
Testbeds and Middleware

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http://hipersoft.rice.edu/stc_site_visit/talks/Testbeds.pdf

PIs Involved

- Andrew Chien (MicroGrid)
- Rich Wolski (NWS, performance prediction)
- Ian Foster (Middleware)

Grid Application Developer

"Cactus"

"Zeus-MP" "Tardis"

"NetSolve" "GTomo"

"SF-Express"

"Distributed Viz"



- How will my software behave on the projected hardware configuration? (performance)
- How will it behave dynamically? (robustness)
- How will it interact with other Grid applications and uses of the system?
- How can I make this a robust, stable, reusable application?

Grid System Software Developer



"GrADS"

"NWS"

"PPS"

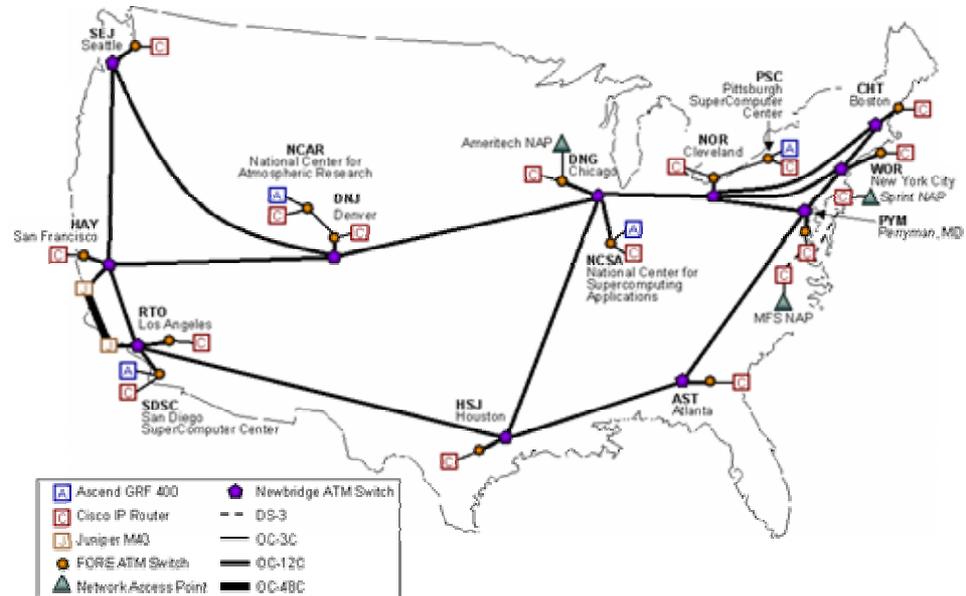
"Globus"

"Nimrod"

Grid Researchers

- Libraries - network, performance instrumentation, runtime environment (e.g. Globus)
- Program Preparation System - dynamic compilers, runtime, etc.
- Do these things work and how well?
- With what applications and what range of applications?

Grid System Administrator



- What if I change my resource access policies?
- What if I add/take away these resources?
- What if I change the "price" charged for resources?
- What happened to my Grid when it melted down last week?

Testbeds for Grid Research

- Successful Systems Research requires experimental evaluation
- Require “in vitro” and “in vivo” testbeds
 - MicroGrid: fine grain control, non-realtime execution
 - MacroGrid: large scale, realtime execution, subject to uncontrollable external influence

GrADS Testbed Infrastructure

- **Common services across testbeds and target execution environment**
 - **Smooth transition between macro and micro testbeds and production Grids**

Experimental GrADS Software Environment

Core GrADS Software Environment

Core Middleware Services

MicroGrid
Testbeds

MacroGrid
Testbeds

Production
Grids

Middleware for GrADS

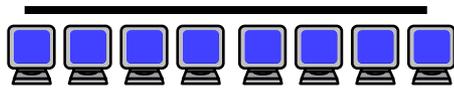
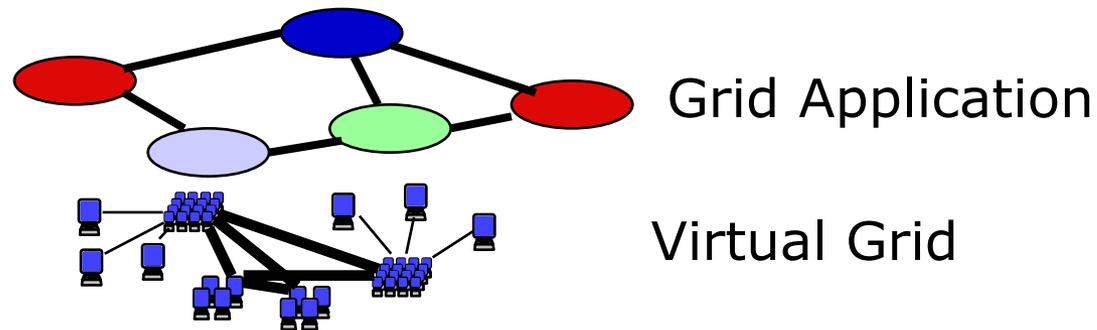
- Grid middleware defines basic services on which GrADS is layered
 - Grid services defines target for GrADS development tools
- CGrADS software builds on Globus
 - Security (authentication, authorization, privacy)
 - Information service (configuration and discovery)
 - Resource management (reservation, management)
- Same services and APIs provided on Micro and Macro testbeds

Why a MicroGrid?

- Realistic modeling of a broad range of Grid systems, applications, environments, and dynamic behavior
 - Challenges: complex dynamic behavior, coupled communication, computing, and storage, Model Performance, Availability, Failure
 - Requirements: Real applications (tools and middleware); Scalable and High fidelity; Repeatable behavior
- Deeper/broader understanding via simulation with detailed control
 - Develop models for system policy, application adaptation, etc.
 - Enable design of robust, reliable, Grids and Applications
- Provide environment for teaching and education
 - Grid education on a campus cluster

MicroGrid Structure

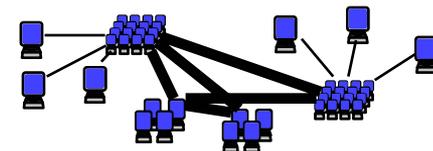
- A scientific tool for modeling Computational Grids
 - Run arbitrary Grid applications on any virtual Grid resources
 - Allow the study of complex dynamic behavior of large systems



LAN Workgroup



Scalable Cluster



Heterogeneous Environment

MicroGrid Approach

- Scalable computing system testbed platform
 - Desktop workstation, cluster, Teragrid, parallel computer
- Virtualized Globus environment
 - Applications and tools run without modification
- Coupled network simulator to model network behavior
 - Based on NS; building new scalable simulator
- Ability to scale:
 - Number and performance of processors
 - Storage performance
 - Network performance
 - Network topology

Why a MacroGrid?

- Study behavior in real environment
 - Performance against open networks, production schedulers background loads
- At speed performance of execution
 - Larger data-sets, coupling with real-time components
- Runtime environment for GrADS Experiments
 - Staging ground for transition to production Grids
- Provides every day development environment
 - Sitting on desktop and on local resources

GrADS MacroGrid Approach

- Build on standard Globus deployment
- Specialized instrumentation and monitoring to drive GrADS software
 - Network Weather Service (measurement and prediction)
- Customized information services to capture execution space
 - GrADS testbed as a “virtual organization”
- Web based tools to disseminate information
 - Oriented towards users and administrators
- Additional services to support software distribution and other group activities

System Status

GrADS Testbed Home

Administrator Services

- [Software Packages](#)
- [Publishing Software information](#)
- [Master Mapfile](#)
- [Accounts Setup](#)
- [Information Services](#)
- [NWS](#)
- [RIB](#)

The GrADS Testbed

- [Status \(from ISI\)](#)
- [Status \(from UIUC\)](#)
- [Status \(ISI alternate\)](#)
- [GrADS GIS Browser](#)

User Services

- [Getting Accounts](#)
- [Getting Support](#)

Testbed Mailing lists

- [help via e-mail](#)

Related Sites

- [GrADS Main Page](#)
- [Docs People](#)

GrADS
Grid Application Development Software Project

Testbed Status (from ISI) as of Sun Apr 29 12:18:08 PDT 2001.

Host	Port	Age	TTL	Software {Name, Version}
amajor.cs.uiuc.edu	2135	103 s	1200 s	{ MPICH-G, 1.1.2 UIUC patch } { Globus, 1.1.3 } { Autopilot, 2.3.0 } { NWS, 2.0.b7 } { ScaLAPACK, 1.6. } { PAPI, 1.1.5 } { HDF5, 1.4.0 } { MPICH-G, 1.1.2 UIUC patch } { Globus, 1.1.3 } { Autopilot, 2.3.0 } { NWS, 2.0.b7 } { ScaLAPACK, 1.6. } { PAPI, 1.1.5 } { HDF5, 1.4.0 } { MPICH-G, 1.1.2 UIUC patch } { Globus, 1.1.3 } { Autopilot, 2.3.0 } { NWS, 2.0.b7 } { ScaLAPACK, 1.6. } { PAPI, 1.1.5 } { HDF5, 1.4.0 } { MPICH-G, 1.1.2 UIUC patch } { Globus, 1.1.3 } { Autopilot, 2.3.0 } { NWS, 2.0.b7 } { ScaLAPACK, 1.6. } { PAPI, 1.1.5 } { HDF5, 1.4.0 }
bmajor.cs.uiuc.edu	2135	106 s	1200 s	{ MPICH-G, 1.1.2 UIUC patch } { Globus, 1.1.3 } { Autopilot, 2.3.0 } { NWS, 2.0.b7 } { ScaLAPACK, 1.6. } { PAPI, 1.1.5 } { HDF5, 1.4.0 }
caledonia.cs.indiana.edu	2135	561 s	1200 s	{ GLOBUS, 1.1.4 } { MPICH-G, 1.1.2 } { BLACS, 1.1.0 } { SCALAPACK, 1.6.0 }
cmajor.cs.uiuc.edu	2135	5 s	1200	{ MPICH-G, 1.1.2 UIUC patch }

Resource Status Information

The GrADS TestBed Plan - Microsoft Internet Explorer

Address: <http://www.isi.edu/grads/>

- [Status \(from ISI\)](#)
- [Status \(from UIUC\)](#)
- [Status \(ISI, alternate\)](#)
- [GrADS GIS Browser](#)

User Services

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Testbed Mailing lists

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Related Sites

- [GrADS Main Page](#)
- [Docs, People](#)
- [AppLeS in GrADS](#)
- [appleseeds](#) AppLeS Utilities
- [xdlutester](#) UTK
- [Cactus Installation](#) Chicago
- [HDF5 Installation](#)

Corrections or Suggestions

- <mailto:shelley@isi.edu>

Updated: March 5, 2001
[Shelley Henderson](#)

Created: August 03, 2000
[Srinivas Gulapalli](#)

hn	opus0.cs.uiuc.edu
objectname	hn=opus0.cs.uiuc.edu, dc=cs, dc=uiuc, dc=edu, o=Grid
ttl	undefined
resourcename	Host opus0.cs.uiuc.edu
hostname	opus0.cs.uiuc.edu
canonicalsystemname	i686 unknown linux 2.2.17-14smp
manufacturer	unknown
model	Pentium II (Deschutes)
machinehardwarename	i686
hostid	ae8014ec
type	workstation
osname	linux
osverson	i686 unknown linux 2.2.17-14smp
osrelease	2.2.17-14smp
ostype	linux
physicalmemorysize	251 MBytes
cputype	GenuineIntel Pentium II (Deschutes) 6 (step 2) (fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 mmx fxsr)
fputype	GenuineIntel Pentium II (Deschutes) 6 (step 2) (fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 mmx fxsr) (fdiv_bug no)
cpucount	1
cpuspeed	448 MHz
cpuload1	1.17
cpuload5	0.25
cpuload15	0.08

Done

Start | The GrADS TestBed Pl... | Microsoft PowerPoint - [Si... | 51% | 1:45 PM

Testbed as Virtual Organization

- Need structure to coordinate distributed experiments
 - Distributed resource base, software base
 - Distributed experimenter base
- Provide project and experiment specific views of Grid
 - Collates and presents information about experiment resources in a uniform view
- More than just Grid stuff
 - Browsers, POC information, web pages, mailing lists etc

Accomplishments

- Globus 1.1.3 Toolkit and NWS established as foundation for GrADS software development
- MicroGrid system demonstrated ability to support existing Globus toolkit, applications and tools (critical for significant experiments)
 - Globus toolkit, a range of emulated network environments
 - Autopilot, Fuzzy Library, SDDF, MPICH-G, ...
 - NPB, Cactus, parts of ScaLAPACK
- MicroGrid system demonstrated accurate simulation
- MacroGrid operational across GrADS computing sites
 - Used for two application experiments to date
- Basic testbed management tools developed
- Starting second iteration of both testbed technologies
 - Performance tuning, feature enhancement
 - Extend scope

We learned...

- **MicroGrid**

- Existing network simulation tools and traffic models are inadequate
 - don't scale, don't support emulation
- Deriving network configuration information is challenging
 - Tie in to MacroGrid historical data
- Extrapolation of results is a challenge due to nonlinearity of behavior
- There's a LOT more work to be done to support
 - large-scale, high speed simulations,
 - with flexible choice of resource models,
 - simulating a wide range of environments, and
 - executing on a wide range of physical hardware resources.

- **MacroGrid**

- Running a testbed is hard
- Need to enhance agility and flexibility of testbed environment
- Having established, maintained infrastructure is a valuable tool

Research Challenges

- **MicroGrid**
 - Scalable Grid Emulation
 - Modeling Grids with 10^5 to 10^9 elements (nodes, routers, etc.)
 - Execute on large scale computational engines (e.g. TeraGrid)
 - Traffic Modeling
 - Background loads for experiments (traditional)
 - New aggregate models for Grid applications (self-interaction)
 - Behavioral Extrapolation
 - Experiments which characterize an application's dynamic behavior
 - Extrapolation to space of runtime conditions
- **MacroGrid**
 - Middleware support for adaptive application development/execution
 - Information infrastructure to drive higher-level CGrADS components
 - Coupling of MacroGrid monitoring into MicroGrid configuration
 - Flexible virtual organization creation

Testbeds in Context

- **The Globus Grid Toolkit**
 - Basic Grid services, API's and tools
- **GrADS**
 - Initial development of testbeds
- **CGrADS**
 - Flexible, persistent testbed environments
 - Tighter coupling between MicroGrid, MacroGrid and production Grid services
 - New services to support application development environments