the City College of New York

LSU CENTER FOR COMPUTATION & TECHNOLOGY

SIMPLIFYING COMPLEX SOFTWARE ASSEMBLY

THE COMPONENT RETRIEVAL LANGUAGE AND IMPLEMENTATION

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COMPONENT FRAMEWORKS

- Set of individual software modules coordinated by glue framework
  - Each component (module) performs a specific task and encapsulates a set of related functions data
  - Frameworks can range from having a few components to many
  - Components communicate via interfaces
- Used for various purposes, HPC examples include
  - Cactus Framework
  - CCA Frameworks (e.g. Caffeine)
  - Domain specific frameworks (e.g. Earth System Modeling Framework)

CACTUS

- Component Framework
  - Over 500 unique components
  - Distributed around the world
- Flesh
  - Core application
- Thorns
  - Independent modules
  - Perform actual computation
- High Performance Computing
  - Massively parallel
  - Runs on high end supercomputer clusters
- Supports many applications
  - Numerical Relativity
  - Quantum Gravity
  - Computational Fluid Dynamics

www.cactuscode.org

CACTUS WORKFLOW

- Managed using “Thornlists”
  - Plaintext list of thorns required for a specific configuration
  - Used to checkout, update, build, and test the source code

```
!REPOSITORY_TYPE     pserver
!REPOSITORY_LOCATION cvs.cactuscode.org
!REPOSITORY_NAME     /cactusdevcvs
!REPOSITORY_USER     eric9

CactusBase/Boundary
CactusBase/CartGrid3D
CactusBase/CoordBase
CactusBase/IOASCII
CactusBase/IOBasic
CactusBase/IOUtil
CactusBase/InitBase
CactusBase/LocalInterp
```

EINSTEIN TOOLKIT

- Toolkit for relativistic astrophysical simulations
- Developed using Cactus
  - Comprised of 135 thorns
  - Initial Data, Evolution/ Analysis methods, Utilities
- First official release 2 months ago

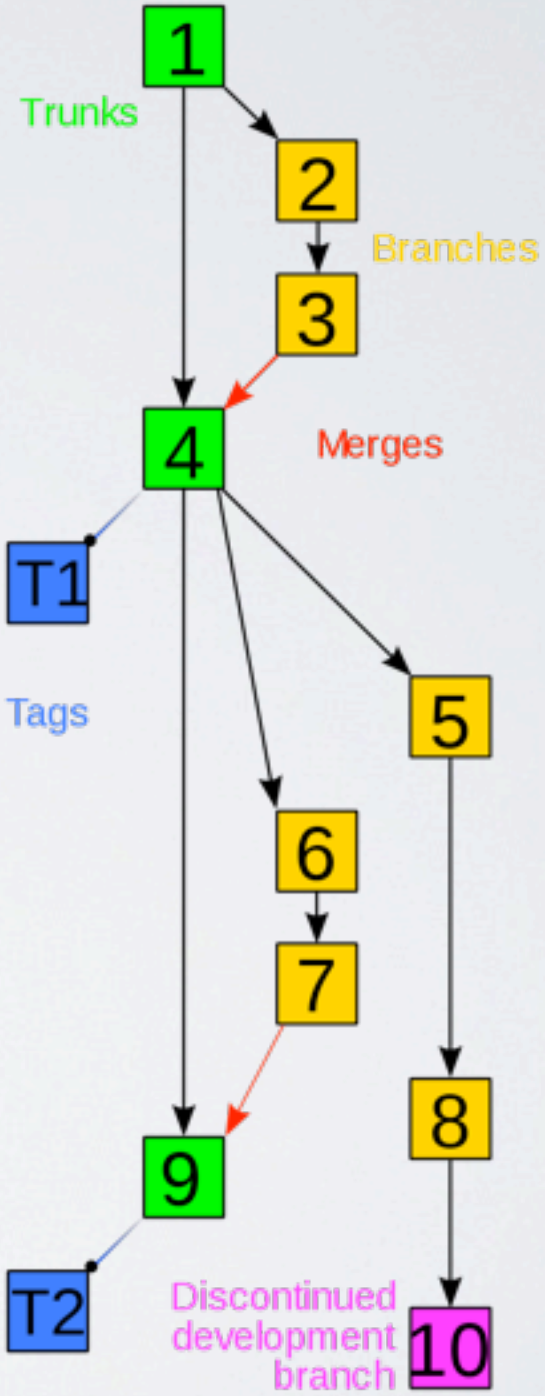
www.einsteintoolkit.org

MOTIVATION

- Distributed Software Frameworks are hard to assemble and manage
  - Einstein Toolkit comprised of 135 individual components
  - Very tedious to manually checkout or update
    - Large barrier to entry for new users

VERSION CONTROL SYSTEMS

- Used to track revisions in source code
- Concurrent Versions System (cvs)
  - Released in 1990
  - Uses client-server model
    - Server stores full history of repository
    - Clients retrieve specific revision
- Subversion (svn)
  - Released in 2000
  - Successor to cvs
  - Also uses client-server model
- Git
  - Released in 2005
  - Uses distributed model
    - Everyone has copy of full history



http://en.wikipedia.org/wiki/File:Revision_controlled_project_visualization-2010-24-02.svg

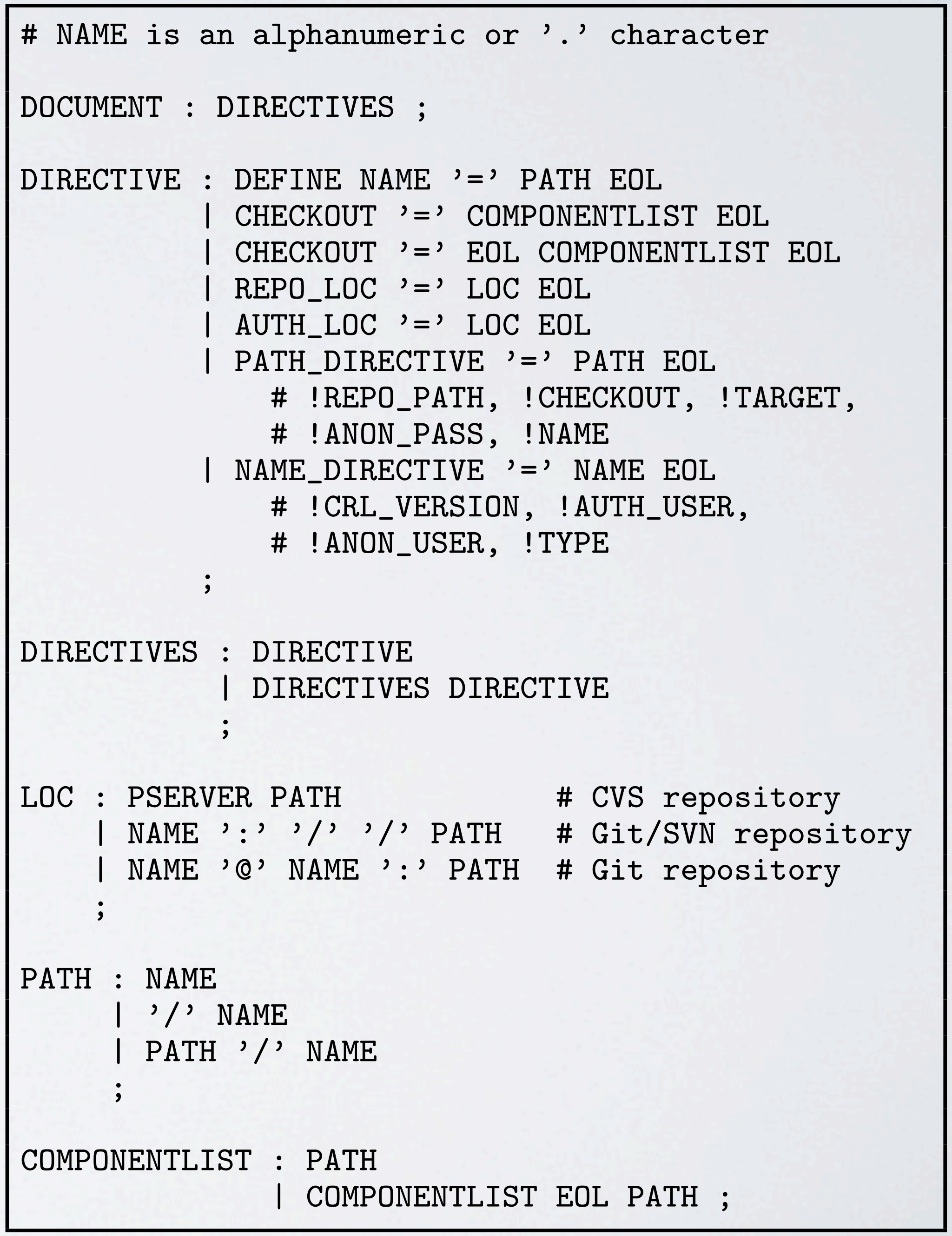
GETCACTUS

- Designed to checkout and update Cactus thorns and flesh
- Specific to Cactus Framework
- Originally designed for CVS
    - SVN and git added later
- Still difficult to distribute the framework
    - Users must edit the thornlist

```
!REPOSITORY_TYPE     pserver
!REPOSITORY_LOCATION cvs.cactuscode.org
!REPOSITORY_NAME     /cactusdevcvs
!REPOSITORY_USER     eric9

CactusBase/Boundary
CactusBase/CartGrid3D
CactusBase/CoordBase
CactusBase/IOASCII
CactusBase/IOBasic
CactusBase/IOUtil
CactusBase/InitBase
CactusBase/LocalInterp
```

COMPONENT RETRIEVAL LANGUAGE

- Designed to fix problems with original GetCactus script
- Provides unified, tool agnostic syntax
- Abstracts authentication procedures
- General-Purpose
    - No longer specific to Cactus



```
# NAME is an alphanumeric or ’.’ character

DOCUMENT : DIRECTIVES ;

DIRECTIVE : DEFINE NAME ’=’ PATH EOL
          | CHECKOUT ’=’ COMPONENTLIST EOL
          | CHECKOUT ’=’ EOL COMPONENTLIST EOL
          | REPO_LOC ’=’ LOC EOL
          | AUTH_LOC ’=’ LOC EOL
          | PATH_DIRECTIVE ’=’ PATH EOL
            # !REPO_PATH, !CHECKOUT, !TARGET,
            # !ANON_PASS, !NAME
          | NAME_DIRECTIVE ’=’ NAME EOL
            # !CRL_VERSION, !AUTH_USER,
            # !ANON_USER, !TYPE
          ;

DIRECTIVES : DIRECTIVE
           | DIRECTIVES DIRECTIVE
           ;

LOC : PSERVER PATH             # CVS repository
    | NAME ’:’ ’/’ ’/’ PATH    # Git/SVN repository
    | NAME ’@’ NAME ’:’ PATH   # Git repository
    ;

PATH : NAME
     | ’/’ NAME
     | PATH ’/’ NAME
     ;

COMPONENTLIST : PATH
              | COMPONENTLIST EOL PATH ;
```

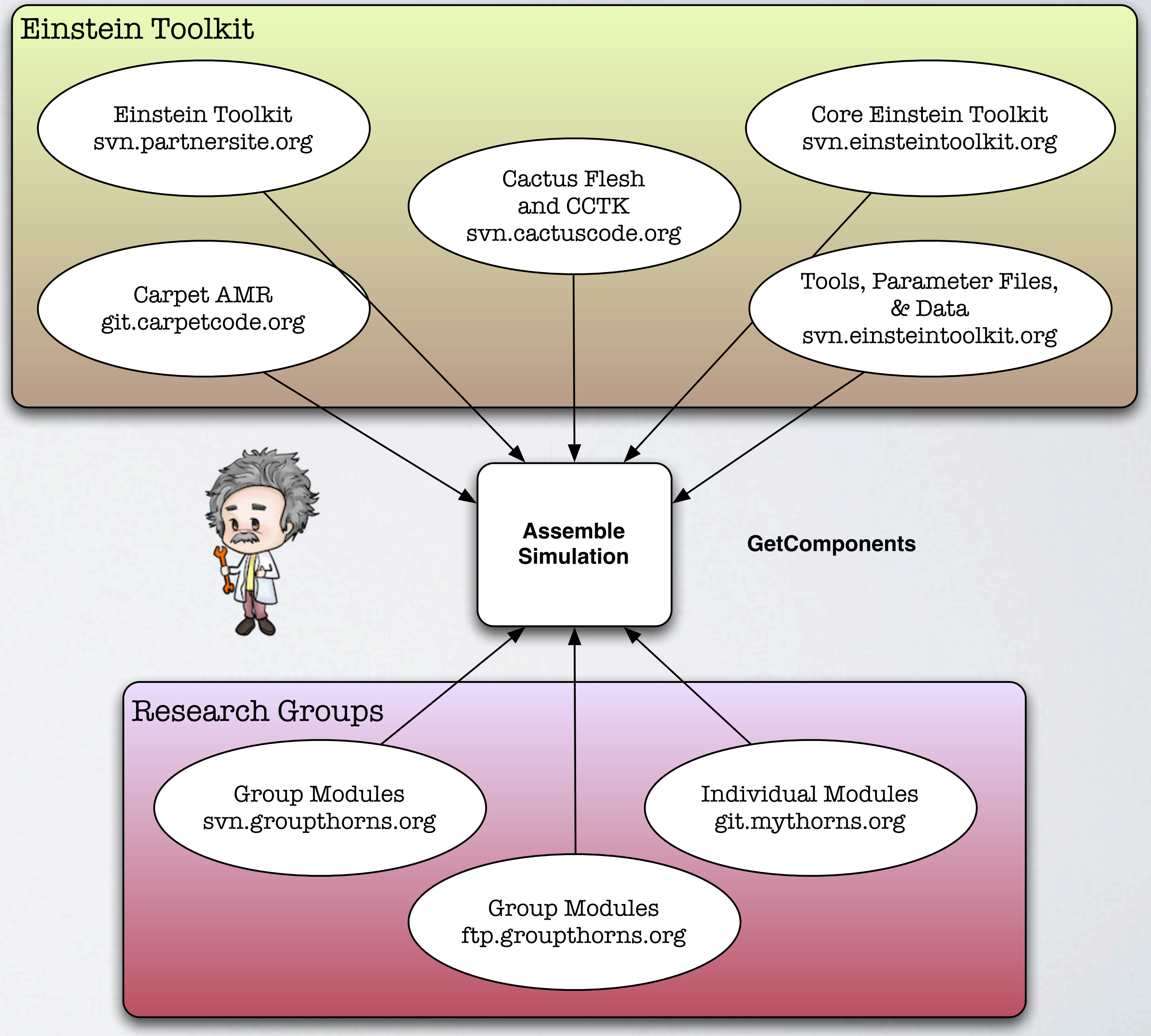
SAMPLE CRL FILE

```
!DEFINE ROOT = Cactus
!DEFINE ARR  = $ROOT/arrangements

!TARGET   = $ROOT
!TYPE     = svn
!AUTH_URL = https://svn.cactuscode.org/flesh/trunk
!URL      = http://svn.cactuscode.org/flesh/trunk
!CHECKOUT = Cactus
!NAME     = .

!TARGET   = $ROOT
!TYPE     = svn
!URL      = https://svn.cct.lsu.edu/repos/numrel/$1/trunk
!CHECKOUT = simfactory

!TARGET   = $ARR
!TYPE     = svn
!AUTH_URL = https://svn.cactuscode.org/arrangements/$1/$2/trunk
!URL      = http://svn.cactuscode.org/arrangements/$1/$2/trunk
!CHECKOUT =
CactusArchive/ADM
CactusBase/Boundary
CactusBase/CartGrid3D
CactusBase/CoordBase
```

```
!TARGET   = $ARR
!TYPE     = git
!URL      = git://github.com/ianhinder/Kranc.git
!AUTH_URL = git@github.com:ianhinder/Kranc.git
!REPO_PATH= Auxiliary/Cactus
!CHECKOUT =
KrancNumericalTools/GenericFD

# McLachlan, the spacetime code
!TARGET   = $ARR
!TYPE     = git
!URL      = git://carpetcode.dyndns.org/McLachlan
!AUTH_URL = carpetgit@carpetcode.dyndns.org:McLachlan
!REPO_PATH= $2
!CHECKOUT = McLachlan/doc McLachlan/m McLachlan/par
McLachlan/ML_BSSN
McLachlan/ML_BSSN_Helper
McLachlan/ML_BSSN_O2
McLachlan/ML_BSSN_O2_Helper
McLachlan/ML_BSSN_Test
McLachlan/ML_ADMConstraints
```

GETCOMPONENTS

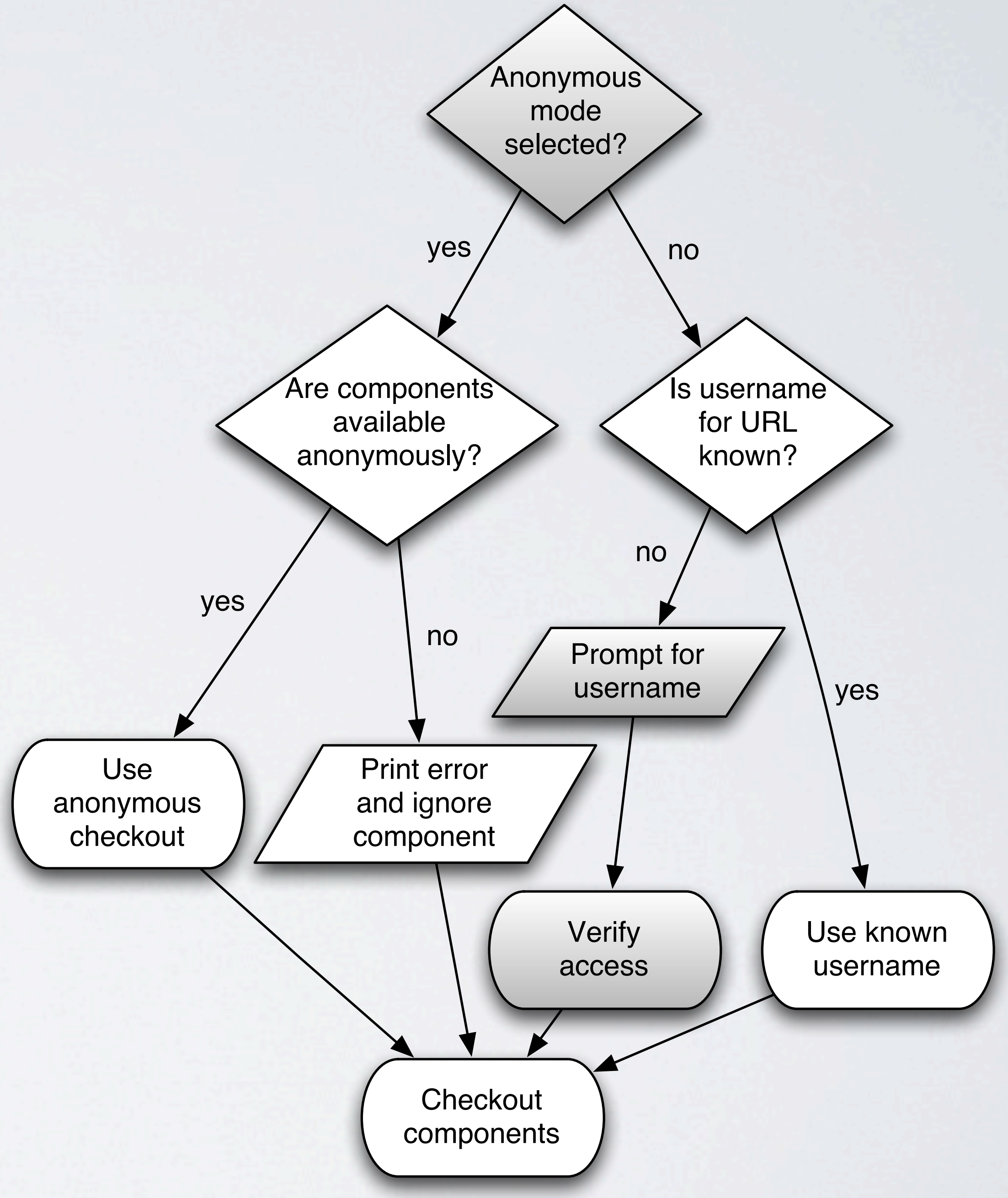
- Designed to be very modular
  - Currently supports 5 version control systems and http/ftp downloads
  - Very easy to add more
- Can take input as local file or URL
- Manages all authentication issues


Einstein Toolkit
Einstein Toolkit svn.partnersite.org
Core Einstein Toolkit svn.einsteintoolkit.org
Cactus Flesh and CCTK svn.cactuscode.org
Carpet AMR git.carpetcode.org
Tools, Parameter Files, & Data svn.einsteintoolkit.org
Assemble Simulation
GetComponents
Research Groups
Group Modules svn.groupthorns.org
Individual Modules git.mythorns.org
Group Modules ftp.groupthorns.org

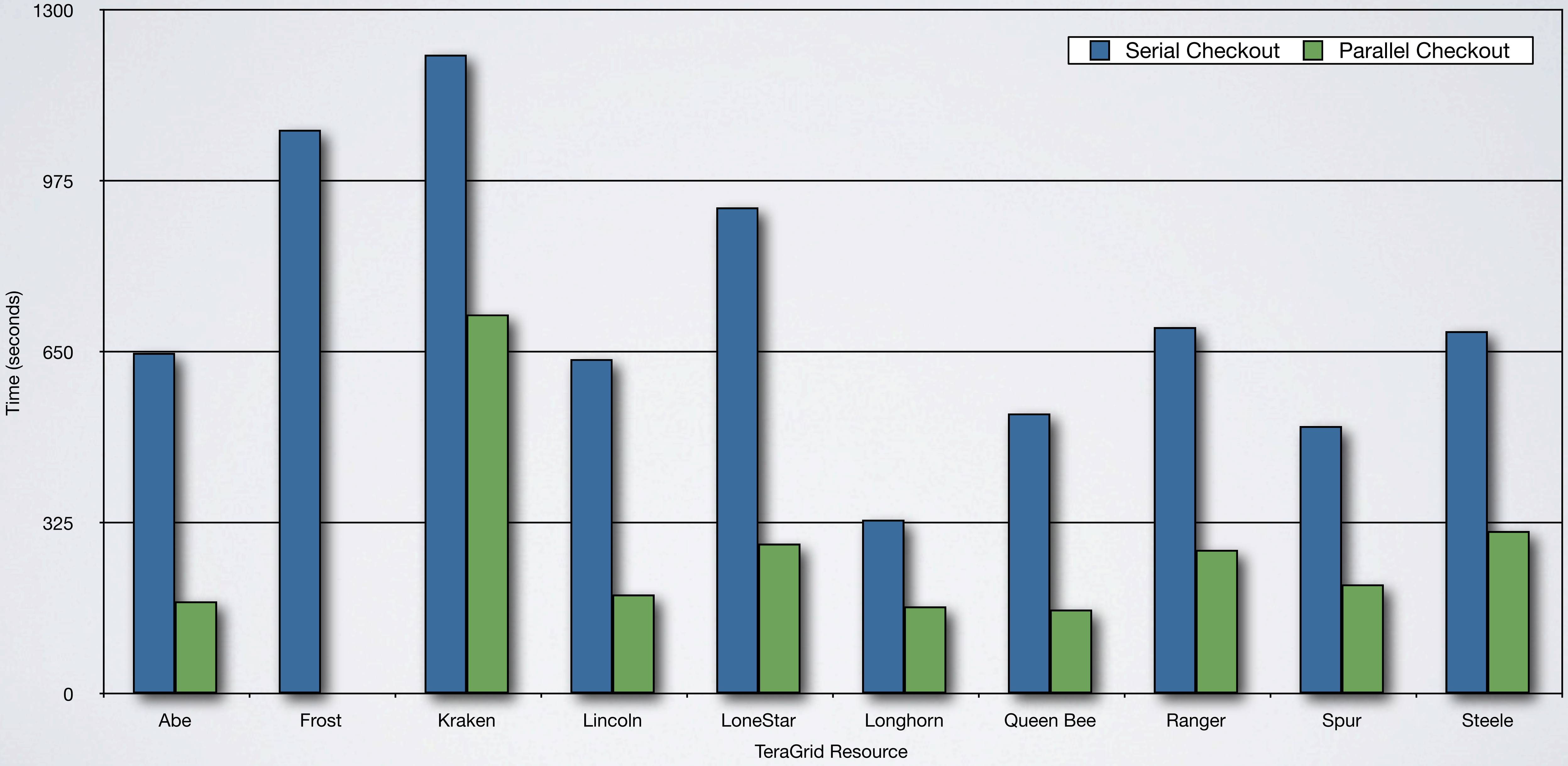
```
./GetComponents http://tinyurl.com/einsteintoolkit-2010-06
```

AUTHENTICATION

- Authentication handled entirely by VCS tools
- GetComponents stores list of authenticated repositories and users
    - Also tracks repositories with specified anonymous access
- Very secure
    - GetComponents never sees any passwords!



CHECKOUT VS. UPDATE SPEED

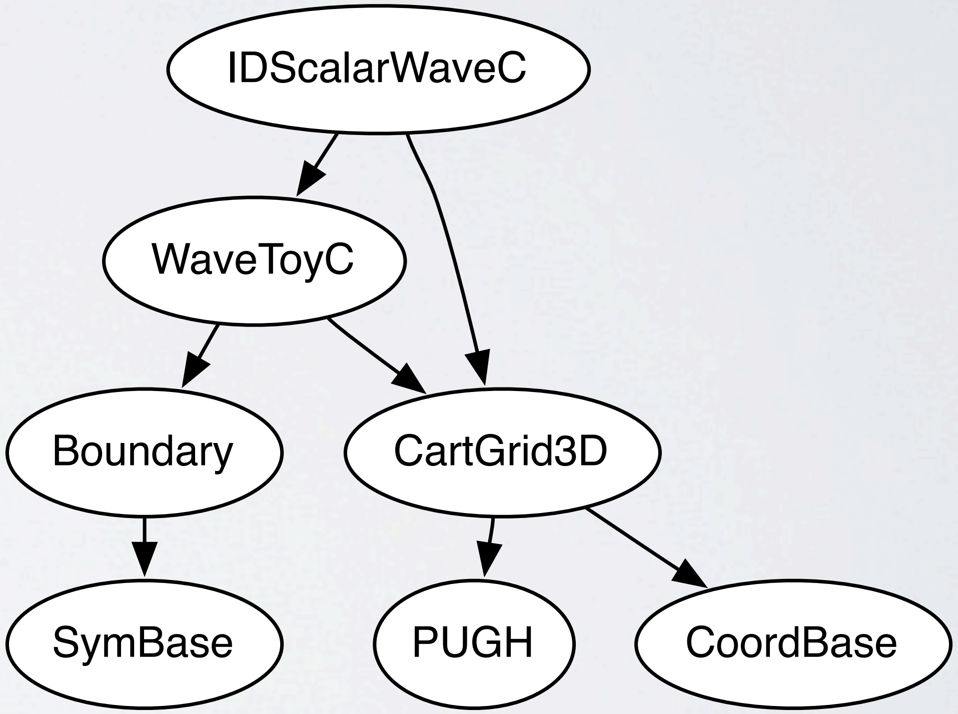


GETCOMPONENTS

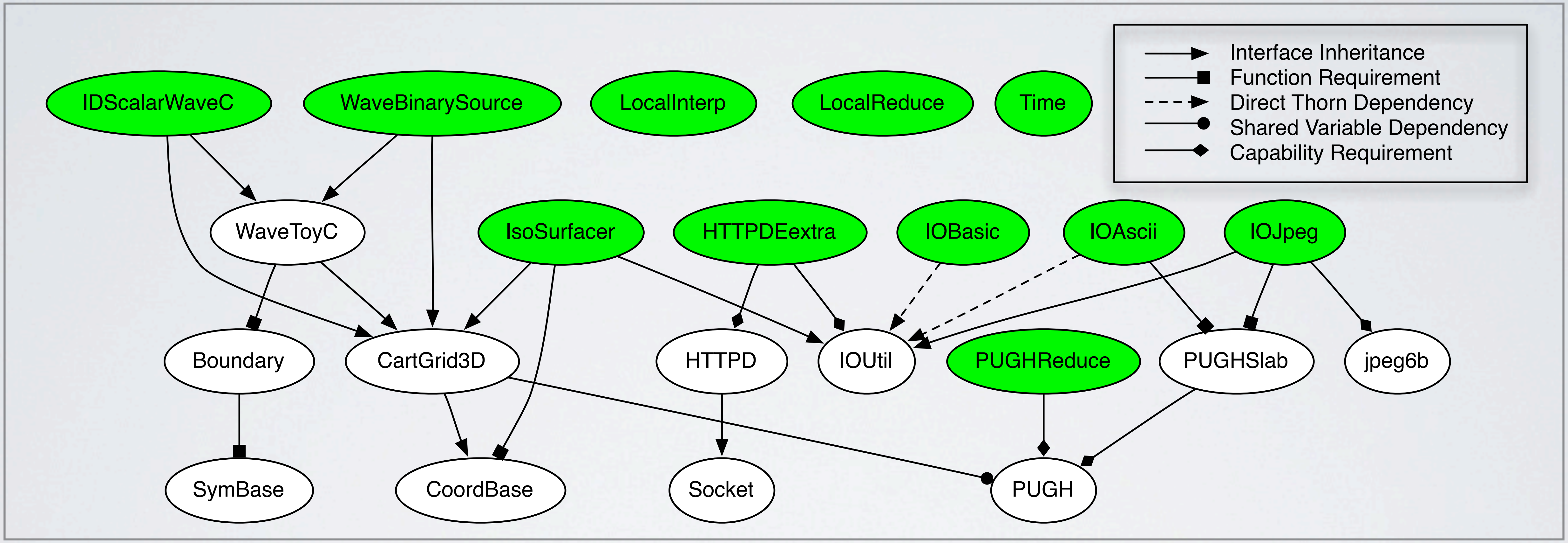
- Generating component lists is still time-consuming and tedious
    - Barrier/impossible for new users
- Don't need all Einstein Toolkit modules to run a simulation
    - How to determine which components are needed for a particular simulation?
    - e.g. what is needed to model two black holes, or a coastal surge?

COMPONENT DEPENDENCIES

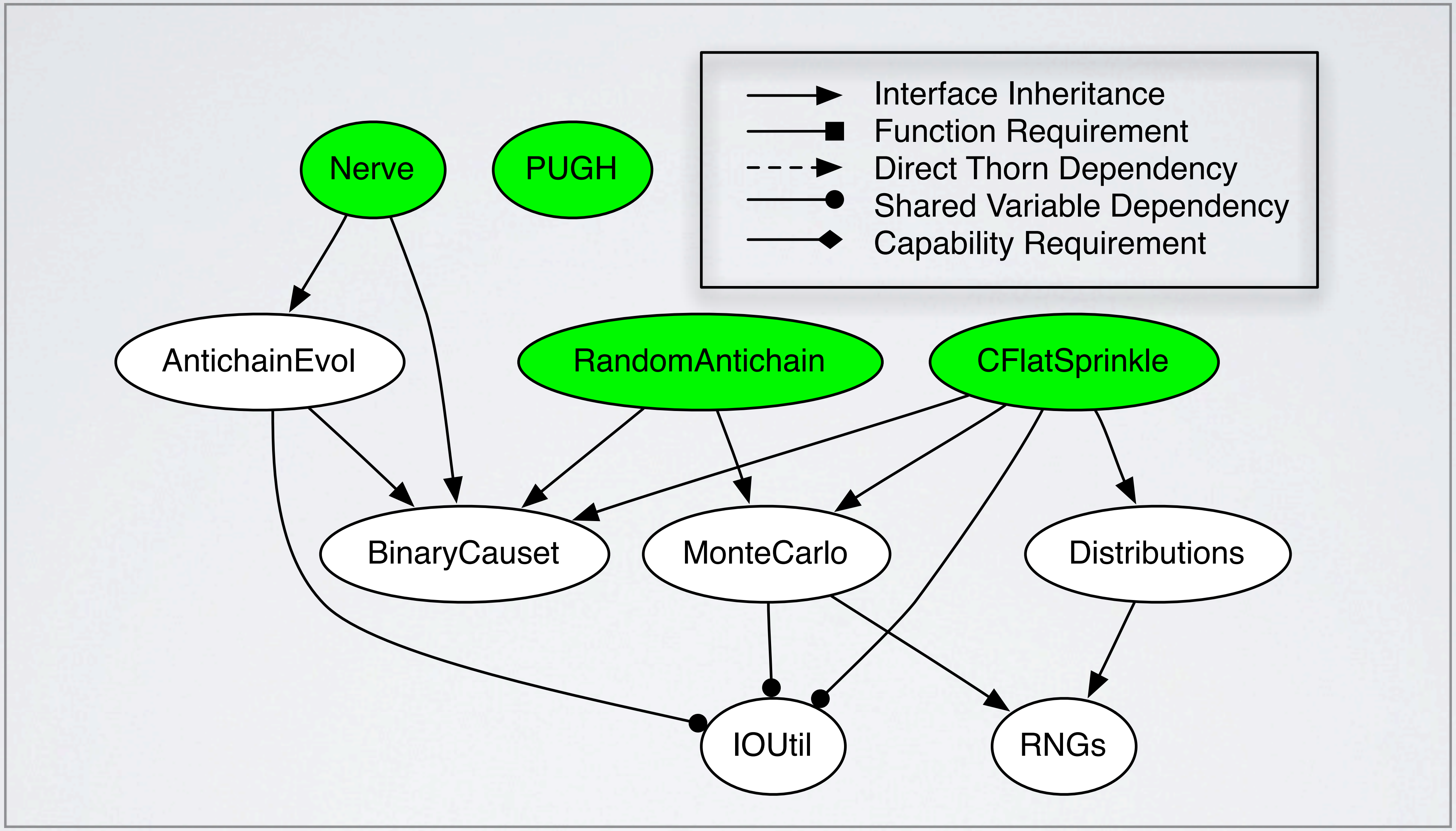
- Dependency tracking could allow custom built simulations
- Specify one component containing data about the simulation
    - Initial values, type of simulation, etc
- Then recursively check component dependencies



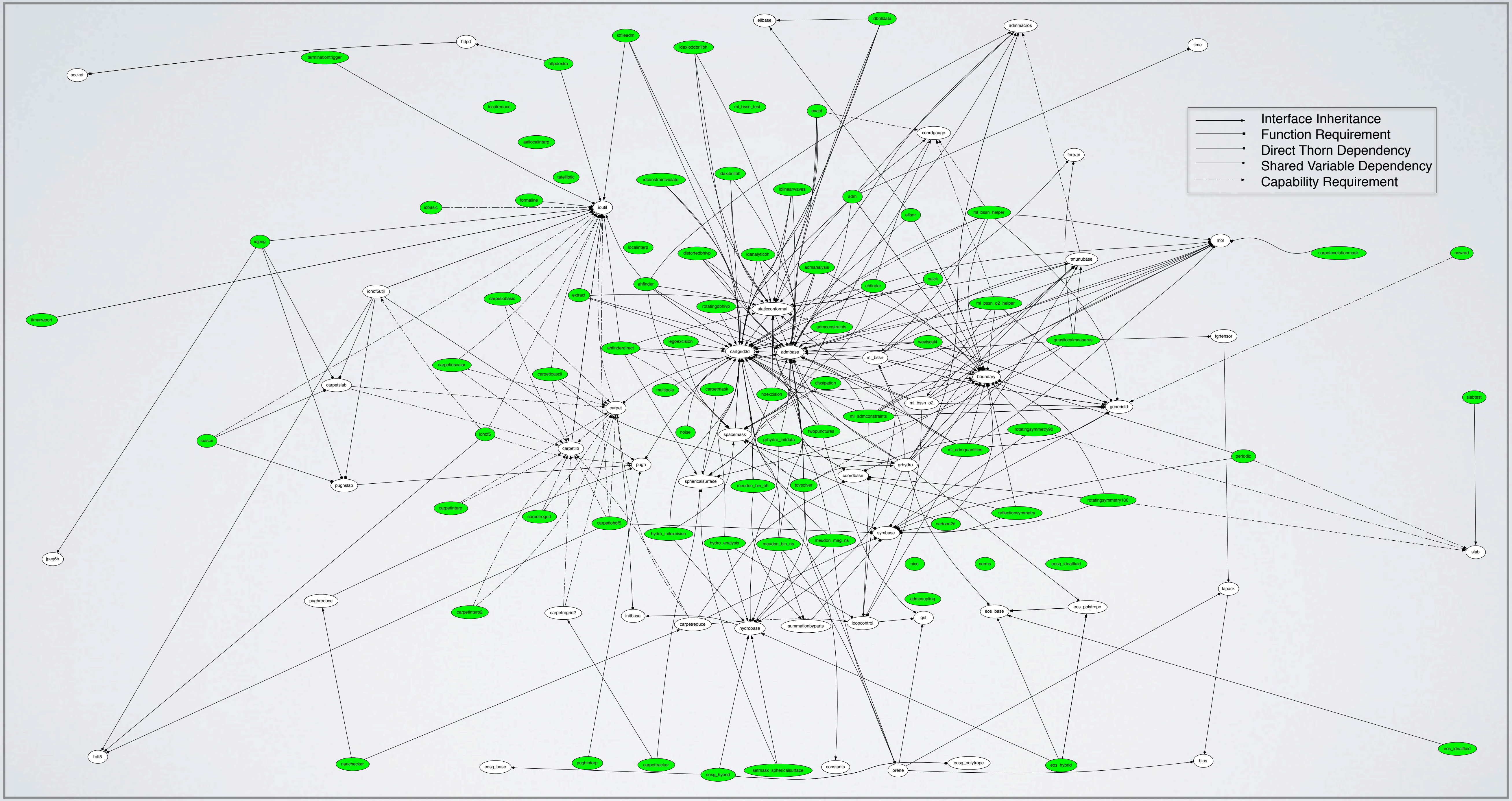
COMPONENT DEPENDENCIES -- WAVETOY EXAMPLE



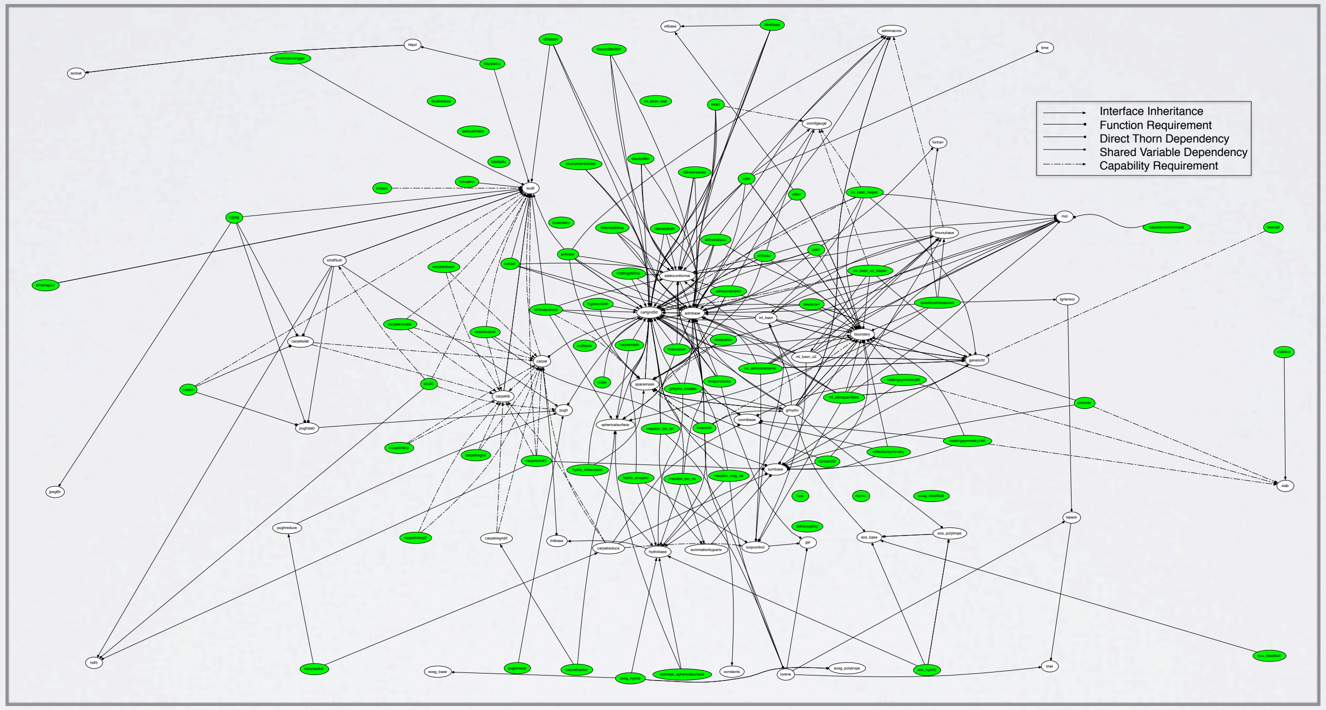
COMPONENT DEPENDENCIES -- QUANTUM GRAVITY



COMPONENT DEPENDENCIES -- EINSTEIN TOOLKIT



COMPONENT DEPENDENCIES -- EINSTEIN TOOLKIT



DISTRIBUTION

- GetComponents is freely available with an open-source license
- www.eseidel.org/download/GetComponents
- Full documentation available
  - `./GetComponents --man`

ACKNOWLEDGEMENTS

- Many thanks to Gabrielle Allen, Steve Brandt, Frank Löffler, and Erik Schnetter