Middleware Adaptation with the Delphoi Service

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Adaptive Applications

- Application needs to adapt itself to Grid resources
- Middleware is needed both for
  - getting performance *information*
  - guide adaptation decisions
- Problem:
  - Monitoring data is low-level (resource centric)
  - Information is scattered among many sources
- Solution: The Delphoi service

GridLab

Building a Grid Application Toolkit (GAT):

- a simple, high-level, application-oriented API
- independent of underlying middleware
  (Globus 2, 3, 4, Avaki, Unicore, . . .)
- using a set of services
  (on top of “core” middleware)
- many services need performance information, e.g.
  - data movement and replication
  - remote visualization
  - resource broker

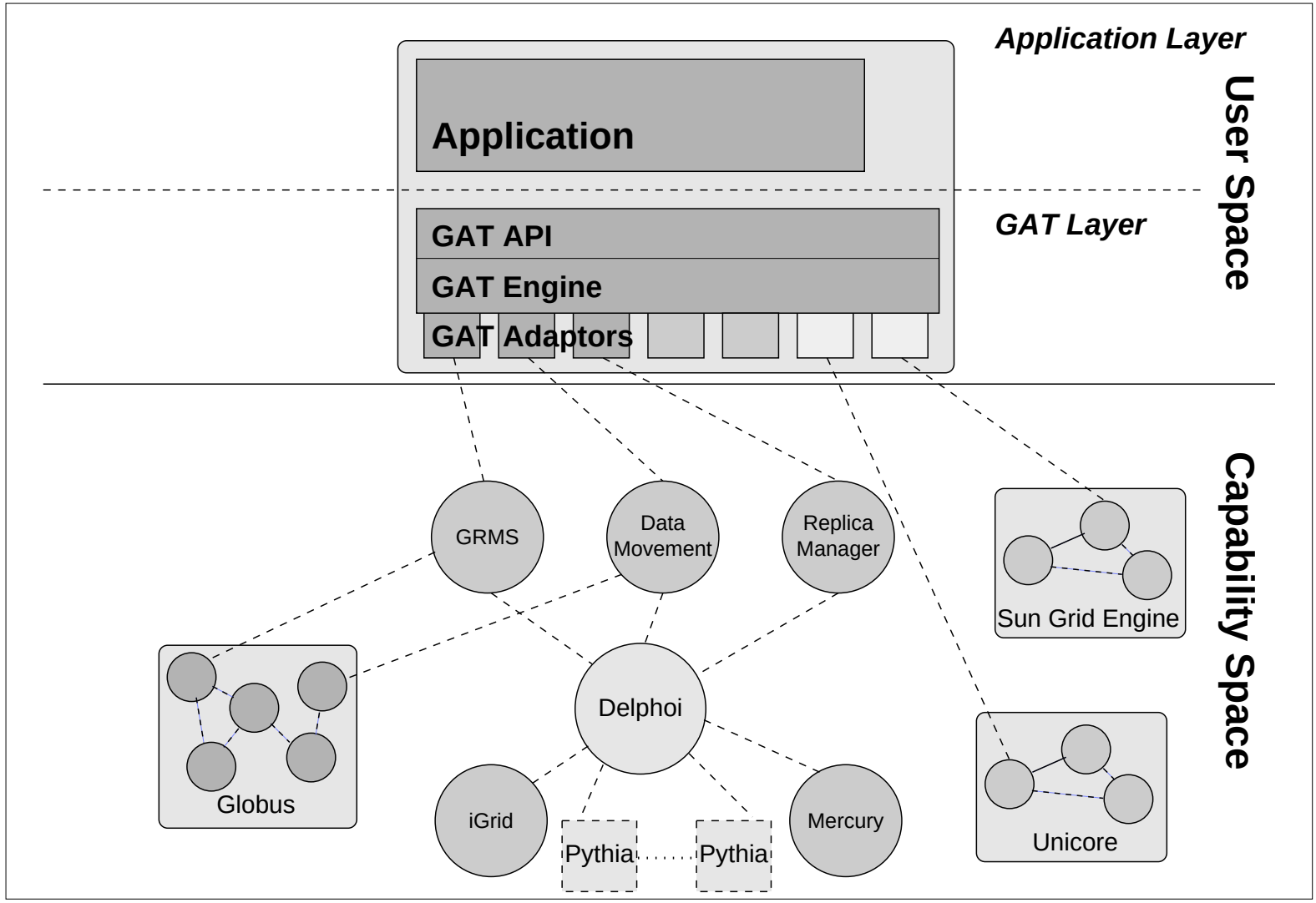
Grid Application Toolkit

Scope of the GAT API:

- Files
- Resources (CPU)
- Event/Information Exchange
- Utility classes
  (error handling, security, preferences...)

- **NOTHING ELSE**

GAT Architecture



Delphoi Use Cases

- remote file transfer optimization
  - protocol selection (GridFTP, scp, . . .)
  - protocol parameter settings (buffers, TCP streams)
- replica selection
  - like file transfer, plus transfer time estimation
- remote data visualization
  - trading image quality for waiting time
  - based on network characteristics
- job waiting time estimation
  - GRMS scheduler needs available queues and expected waiting times

Delphoi Functionality

- Meta information
- Low-level resource and network information
- High-level network information
- Queueing information
- Logging

Meta Information

- `String[] getActiveSites[]`
- `MetricInfo[] knownMetrics(String hostName)`
  - MetricInfo contains metric name and parameters
  - Example: *freeDiskSpace* and */dev/hda*

- These calls are essential to find out what is available in a Grid (VO).

Low-level Information

```
String estimateMetric(
    String hostName,
    MetricInfo metric,
    String operation,    // min, max, mean
    Calendar startTime,  // past, present, future
    Calendar endTime)

String[] estimateMetricForMultipleHosts()

String[] getRawMeasurementData()
```

Network Metrics

Currently supported: (according to GFD.023)

- path.delay.oneway
- path.delay.roundtrip
- path.bandwidth.available
- path.bandwidth.utilized
- path.bandwidth.capacity
- hoplist

High-level Information

```
TcpOptions estimateTcpOptions(
    String sourceHostName,
    String destinationHostName,
    long dataSize,
    String transferMethod,    // e.g. GridFTP
    int maxTcpStreams,
    Calendar startTime)
```

Returns TCP Options (send buffer size and parallel streams) to optimize data transfer

High-level Info. (2)

```
double estimateTransferTime(
    String sourceHostName,
    String destinationHostName,
    long dataSize,
    String transferMethod,
    Calendar startTime)

double[] estimateTransferTimeOneToMany()
   // e.g., selecting scheduling target

double[] estimateTransferTimeManyToOne()
   // e.g., replica selection
```

High-level Info. (3)

```
void logDataTransfer(
        String source,
        String destination,
        long dataSize,
        String transferMethod,
        TcpOptions options,
        Calendar startTime,
        Calendar endTime)
```

- Application can give timing feedback
- Optional, only for improving predictions

Queueing Information

```
Queue[] getQueues()
    // host name, schedulers, queue names

QueueConf getQueueConf(Queue queue)
    // hosts, CPUs, limits,...

QueueWaitingTime getQueueWaitingTime(
    Queue queue,
    int jobSize,          // number of CPUs
    Calendar startTime,
    Calendar endTime)
```

For prediction, job sizes are put in four categories: single (1), small (2-4), medium (5-16), large (17+)

Queueing Info (2)

```
ResourceUtilization getResourceUtilization(
    Queue queue,
    Calendar startTime,
    Calendar endTime)
```

- Average number of free hosts available to a queue
- Measure for machine utilization

Logging

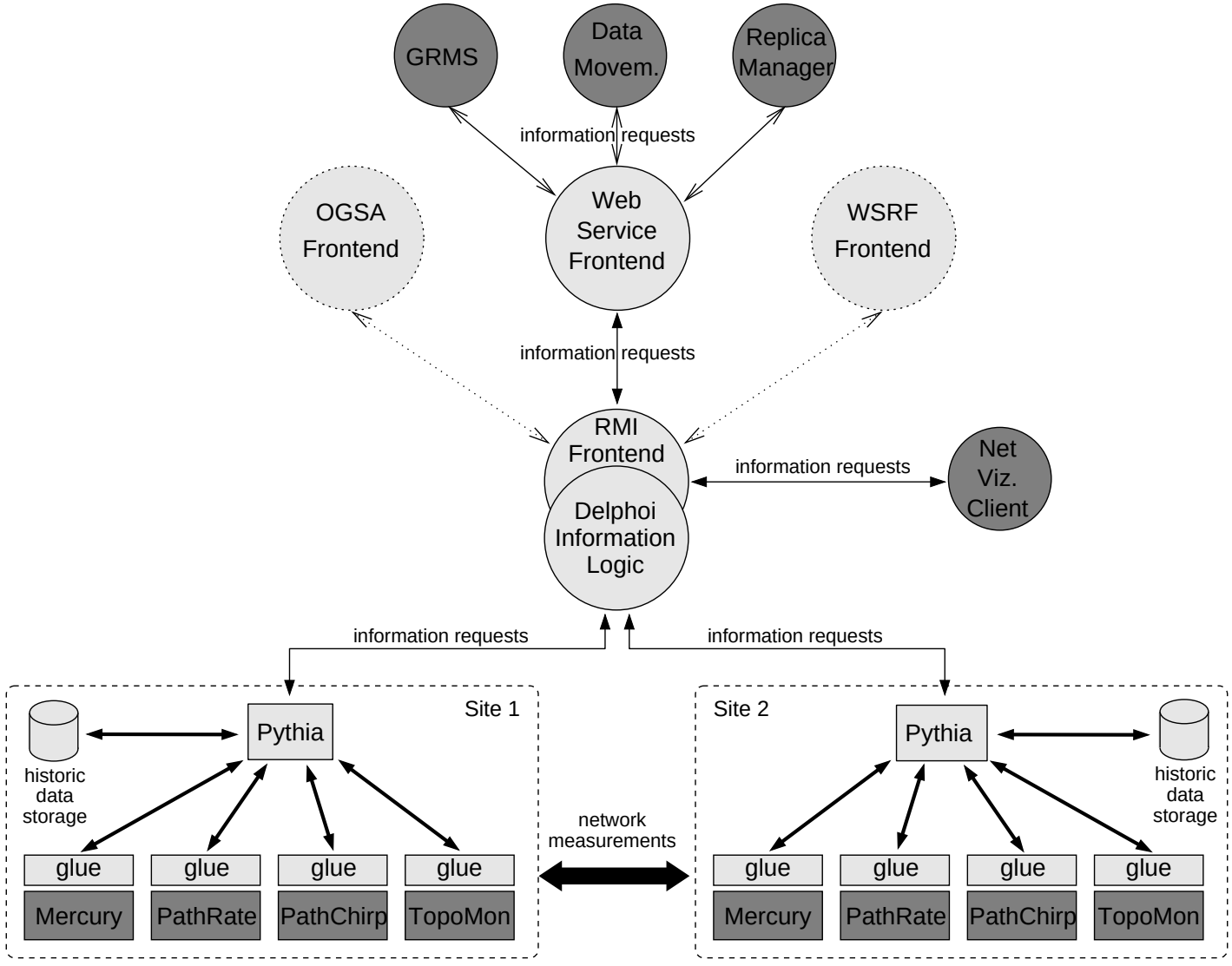
Applications and services can log messages

- using the Mercury monitor
- service/application, component, origin (user/host), severity, message

```
String[] getLogs(String service,
    String component,
    String origin,
    int severity,
    Calendar startTime,
    Calendar endTime)
```

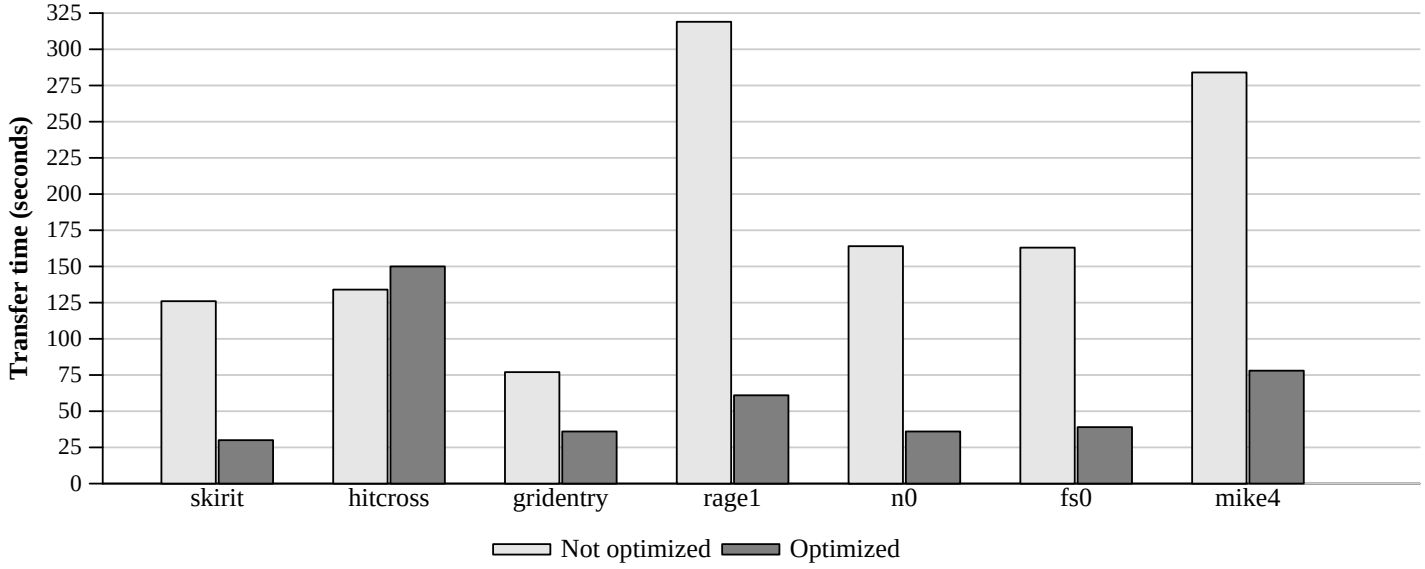
- Regular expression matching on parameters

The Delphoi Service



Example using Delphoi

File transfer optimization (from litchi.zib.de)



- Delphoi automatically predicts the optimal GridFTP settings

Conclusions

- Applications need middleware to
  - get performance information
  - guide adaptation decisions
- The Delphoi service provides
  - a unified interface to various information sources
  - application-level information with prediction

- available from `www.gridlab.org/delphoi/`