

Cactus Tools for the Grid



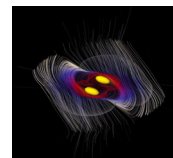
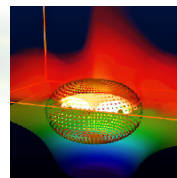
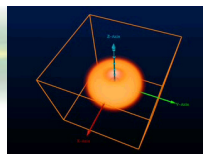
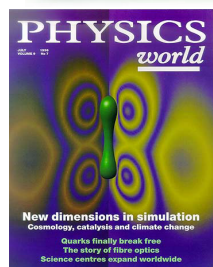
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www.CactusCode.org

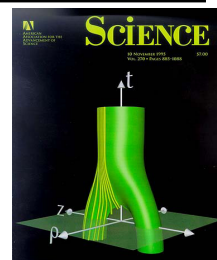
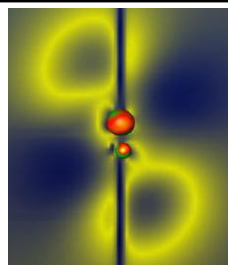
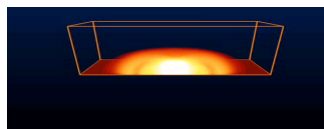


Cactus



**CACTUS is a freely available, modular,
portable and manageable environment
for collaboratively developing parallel, high-
performance multi-dimensional simulations**

**THE GRID: Dependable,
consistent, pervasive access
to high-end resources**



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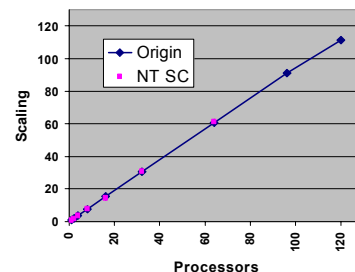
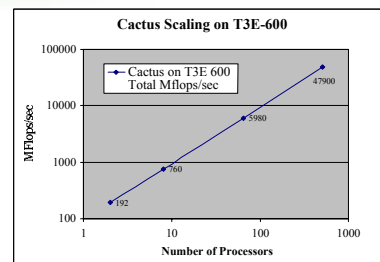
What is Cactus

- Flesh (ANSI C) provides code infrastructure (parameter, variable, scheduling databases, error handling, APIs, make, parameter parsing,)
- Thorns (F77/F90/C/C++/Java/Perl/Python) are **plug-in** and **swappable** modules or collections of subroutines providing both the computational infrastructure and the physical application. **Well-defined interface** through 3 config files
- Just about anything can be implemented as a thorn: **Driver layer** (MPI, PVM, SHMEM, ...), **Black Hole** evolvers, elliptic solvers, reduction operators, interpolators, web servers, grid tools, IO, ...
- **User driven**: easy parallelism, no new paradigms, flexible
- Collaborative: thorns borrow concepts from OOP, thorns can be shared, lots of collaborative tools
- Computational Toolkit: existing thorns for (Parallel) IO, elliptic, MPI unigrid driver,
- Integrate other common packages and tools: **HDF5**, **Globus**, **PETSc**, **PAPI**, **Panda**, **FlexIO**, **GrACE**, **Autopilot**, **LCAVision**, **OpenDX**, **Amira**, ...
- **Trivially Grid enabled!**



Current Version Cactus 4.0

- Cactus 4.0 beta 1 released September 1999
- Community code: Distributed under **GNU GPL**
- Currently: Cactus 4.0 beta 8
- Supported Architectures:
 - **SGI Origin**
 - **SGI 32/64**
 - **Cray T3E**
 - **Dec Alpha**
 - **Intel Linux IA32/IA64**
 - **Windows NT**
 - **HP Exemplar**
 - **IBM SP2**
 - **Sun Solaris**
 - **Hitachi SR8000-F**
 - **NEC SX-5**
 - **Mac Linux**
 - ...





Cactus Computational Toolkit:

Parallel utilities (thorns) for computational scientist

CactusBase

- Boundary, IOUtil, IOBasic, CartGrid3D, IOASCII, Time

CactusBench

- BenchADM

CactusConnect

- HTTPD, HTTPDExtra

CactusExample

- WaveToy1DF77, WaveToy2DF77

CactusElliptic

- EllBase, EllPETSc, EllSOR, EllTest

CactusPUGH

- Interp, PUGH, PUGHSlab, PUGHReduce

CactusPUGHIO

- IOFlexIO, IOHDF5, IsoSurfacer

CactusIO

- IOJpeg

CactusTest

- TestArrays, TestCoordinates, TestInclude1, TestInclude2, TestComplex, TestInterp, TestReduce

CactusWave

- IDScalarWave, IDScalarWaveC, IDScalarWaveCXX, WaveBinarySource, WaveToyC, WaveToyCXX, WaveToyF77, WaveToyF90, WaveToyFreeF90

CactusExternal

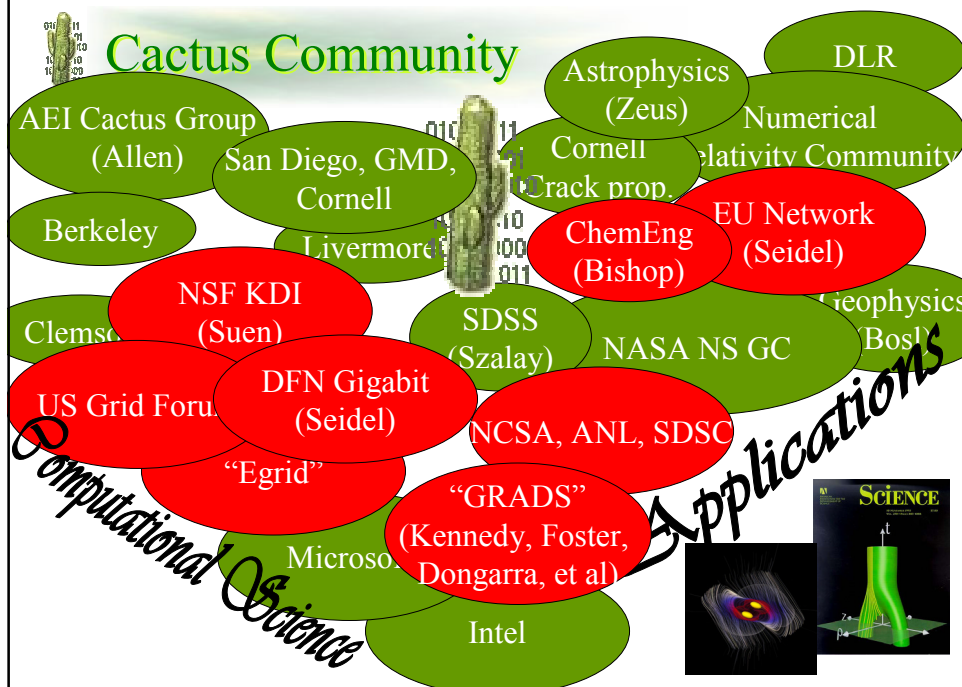
- FlexIO, jpeg6b

BetaThorns (In Development)

- IOStreamedHDF5, Renderer, IOHDF5Util,..., many more



Cactus Community



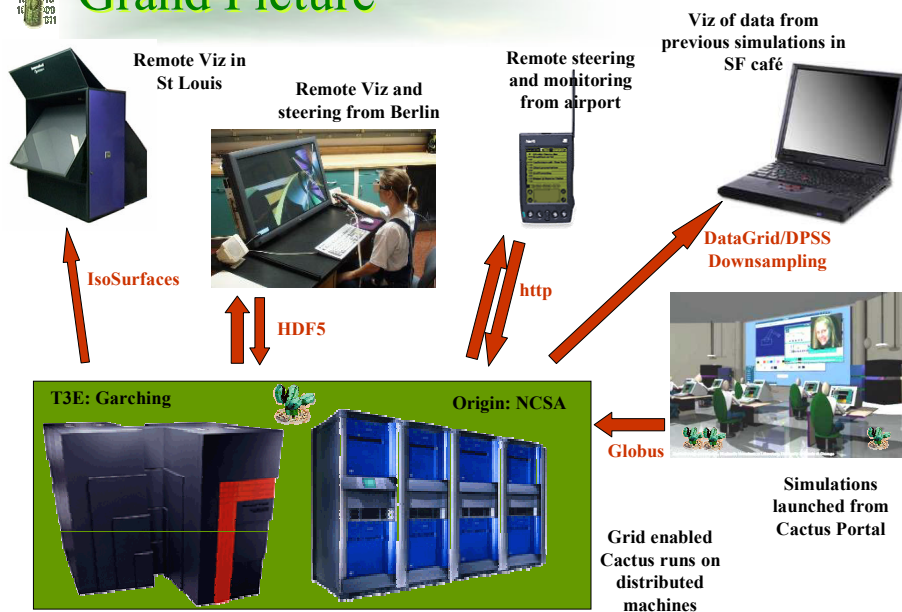


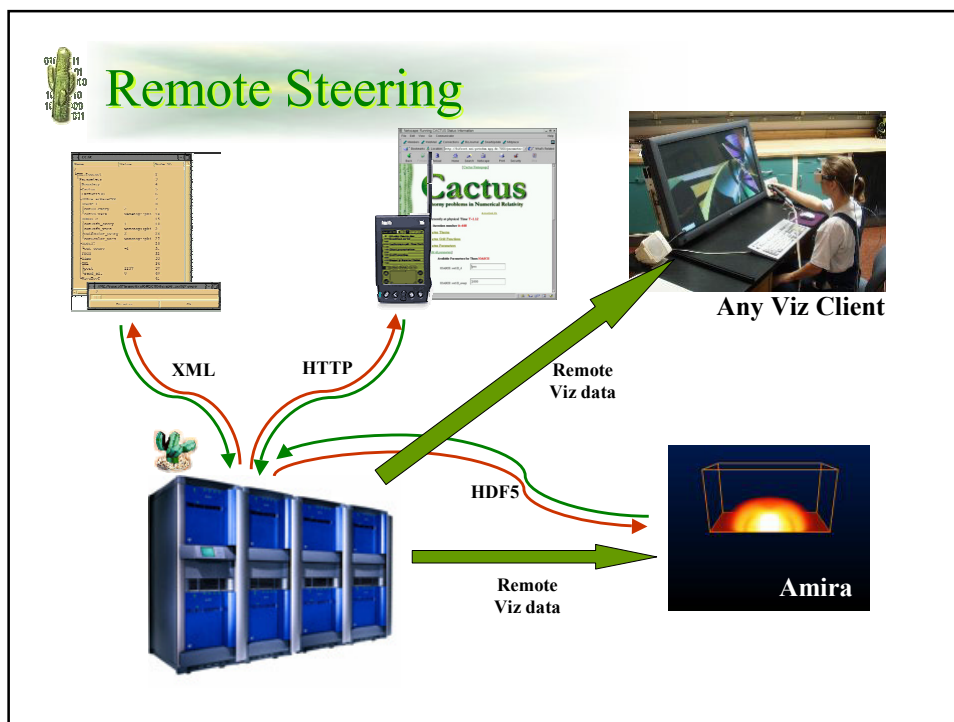
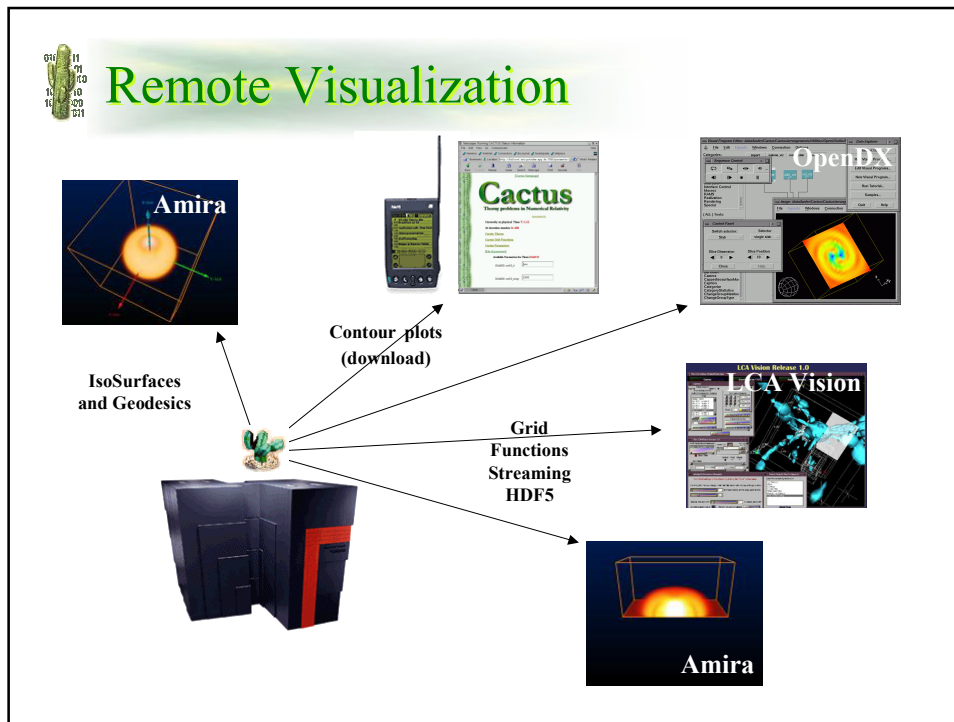
Grid Computing

- AEI Numerical Relativity Group has access to high-end resources in over ten centers in Europe/USA
- They want:
 - Bigger simulations, more simulations and faster throughput
 - Intuitive IO at local workstation
 - **No new systems/techniques to master!!**
- How to make best use of these resources?
 - Provide easier access ... noone can remember ten usernames, passwords, batch systems, file systems, ... great start!!!
 - Combine resources for larger productions runs (more resolution badly needed!)
 - Dynamic scenarios ... automatically use what is available
 - Remote/collaborative visualization, steering, monitoring
- Many other motivations for Grid computing ...



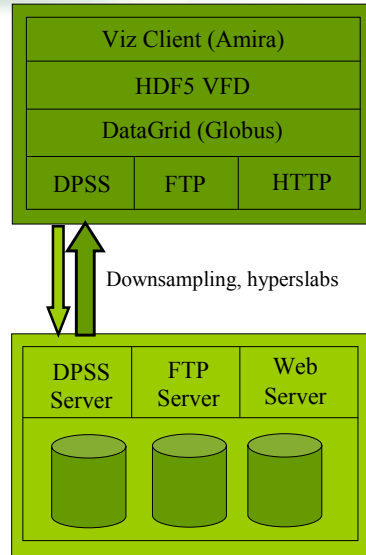
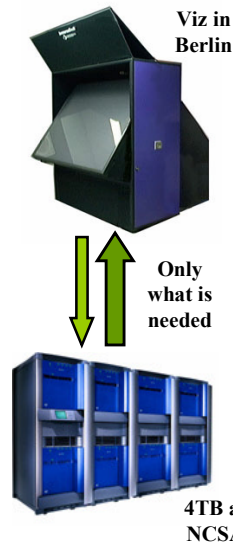
Grand Picture







Remote Offline Visualization



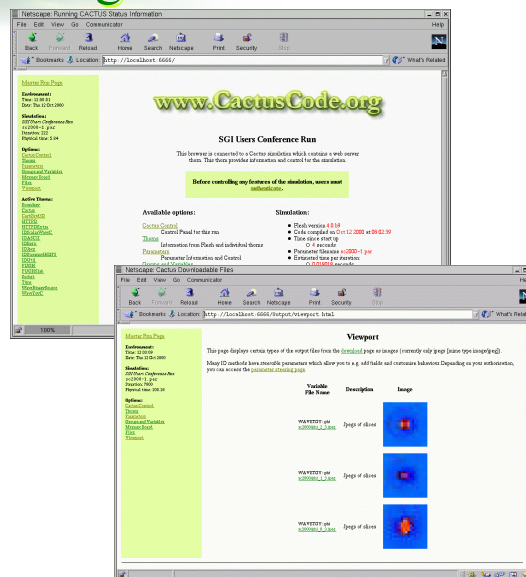
Visualization Client

Remote Data Server



Remote Monitoring: Thorn HTTPD

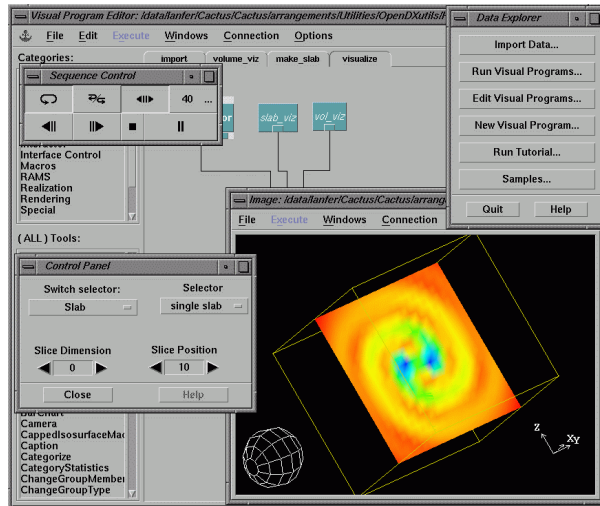
- Thorn which allows simulation any to act as its own web server
- Connect to simulation from **any browser anywhere ...** collaborate
- Monitor run: parameters, basic visualization, ...
- Change **steerable** parameters
- See running example at www.CactusCode.org
- Wireless remote viz, monitoring and steering





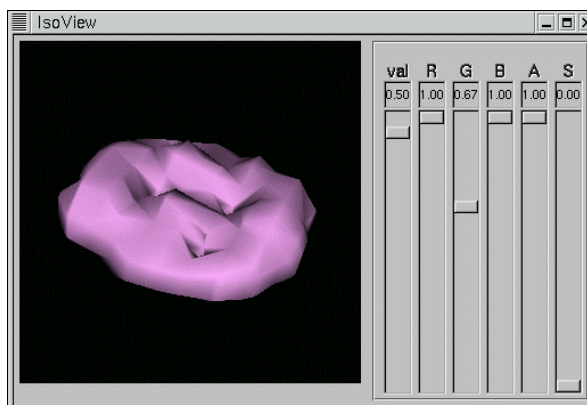
Remote Viz: OpenDX

- Open source, (free), multiplatform, large active development community, easy to program
- Reads HDF5 (Cactus) data from file or remotely streamed from Cactus
- Simple GUI, select different *hyperslabs* from 3D data
- Also support for streamed ASCII data from Cactus



Remote Viz: IsoView

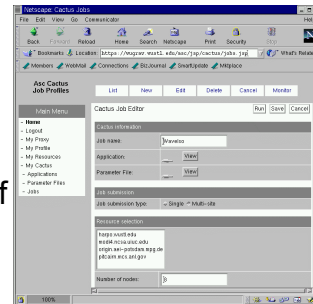
- Lightweight, free, isosurface viewer
- Distributed from Cactus website
- Displays isosurfaces streamed from Cactus (thorn IsoSurfacer calculates isosurfaces inline with the parallel simulation)
- Connect to running simulation on any remote machine
- Steer isosurface value from client





Cactus Portal

- KDI ASC Project
- Technology: Globus, GSI, Java Beans, DHTML, Java CoG, MyProxy, GPDk, TomCat, Stronghold
- Locates resources, builds/finds executables, central management of parameter files/job output, submit jobs to local batch queues, tracks active jobs
- Submission of distributed runs
- Adding more collaborative features (eg group accounting, ...)
- Accesses the ASC Grid Testbed (SDSC, NCSA, Argonne, ZIB, LRZ, AEI)



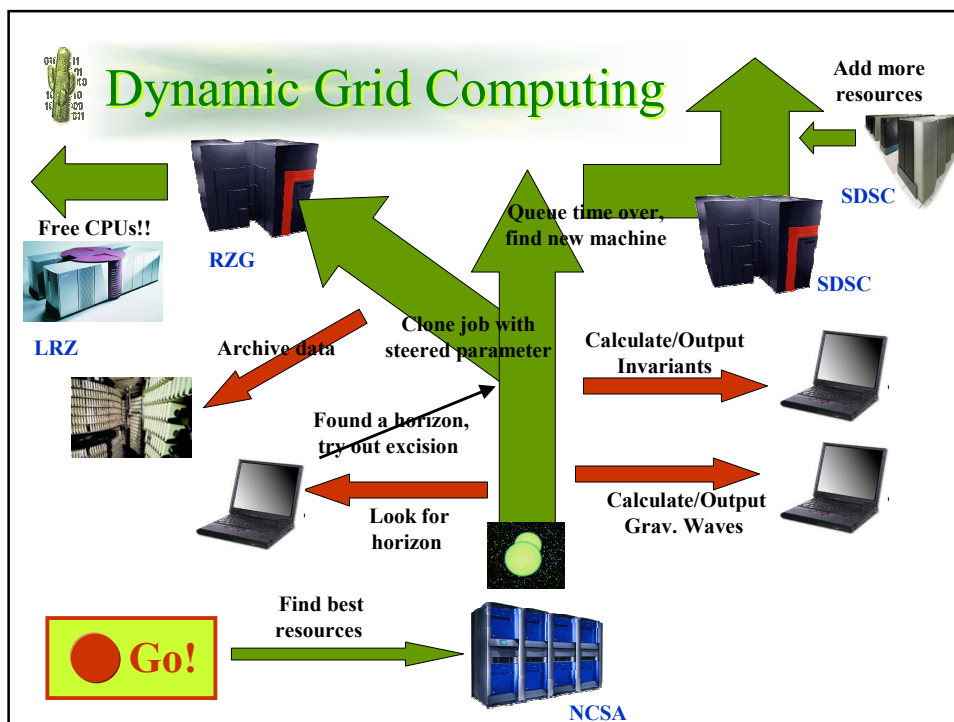
New Grid Applications

- Dynamic Staging: move to faster/cheaper/bigger machine
 - "Cactus Worm"
- Multiple Universe
 - create clone to investigate steered parameter ("Cactus Virus")
- Automatic Convergence Testing
 - from initial data or initiated during simulation
- Look Ahead
 - spawn off and run coarser resolution to predict likely future
- Spawn Independent/Asynchronous Tasks
 - send to cheaper machine, main simulation carries on
- Thorn Profiling
 - best machine/queue
 - choose resolution parameters based on queue
 -



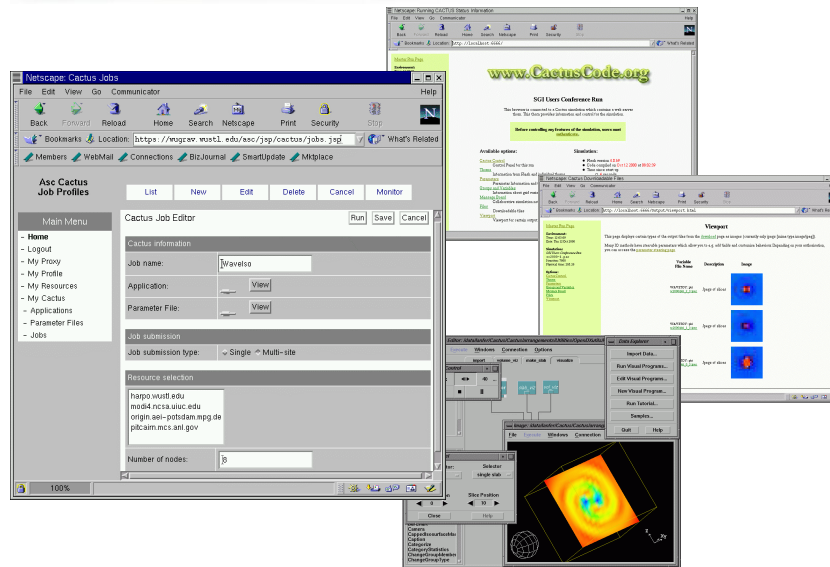
New Grid Applications (2)

- **Dynamic Load Balancing**
 - inhomogeneous loads
 - multiple grids
- **Portal**
 - resource choosing
 - simulation launching
 - management
- **Intelligent Parameter Surveys**
 - farm out to different machines
- **Make use of**
 - Running with management tools such as Condor, Entropia, etc.
 - Scripting thorns (management, launching new jobs, etc)
 - Dynamic use of eg MDS for finding available resources





Users View



Cactus Grid Development

- Projects: GrADs, KDI Astrophysics Collaboratory, TIKSL/GriKSL, EGrid/GGF, Globus team, AEI
- Grid Application Development Toolkit: Application developer should be able to build simulations with tools that easily enable dynamic grid capabilities e.g. Query information server, Network Monitoring, Simulation instrumentation/Contract specification, Spawning and Migrating, Authentication Server, Data handling, Data transfer, Visualization, Steering, ...
- Remote visualization, steering, data management
- User Portal
- Dynamics Applications



- Web Site: www.CactusCode.org (Documentation/Tutorials etc)
- Cactus Worm: www.CactusCode.org/Development/Egrid.html

- www.egrid.org
- www.gridforum.org

● www.ascportal.org

- www.zib.de/Visual/projects/TKSL/

- jean-luc.aei.mpg.de

Any questions: cactus@cactuscode.org