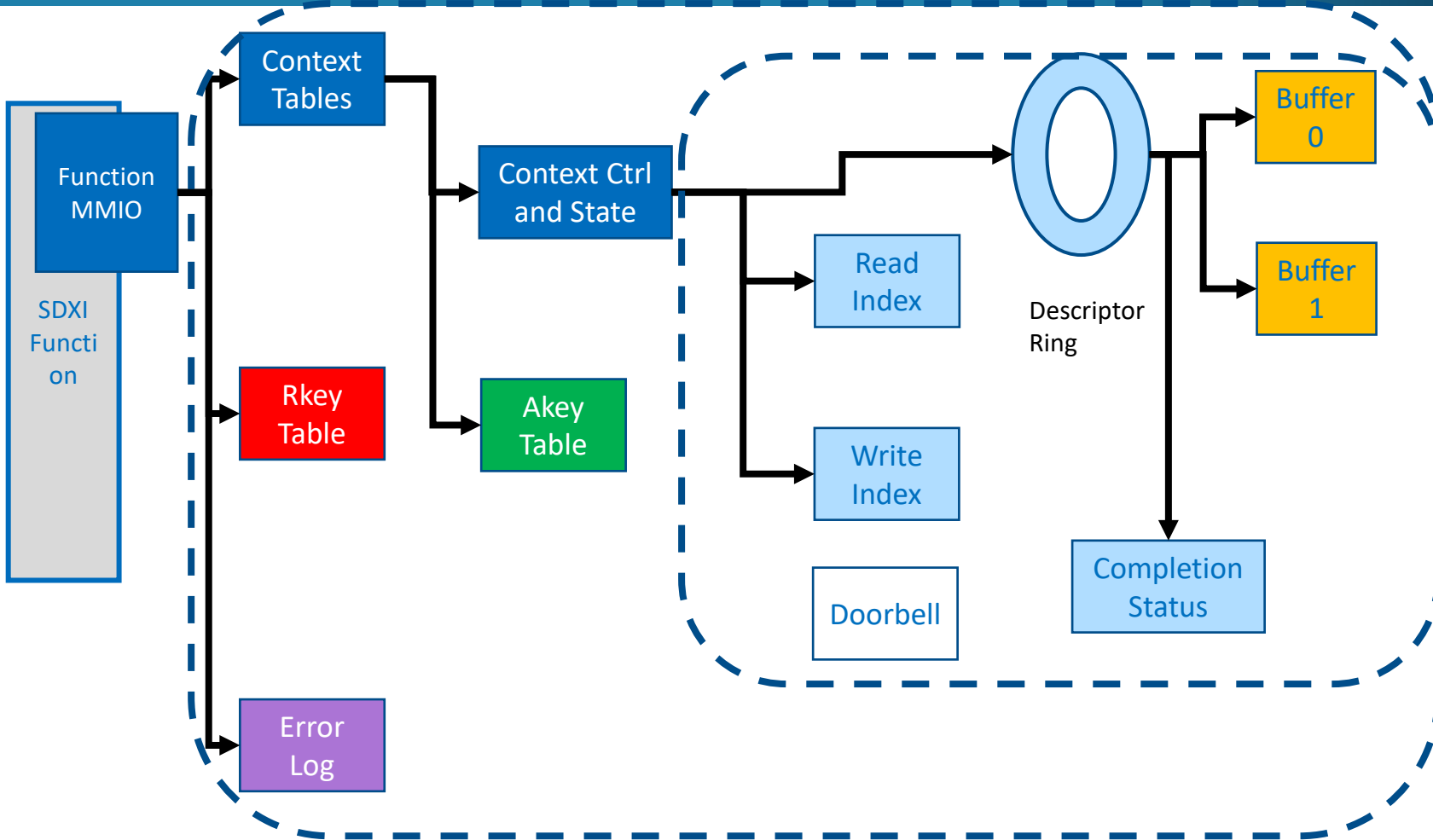
SDXI Intro and brief overview of v1.0

SDXI Intro

- Smart Data Accelerator Interface (SDXI) is a SNIA standard for a memory to memory data movement and acceleration interface that is -
 - Extensible
 - Forward-compatible
 - Independent of I/O interconnect technology
 - Features:
 - Virtualized address space to address space data movement
 - Offloads data movement, common memory operations, and data transformations while moving data
 - Offloads data movement while preserving address space and context isolation.
 - Standardized interfaces and architected states for DMA engine
 - Standardized for user-level software.
- v1.0 released!
 - <https://www.snia.org/sdxi>
- SNIA's SDXI TWG is now working on v1.1 now
 - SDXI TWG also has a software focused group that is working on a reference libsdxi implementation

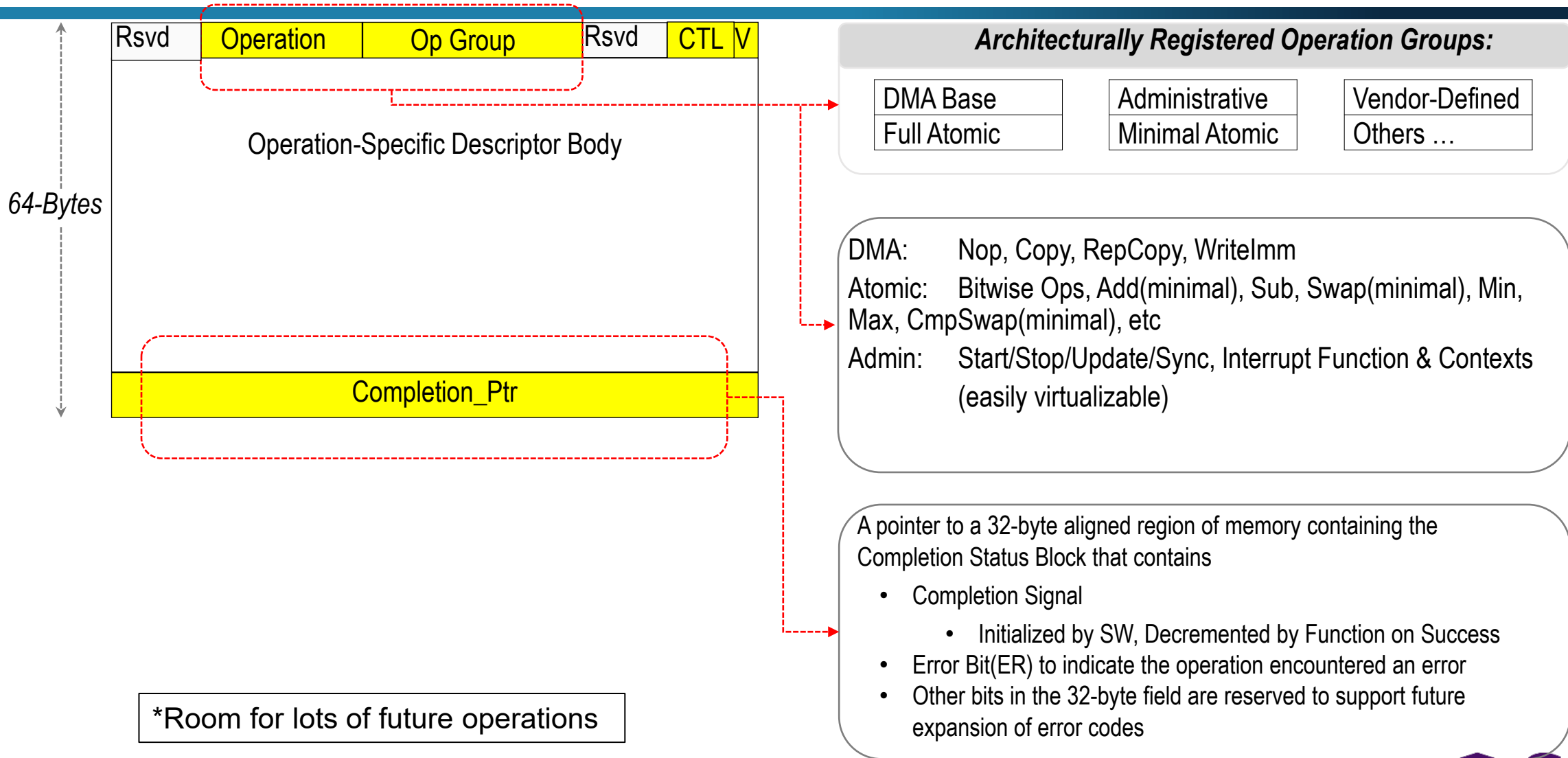


Memory Structures(1) – Simplified view

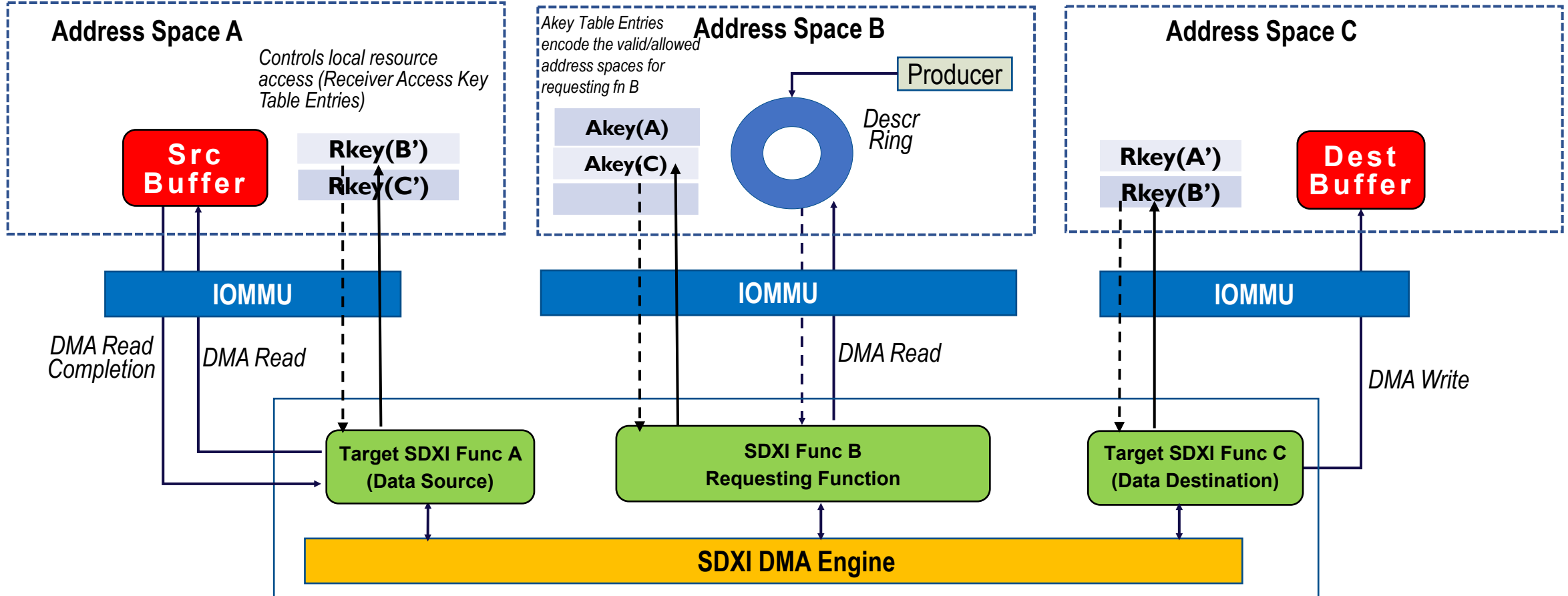


- All states in memory
- One standard descriptor format
- Easy to virtualize
- Architected function setup and control
 - *layered model for interconnect specific function management
 - SDXI class code registered for PCIe implementations

A Standard Descriptor Format (1)



Multi-Address Space Data Movement within an SDXI function group (2)



Need more on SDXI Internals

- SNIA SDXI Specification v1.0 Internals
 - <https://www.youtube.com/watch?v=wjc4ZnCQibw&pp=ygUNc2RjIDlwMjMgc2R4aQ%3D%3D>



SDXI v1.1 Preview

SDXI v1.1 investigations

- Connection manager
- New data mover operations for smart acceleration
- SDXI Host to Host investigations
- Scalability & Latency improvements
- Cache coherency mode for data movers
- Security Features for data movers
- Data mover operations involving persistent memory targets
- QoS
- Related use cases
- Heterogenous environments

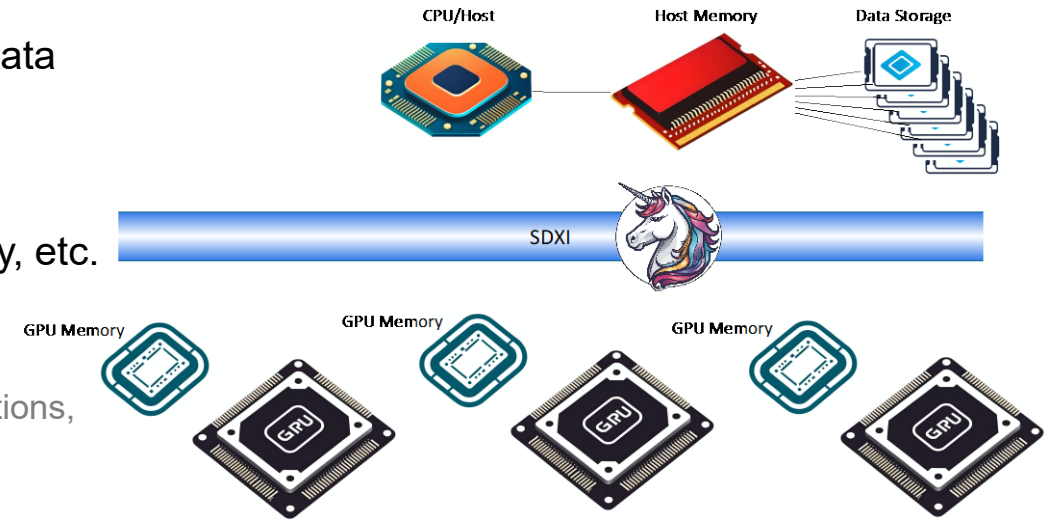
SDXI v1.1 Update



Does it apply to AI? Yes!!!

- Varying data formats and intermediate data representations used in AI/ML data pipelines
 - E.g., file, Columnar, Binary, Text, Tabular, Nested, Array-based, Hierarchical
- Training/inferencing operations involve tensors in memory
- Tensors may be in different address spaces like Host Memory, GPU Memory, etc.
- Need operations to be able to perform
 - Format Conversions
 - In memory Vector/Tensor transformations like scaling, normalization, matrix operations, etc.
 - ...
- Vendor-specific accelerators can increase TCO
- Possible Solution: Smart Data Interconnect (SDXI) is a SNIA standard for a memory to memory data movement generation interface that is
 - Vendor-agnostic
 - Independent of I/O interconnect technology
 - Facilitates data movement between different address spaces.
 - Standard extends to in-memory Offloads/transformations leveraging the architectural interface.

SDXI has emerging AI use cases



SDXI v1.1, v1.2, and v2.0

- While investigating features for v1.1 SDXI TWG developed a framework for features:
 - v1.1
 - Mostly errata fixes from v1.0,
 - Additional use cases prioritized by member participation
 - Retains compatibility with v1.0
 - v1.2
 - Overflow from v1.2
 - Retains compatibility with v1.0, and v1.1
 - v2.0
 - More intrusive features

v1.1 Sneak Peak

- SDXI v1.1 Practical Considerations

- Definable Operations to enable innovation
- Define new data mover operations to enable critical member use cases
- Improvements around memory ordering
- Improved point of view for
 - Connection Manager
 - Use cases involving memory fabrics,
 - Host to Host use cases
 - QoS use case
 - Storage Use Cases involving NVMe, and Computational Storage
 - Security considerations
 - AI Use cases

v1.1 Candidate: Definable Operations Group

- v1.0 Vendor-defined operations group definition was rigid
- Required vendors to register a vendor opcode
 - Slows innovation for implementations innovating with new opcodes
- Innovators want flexibility in defining new operations
 - However, require leverage with software, APIs without rewriting infrastructure code
- Definable operations group to the rescue!
 - Requires new UUID for definable operations in vendor space
 - Each vendor can support a profile to enable its own set of definable operations
- However,
 - Are you using the v1.0 vendor-defined encodings ?
 - Expect this v1.0 feature to get deprecated with v1.1

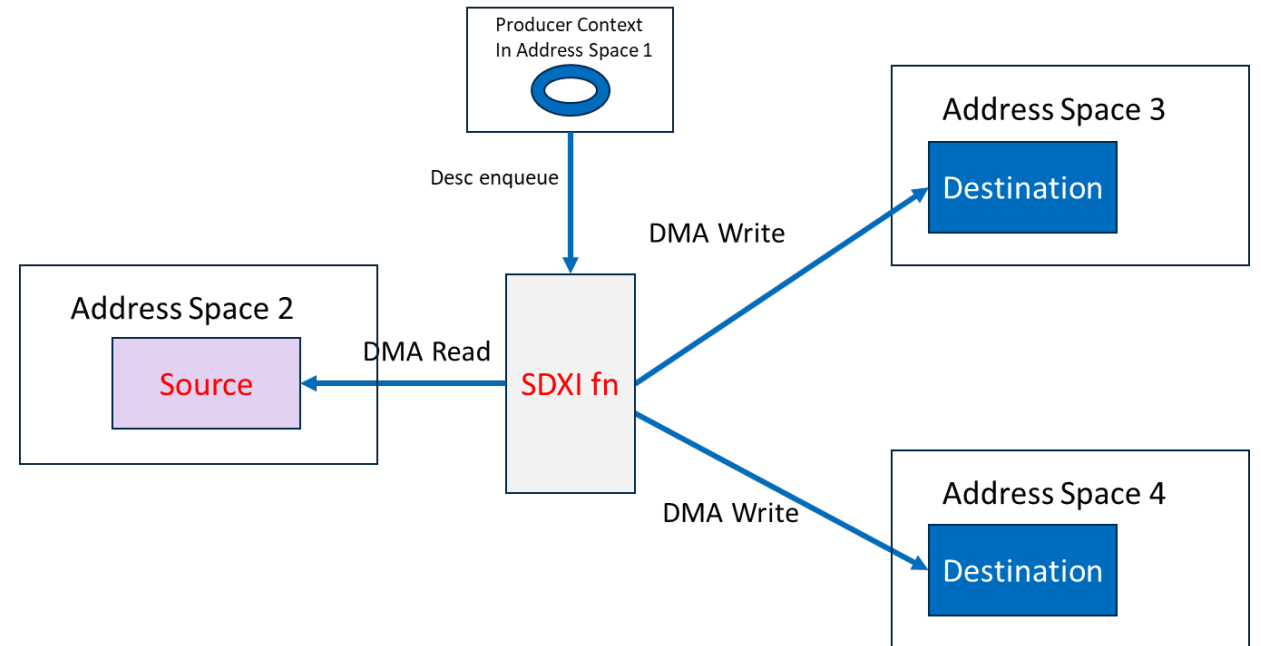
While we are on the topic of deprecation:

- Potential candidates for deprecation from v1.0
 - Mailbox
 - Vendor Defined Operations Group in favor of Definable Operations Group
- Are you affected? Please yell or joining the workgroup!

v1.1 Candidate: Make me another copy!

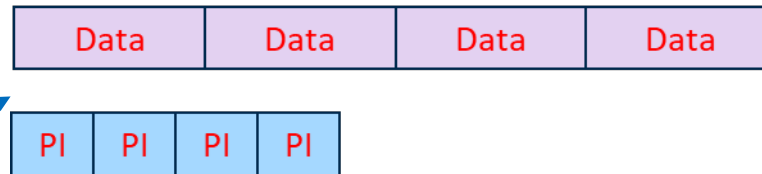
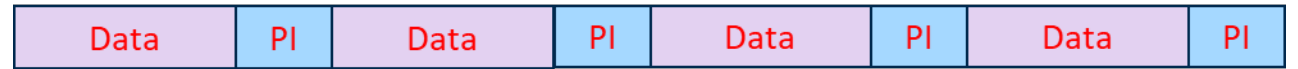
Double Copy

- Single Source buffer two destination buffers
- Single Source buffer, and two destination buffers
 - Each buffer can be in different address spaces.
 - Producer context can also be in an independent address space.



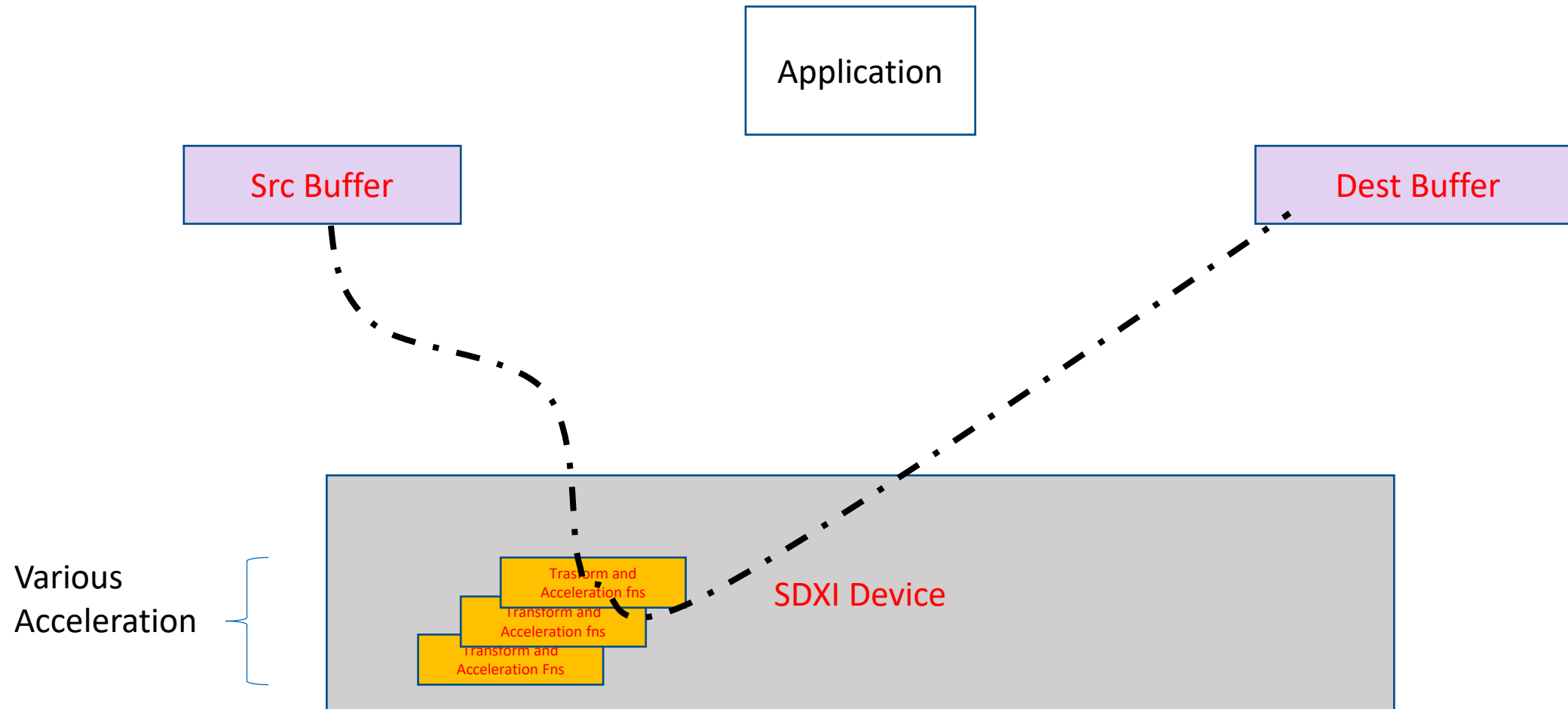
v1.1 Candidate: Data Integrity

- Cyclic Redundancy Checks(CRC)
- Protection Information(PI)
 - Memory to memory with PI Check, Strip, Insert, Update, Compare, etc.



Is there anybody using this format?

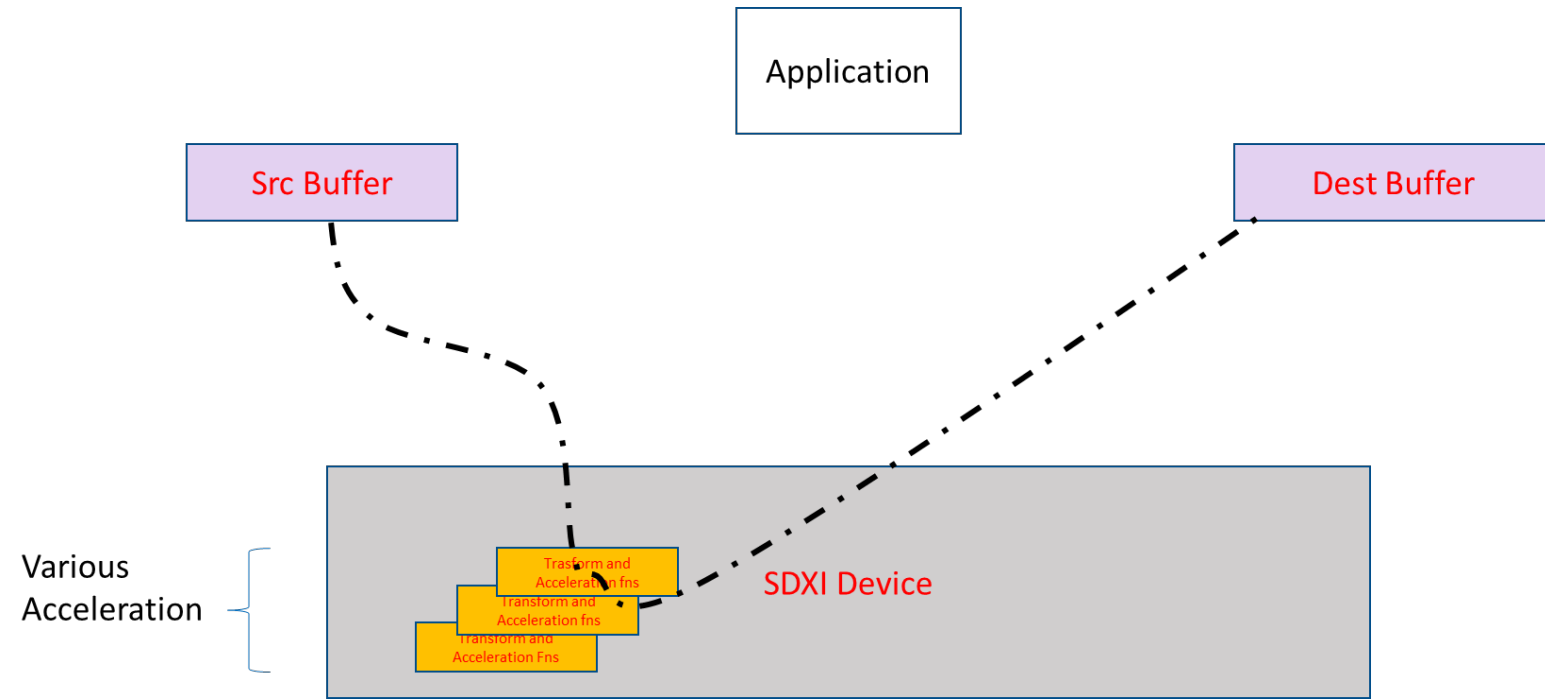
v1.1: New Data Mover Operations



v1.1 Memory Operations and Data Transformations

Operations

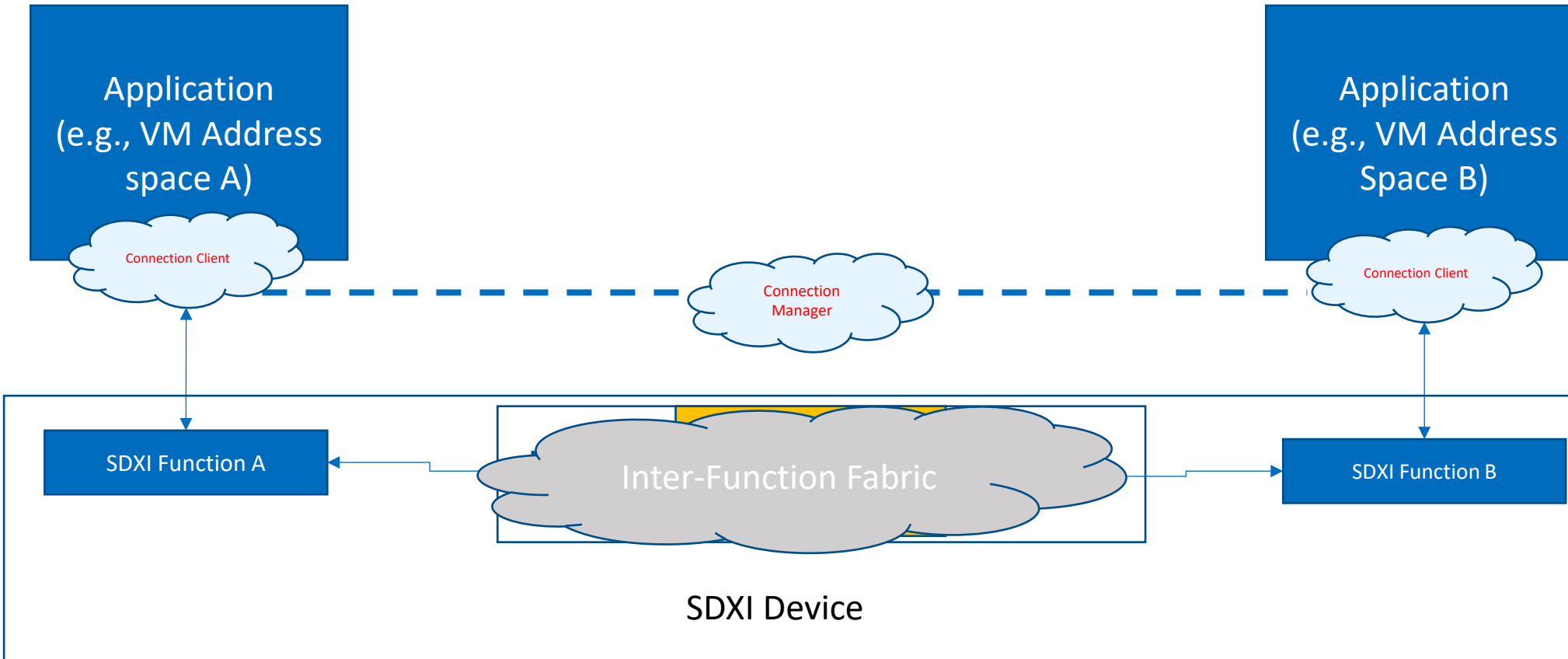
- POSIX memory ops
- Compression
- Encryption
- Bring Your Own Operation(BYOO)



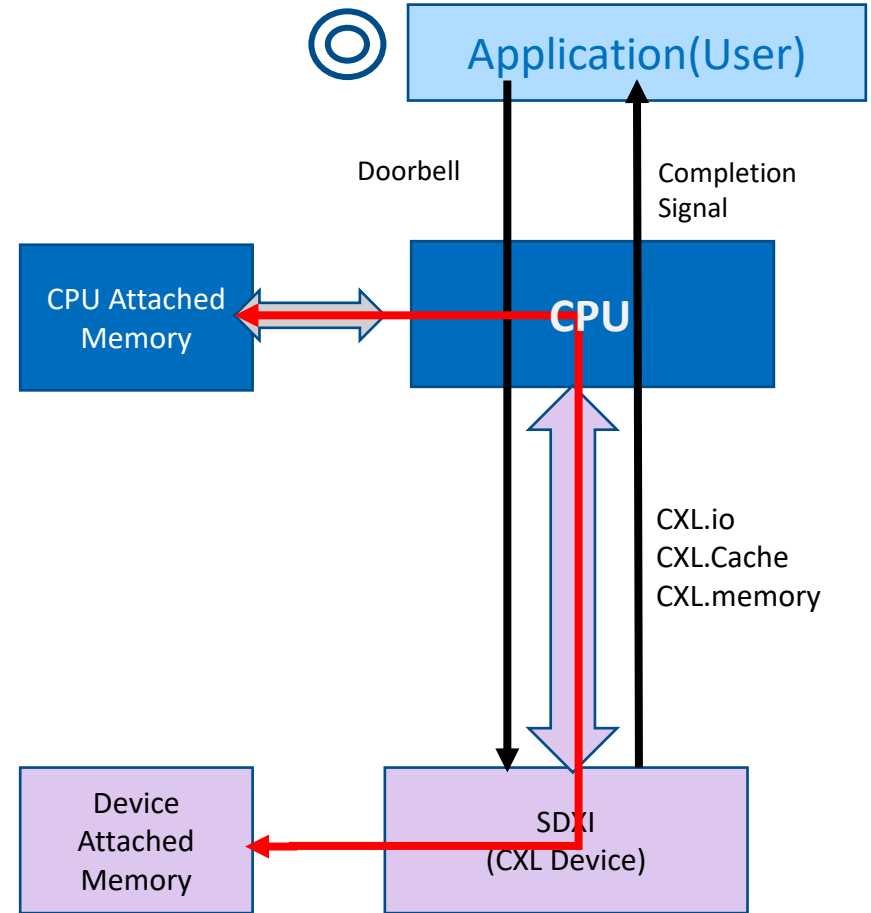
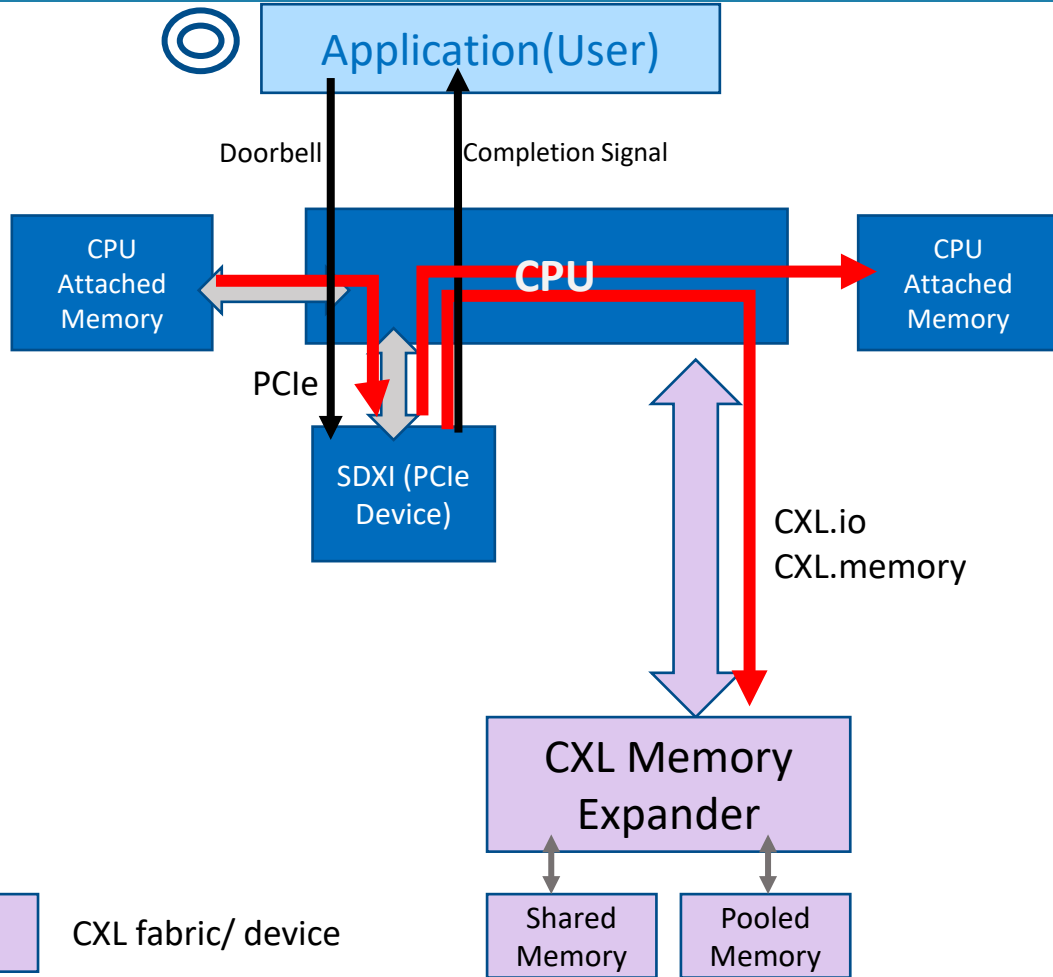
v1.1: Memory Ordering improvements



- SDXI v1.0 memory ordering
 - Write after Write – ‘seq’
 - Read after Completion of previous operation – ‘sync’
- Memory ordering relaxations and clarifications
 - Read after Write
 - Valid bit checking
 - Flagged Write

Point of view: Connection Manager



Point of view: CXL based Architectures



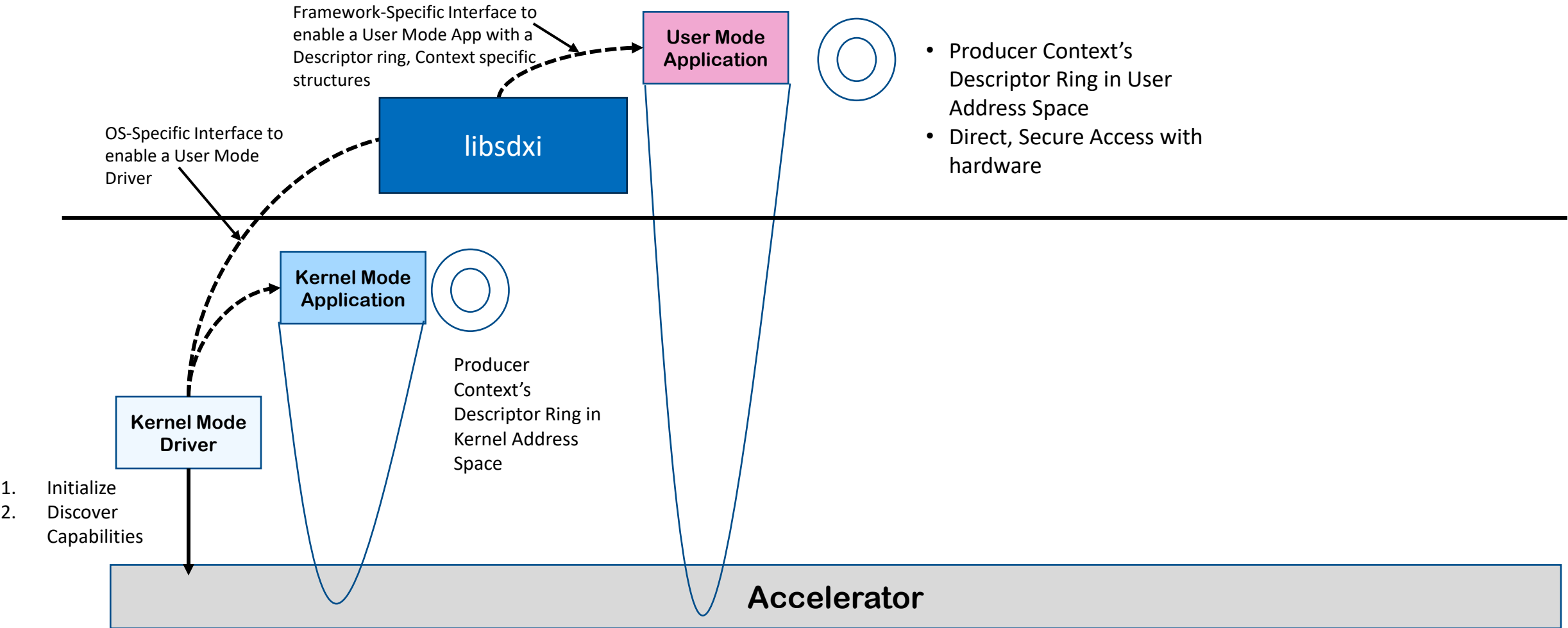
 CXL fabric/ device
 SDXI protocol

Software Enablement

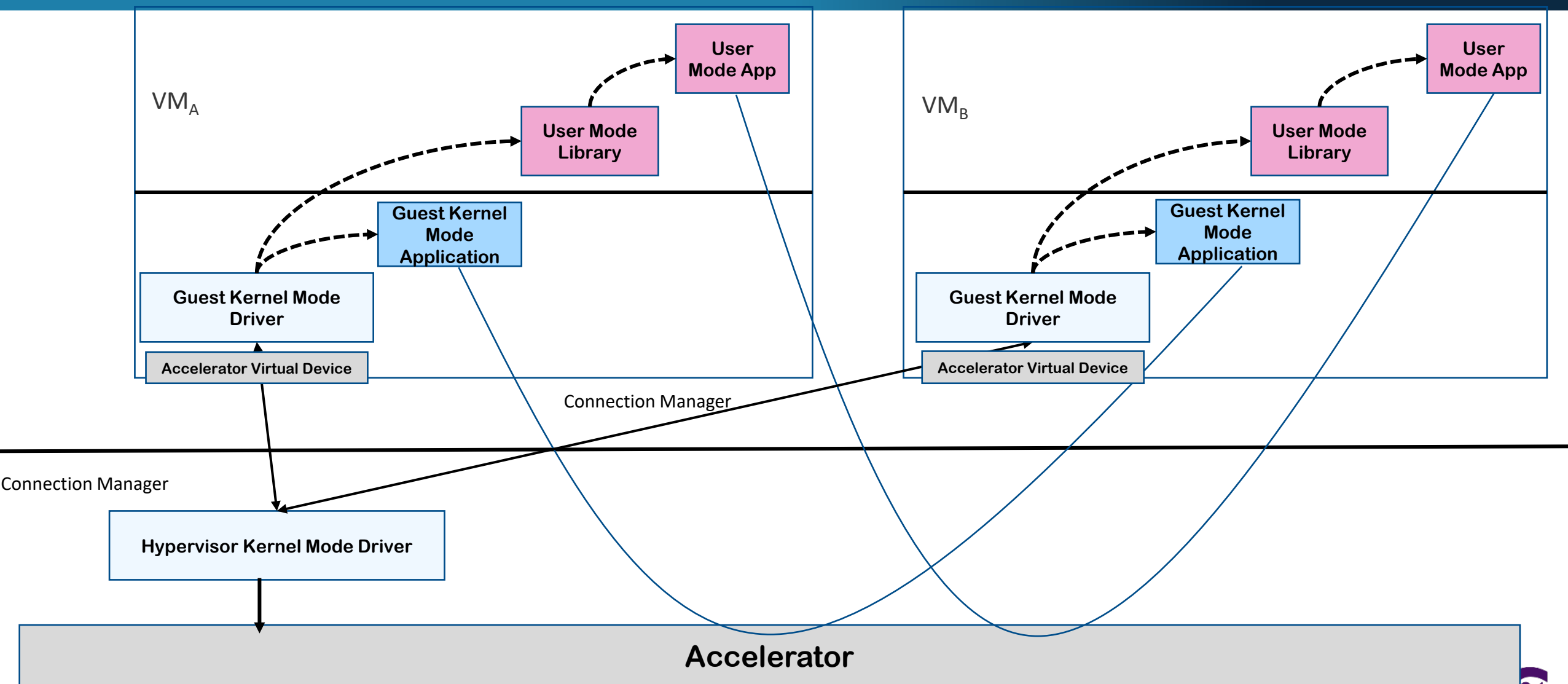
Software Ecosystem

- SDXI TWG is working on libsdxi
 - OS-agnostic user space library
 - Helps user space applications use SDXI accelerated data movement operations
 - Control Plane API
 - Probing resource discovery
 - Context management
 - Connection management
 - Data Plane API
 - Memcpy
 - Zero Memfill
 - <Memory Operations>
- SDXI TWG is enabling SDXI driver work in various OSes
- SDXI Kernel mode Use cases
 - Linux DMA engine
 - Mem-zero
 - Autonuma aka numa page migration
- SDXI emulation project investigation for ecosystem development

Baremetal Stack View



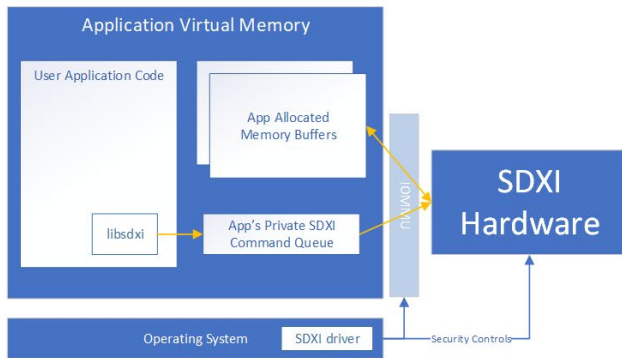
Scale with Compute Virtualization– Multi-VM address space



Proofpoints

Proofpoints: SDXI PoC Demo at Memcon 2024

SDXI Sample User Mode application with Linux



```
Terminalizer

ls: cannot access '/dev/sdxi': No such file or directory
$ modprobe sdxi
$ ls /dev/sdxi -l
crw----- 1 root root 240, 0 Mar  4 12:59 /dev/sdxi
$ cd libsdxi/
$ ls
aclocal.m4      config.guess  configure.ac  install-sh   Makefile.am  run.sh
AUTHORS        config.log   COPYING      libtool     Makefile.in  samples
autogen.sh     config.status depcomp      LICENSE     missing      src
autom4te.cache config.sub   docs         ltmain.sh   NEWS
ChangeLog     configure   include      m4          README
compile       configure~  INSTALL     Makefile    README.md
$ cd samples/
$ ls
context      Makefile    memcopy    recopy    samples.h  uadd.c    write-imm.c
context.c    Makefile.am memcopy.c  recopy.c  test.py    uadd.o    write-imm.o
context.o    Makefile.in memcopy.o  recopy.o  uadd      write_imm
$ vi memcopy.c
$ ./memcopy
SDXI memory copy test ...
    memory buffer src = 0x55a216dc8000
    memory buffer dst = 0x55a216dca000
Memory copy ==> SUCCESS
$
```



Summary and Call to Action

- SNIA is developing SDXI a memory to memory data movement standard
 - v1.0 released!
- Multiple companies involved in the effort
- SDXI standard continues to improve with new features and use cases
 - SDXI TWG working v1.1 specification
 - TWG has a framework and roadmap for v1.1, v1.2, and v2.0
- SDXI software ecosystem is developing, and proof points are emerging
- Learn More:
 - <https://www.snia.org/sdxi>

Q&A



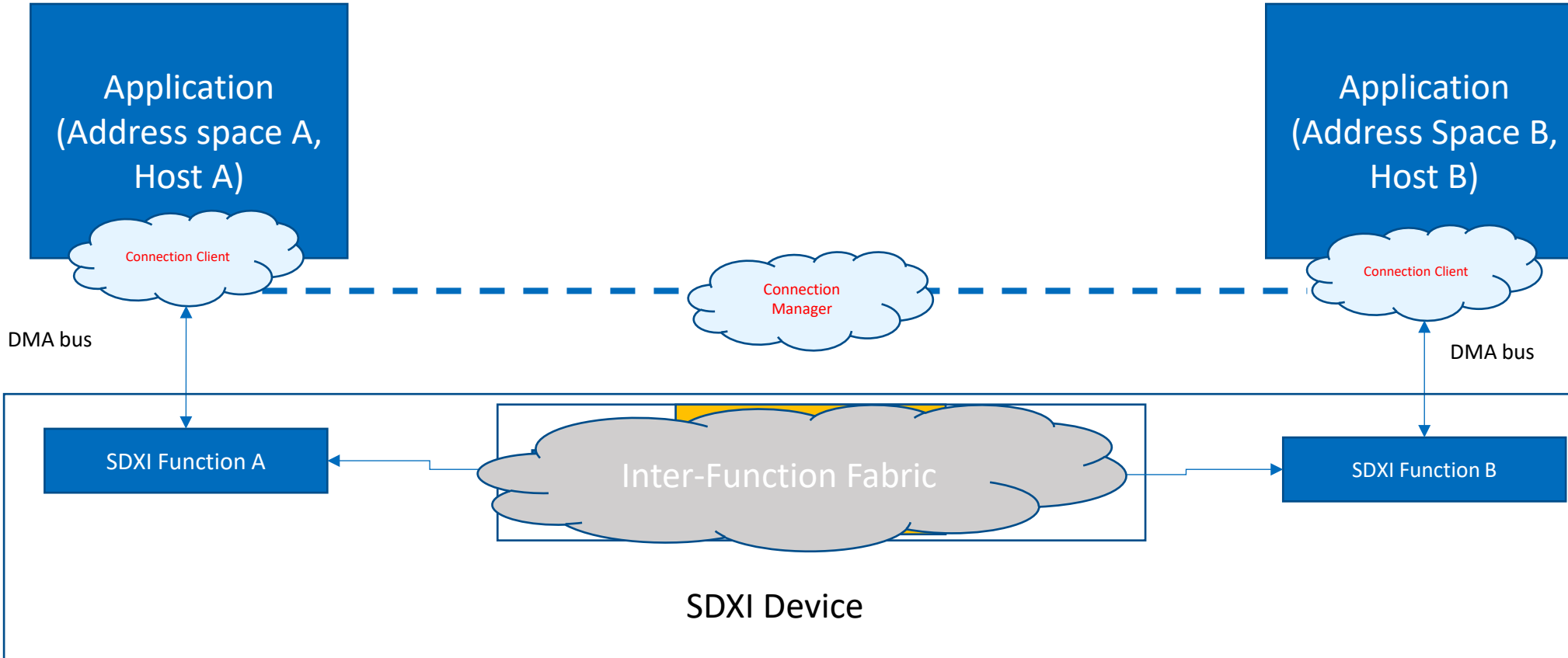
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Backup

Section Subtitle

Host to Host



Section Title

Section Subtitle



Section Title

Section Subtitle

Light Slide Title

- Bullets 1
 - Bullets 2
 - Bullets 3
 - Bullets 4
 - Bullets 5

Dark Slide Title

- Bullets 1
 - Bullets 2
 - Bullets 3
 - Bullets 4
 - Bullets 5



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