
LEAD Workflow Orchestration

Lavanya Ramakrishnan

Renaissance Computing Institute

University of North Carolina - Chapel Hill

Duke University

North Carolina State University



Outline

- **Background and LEAD Service Architecture**
 - web services, BPEL
- **LEAD Workflows**
 - status, site visit example run
 - characteristics, workflow structures
- **LEAD Virtual Grid Integration**
 - resource management

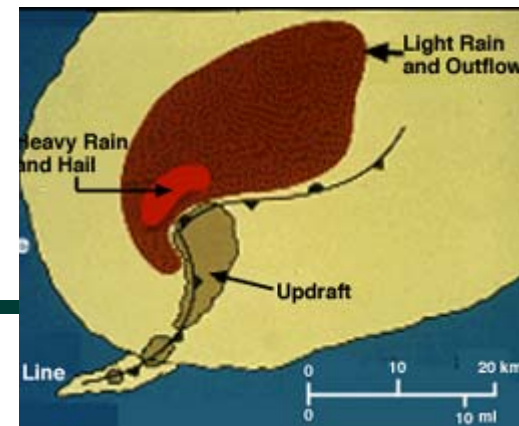
Linked Environments for Atmospheric Discovery

- **Rationale**

- each year, mesoscale weather - floods, tornadoes, hail, strong winds, lightning, hurricanes and winter storms - causes hundreds of deaths, routinely disrupts transportation and commerce, and results in annual economic losses in excess of \$13B.

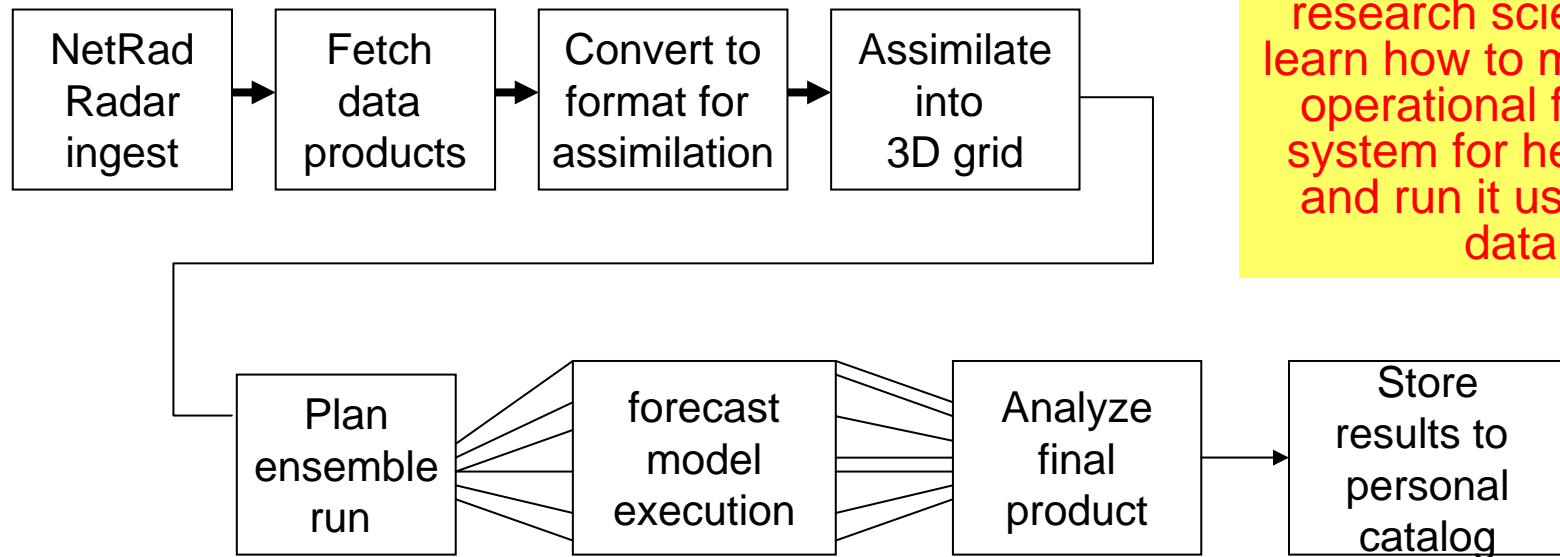
- **From “offline” to “online” forecasting**

- data assimilation and adaptive evaluation



Static Forecasting

- Large-scale tightly coupled components
 - not adaptable to weather or resource behavior
 - modifications are not trivial



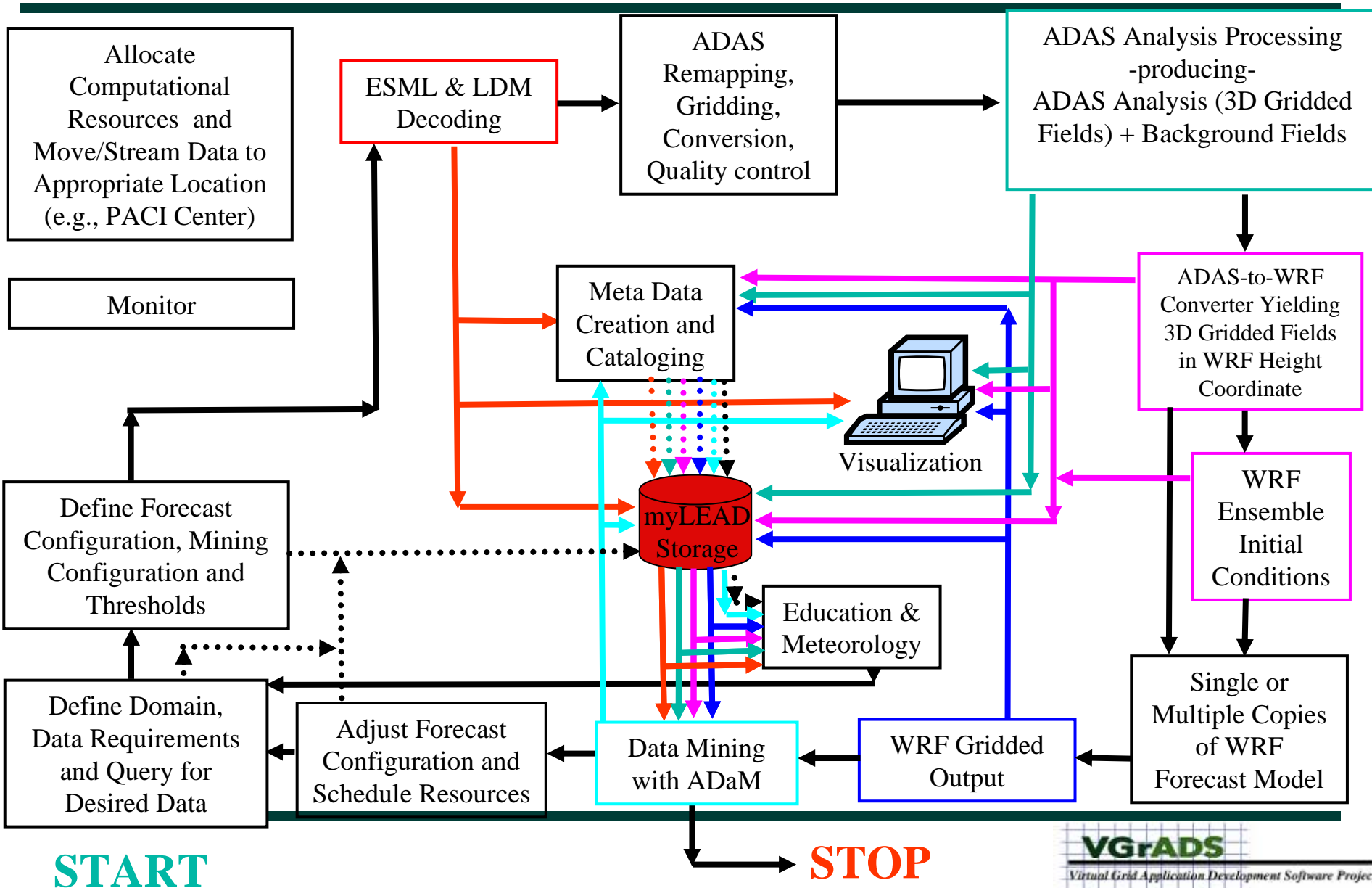
Center for Analysis and Prediction of Storms (CAPS, OU):
It took an MS student 6 months, working with a research scientist, to learn how to modify the operational forecast system for her needs and run it using real data

Dynamic Adaptive LEAD System

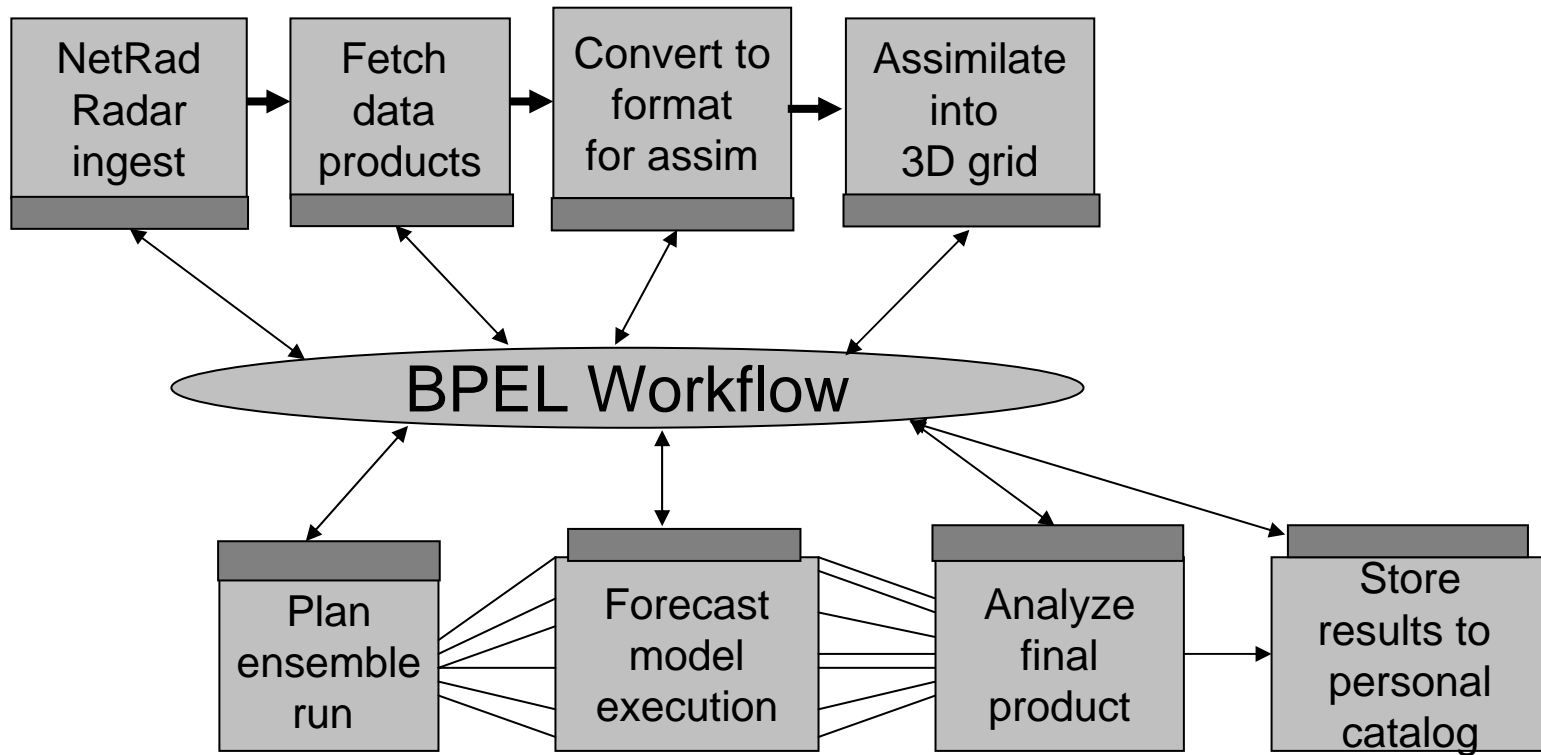
- **Meteorology goal**
 - to provide timely and accurate forecasts using dynamic adaptation
- **Computer Science goal**
 - map application requirements to resource capabilities
 - redundant runs, scheduling policies
 - adapt to weather as well as resource behavior

Need real time monitoring to make adaptation decisions

LEAD Control and Data Flow



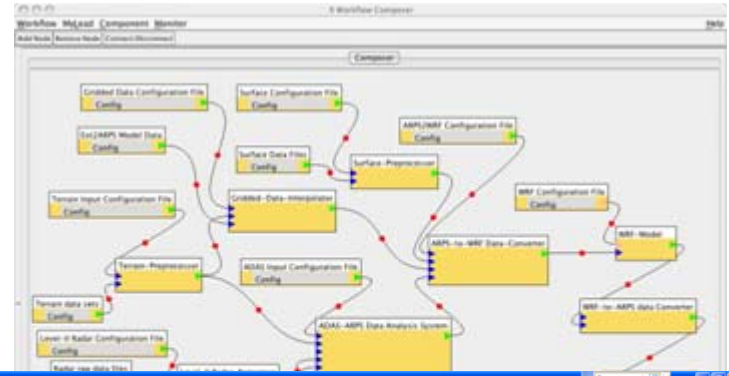
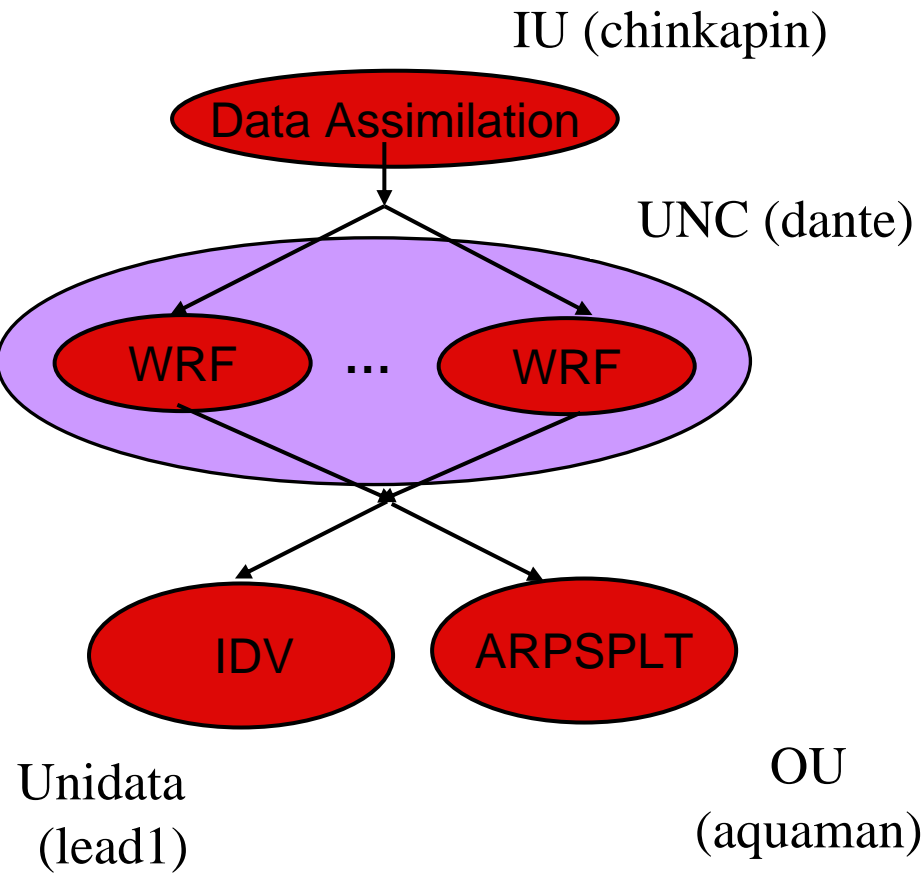
Service Oriented LEAD Workflows



Business Process Execution Language (BPEL)

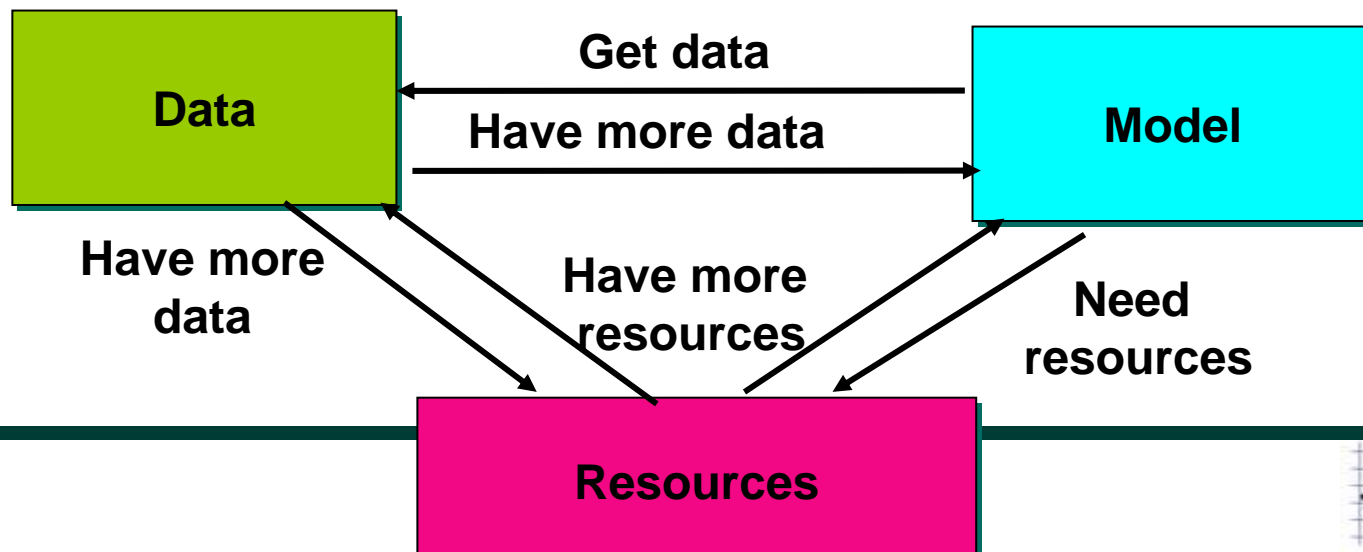
- **BPEL (aka WSBPEL and BPEL4WS)**
 - enable cross-enterprise automated business processes
 - multiple vendor participation
 - Oracle, Microsoft, IBM, SUN, SAP, BEA, EDS, Adobe, ...
 - multiple implementations
 - Oracle BPEL, IBM BPWS4J and Microsoft BizTalk Process Managers, Active BPEL (www.activebpel.org) Open Source Process Manager
- **Features**
 - loop and control logic, synchronous/asynchronous communication
 - composition and concurrent execution

LEAD Site Visit Experimental Ensemble



Characteristics of LEAD Workflows

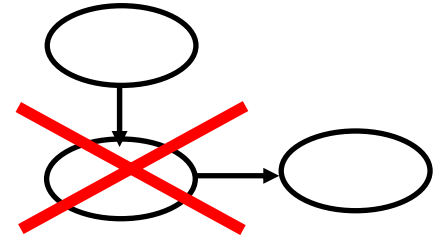
- **Coupled analysis and assimilation tools, data repositories**
 - change configuration rapidly and automatically in response to weather
 - Streaming data, steer remote observing technologies
- **Multilevel monitoring and intelligent control**
 - workflow, resource, application, service
 - performance and reliability guarantees of the resources



Adapting Workflow Structure

- **Reactive Adaptation**

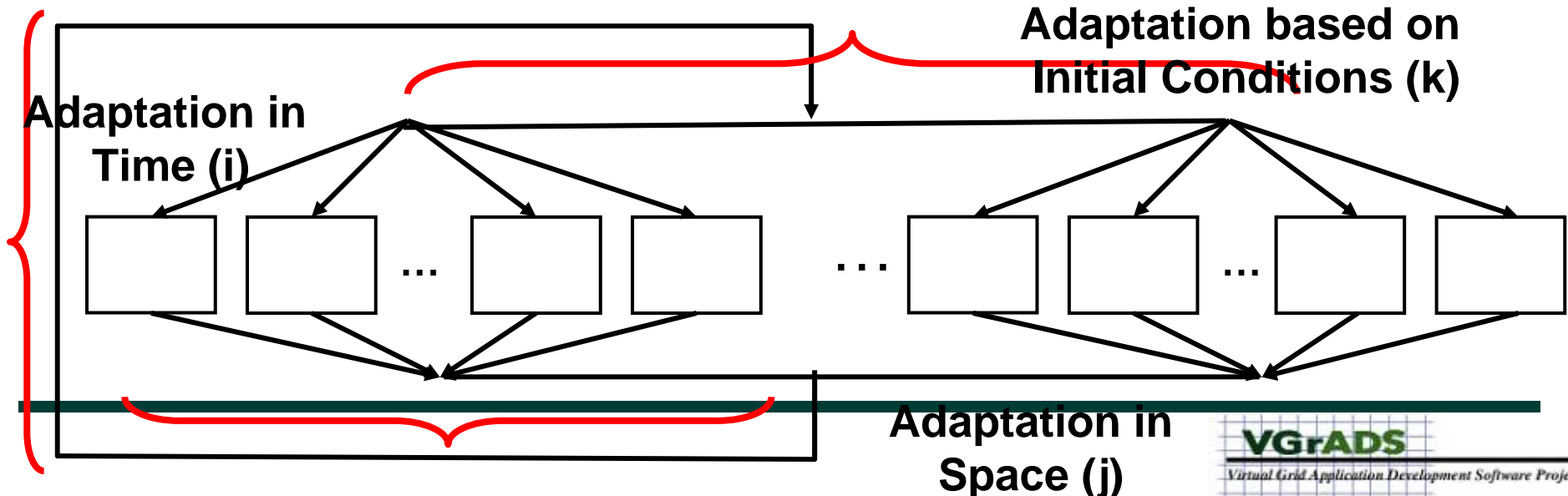
- e.g. service failure, resource behavior



- **Proactive prediction and decisions**

- adjust i , j , k (weather science meets the infrastructure science) to meet individual workflow guarantees

- global optimization of number of workflows being serviced



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LEAD Architecture

Crosscutting Services

User Interface

LEAD Portal

Desktop Applications

- IDV
- WRF Configuration GUI

Portlets

Visualization

Workflow

Education

Browse

Control

Ontology

Query

Monitor

Helper

MyLEAD

Client Interface

Configuration and Execution Services

Application Resource Broker (Scheduler)

Workflow Monitor

Stream Service

Control Service

Authorization

Application & Configuration Services

Workflow Engine/Factories

Query Service

Ontology Service

Authentication

Host Environment

Execution Description

Workflow Services

Application Host

Application Description

Decoder/Resolver Service

Transcoder Service/ESML

Data Services

Monitoring

GPIR

Geo-Reference GUI

WRF, ADaM, IDV, ADAS

Resource Cat

Catalog Services

THREDDS

Resource Access Services

Grid FTP

Scheduler

OPenDAP

Generic Ingest Service

RLS

OGSA-DAI

Notification

GRAM

SSH

LDM

Distributed Resources

Computation

- Observations
- Streams
 - Static
 - Archived

Specialized Applications

Steerable Instruments

Data Bases

Storage

LEAD Architecture

Crosscutting
Services

MyLEAD

Authorization

Authentication

Monitoring

Notification

LEAD Portal

BPEL Workflow Engine

Client Interface

Application Services (e.g. WRF, IDV, etc)

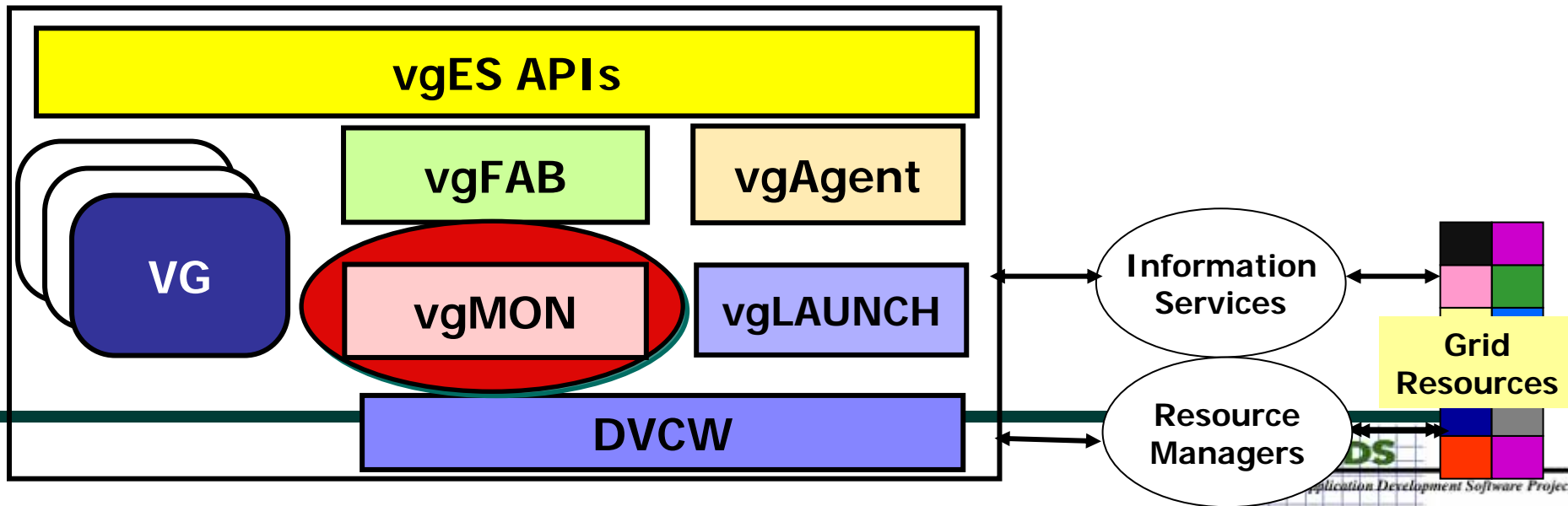
**Resource and Data Management (VGrid,
myLEAD, etc)**

**Protocols (e.g. web services, GridFTP,
Gatekeeper)**

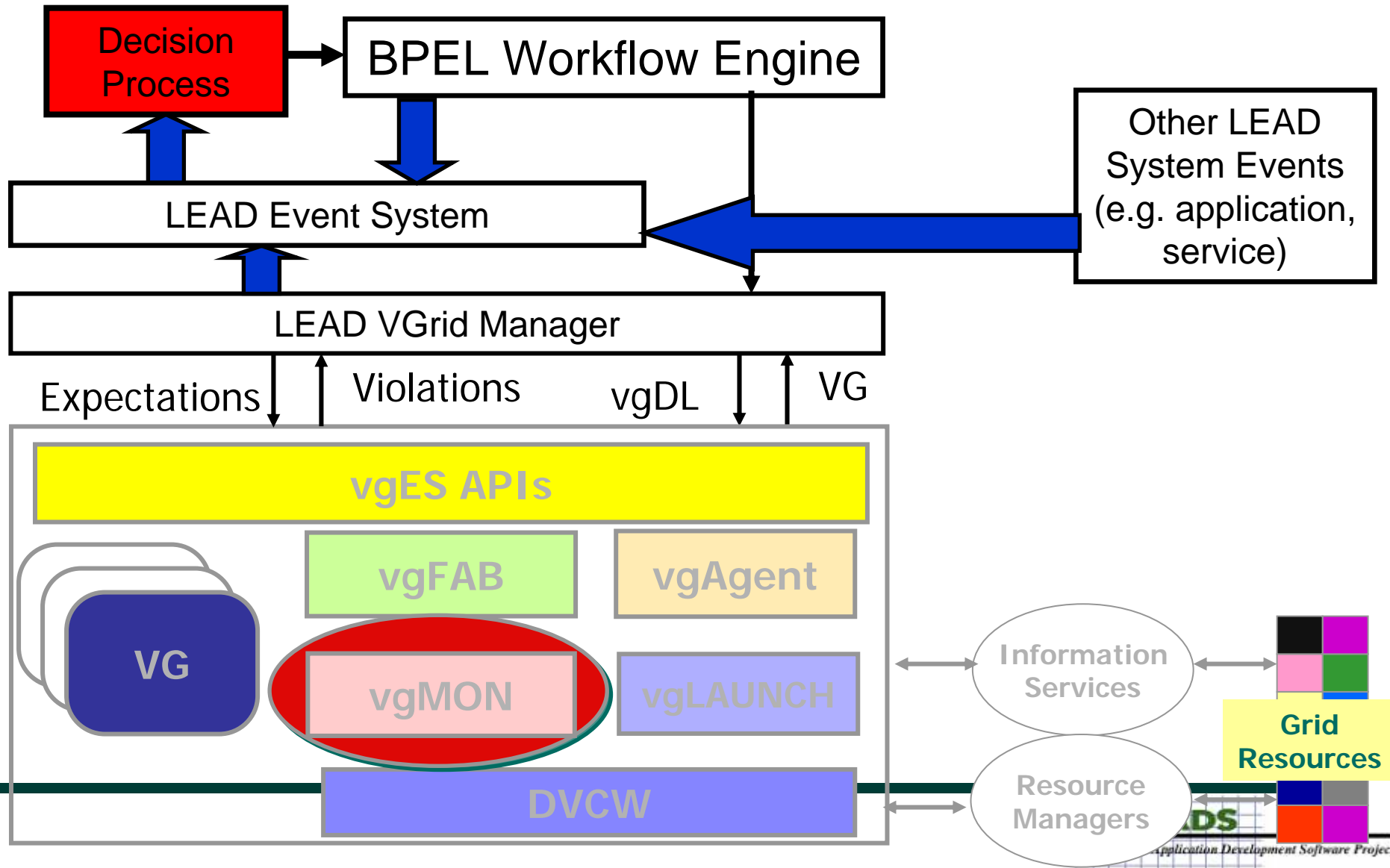
Distributed Resources (compute, disk)

Virtual Grid provides LEAD ...

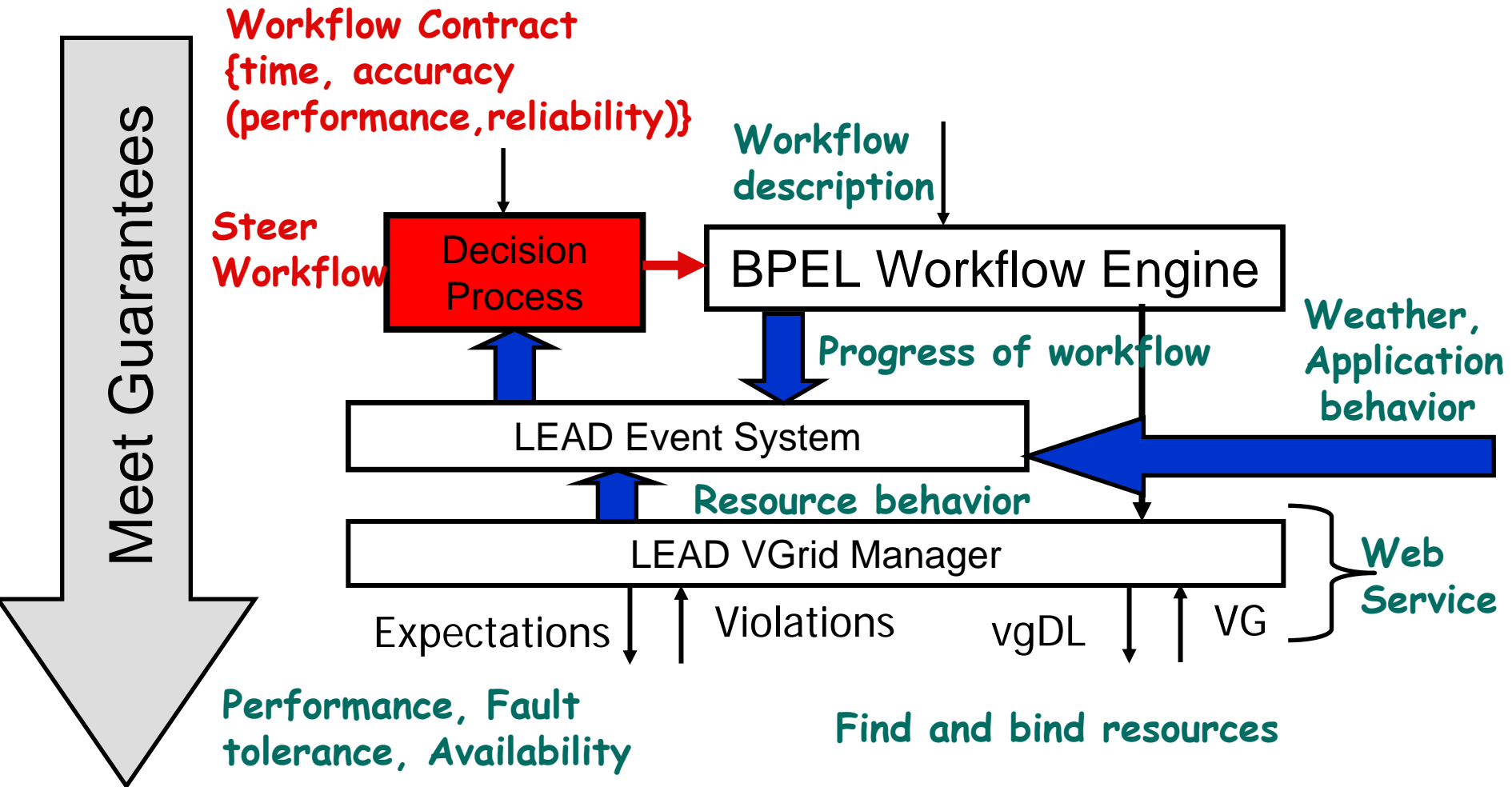
- Dynamic, scalable resource abstraction framework
 - scheduler, resource broker
- Integrated monitoring and notification of resource behavior
 - NWS, NWS-HAPI



Proposed LEAD – VGrADS Architecture



Some Thoughts ...

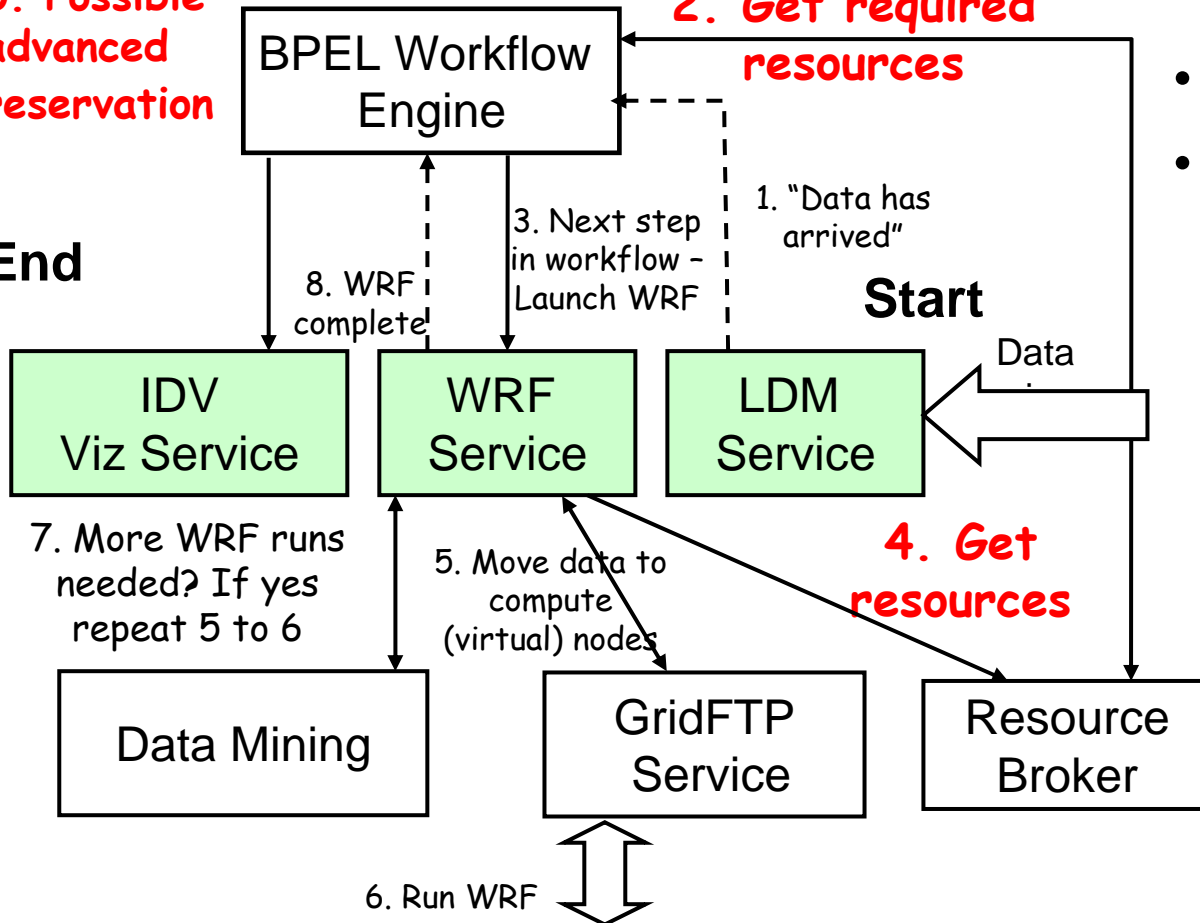


LEAD Dynamic Workflows

0. Possible advanced reservation

End

2. Get required resources



- Multilevel monitoring
- Multiple decision points
- Streaming data
 - Unidata LDM
- Service monitoring
 - web service load
- Application
 - behavior on resources
- Resource
 - performance
 - reliability

Resources - compute, network storage

vgDL Specification for LEAD

```
LEADSpec = LDMNode = {isLDMNode}
```

```
// Note the loose coupling
```

```
far WRFNode = {memory >= 500MB, cpu > 2000,  
diskspace > 4GB}
```

```
far VizNode = {memory >=4GB, cpu > 4000}
```

```
vgidLEAD = vgCreateVG(vgESsrv.renci.org, LEADspec, 1000,  
null);
```

```
vgRoot = vgGetRoot(vgidLEAD);
```

```
WRFspec = LooseBagof<C> [1:32];
```

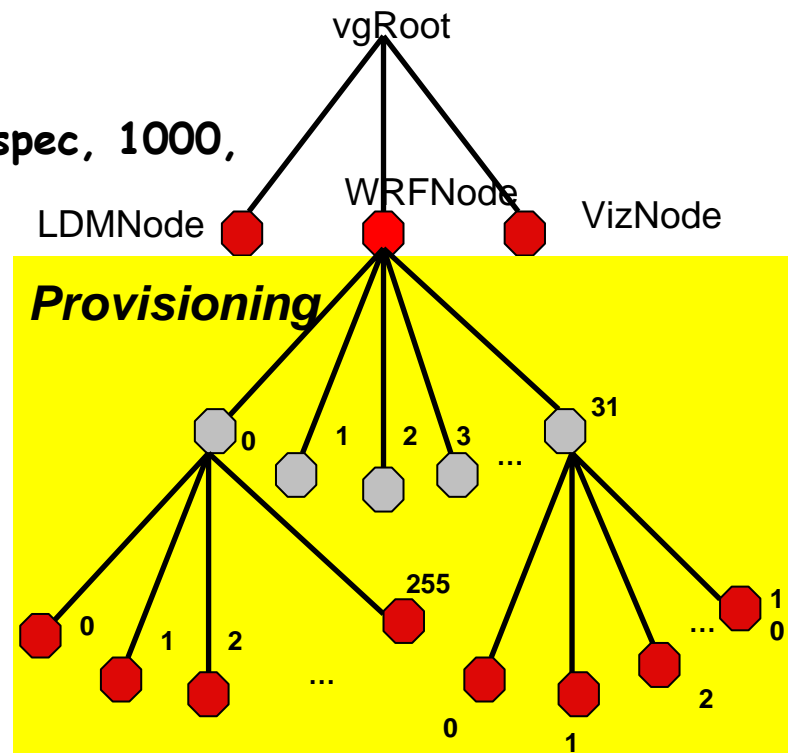
```
C = Clusterof<node>[4:256];
```

```
node = {node.memory > 500MB,  
node.cpu > 2000};
```

```
C = {C.hasSharedFileSystem = true}
```

```
vgidLEAD = vgGetMyVG(); wrfNode = vgGetMyNode();
```

```
status = vgAddToVG(vgidLEAD, WRFspec, wrfNode,1000, init_WRF);
```

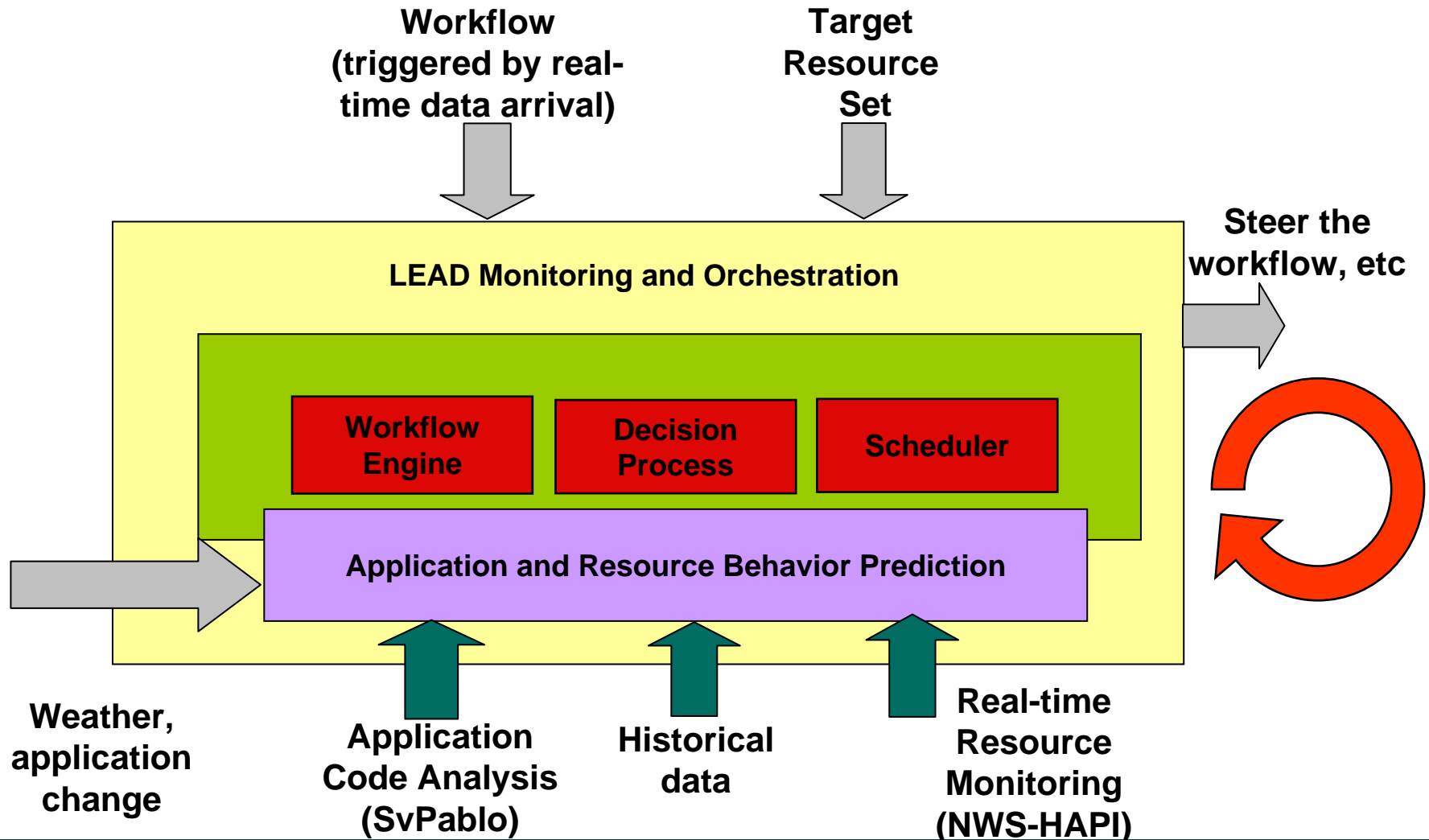


LEAD Virtual Grid Research Implications

- **Streaming data in resource scheduling**
 - fixed point makes scheduling complicated
- **Persistent and transient services**
 - service directory, monitoring, scheduling
- **Data management across the virtual grid**
 - run time knowledge of data location
- **Integrated decision process**
 - performance and reliability guarantees
 - application, weather

Comments?

LEAD Monitoring Architecture



LEAD Control and Data Flow

LEGEND

