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& TECHNOLOGY

Being Optimally Lazy:
The case for integrating SAGA with Condor

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If Computer Scientists are from Mars....

- e-Science is about Applications, ideally new and exciting..
- Applications need to use Infrastructure seamlessly
  - "e-Infrastructure that will enable novel and different research" linked with e-Science
  - Handle current heterogeneity and future developments
- Development and deployment of "novel" applications
  - Complex, dynamic, qualitative and quantitative use
  - Application-Level Interoperability, Scheduling
- Lack of distributed programming abstractions (DPA) for applications is one (of several) important barriers...

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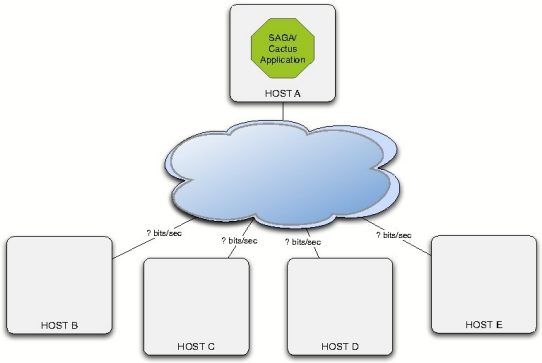
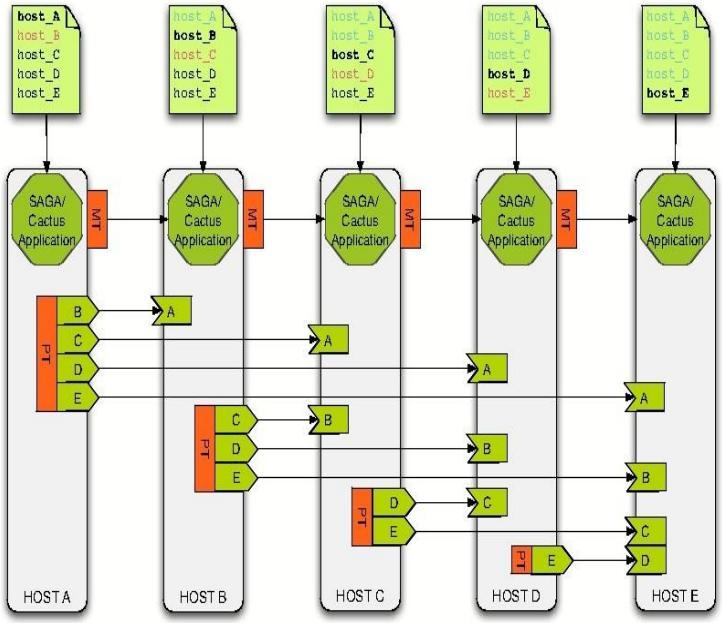
A Network Performance Aware Application

- Capable of acquiring application-specific network characteristic data
- Determine ideal migration target across heterogeneous systems without changes in the application code
- Reusable and extensible





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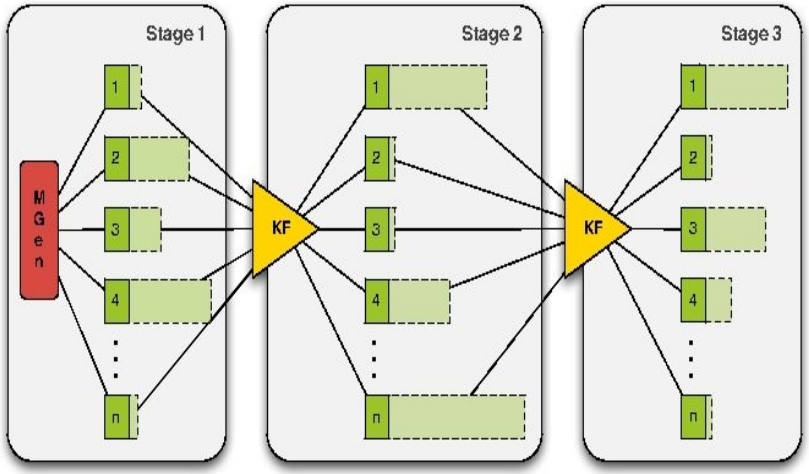
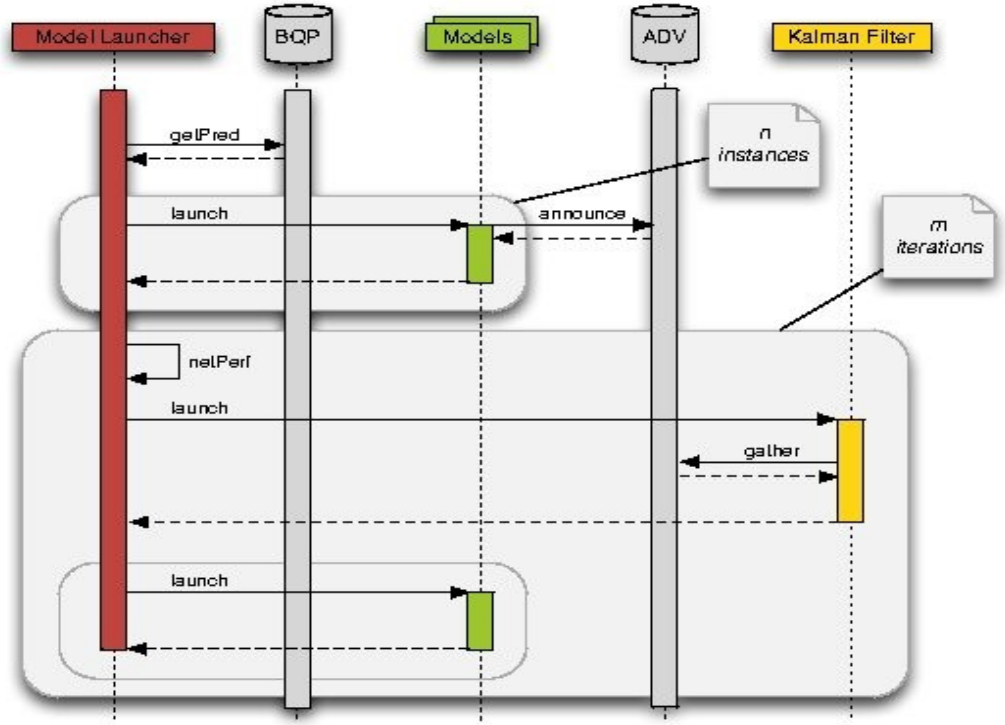
Hard-to-predict Runtime Characteristics

Life Beyond DAGMAN OR *Homage to the "Known Unknowns"*





SAGA: A Quick Tour

- A lack of:
  - Programming interface that provides common distributed functionality with the correct level of abstractions?
  - Ability to hide underlying complexities, varying semantics, heterogenities and changes from application program(er)
- Simple, integrated, stable, uniform, high-level interface
- Simplicity partly arises from scope being restricted (80/20)
- Like MapReduce – leave details of distribution *etc.* out
- Measure(s) of success:
  - Does SAGA enable quick development of "new" distributed applications?
    - Does it enable greater functionality using less code?
  - Can programming patterns/abstraction (all-pairs, map-reduce) be supported?
  - Will it enable applications across different systems? (ALI)

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Copy a File: Globus GASS

```
int copy_file (char const* source,   char const* target)
{
globus_url_t                        source_url;
globus_io_handle_t                  dest_io_handle;
globus_ftp_client_operationattr_t   source_ftp_attr;
globus_result_t                     result;
globus_gass_transfer_requestattr_t  source_gass_attr;
globus_gass_copy_attr_t             source_gass_copy_attr;
globus_gass_copy_handle_t           gass_copy_handle;
globus_gass_copy_handleattr_t       gass_copy_handleattr;
globus_ftp_client_handleattr_t      ftp_handleattr;
globus_io_attr_t                    io_attr;
int                                 output_file = -1;

if ( globus_url_parse (source_URL, &source_url) != GLOBUS_SUCCESS ) {
  printf ("can not parse source_URL \"%s\"\n", source_URL);
  return (-1);
}

if ( source_url.scheme_type != GLOBUS_URL_SCHEME_GSIFTP &&
     source_url.scheme_type != GLOBUS_URL_SCHEME_FTP    &&
     source_url.scheme_type != GLOBUS_URL_SCHEME_HTTP   &&
     source_url.scheme_type != GLOBUS_URL_SCHEME_HTTPS  ) {
  printf ("can not copy from %s - wrong prot\n", source_URL);
  return (-1);
}
globus_gass_copy_handleattr_init  (&gass_copy_handleattr);
globus_gass_copy_attr_init        (&source_gass_copy_attr);

globus_ftp_client_handleattr_init (&ftp_handleattr);
globus_io_fileattr_init           (&io_attr);

globus_gass_copy_attr_set_io      (&source_gass_copy_attr, &io_attr);
                                   &io_attr);
globus_gass_copy_handleattr_set_ftp_attr
                                  (&gass_copy_handleattr,
                                   &ftp_handleattr);
globus_gass_copy_handle_init      (&gass_copy_handle,
                                   &gass_copy_handleattr);

if (source_url.scheme_type == GLOBUS_URL_SCHEME_GSIFTP ||
    source_url.scheme_type == GLOBUS_URL_SCHEME_FTP    ) {
  globus_ftp_client_operationattr_init (&source_ftp_attr);
  globus_gass_copy_attr_set_ftp (&source_gass_copy_attr,
                                 &source_ftp_attr);
}
else {
  globus_gass_transfer_requestattr_init (&source_gass_attr,
                                         source_url.scheme);
  globus_gass_copy_attr_set_gass(&source_gass_copy_attr,
             &source_gass_attr);
}

output_file = globus_libc_open ((char*) target,
              O_WRONLY | O_TRUNC | O_CREAT,
              S_IRUSR  | S_IWUSR | S_IRGRP |
              S_IWGRP);
if ( output_file == -1 ) {
  printf ("could not open the file \"%s\"\n", target);
  return (-1);
}
/* convert stdout to be a globus_io_handle */
if ( globus_io_file_posix_convert (output_file, 0,
                                   &dest_io_handle)
     != GLOBUS_SUCCESS) {
  printf ("Error converting the file handle\n");
  return (-1);
}

result = globus_gass_copy_register_url_to_handle (
         &gass_copy_handle, (char*)source_URL,
         &source_gass_copy_attr, &dest_io_handle,
         my_callback, NULL);
if ( result != GLOBUS_SUCCESS ) {
  printf ("error: %s\n", globus_object_printable_to_string
          (globus_error_get (result)));
  return (-1);
}
globus_url_destroy  (&source_url);
return (0);
}
```

SAGA Example: Copy a File

High-level, uniform

```
#include <string>
#include <saga/saga.hpp>

void copy_file(std::string source_url, std::string target_url)
{
  try {
    saga::file f(source_url);
    f.copy(target_url);
  }
  catch (saga::exception const &e) {
    std::cerr << e.what() << std::endl;
  }
}
```

SAGA Interface
Job Submission API

```
01: // Submitting a simple job and wait for completion
02: //
03: saga::job_description jobdef;
04: jobdef.set_attribute ("Executable", "job.sh");
05:
06: saga::job_service js;
07: saga::job job = js.create_job ("remote.host.net",
jobdef);
08:
09: job.run();
10:
11: while( job.get_state() == saga::job::Running )
12: {
13:   std::cout << "Job running with ID: "
14:             << job.get_attribute("JobID") << std::endl;
15:   sleep(1);
16: }
```

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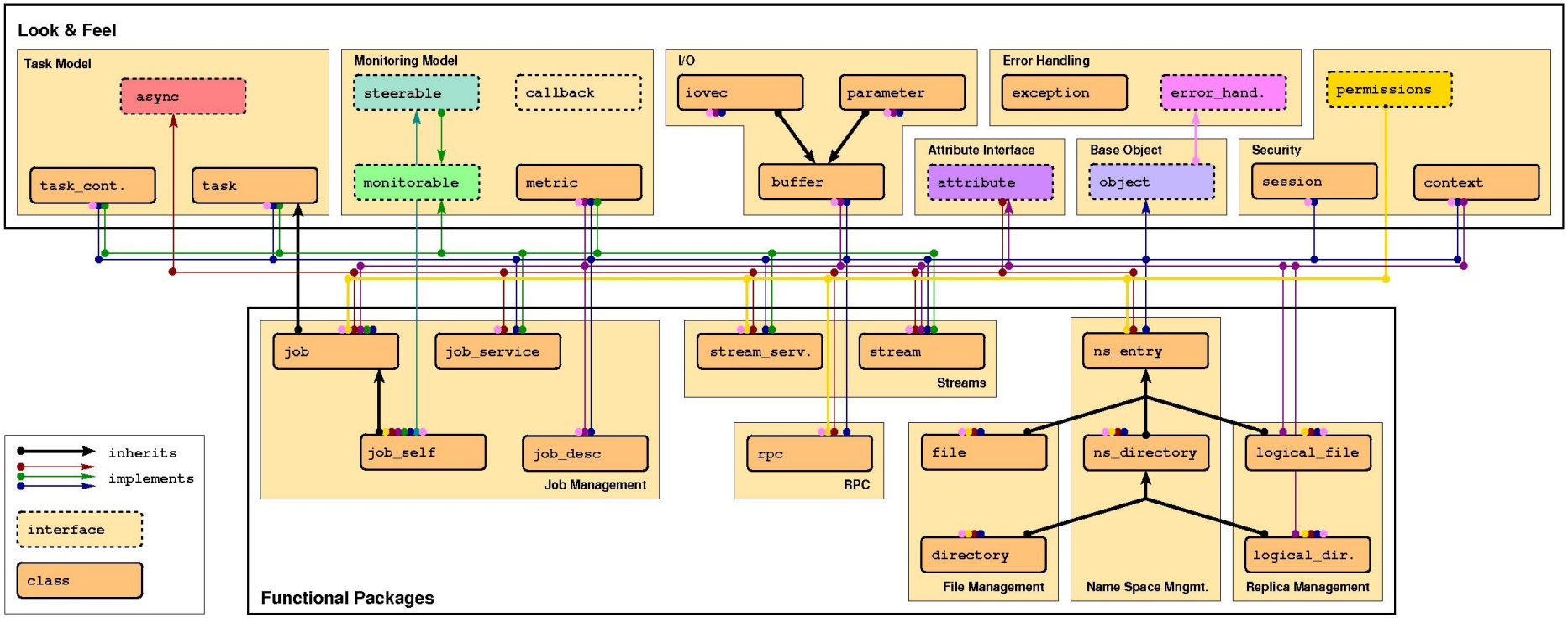
SAGA: Class Diagram



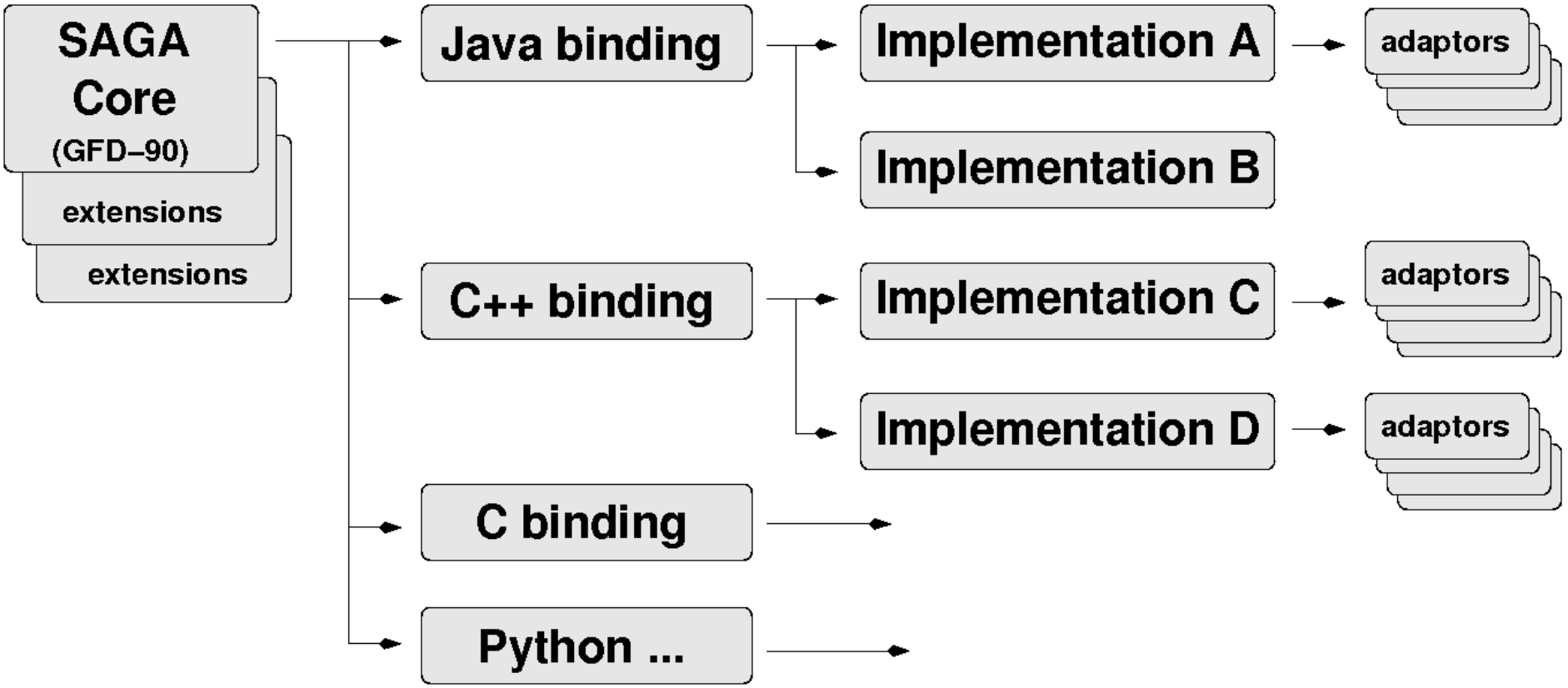
In the works: CPR, Information Services, Service Discovery, Messaging....

SAGA API: Towards a Standard

Standards help Interoperability

- The need for a standard programming interface
  - "Go it alone" versus "Community" model
  - Reinventing the wheel again, yet again, and again
  - MPI as a useful analogy of community standard
  - OGF the natural choice; establish SAGA-RG
- Open Grid Forum: Design derived from 23 Use Cases
  - Different projects, applications and functionality
    - Biological, Coastal-modelling, visualization ..
  - Functional Areas: Job Mgmt, Data Management (Files, Logical Files...), Streams & ...
  - Non-functional Areas: Asynchronous, QoS, Bulk
- Interface is language independent, object-oriented and each sub-system is independent, SIDL (extensible)

The SAGA Landscape



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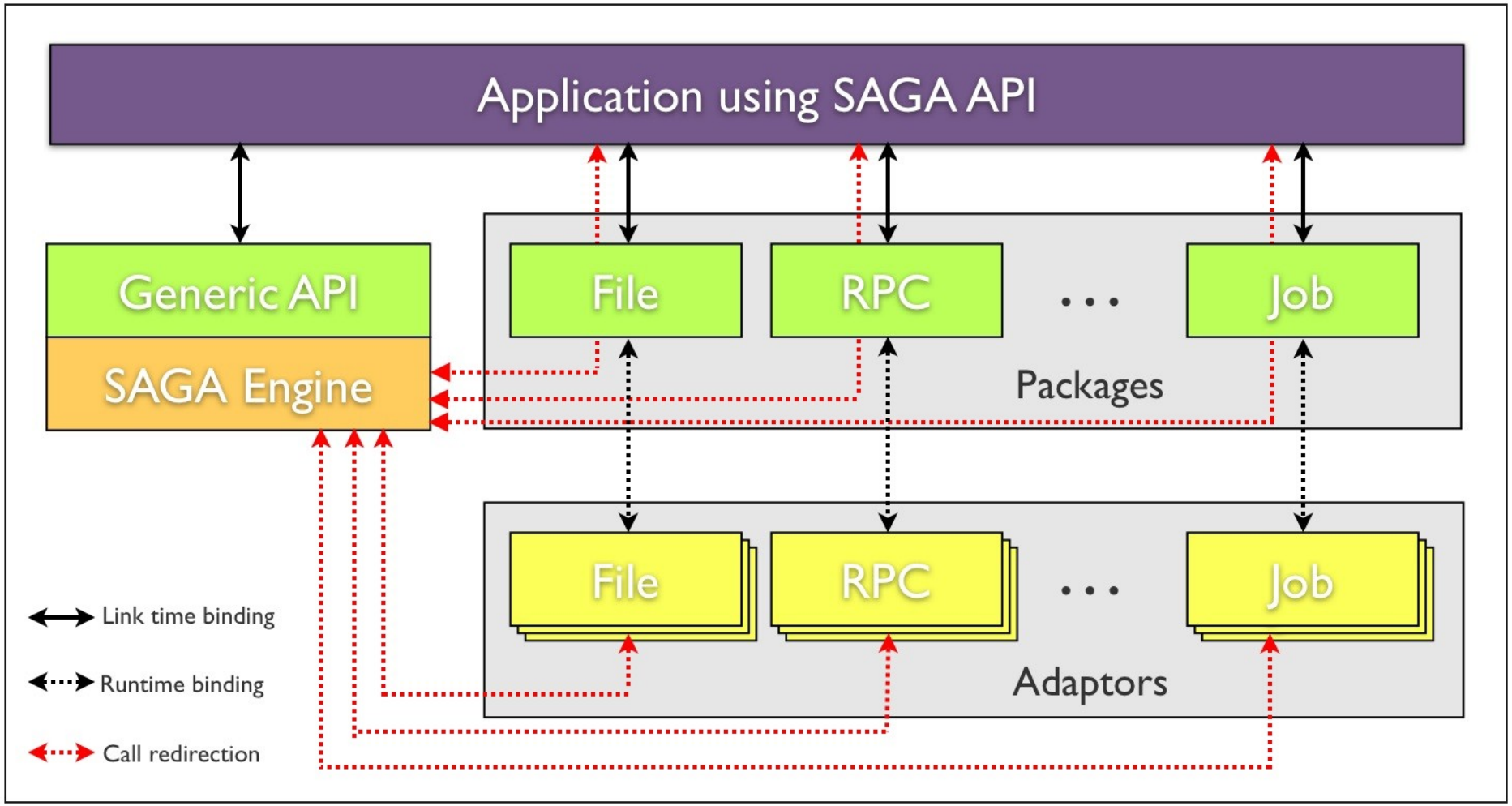
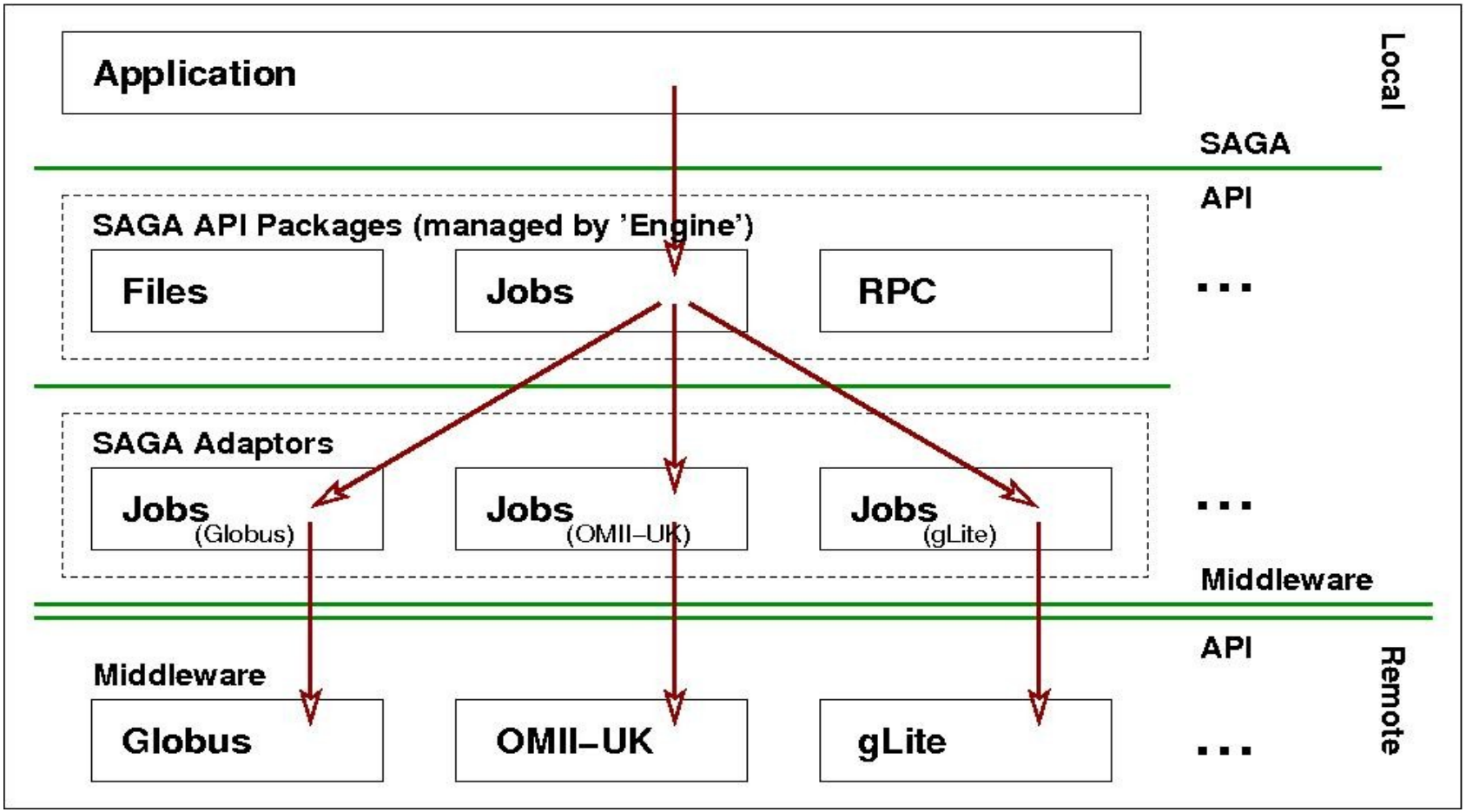
SAGA
C++ (LSU)



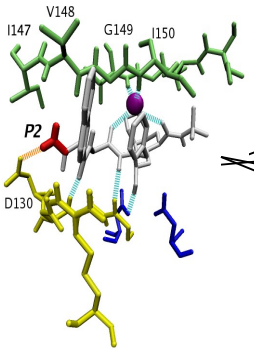
SAGA: Job Submission

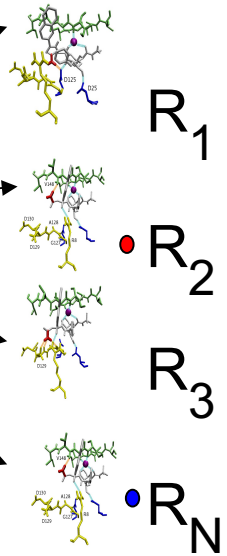
Role of Adaptors (middleware binding)

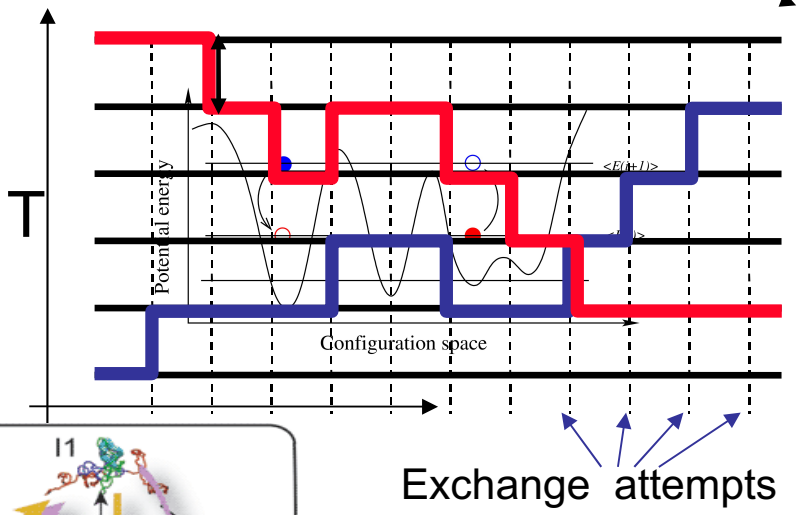


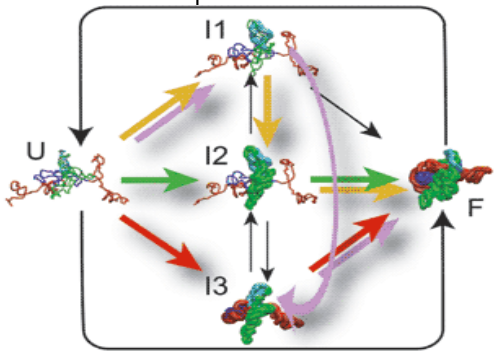
Replica Exchange Algorithm

- Task Level Parallelism
  - Embarrassingly distributable!
  - Loosely coupled
- Create replicas of initial configuration
- Spawn 'N' replicas over different machine
- Run for time *t ;* Attempt configuration swap
- Run for further time t; Re till finish









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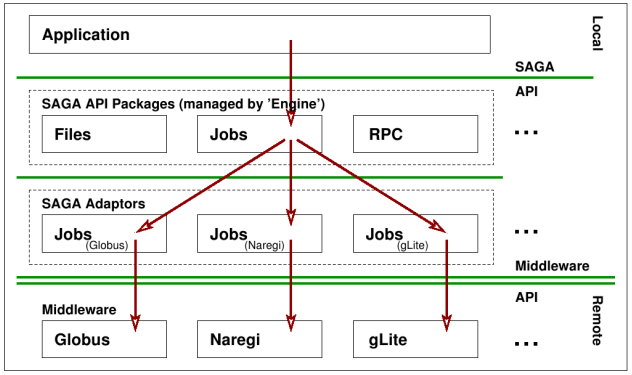
RE: Programming Requirements

- RE can be implemented using following “primitives”
  - Read job description
    - # of processors, replicas, determine resourc
  - Submit jobs
    - Move files, job launch
  - Checkpoint and re-launch simulations
    - Exchange, RPC (to swap or not)
- Implement above using “grid primitives” provided by SAGA
  - Separated “distributed” logic from “simulation” logic
    - Independent of underlying code/engine
    - Science kernel is independent of details of distributed resource management
- ***Need to use resources integrated from Desktop to Supercomputers!!***



“Grid” Universe

- All handled in your submit file
- Supports a number of “back end” types:
  - Globus: GT2, GT4
  - NorduGrid
  - UNICORE
  - Condor
  - PBS
  - LSF
  - EC2
  - NQS

http://www.cs.wisc.edu/condor

Condor APIs

- Command line tools

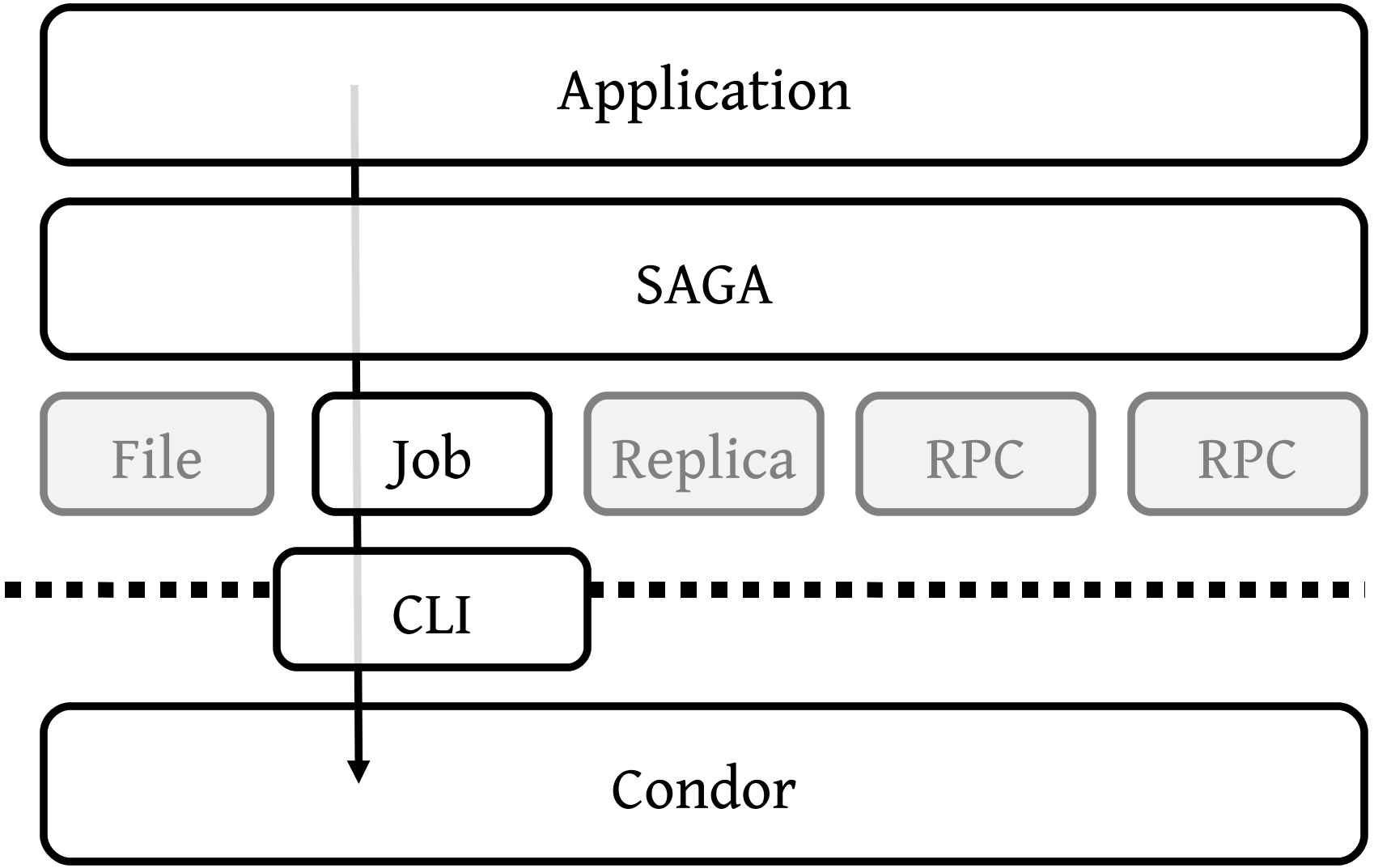
  the *de facto* API

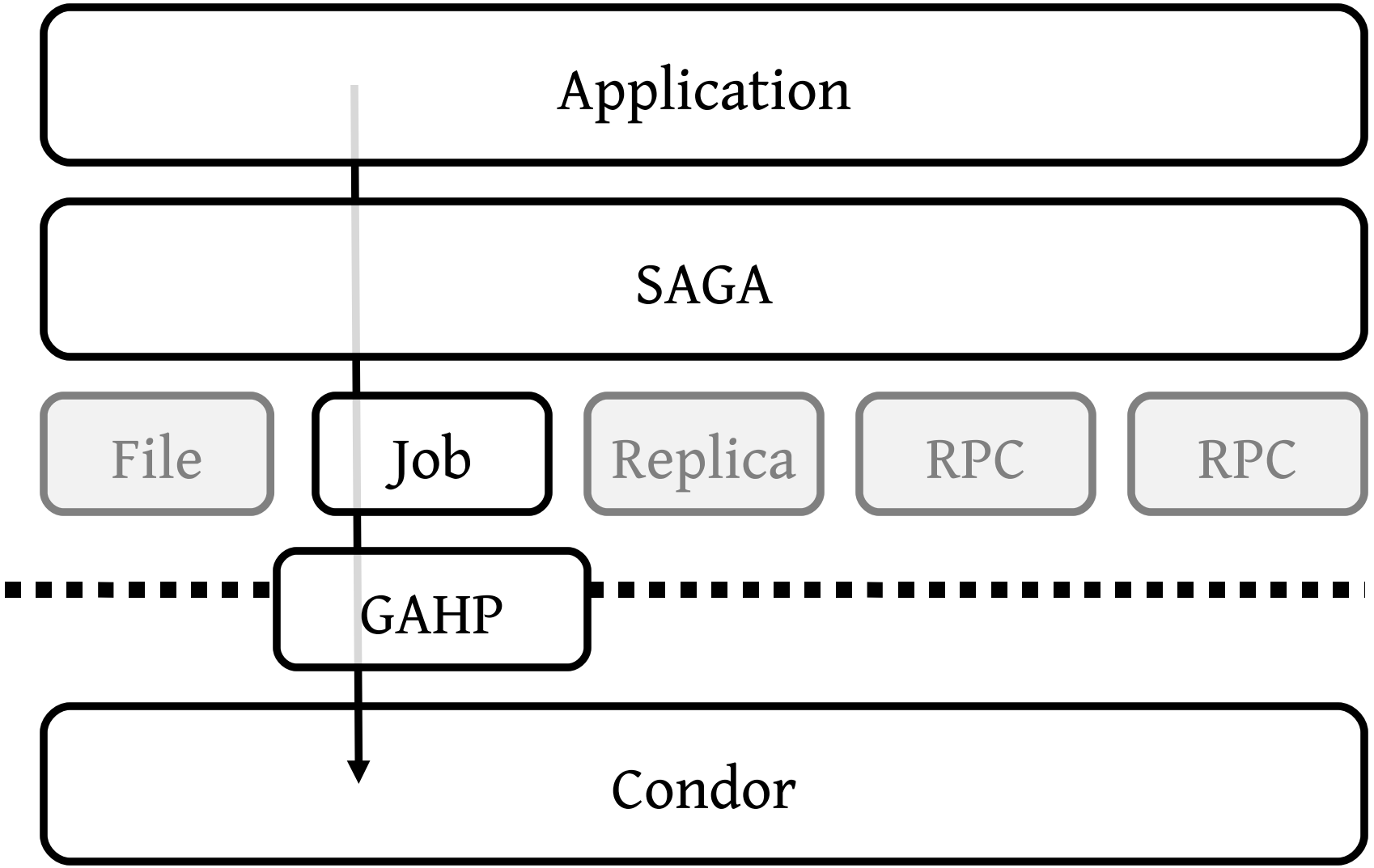
- SOAP

  The API

- GAHP

  An ASCII communication protocol


Application
SAGA
File
Job
Replica
RPC
RPC
CLI
Condor


Application
SAGA
File
Job
Replica
RPC
RPC
GAHP
Condor

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class saga::job::service

class saga::job::description

Executable, Arguments, Environment, Input,

Output, Error, FileTransfer

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class saga::job::job

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class saga::job::job

- run()
- cancel()
- wait()
- suspend()
- resume()

- condor_submit
- condor_rm
- (condor_run)
- condor_hold
- condor_release

Demo

```
#include <saga.hpp>

int main()
{
    using namespace std;
    using namespace saga;
    using namespace saga::job::attributes;

    job::service js("condor://gg201.cct.lsu.edu");

    job::description jd;
    jd.set_attribute(description_executable, "/bin/sleep");
    jd.set_vector_attribute(description_arguments, vector<string>(1, "1000"));

    job::job job = js.create_job(jd);

    job.run();
}
                                                    19,0-1        All
```

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Acknowledgments

- Funding Agencies:
  - US NSF/ La BoR
    - Cybertools projects
  - UK EPSRC:
    - OMII-UK “OMII SAGA” project
    - Theme “Distributed Programming Abstractions”
  - CCT Internal Funds
  - NIH and Google*

* Keep Clicking on those advertisements!

http://saga.cct.lsu.edu

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Acknowledegments: The SAGA Team

Hartmut Kaiser

Thilo Kielmann

Andre Merzky

Ceriel Jacobs

Ole Weidner

Kees Verstop

+ Many other students