



CCA Status and Plans

CCA Forum Tutorial Working Group

[http://www.cca-forum.org/tutorials/
tutorial-wg@cca-forum.org](http://www.cca-forum.org/tutorials/tutorial-wg@cca-forum.org)

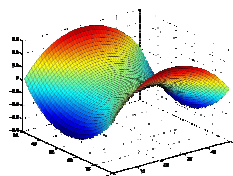
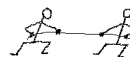
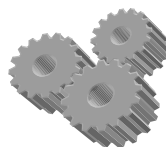


CCTTSS Research Thrust Areas and Main Working Groups

- Scientific Components
 - Scientific Data Objects
Lois Curfman McInnes, ANL (curfman@mcs.anl.gov)
- “MxN” Parallel Data Redistribution
 - Jim Kohl, ORNL (kohlja@ornl.gov)
- Frameworks
 - Language Interoperability / Babel / SIDL
 - Component Deployment / Repository
Gary Kumfert, LLNL (kumfert@llnl.gov)
- User Outreach
 - David Bernholdt, ORNL (bernholdtde@ornl.gov)

Scientific Components

- Abstract Interfaces and Component Implementations
 - Mesh management
 - Linear, nonlinear, and optimization solvers
 - Multi-threading and load redistribution
 - Visualization and computational steering
- Quality of Service Research
- Fault Tolerance
 - Components and Frameworks



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Scientific Components Extended R&D Agenda

- Complete development of abstract interfaces and base component prototypes
- Advanced component development
 - Second-level component extensions
 - Application-specific components for chemistry and climate
- Implement fault tolerance and recovery mechanisms
- Develop quality of service models for numerical components
 - Integrate QoS system into repository
- Develop interfaces and implementations for multi-level nonlinear solvers and hybrid mesh management schemes
 - Collaboration with TOPS and TSTT centers

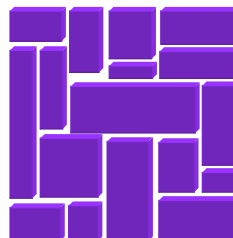
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Scientific Data Objects & Interfaces



- Define “Standard” Interfaces for HPC Scientific Data
 - Descriptive, Not (Necessarily) Generative...
- Basic Scientific Data Object
 - David Bernholdt, ORNL
- Structured & Unstructured Mesh
 - Lori Freitag, ANL
 - Collaboration with SciDAC TSTT Center
- Structured Block AMR
 - Phil Colella, LBNL
 - Collaboration with APDEC & TSTT



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Scientific Data Interfaces

- Low Level, Raw Data
 - Supports high performance access to memory
 - Based on IOVec
 - Assumes a contiguous memory block
 - Supports basic data types such as integer, float, double
 - No topology information
- Local & Distributed Arrays
 - Abstract interfaces for higher-level data description
 - 1D, 2D, 3D dense arrays
 - Various distribution strategies
 - HPF-like decomposition types (Block/Cyclic...)

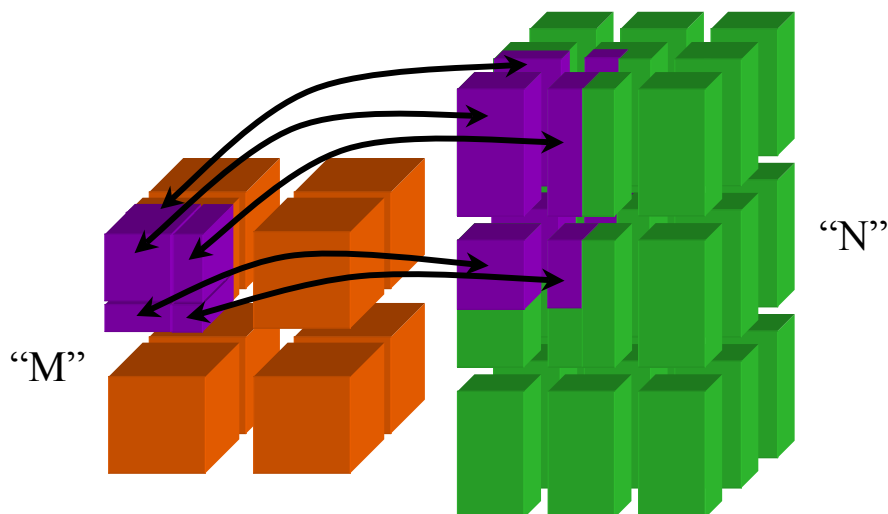
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Mesh Interfaces

- Unstructured Meshes
 - Abstract interfaces for mesh and geometry access and modification
 - Supports geometry and topology access via iterators, arrays, worksets
 - Separates structured and unstructured mesh access for performance
- Block Structured AMR
 - Abstract interfaces for allowing block structured AMR packages to exchange data

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“MxN” Parallel Data Redistribution: The Problem...



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“MxN” Parallel Data Redistribution: The Problem...

- Create complex scientific simulations by coupling together multiple parallel component models
 - Share data on “M” processors with data on “N”
 - $M \neq N \sim$ Distinct, Pronounced “M by N”...
 - Model coupling, e.g., climate, solver / optimizer
 - Collecting data for visualization (“Mx1”)
- Define “standard” interface
 - Fundamental operations for any parallel data coupler
 - Full range of synchronization and communication options

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Hierarchical MxN Approach

- Basic MxN Parallel Data Exchange
 - Component implementation
 - Initial prototypes based on CUMULVS & PAWS
 - Interface generalizes features of both
- Higher-Level Coupling Functions
 - Units, time & grid Interpolation, flux conservation
- “Automatic” MxN Service via Framework
 - Implicit in method invocations, “parallel RMI”



<http://www.csm.ornl.gov/cca/mxn/>

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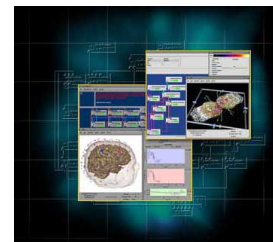
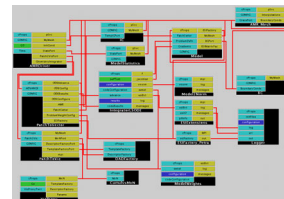
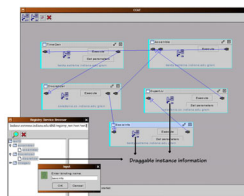
CCA Frameworks

- Component Containers & Run-Time Environments
- Research Areas:
 - Integration of prototype frameworks
 - SCMD/parallel with distributed
 - Unify framework services & interactions...
 - Language interoperability tools
 - Babel/SIDL, incorporate difficult languages (F90...)
 - Production-scale requirement for application areas
 - Component deployment
 - Component repository, interface lookup & semantics

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CCA Framework Prototypes

- Ccaffeine
 - SPMD/SCMD parallel
 - Direct connection
- CCAT / XCAT
 - Distributed
 - Network connection
- SCIRun
 - Parallel, multithreaded
 - Direct connection
- Decaf
 - Language interoperability via Babel



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Outreach and Applications Integration



- Not Just “Thrown Over The Fence”...
- Several Outreach Efforts:
 - General education and awareness
 - Tutorials, like this one!
 - Papers, conference presentations
 - Strong liaison with adopting groups
 - Beyond superficial exchanges
 - Real production requirements & feedback
 - Chemistry and climate work within CCTTSS
 - Actual application development work (\$\$\$)
- SciDAC Emphasis
 - More vital ***applied*** advanced computing research!

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Current CCA / CCTTSS Status

- CCA Specification at Version 0.5
- Several Working Prototype Frameworks
- Functional Multi-Component Parallel and Distributed Demonstration Applications
- Draft specifications for
 - Basic scientific data objects
 - MxN parallel data redistribution
- Demonstration Software ***Available for Download***
 - 4 different “direct connect” applications, 1 distributed
 - 31 distinct components, up to 17 in any single application, 6 used in more than one application

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CCA Tutorial Summary

- Go Forth and Componentize...
 - And ye shall bear good scientific software
- Come Together for Domain Standards
 - Attain true interoperability & code re-use
- Use The Force:
 - <http://www.cca-forum.org/tutorials/>
 - <http://www.cca-forum.org/software.html>
 - tutorial-wg@cca-forum.org
 - cca-forum@cca-forum.org

