Computational Storage – Driving Success, Driving Standards

A SNIA Webcast Discussion with Bill Martin, Samsung; Jason Molgaard, Arm; Oscar Pinto, Samsung; Scott Shadley, NGD Systems

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Today’s Speakers

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SNIA-at-a-Glance

185 industry leading organizations

2,000 active contributing members

50,000 IT end users & storage pros worldwide
Computational Storage - A Quick History and Status
Common Language, Common Goals

- The challenge with driving new technology can be the convolution of data
  - The ability to say the same thing with different words
- Computational Storage had many names – back as far as 2010
  - Scale-In
  - In-Situ Processing
  - Compute to Data
  - In-Data Processing
- A change to the taxonomy model was needed and a SNIA Technical Work Group (TWG) was formed
The Ongoing Work of SNIA to Define Standards

- TWG Working group is continuing to see growth
  - Member count is up, Users ‘following’ and ‘participating’
  - 51 companies, 261 individual members

- Work in the Special Interest Group
  - CS SIG – Webinars, Blogs, Events

- Collaborating with other Groups
  - NVM Express – Computational Programs
  - Be sure to check out the Storage Developer Conference session presented by the Co-Chairs on that work
The Efforts to Get Information Out is Continuing

- ComputerWeekly.com
  - 13-part Series

- Gartner Analysts
  - 2018 and 2021 ‘Cool Vendor’
  - Hype Cycle Entry

- Sponsored Efforts
Computational Storage - The Work Being Done
A Potential Use Case for Computational Storage

- Generate Metadata database (e.g. tags) over a large set of unstructured data locally stored on the drive, with an integrated AI inference engine.

- Operation may be:
  - Triggered by a host processor
  - Done offline as a background task (batches)

- Metadata database may be then used by upper layer Big Data Analytics software for further processing.

- Can work both on direct attached storage or on remote over the network storage.

- Examples: Video search, Ad insertion, Voice call analysis, Images, Text scan, etc.
Current Progress of TWG Output

- Architectural Document has been released
  - V0.8 is now in Public Review
  - Many updates from 0.5

- API Document has been released
  - V0.5 is now in Public Review

- Security now being reviewed
  - In collaboration with SNIA Security TWG

- Today we’ll be speaking about Architecture and API
The Taxonomy of Computational Storage
Computational Storage Architecture
Implementing The Taxonomy of Computational Storage

CSx

→

CSxProperties

→

engine type X

CSEInfo

→

ComputeResource

CSEE

→

CSEEProperties

→

CSEEInfo

→

CSEEInstance^*

CSE

→

CSEProperties

→

CSEInfo

→

ComputeResource

CSF

→

CSFPProperties

→

CSFInfo

→

CSFInstance^*

*CSFInstance, CSEEInstance – activated for usage
+CSEEInfo, CSFInfo – each in repository

^CSEEInfo, CSEEInstance – hard-coded in CSE
^CSFInfo, CSFInstance – hard-coded in CSEE

CSEE

→

CSEEProperties

→

CSEEInfo^*

→

CSEEInstance^*^*

→

ComputeResource

CSF

→

CSFPProperties

→

CSFInfo^*

→

CSFInstance^*^*

→

ComputeResource
Direct Computational Storage Implementation

- **Assumption**
  - Data on which computation is to be performed is placed in the FDM, prior to the request to the CSE, through some process that is not shown in this figure
  - Result data, if any, is returned to the host through some process that is not shown in this figure

- **Process**
  1. The host sends a command to the CS controller to invoke the CSF;
  2. The CSE performs the requested computation on data that is in FDM and places the result, if any, into FDM; and
  3. The CSE returns a response to the host.
Computational Storage on Device Data

- **Assumption**
  - This example is for a computation on data that is in device storage

- **Process**
  1. The host sends a command to invoke the CSF;
     a. The command specifies the Device Storage location of the data;
  2. The CSE moves data from Device Storage to FDM;
  3. The CSE performs the requested computation on data that is in FDM and places the result, if any, into FDM; and
  4. The CSE returns a response to the host.
Indirectly Using Computational Storage on Device Data

Assumption:
- This example is for a device to host operation

Process:
1. The host sends a storage request to a Storage Controller where:
   a. that storage request is associated with a target CSF; and
   b. the storage controller determines what CSF is associated with the storage request;
2. The Storage Controller moves data from storage into the FDM;
3. The Storage Controller instructs the CSE to perform the indicated computation on the data in the FDM;
4. The CSE performs the computation on the data and places the result, if any, into the FDM; and
5. The Storage Controller returns the computation results, if any, from the FDM to the host.
Computational Storage APIs
CS API Library Overview

- One Set of APIs across all CSx types
  - CSP, CSD, CSA
  - Common set of APIs for different CS devices
- One interface to different device and connectivity choices
  - Hardware ASIC, CPU, FPGA, etc
  - NVMe/NVMe-oF, PCIe, custom, etc
- Configurations may be local/remote attached
- Hides vendor specific implementation details below library
- Abstracts device specific details
- APIs to be OS agnostic
About API Library

- **Uniform interface for multiple configurations**
  - APIs provided in common library
- **Each CSx managed through its own device stack**
  - Library may interface with additional plugins based on implementation requirements
  - Plugins help connect a CSx to abstracted CS interfaces
- **Extensible Interface**
- **API Requirements**
  - One interface across CS devices: CSP, CSD, CSA
  - Discovery
  - Device Access
  - Device Memory (mapped/unmapped) allocations
  - Near Storage Access
  - Copy Device Memory
  - Download Functions (CSFs)
  - Execute CSFs
  - Device Configuration & Management
  - Security
Applying Computational Storage

Input data does not get transferred to Host DRAM
Example with CS APIs

1. Discover CSx & CSF
2. Allocate Device Memory
3. Queue Storage Request
4. Queue Compute Request
5. Queue Copy Memory Request
What Next?
Explore SNIA Computational Storage Activities

- **SNIA Computational Storage Technical Work Group**
  - Actively working on establishing hardware and software architectures to allow for compute to be more tightly coupled with storage at the system and drive level

- **SNIA Computational Storage Special Interest Group**
  - Fostering the acceptance and growth of computational storage in the marketplace

- **SNIA Computational Storage Architecture and Programming Model v0.8 rev 0**
  - Defines recommended behavior for hardware and software that supports Computational Storage

- **SNIA Computational Storage API v0.5 rev 0**
  - Defines the interface between an application and a Computational Storage device (CSx)

Is your company a SNIA member? [Find out] …….and [contribute to the specifications]

Implementing computational storage? [Provide a public feedback comment]
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- A Q&A from this webcast will be posted to the SNIA Compute, Memory, and Storage Blog

Check out our blog: sniacmsiblog.org
We welcome your questions

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and
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