

Data Reorganization and Future Embedded HPC Middleware

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The Data Reorganization Forum



<http://www.data-re.org>

Join the mailing list discussion!

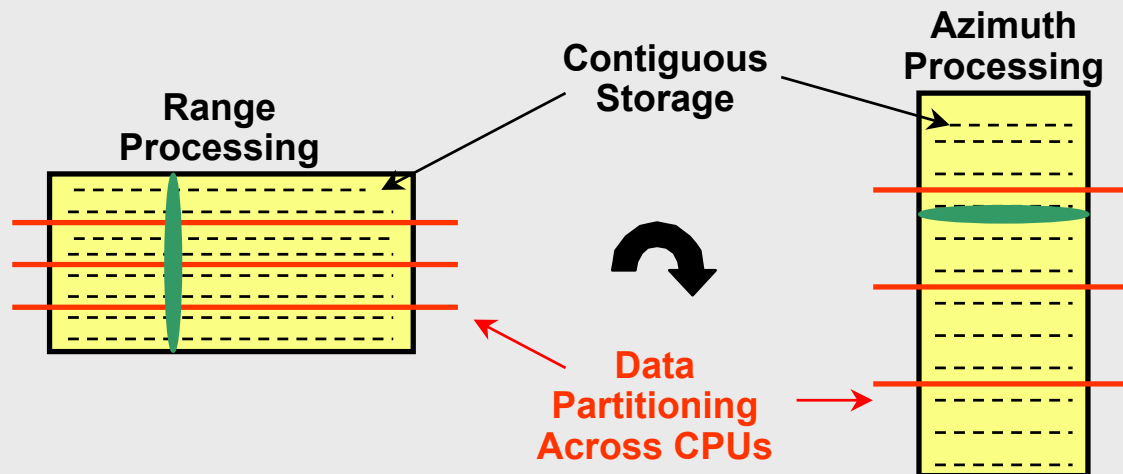
Goal: Final specification by June 2001

- **Broad community participation includes:**
 - FFRDCs and Government/Defense Laboratories
 - Defense integrators
 - Commercial embedded multicomputer vendors
 - Commercial HPC tool vendors
- **Examining API's, algorithms, and application requirements**

What Problems Does Data Reorg Try To Solve?

Data Partitioning and Redistribution Issues for Signal/Image Processing (SIP) Applications

- Block partitioning is most common
 - Whole problems stored in 1 memory for performance
- Data redistribution communication is “severe”
 - Prototypical example is matrix transpose in 2DFFT/SAR



Interface Scalability



Long-term future: higher-level / integrated / OO ???



Future Practice (with Data Reorg API)

- Programmer uses high-level partitioning services
- Middleware handles data partitioning details
- Data redistribution with a single high-level call
- Compute using VSIPPL

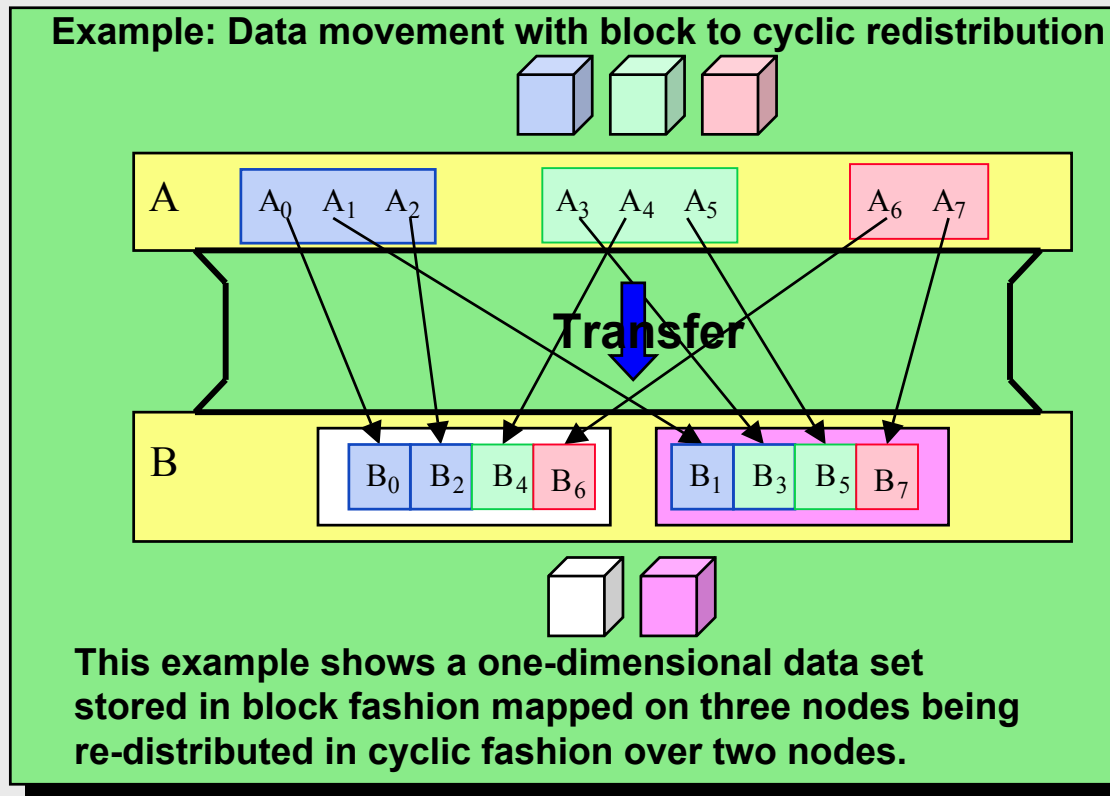
**Easier to scale
programming
effort**

State of the Art (current standard APIs)

- Programmer manually computes data partitioning
- Programmer manually redistributes data (MPI or MPI/RT)
- Compute using VSIPPL

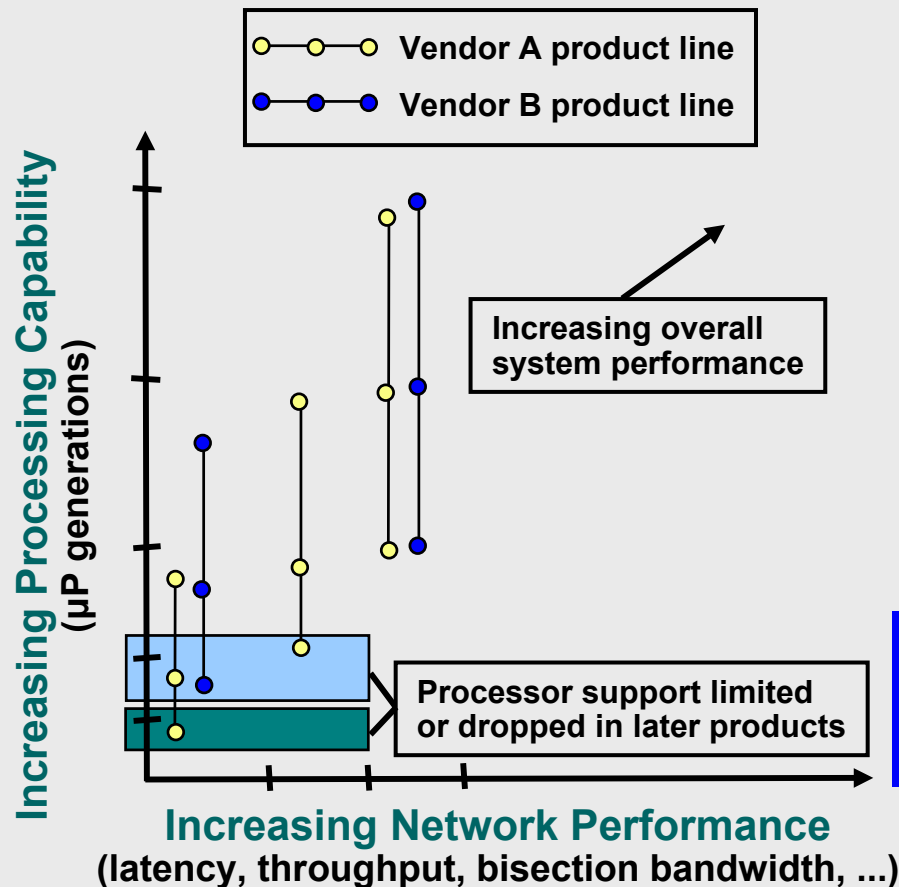
**Hard to scale
programming
effort
to large
systems**

Data Reorg Interface Example



- Application programmer uses DRI to move data
- DRI hides complex data movement from programmer

Model-Year Portability



Portable software leverages inevitable advances in COTS HPC technology

Defense system lifetimes: long
COTS HPC system lifetimes: short

“Point” solutions specific to a single vendor are long-term *cost ineffective*

Portable software with high performance is a powerful tool and is the ultimate goal

Challenges to Achieving Consensus In A Committee Context

Three Areas of Concern

Operational

- Will this API make it easier to write SIP applications?
- Does API support most common data reorgs for SIP?

**Scoped / Prioritized
to satisfy most SIP
application needs**

Research

- Allow integration of research approaches in API implementations
- Enable optimized implementations for a broad class of HPC architectures

Overlap with other APIs

- Common user / library buffers
- VSIPL, MPI, MPI/RT
- Which API allocates data?

Data Reorg Committee Status

Data Reorg Objects and Implementation Approaches



DRI “Standalone”
Middleware Adapter

DRI “CORE”

CORE

- Uniquely part of Data Reorganization API
- Must be provided in all Data Reorg implementations
- Objects:
 - DRI_Global_Data
 - DRI_Partition
 - DRI_Distribution
 - DRI_Layout
 - DRI_View
 - DRI_Overlap

Data Reorg Objects and Implementation Approaches

DRI “Standalone”

Middleware Adapter

DRI “CORE”

Standalone

- Functionality overlaps with other middleware
- Full implementation (without Middleware Adapter) gives a “pure” data reorg programming environment

- **Objects:**

Datatypes

DRI_Dataspec

Process Sets

DRI_Group

User and Library Memory

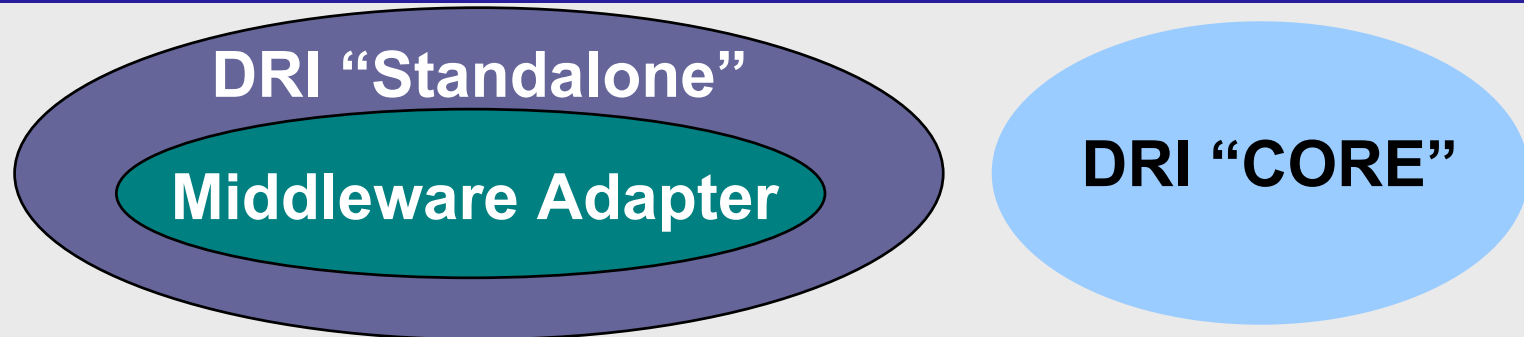
DRI_Bufferset

DRI_Buffer_Id

Data Transmission Constructs

DRI_Channel

Data Reorg Objects and Implementation Approaches



Middleware Adapter

- Defines a hybrid interface that leverages supporting middleware
 - MPI
 - MPI/RT
 - Mercury PAS
 - Sky SCL
- Objects:
 - Selected from "Standalone", depending on supporting middleware

Data Re-org Forum Plan

- Two more official meetings
- Several informal “working” meetings
 - Resolve issues with buffers and buffersets
 - Resolve issues with memory layouts and distributions
- Near-Term activities:
 - Establish CORE and Standalone Interfaces
 - Define MPI Middleware Adapter for Data Reorg
 - Final document detailing ideas and lessons learned

In the long term, the forum feels that a larger effort in this area would have substantial benefits for the high-performance embedded computing community