GridSolve: A Seamless Bridge Between the Standard Programming Interfaces and Remote Resources

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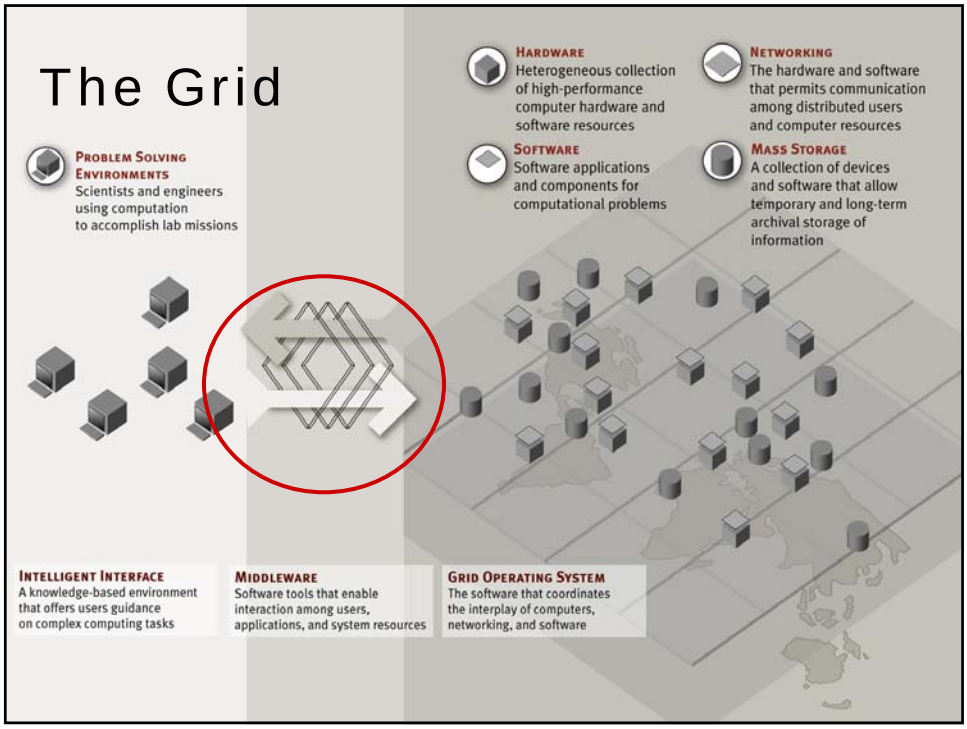
Overview

- Grid/NetSolve
  - Grid enabled software
  - Allows easy access to remote resources
- No magic
  - Someone has to write a program
  - The program may run on a parallel computer
- NetSolve is a tool for distributed computing



What is NetSolve?

- Client-server RPC-like system
  - Designed for ease-of-use
- Interactions mediated by an agent
  - e.g. scheduling, tracking, fault tolerance
- Dynamic service bindings
  - Client does not need to have stubs for the services that it wishes to use
- Multiple clients
  - C, Fortran, Matlab, Java, Mathematica, Octave
- Extended to support GridRPC API
  - Part of GGF working group defining a standard API

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University of Tennessee's NetSolve Grid Enabled Server

- NetSolve is an example of a Grid based hardware/software/data server.
- Based on a Remote Procedure Call model but with …
  - resource discovery, dynamic problem solving capabilities, load balancing, fault tolerance asynchronicity, security, …
- Easy-of-use paramount
- Its about providing transparent access to resources.
- Legacy codes easily wrapped into services

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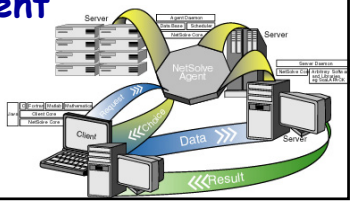
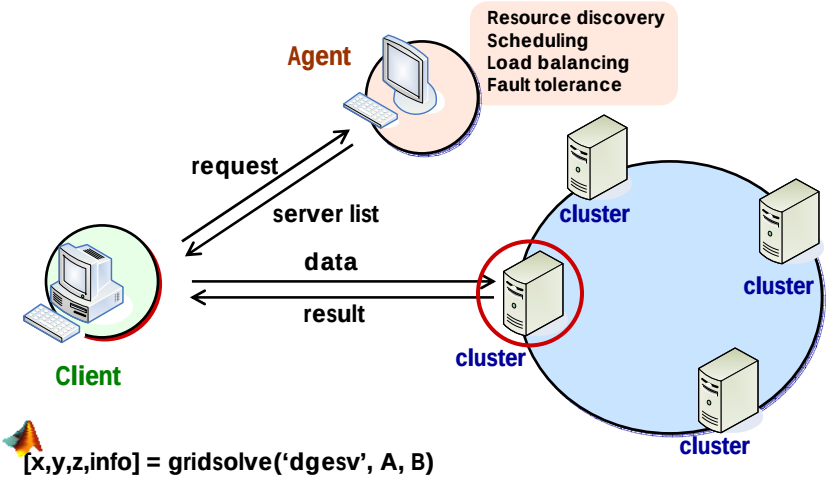


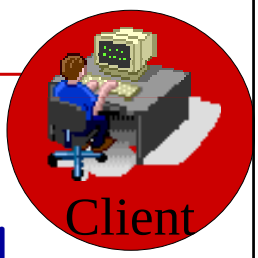
GridSolve Architecture



[x,y,z,info] = gridsolve('dgesv', A, B)

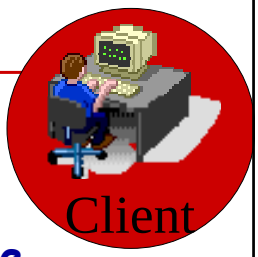
Can be from Matlab, C, Fortran, Python, Java, Mathematica, Excel, …

NetSolve Client



- Function Based Interface.
- Client program embeds call from NetSolve's API to access additional resources.
- Interface available to C, Fortran, Matlab, and Mathematica.
- Opaque networking interactions.
- NetSolve can be invoked using a variety of methods: blocking, non-blocking, task farms, …

NetSolve Client

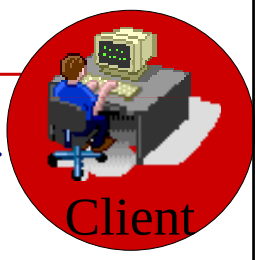


- Intuitive and easy to use.
- Matlab Matrix multiply e.g.:
  - A = matmul(B, C);

A = netsolve('matmul', B, C);

- Possible parallelisms hidden.

NetSolve Client



i. Client makes request to agent.

ii. Agent returns list of servers.

iii. Client tries first one to solve problem.

NetSolve Agent

- Name server for the NetSolve system.
- Information Service
  - client users and administrators can query the hardware and software services available.
- Resource scheduler
  - maintains both static and dynamic information regarding the NetSolve server components to use for the allocation of resources

NetSolve Agent

- Resource Scheduling (cont'd):
  - CPU Performance.
  - Network bandwidth, latency.
  - Server workload.
  - Problem size/algorithm complexity.
  - Calculates a "Time to Compute." for each appropriate server.
  - Notifies client of most appropriate server.

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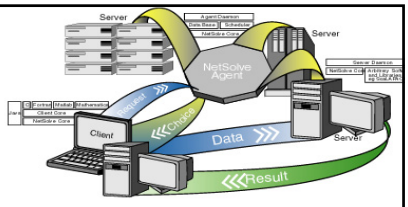
Basic Usage Scenarios



- Grid based numerical library routines
  - User doesn't have to have software library on their machine, LAPACK, SuperLU, ScaLAPACK, PETSc, ARPACK, …
- Task farming applications
  - "Pleasantly parallel" execution eg Parameter studies
  - Scavenge cycles
- Remote application execution
  - Complete applications with user specifying input parameters and receiving output

- "Blue Collar" Grid Based Computing
  - Does not require deep knowledge of network programming
  - Level of expressiveness right for many users
  - User can set things up, no "su" required
  - In use today, up to 130 servers on the experimental grid
- Can plug into Globus, Condor, NINF, …

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Task Farming - Multiple Requests To Single Problem

- **A Solution:**
  - Many calls to netslnb( ); /* non-blocking */
- **Farming Solution:**
  - Single call to netsolve_farm( );
- **Request iterates over an "array of input parameters."**
- **Adaptive scheduling algorithm.**
- **Useful for parameter sweeping, and independently parallel applications.**

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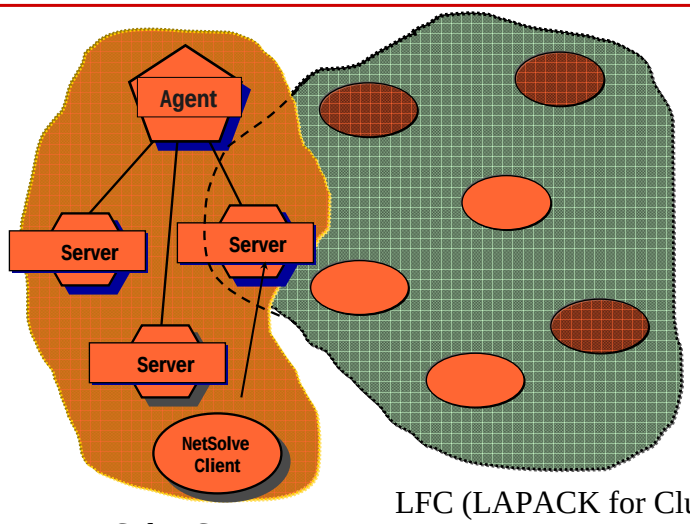
Server Proxies – Hide Parallelism



NetSolve System

LFC (LAPACK for Clusters), Condor, ScaLAPACK, etc.

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User maybe unaware of parallel processing

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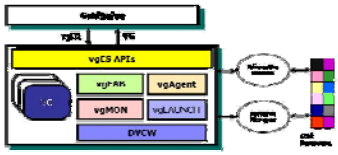
GridSolve Usage with VGrADS

- Simple-to-use access to complicated software libraries, with no knowledge of grid based computing.
- Selection of best machines in your grid to service user request
- Portability
  - Non-portable calls can be run from a client using RPC like mechanisms as long there is a server provisioned with the code
- Legacy codes easily wrapped into services

- Plug into VGrADS Framework
- Using the vgES for resource selection and launching of application:
  - Integrated performance information
  - Integrated monitoring
  - Fault prediction
  - Integrating the software and resource information repositories



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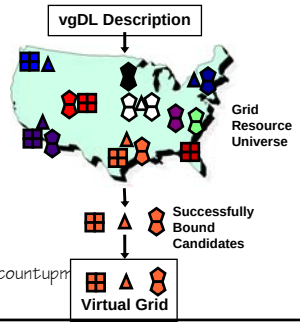
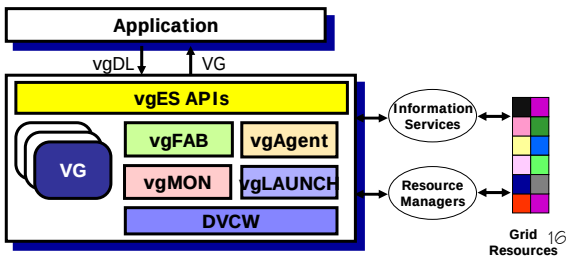
Virtual Grid Execution System (vgES)

- A Virtual Grid (VG) takes
  - Shared heterogeneous resources
  - Scalable information service
- and provides
  - An hierarchy of application-defined aggregations (e.g. ClusterOf) with constraints (e.g. processor type) and rankings

- Virtual Grid Execution System (vgES) implements VG
  - VG Definition Language (vgDL)
  - VG Find And Bind (vgFAB)
  - VG Monitor (vgMON)
  - VG Application Launch (VgLAUNCH+DVCW)
  - VG Resource Info (vgAgent)





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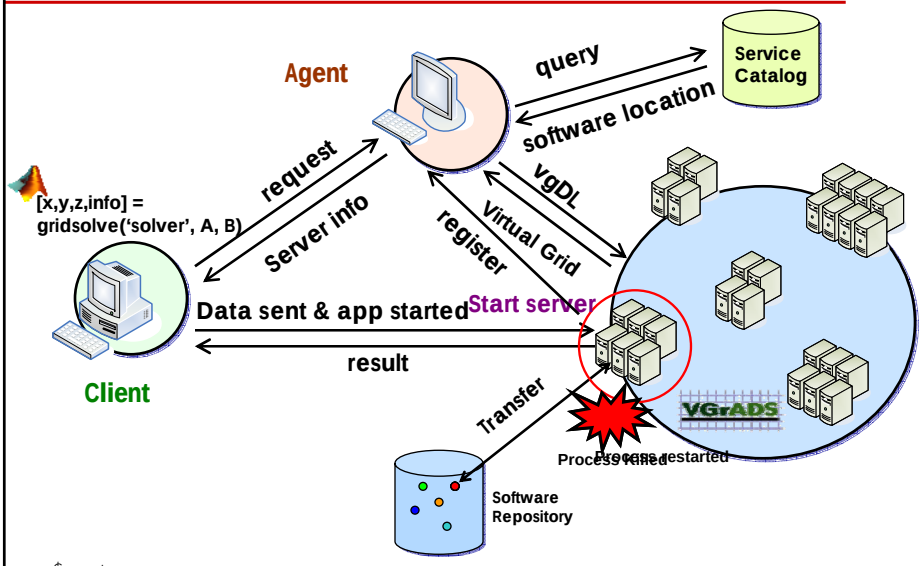
VGrADS/GridSolve Architecture



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Data Persistence

- Chain together a sequence of NetSolve requests.
- Analyze parameters to determine data dependencies. Essentially a DAG is created where nodes represent computational modules and arcs represent data flow.
- Transmit superset of all input/output parameters and make persistent near server(s) for duration of sequence execution.
- Schedule individual request modules for execution.

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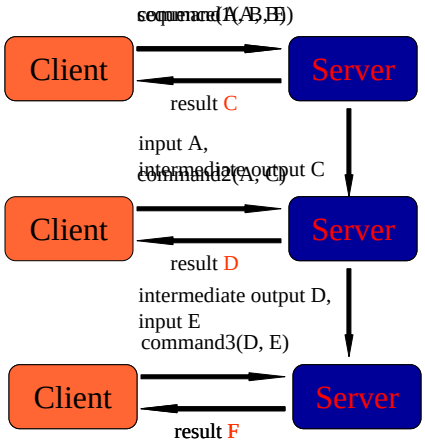
Data Persistence (cont'd)




```
netsl_begin_sequence( );
netsl("command1", A, B, C);
netsl("command2", A, C, D);
netsl("command3", D, E, F);
netsl_end_sequence(C, D);
```

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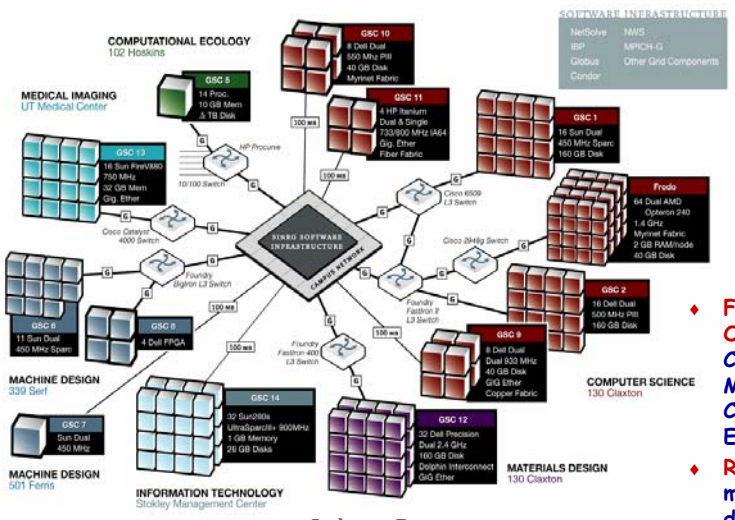
Current SInRG Infrastructure



- **Federated Ownership**: CS, Chem Eng., Medical School, Computational Ecology, El. Eng.
- **Real applications**, middleware development, logistical networking

Industry Partners:
Microsoft, Sun, Dell, Cisco, Foundry, Dolphin, Myracom

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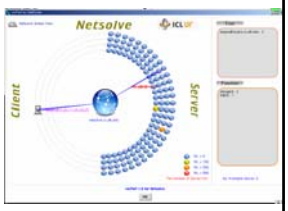
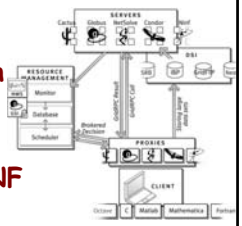
NetSolve- Things Not Touched On

- Integration with other NMI tools
  - Globus, Condor, Network Weather Service
- Security
  - Using Kerberos V5 for authentication.
- Monitor NetSolve Network
  - Track and monitor usage
- Fault Tolerance
- Local / Global Configurations
- Dynamic Nature of Servers
- Automated Adaptive Algorithm Selection
  - Dynamic determine the best algorithm based on system status and nature of user problem
- NetSolve evolving into GridRPC
  - Being worked on under GGF with joint with NINF





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Software at: http://icl.cs.utk.edu/netsolve/

NetSolve Team

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