The Future of IPython: Interactive Parallel and Distributed Computing

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IPython: An Enhanced Interactive Python Shell

- IPython is an enhanced interactive Python shell
- It is becoming the de facto shell for scientific computing in Python
- Included with most major Linux distributions
- Capabilities:
  - User extensible syntax
  - GUI integration (wx, Qt, GTK, etc.)
  - Seamless system shell access
  - Dynamic object/namespace introspection: docstrings, attributes, methods, source code
  - Numbered input/output prompts with command history
  - Session logging and restoring
  - Embeddable

http://ipython.scipy.org

Goals

Create an open source architecture that enables parallel and distributed programs to be developed, monitored, executed and debugged interactively and collaboratively.

- All of IPython's capabilities will be available over the wire.
- Easy things should be easy.
- It should integrate well with existing C/C++/Fortran/MPI code.
- It should support many different styles of parallelism: message passing, task farming, distributed memory.
- Fully interactive work with up to 256 processors (latency < 0.1 sec).
- Wide range of hardware: laptops to NERSC supercomputers

Realities of Distributed Scientific Computing

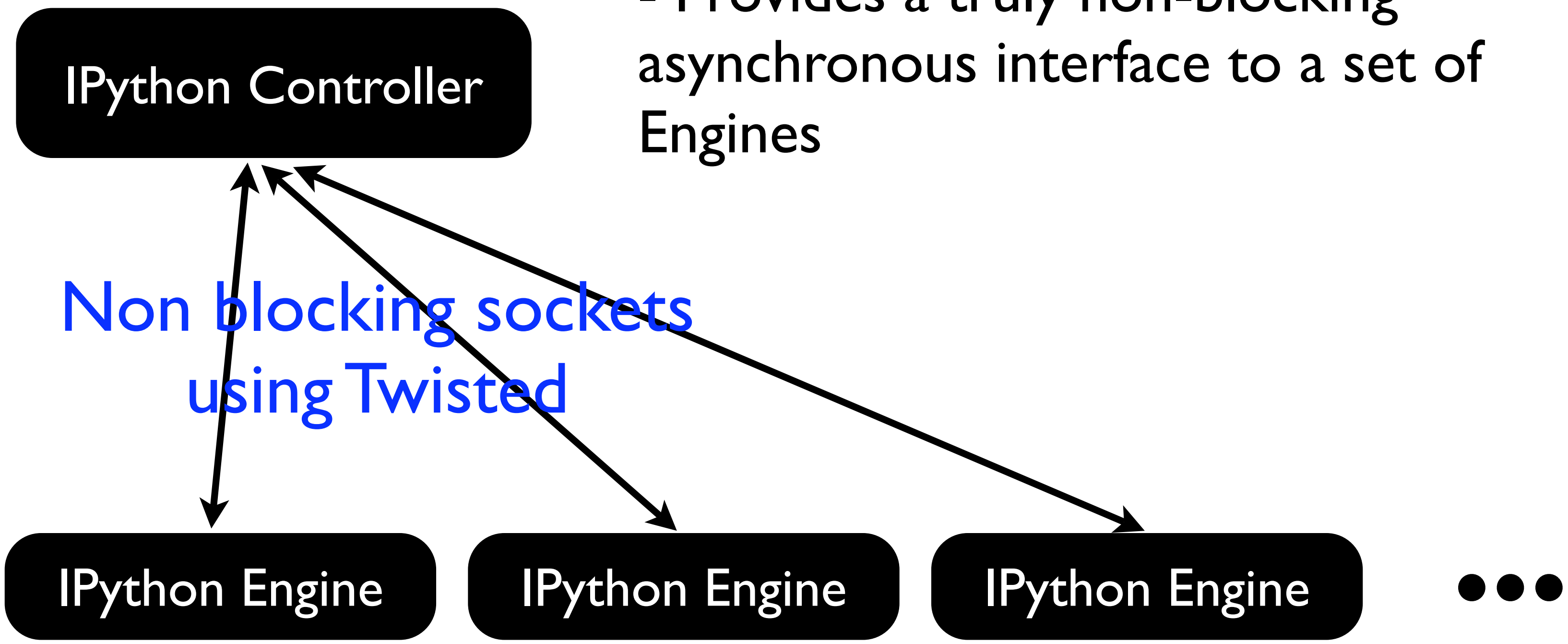
- Scientific code is often written in in compiled langauges (C/C++/Fortran).
- This code takes a long time to execute.
- While this code is running, nothing else (such as network communications) can happen in process.
- This is completely orthogonal to the asynchronous nature of distributed, network based computing.
- Because of the Global Interpreter Lock (GIL) threads don’t provide a general solution to this problem.

Minimal Requirements for Good Parallelism in Python

- Multiple processes.
- Non-blocking sockets.
- Asynchronous error/fault handling.

Architecture

- Manages the Engines
- Queue for each Engine
- Provides a truly non-blocking asynchronous interface to a set of Engines



IPython Controller

Non blocking sockets
using Twisted

IPython Engine

IPython Engine

IPython Engine

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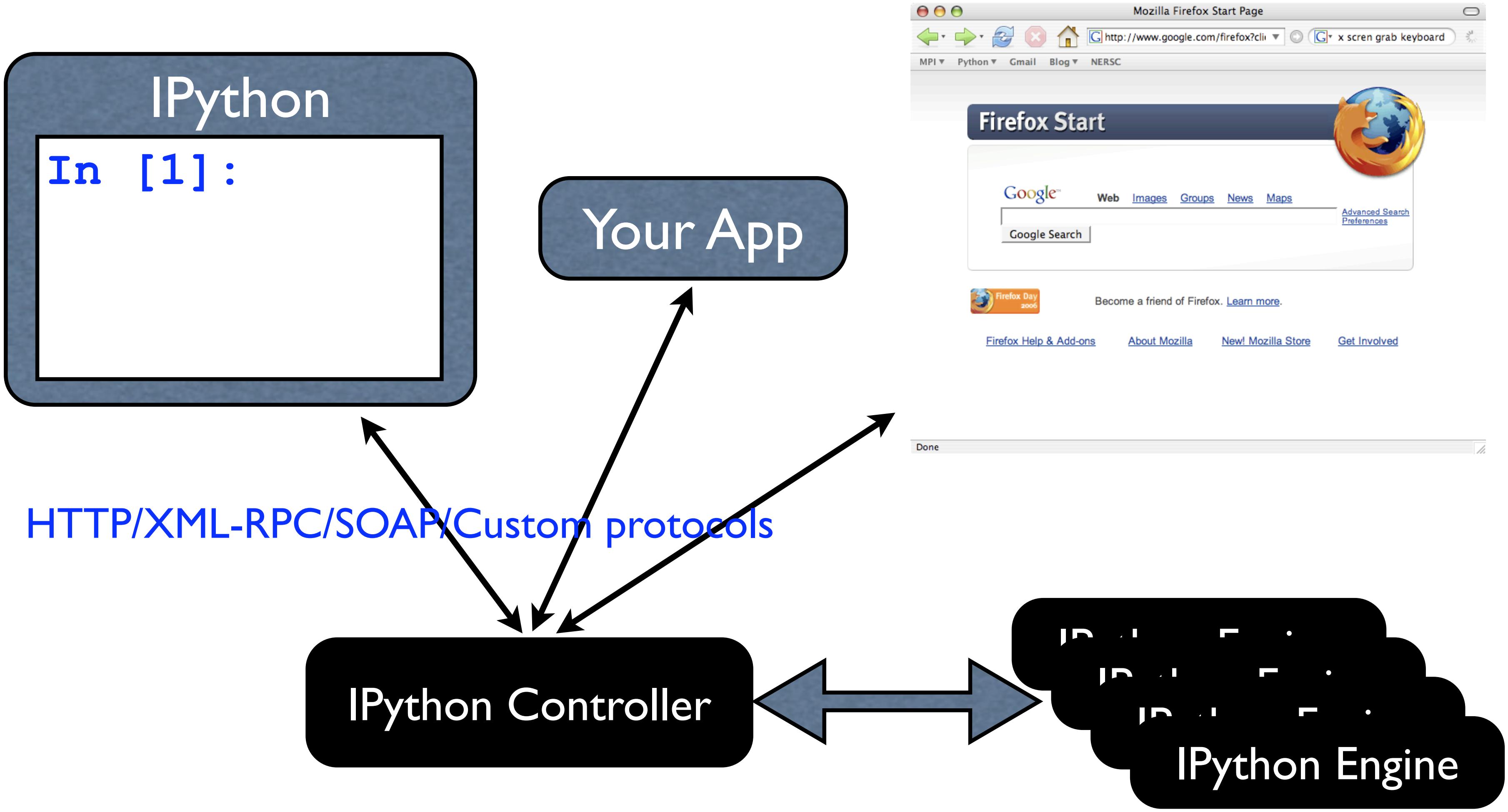
(I)Python virtual machines exposed to the network. These can and will block!

Architecture

Multiple/simultaneous users/apps can connect to the Controller = collaboration



IPython

```
In [1]:
```

Your App

Mozilla Firefox Start Page

http://www.google.com/firefox?cli

x scren grab keyboard

MPI ▾ Python ▾ Gmail Blog ▾ NERSC

Firefox Start

Google

Web Images Groups News Maps

Advanced Search

Preferences

Google Search

Firefox Day 2006

Become a friend of Firefox. Learn more.

Firefox Help & Add-ons About Mozilla New! Mozilla Store Get Involved

Done

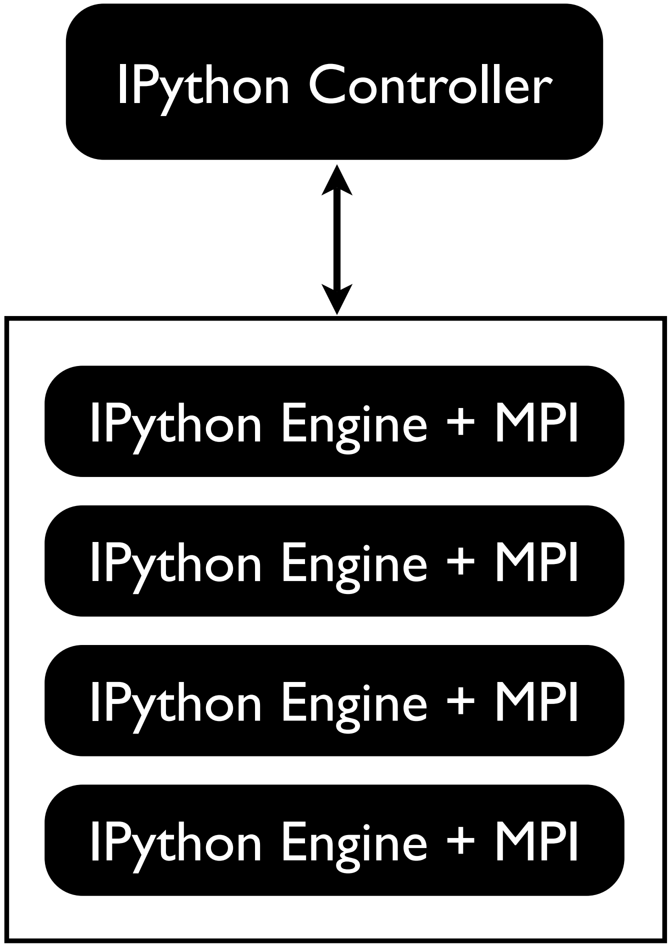
HTTP/XML-RPC/SOAP/Custom protocols

IPython Controller

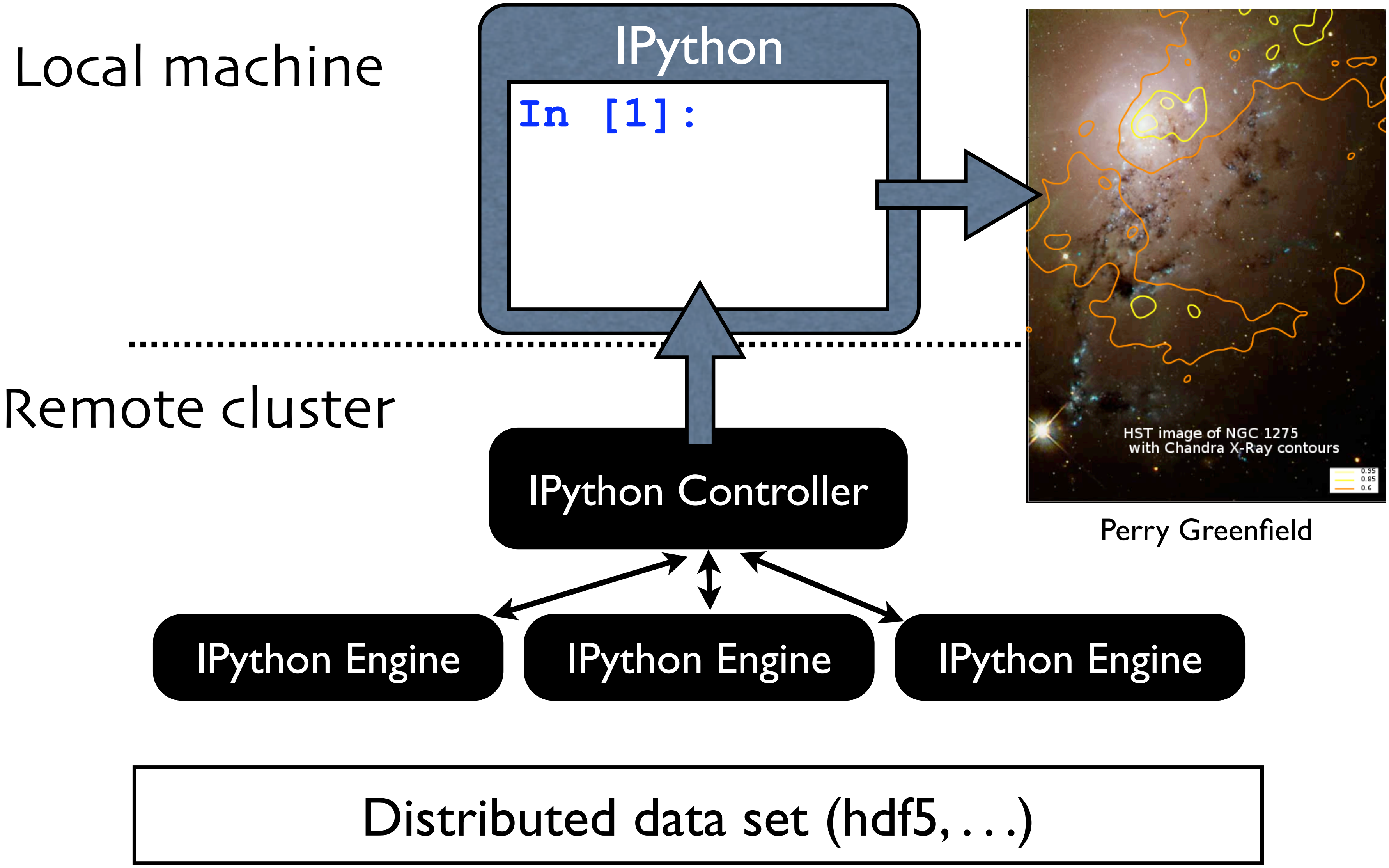
IPython Engine

Interactive Steering of Traditional Parallel Codes

- The IPython Engine can optionally initialize MPI at startup.
- User code can call wrapped C/C++/Fortran code that makes calls to MPI.
- We also support many of the Python/MPI bindings.
- The Controller and Frontend/ Clients don't use MPI.
- Full interactive control of a traditional parallel app.



Interactive and Parallel Data Analysis of Massive Distributed Data Sets



Local machine

IPython

```
In [1]:
```

Remote cluster

IPython Controller

IPython Engine

IPython Engine

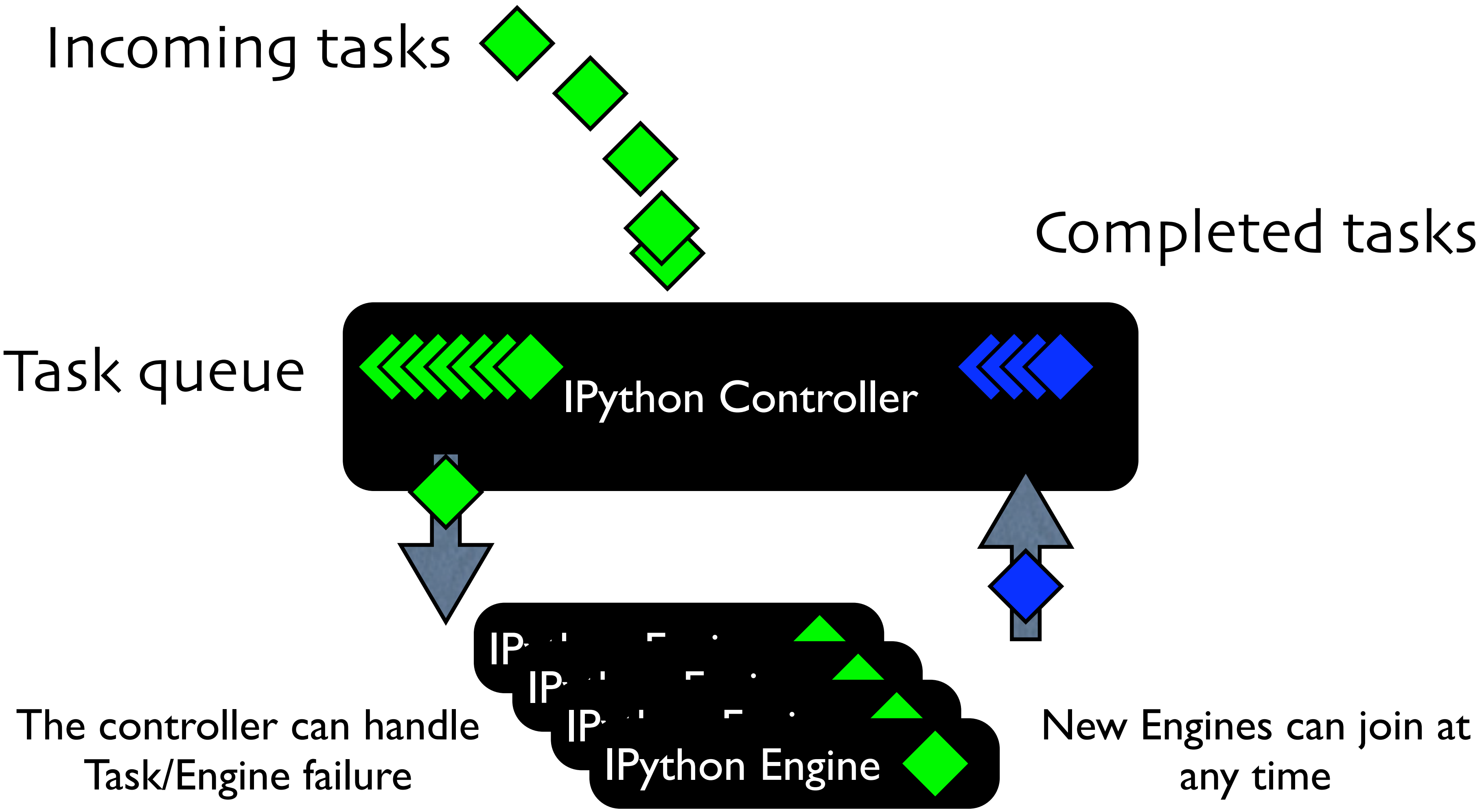
IPython Engine

Distributed data set (hdf5, . . .)

HST image of NGC 1275 with Chandra X-Ray contours

Perry Greenfield

Load Balanced, Fault Tolerant Task Farming



Incoming tasks

Completed tasks

Task queue

IPython Controller

IPython Engine

The controller can handle Task/Engine failure

New Engines can join at any time

Status

- Most of the infrastructure for interactive parallel and distributed is done.
- Working on testing/optimization/documentation.
- Beginning to implement the “IPythonic Features.”
- Watch ipython.scipy.org for updated info.
- Or check it out:

```
svn co http://ipython.scipy.org/svn/ipython/
ipython/branches/chainsaw ipython1
```

http://ipython.scipy.org/moin/Design