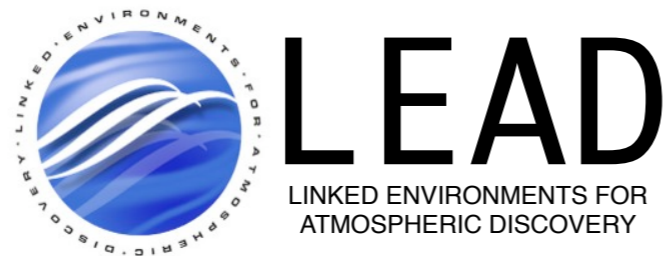


# Fault-Tolerance and Recovery for Large-Scale Scientific Workflows Using Qualitative Performance Analysis

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Emma Buneci, Gopi Kandaswamy, Anirban Mandal

SC '07 Demo



# Presentation Outline

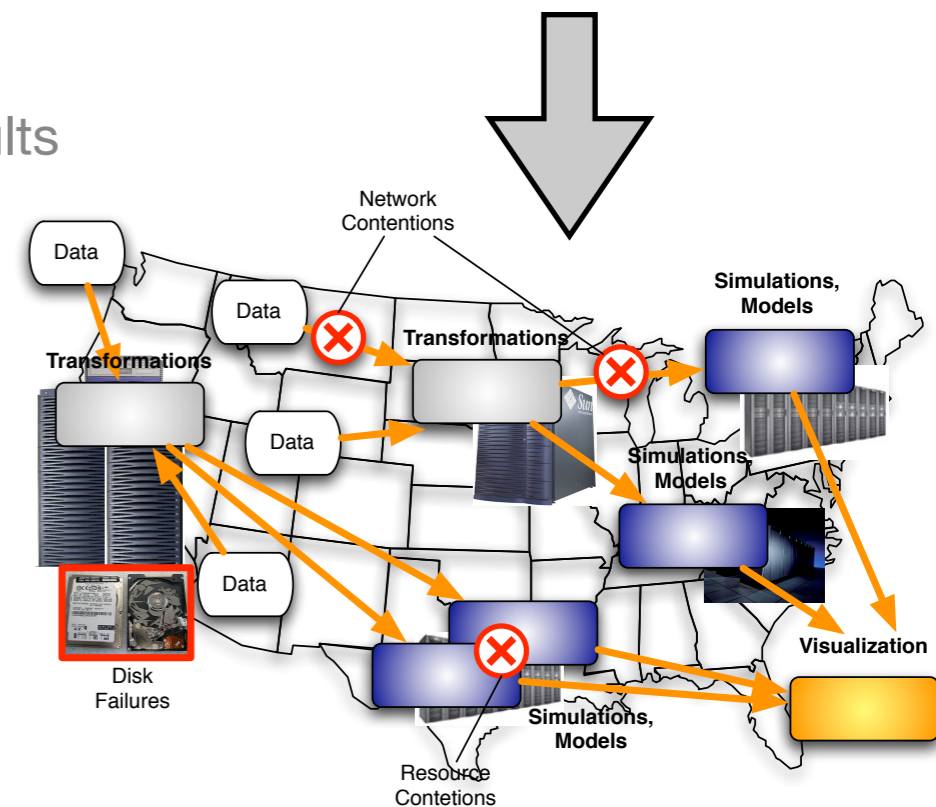
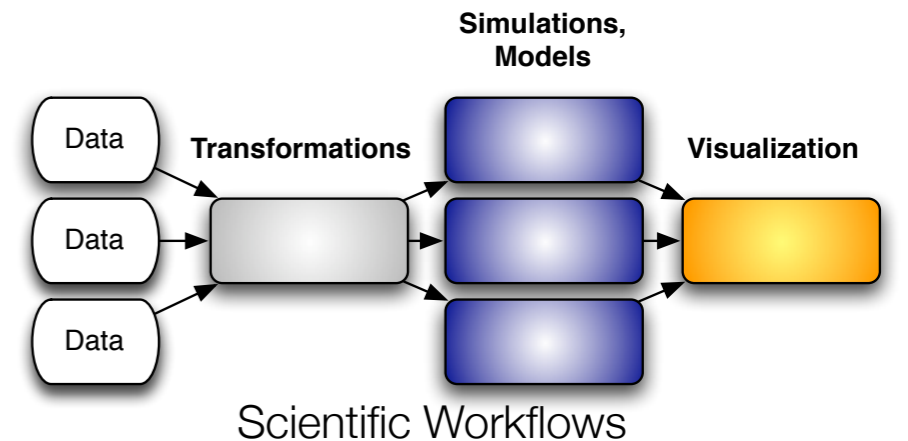
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- Motivation and Problem Statement
- Fault Tolerance and Recovery Service
- Qualitative Performance Analysis Service
- Integration for Workflow QoS
- Demonstration



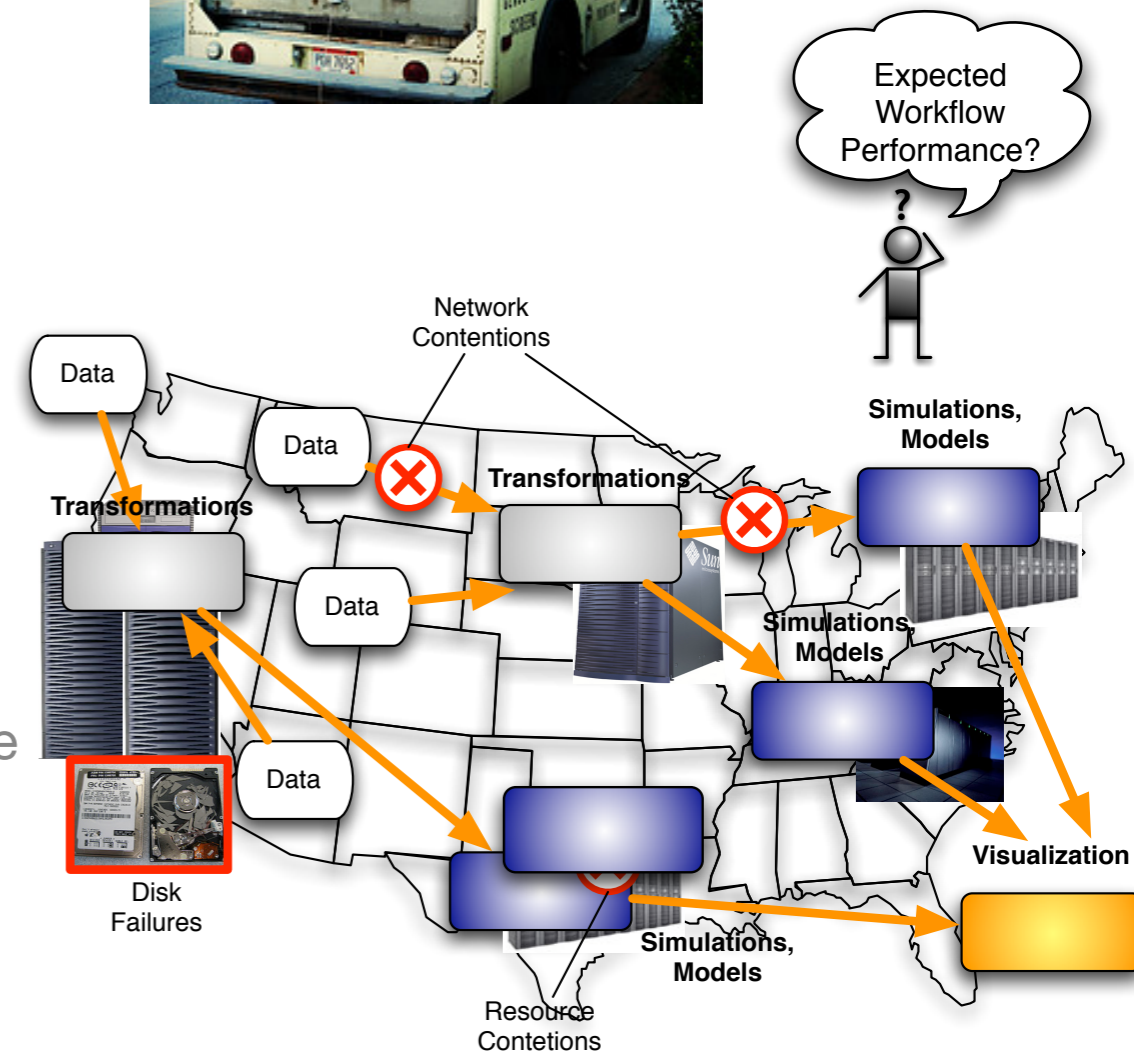
# Scientific Workflows & Distributed Environments

- Large, complex workflows are sensitive to failures
  - Faults are the norm, rather than exceptions
    - distributed systems, services and resources
  - Completion “guarantees” are problematic
    - Workflow completion is probabilistic in the presence of faults
- Many time-critical workflows are deadline driven
  - Severe weather events, disaster response, ...



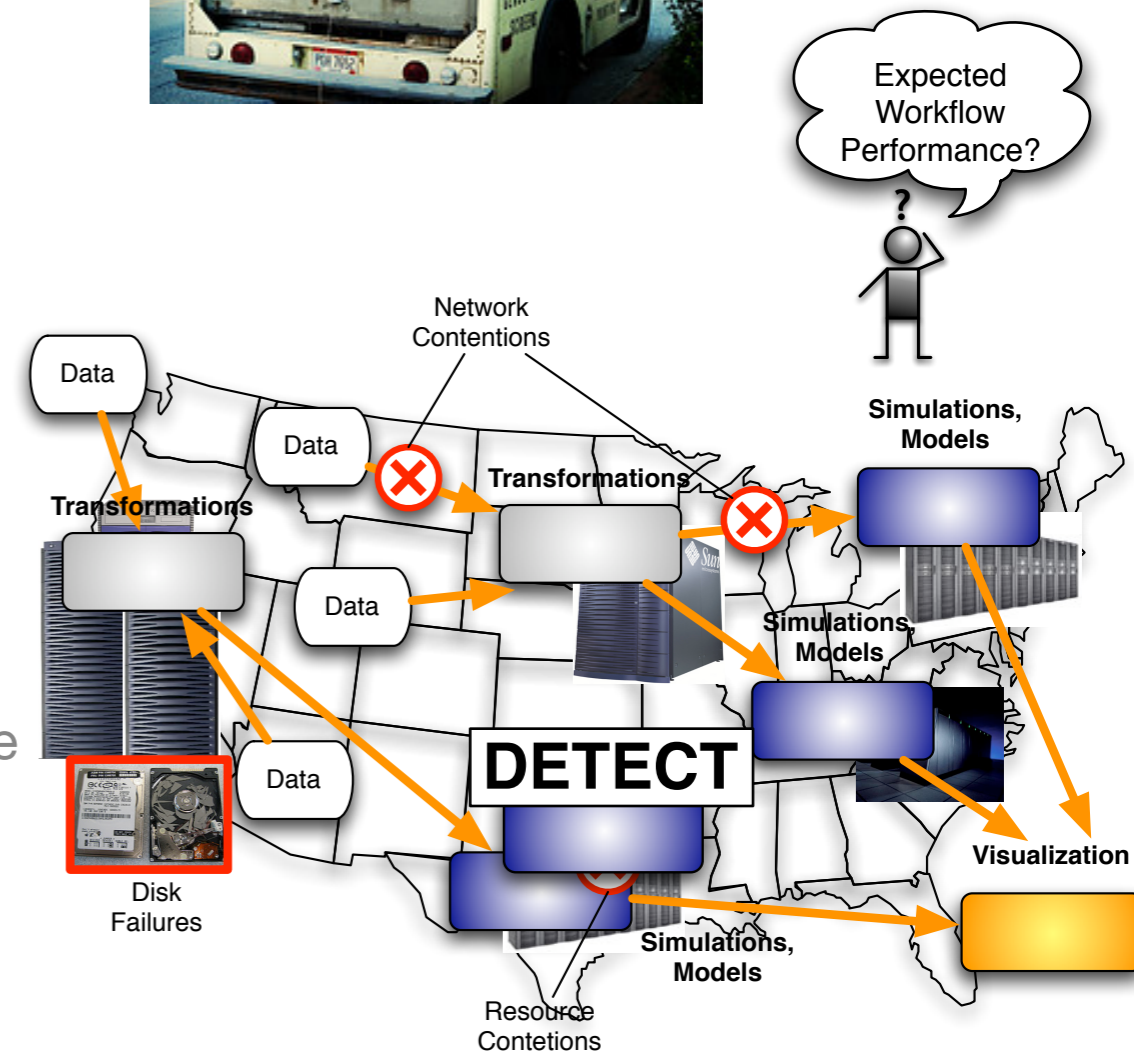
# Problem Statement

- Need
  - Fault-tolerant scientific workflows
- Approach
  - Qualitative performance analysis over time
    - Behavioral validation
    - Behavioral diagnosis
  - Fault-tolerance & recovery policies
    - Triggered as directed by qualitative analysis engine
    - Over-provisioning, simple restart or migration



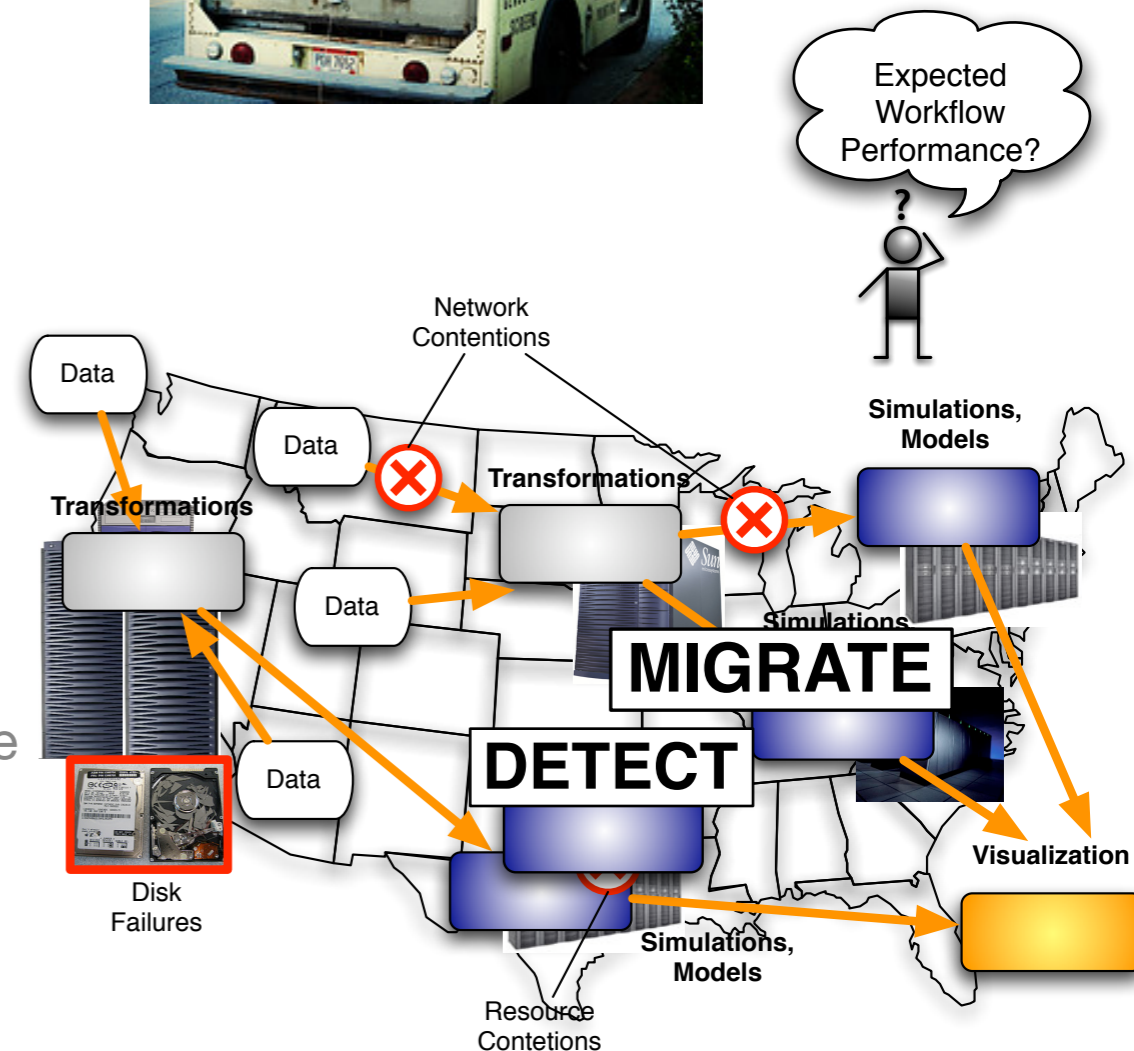
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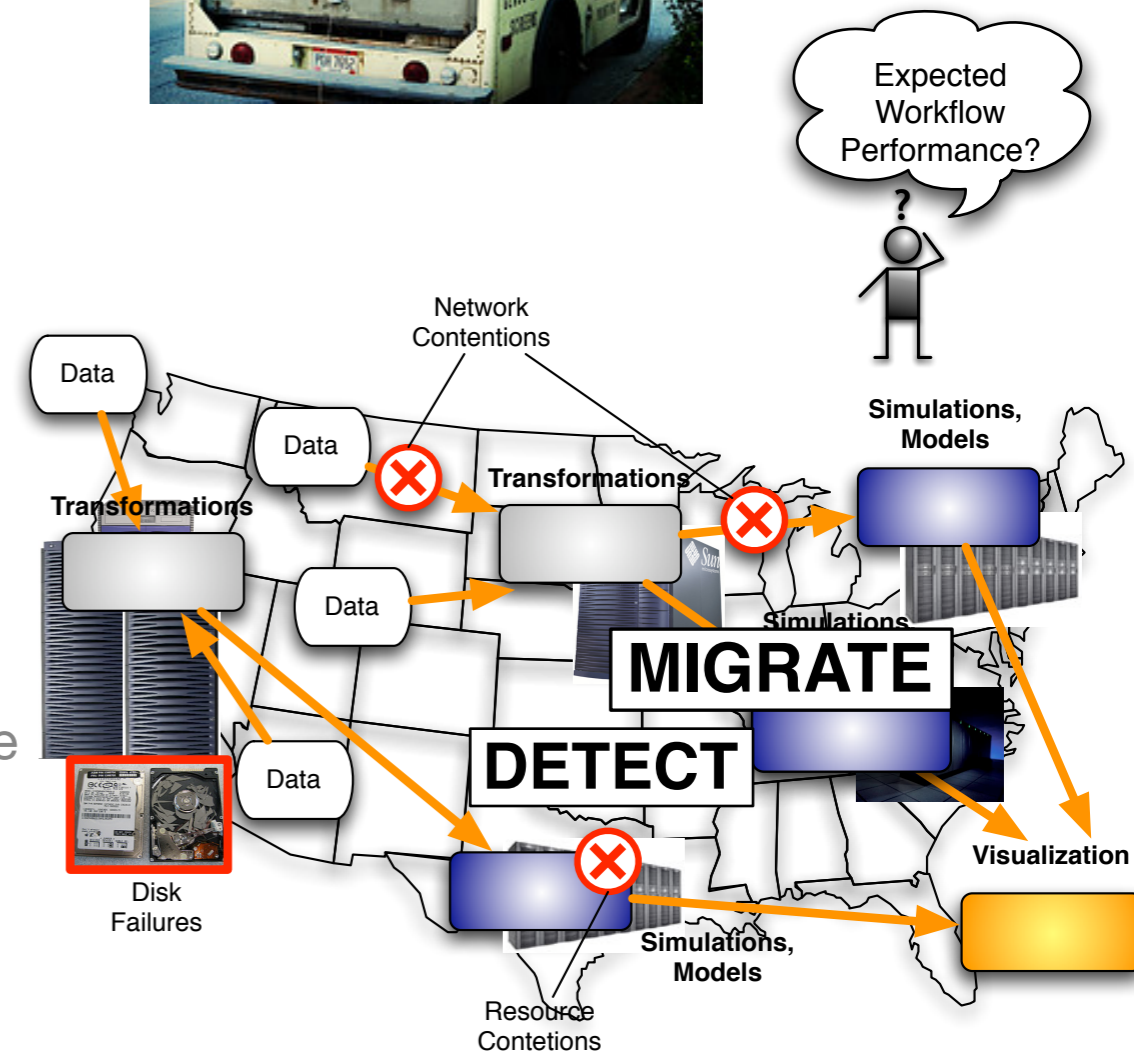
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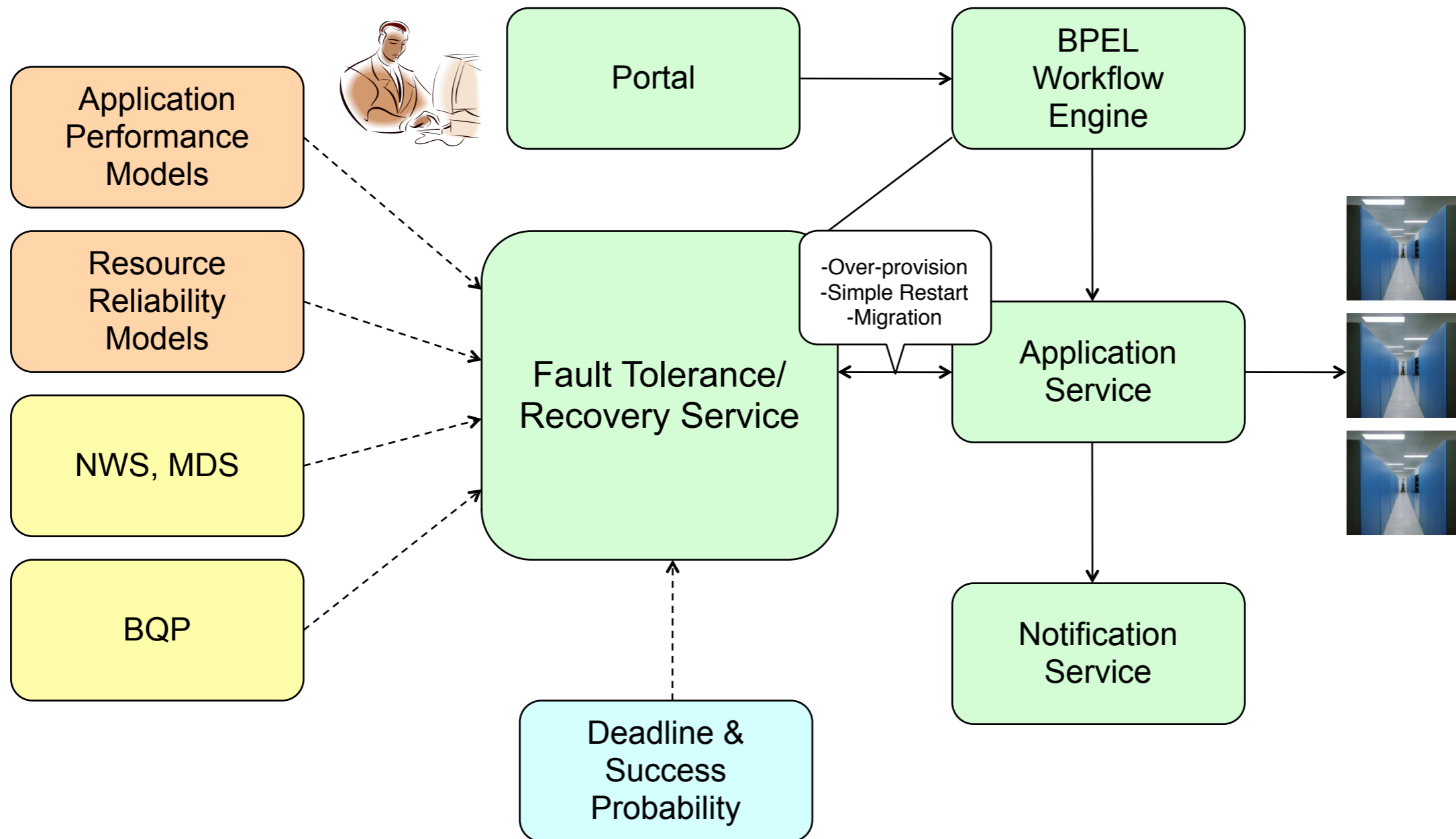


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# Fault Tolerance & Recovery (FTR) Service

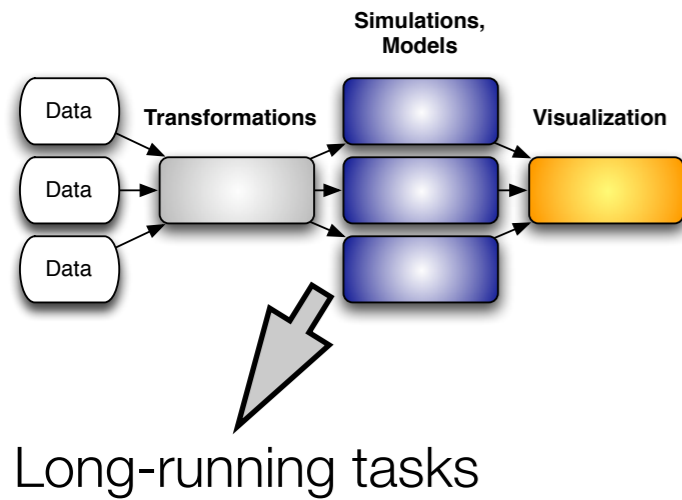


# Qualitative Performance Analysis (QPA) Service

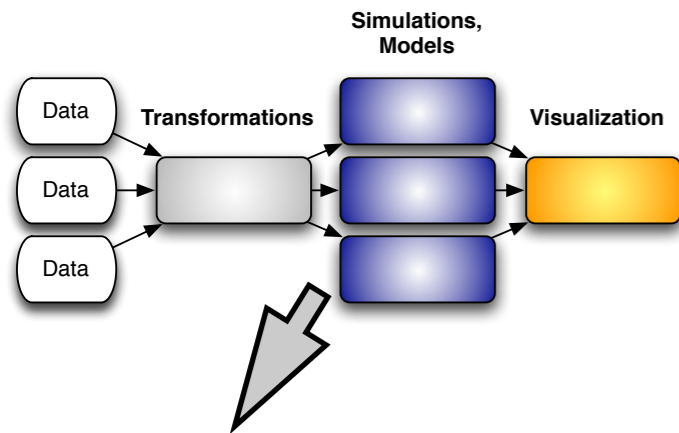
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# Qualitative Performance Analysis (QPA) Service

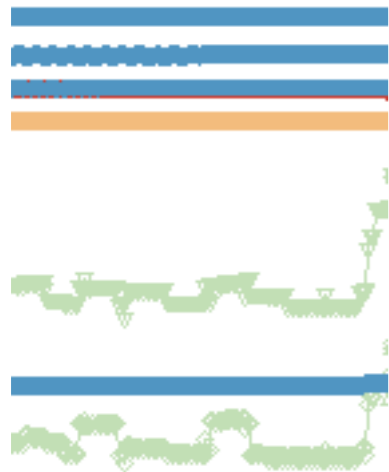
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# Qualitative Performance Analysis (QPA) Service

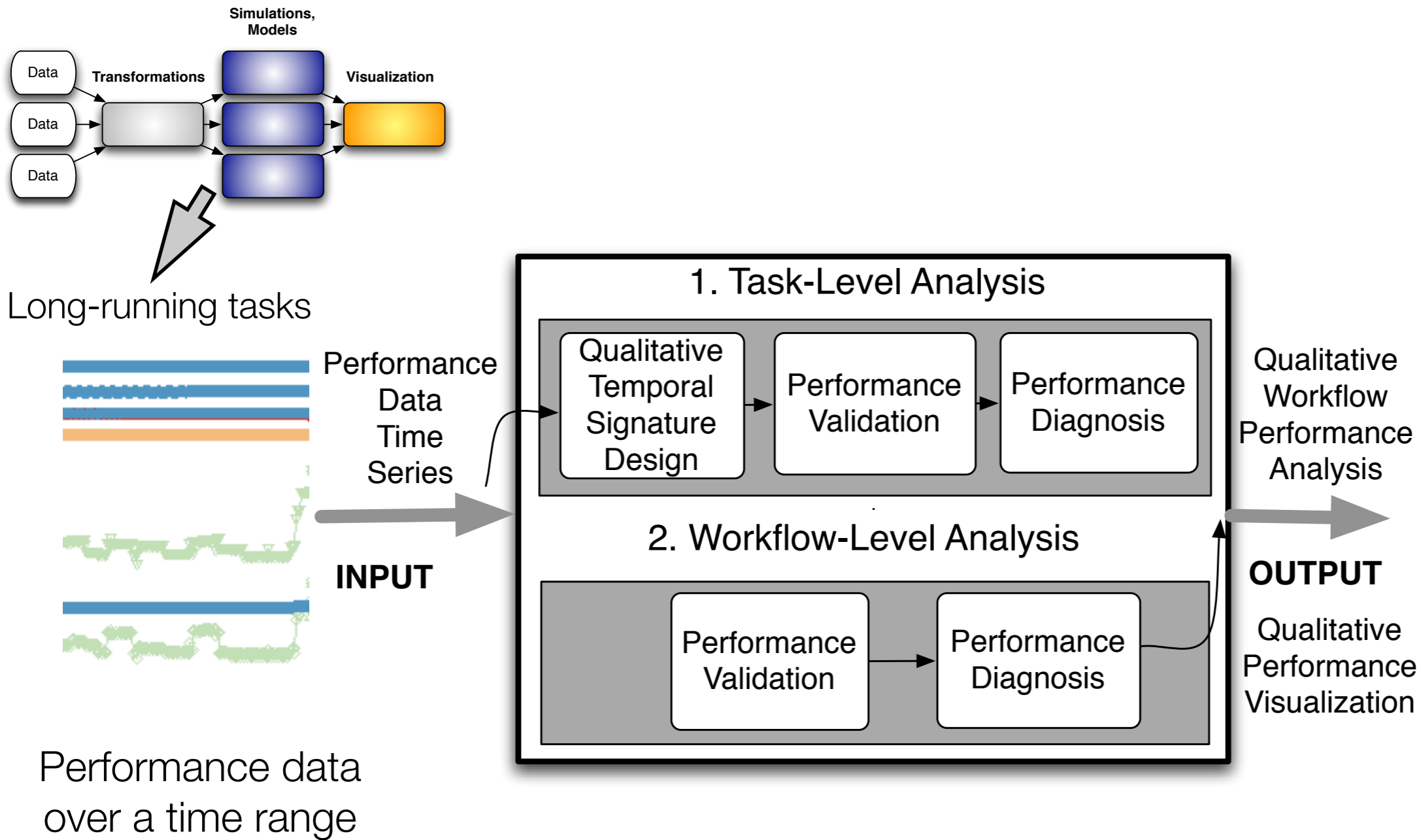


Long-running tasks

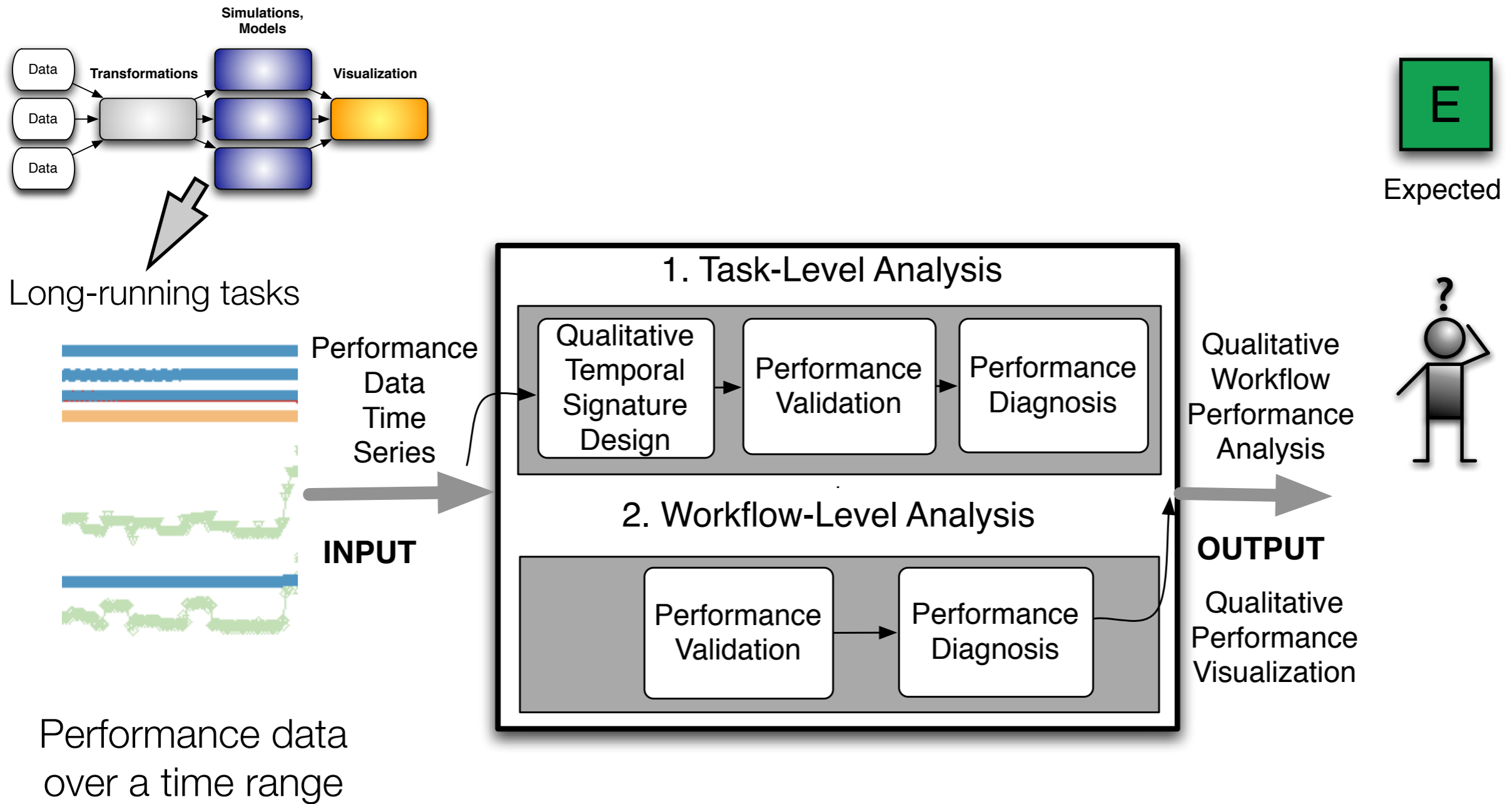


Performance data  
over a time range

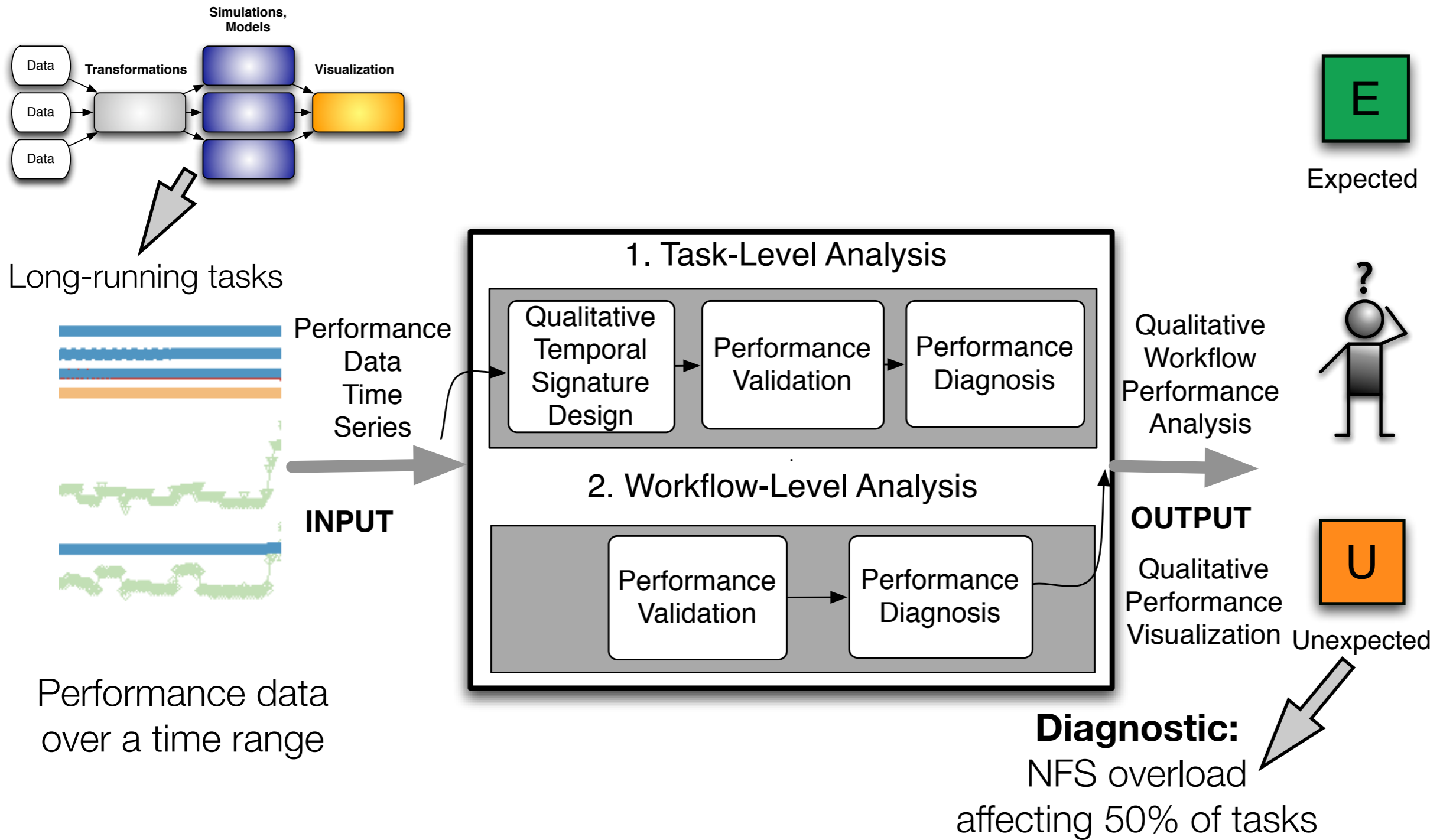
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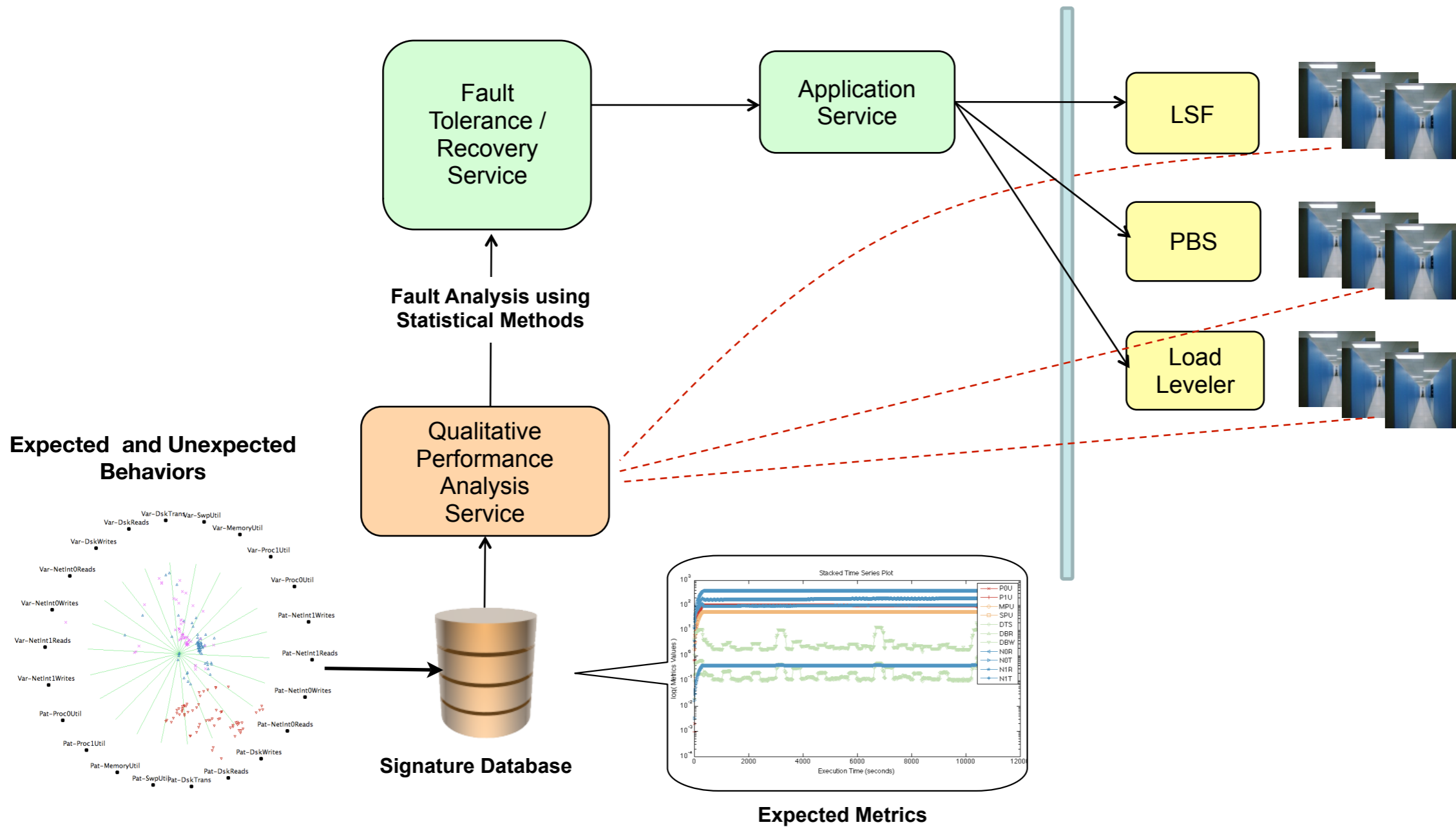
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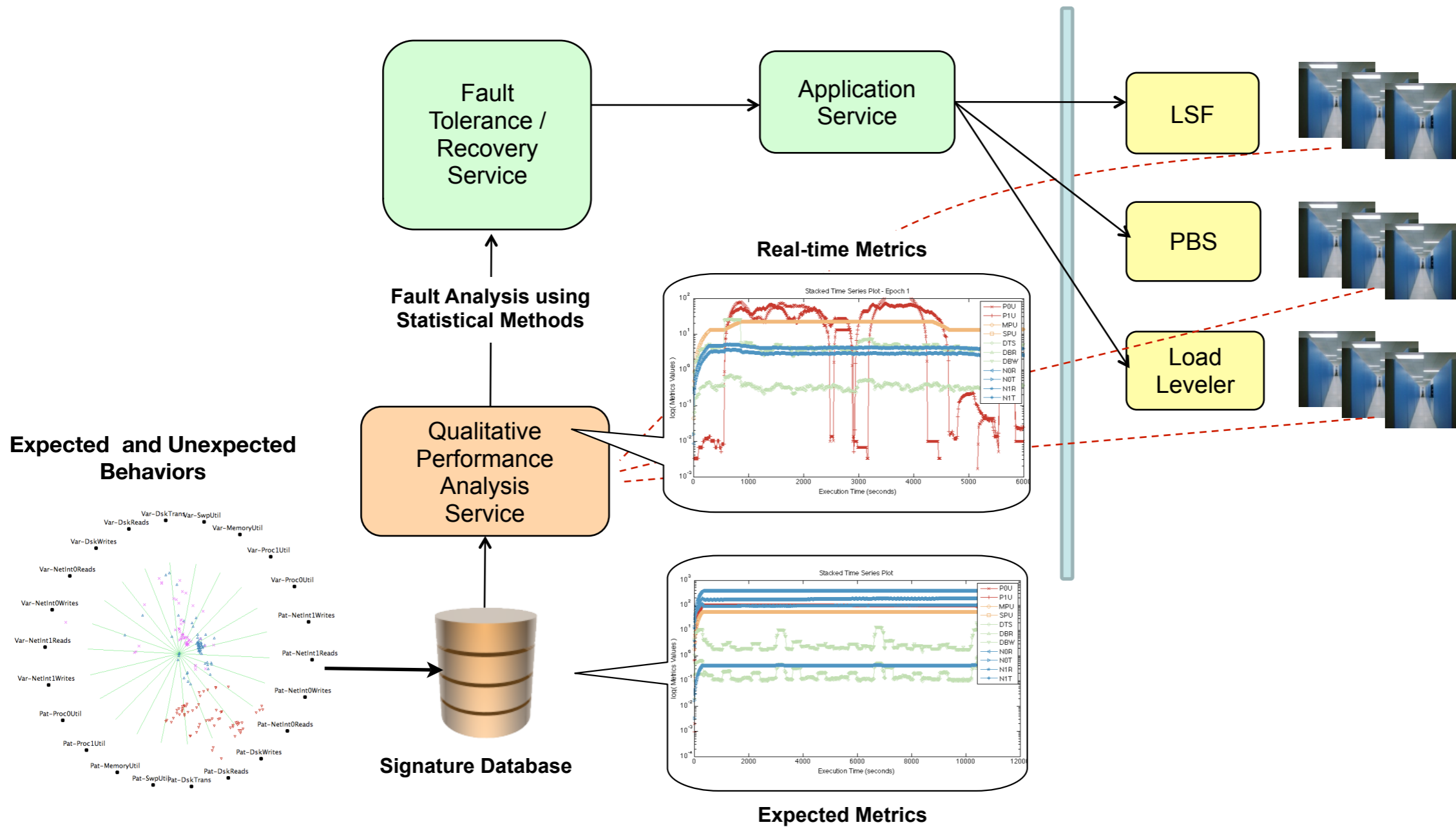
# Qualitative Performance Analysis (QPA) Service



# FTR & QPA Services: Scientific Workflows QoS



# FTR & QPA Services: Scientific Workflows QoS



# Performance Monitoring of Workflows

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# Performance Monitoring of Workflows

Instance of NAM Initialized WRF V2.2 Forecast (test1) - NAM Initialized WRF V2.2 Forecast (test1)

Workflow File BPEL MyLead Component Monitor MyProxy Help

Add Node Remove Node Connect/Disconnect

WRF V2.2 Model Running

bigred.iu.teragrid.org/1

WRF Forecast V2\_2 Model

grid-w.ncsa.teragrid.org/1

NAM Initial Conditions V5\_2\_7 Interpolator

grid-w.ncsa.teragrid.org/1

ARPS2WRF V5\_2\_7 Interpolator

grid.org/1

in\_V5\_2\_7\_Preprocessor

grid-w.ncsa.teragrid.org/1

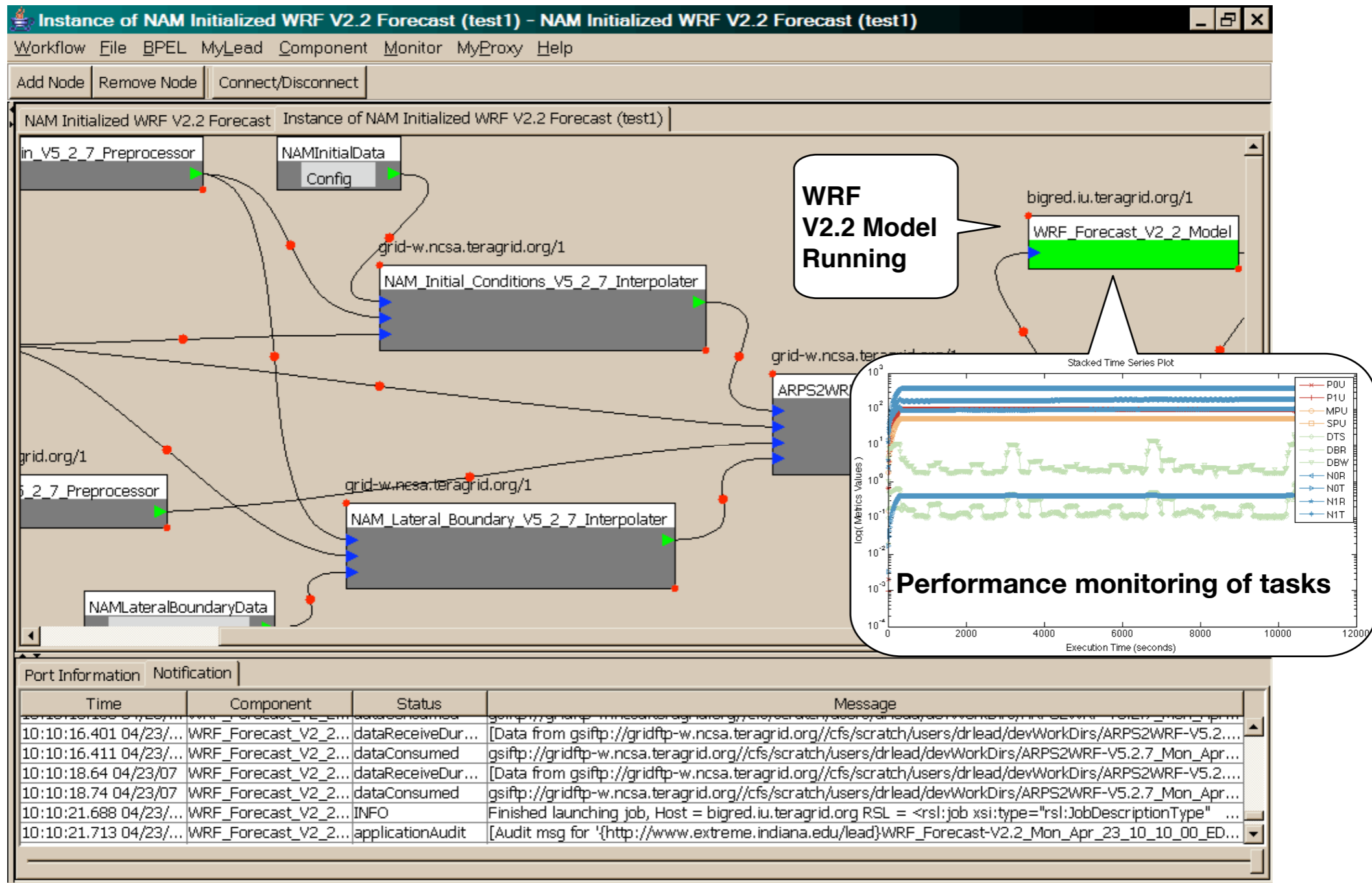
NAM Lateral Boundary V5\_2\_7 Interpolator

NAMLateralBoundaryData

Port Information Notification

Time	Component	Status	Message
10:10:16.401 04/23/...	WRF_Forecast_V2_2...	dataReceiveDur...	[Data from gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2...
10:10:16.411 04/23/...	WRF_Forecast_V2_2...	dataConsumed	gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2.7_Mon_Apr...
10:10:18.64 04/23/07	WRF_Forecast_V2_2...	dataReceiveDur...	[Data from gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2...
10:10:18.74 04/23/07	WRF_Forecast_V2_2...	dataConsumed	gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2.7_Mon_Apr...
10:10:21.688 04/23/...	WRF_Forecast_V2_2...	INFO	Finished launching job, Host = bigred.iu.teragrid.org RSL = <rsl:job xsi:type="rsl:JobDescriptionType" ...
10:10:21.713 04/23/...	WRF_Forecast_V2_2...	applicationAudit	[Audit msg for '{http://www.extreme.indiana.edu/lead}WRF_Forecast-V2.2_Mon_Apr_23_10_10_00_ED...

# Performance Monitoring of Workflows



# Performance Monitoring of Workflows

**Global Performance Status**  
 LAST UPDATED: Monday, 11:03:27 EST 2007

	<b>E</b>	<b>U</b>	<b>F</b>	<b>?</b>	<b>TOTAL</b>
Total Tasks	254	1	0	1	256

**WRF V2.2 Model Running**

**Performance monitoring of tasks**

**Stacked Time Series Plot**

log(Metrics Values)

Execution Time (seconds)

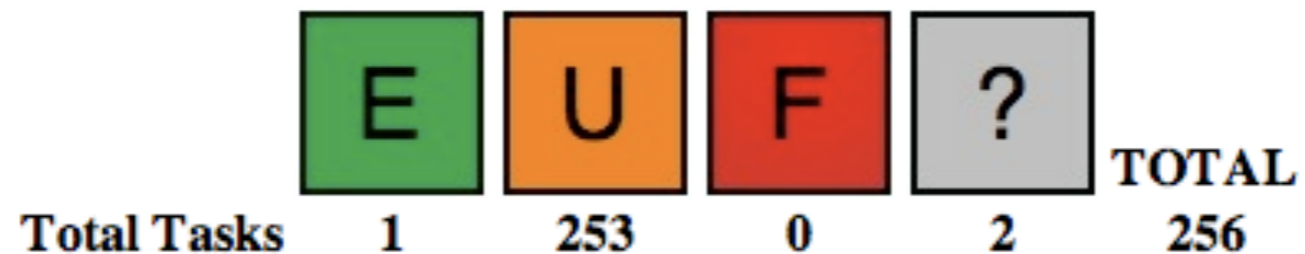
Time	Component	Status	Message
10:10:16.401 04/23/...	WRF_Forecast_V2_2...	dataReceiveDur...	[Data from gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2...
10:10:16.411 04/23/...	WRF_Forecast_V2_2...	dataConsumed	gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2.7_Mon_Apr...
10:10:18.64 04/23/07	WRF_Forecast_V2_2...	dataReceiveDur...	[Data from gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2...
10:10:18.74 04/23/07	WRF_Forecast_V2_2...	dataConsumed	gsiftp://gridftp-w.ncsa.teragrid.org/cfs/scratch/users/drlead/devWorkDirs/ARPS2WRF-V5.2.7_Mon_Apr...
10:10:21.688 04/23/...	WRF_Forecast_V2_2...	INFO	Finished launching job, Host = bigred.iu.teragrid.org RSL = <rsl:job xsi:type="rsl:JobDescriptionType" ...
10:10:21.713 04/23/...	WRF_Forecast_V2_2...	applicationAudit	[Audit msg for '{http://www.extreme.indiana.edu/lead}WRF_Forecast-V2.2_Mon_Apr_23_10_10_00_ED...



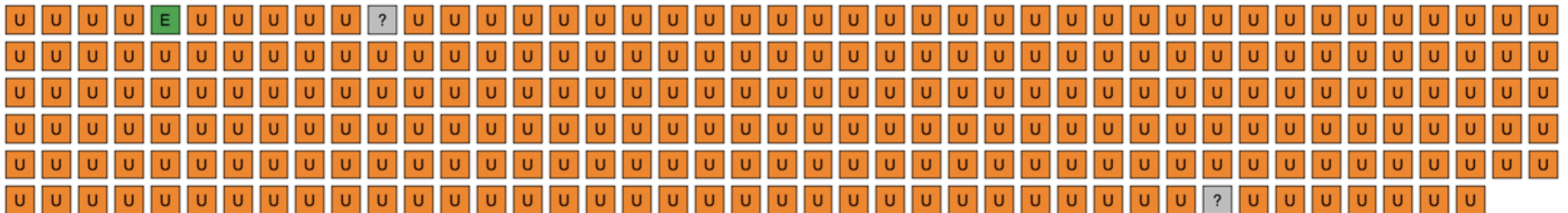
# Workflow Behavioral Diagnosis

## Global Performance Status

LAST UPDATED: Monday, 12:03:27 EST 2007

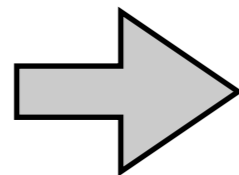


### All Tasks ( 256 )



Failed Status Tasks ( 0 )

Unexpected Status Tasks ( 253 )



Unexpected Possible Diagnosis:

\* NFS Overload: 253 Tasks

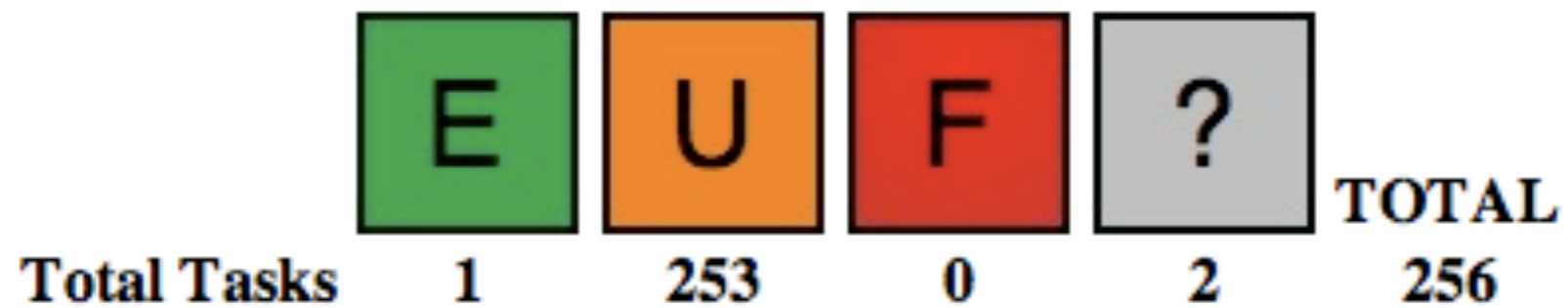
# Policies for Triggering Fault-tolerance & Recovery

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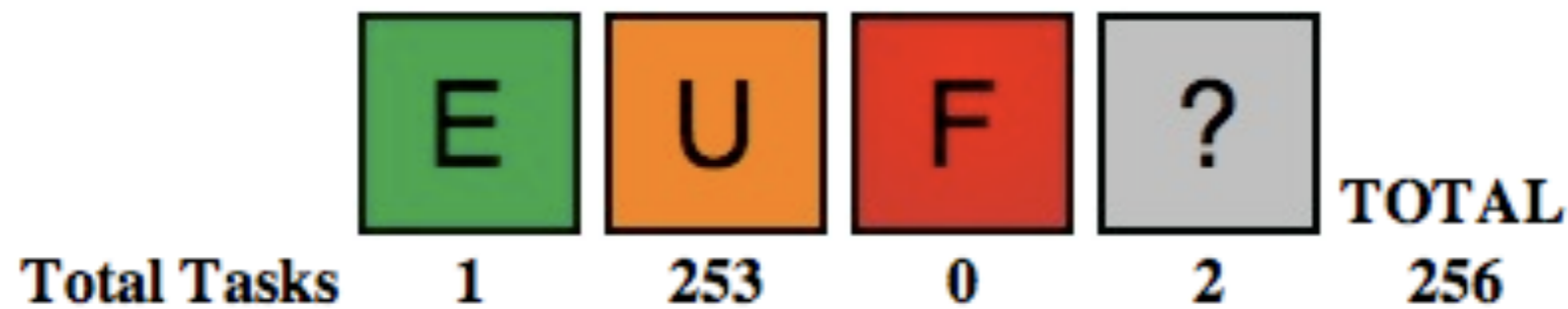
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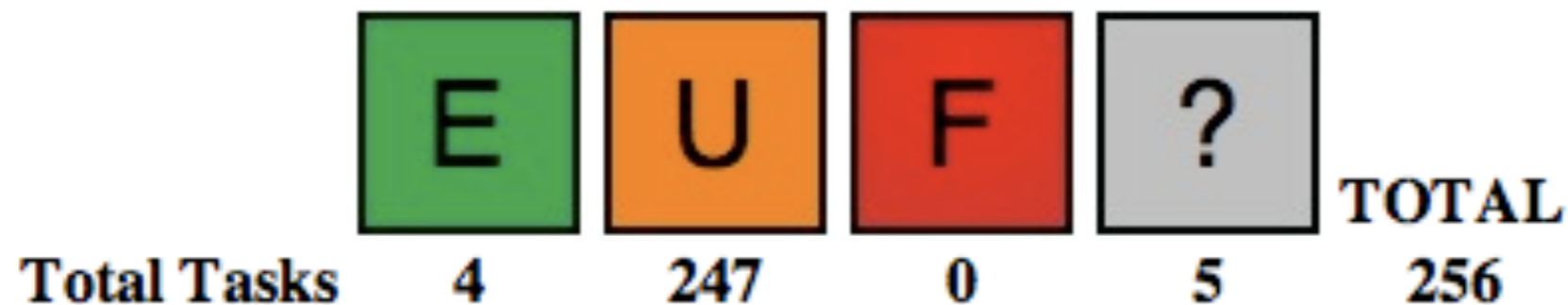
# Policies for Triggering Fault-tolerance & Recovery

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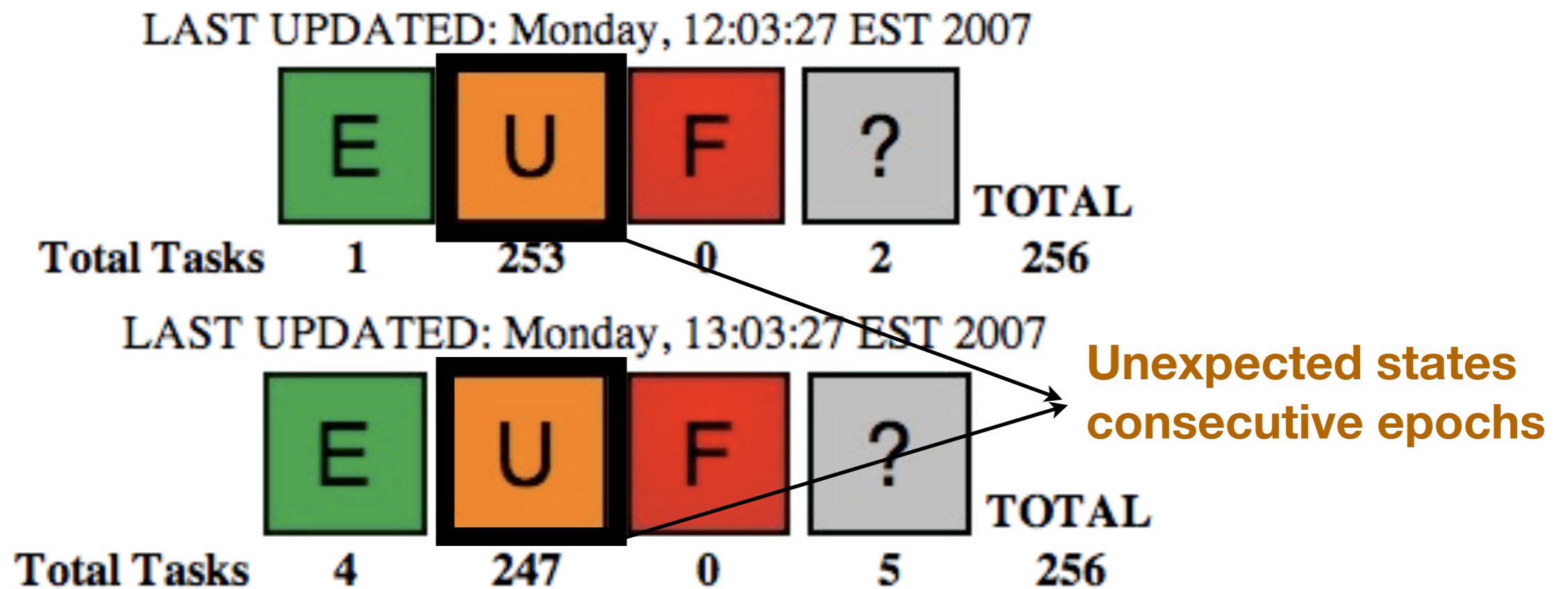
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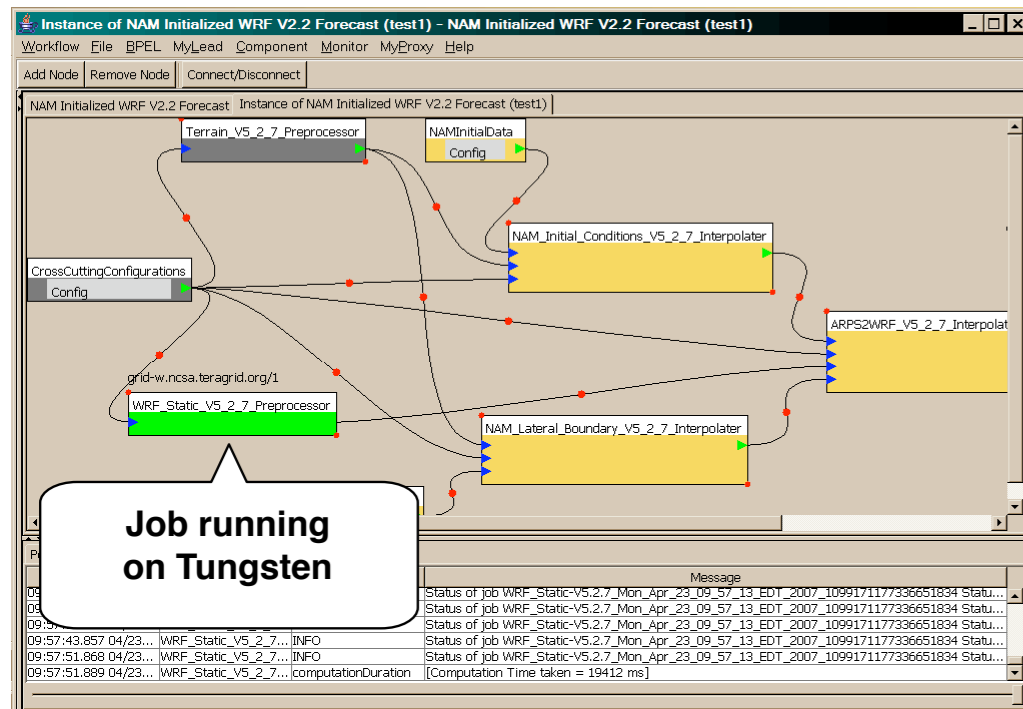
# Policies for Triggering Fault-tolerance & Recovery



# Dynamic Job Migration

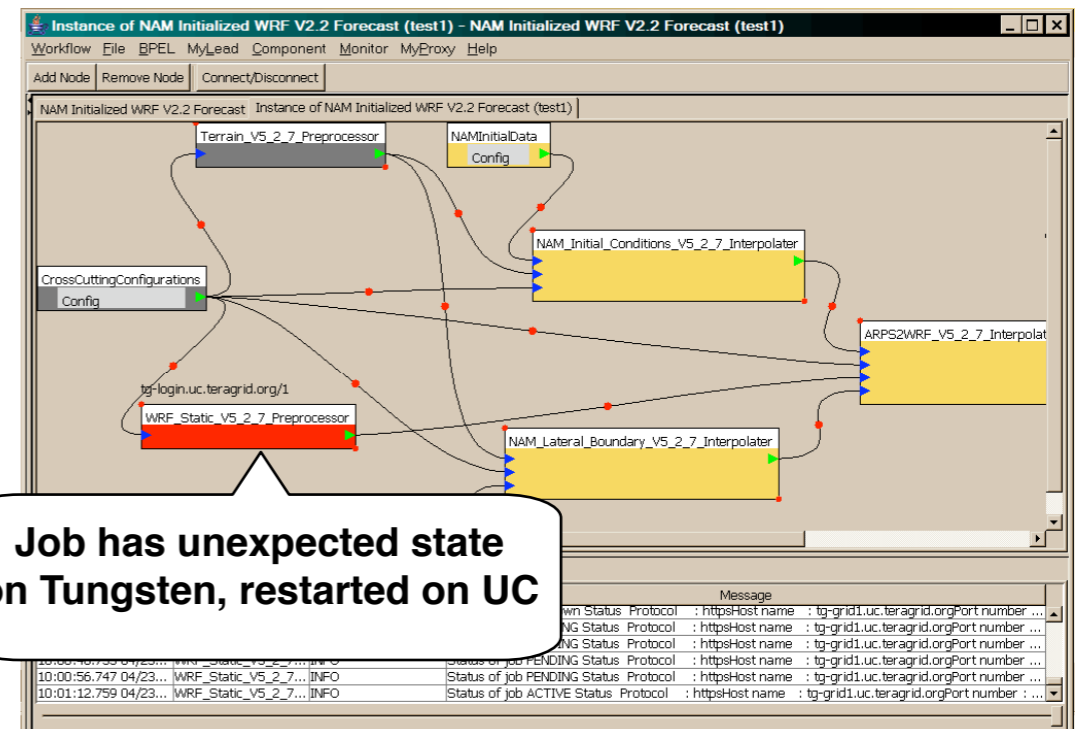
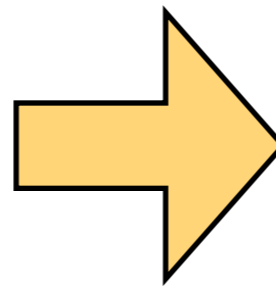
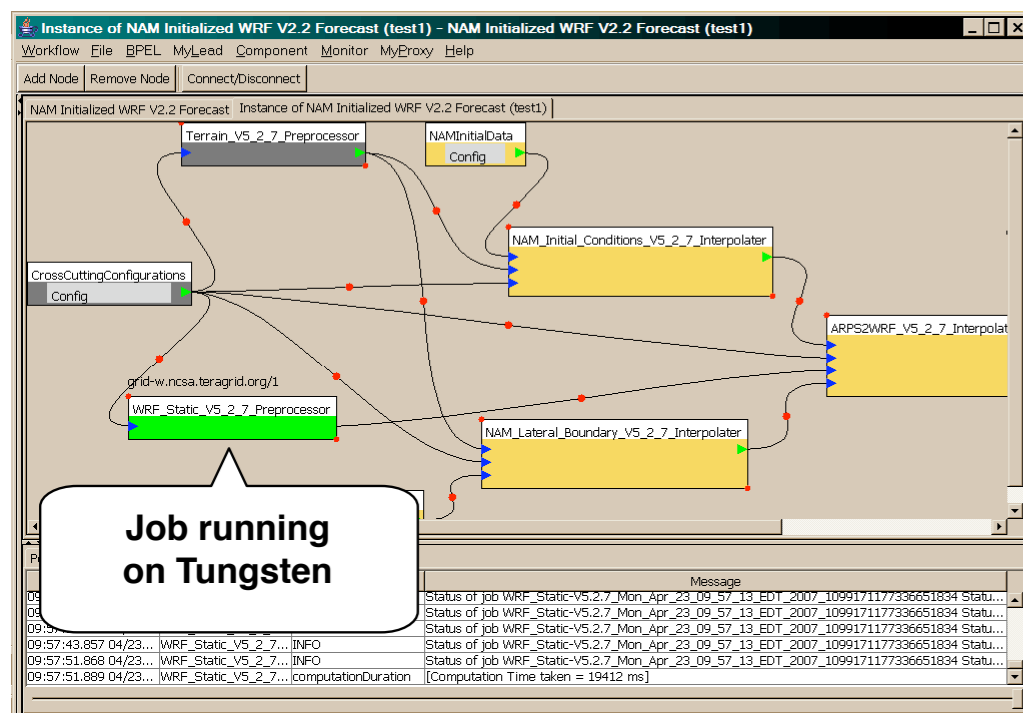
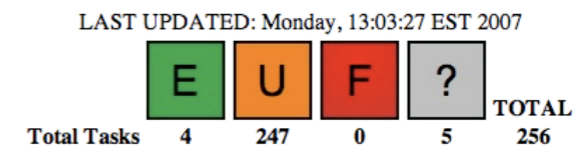
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# Dynamic Job Migration

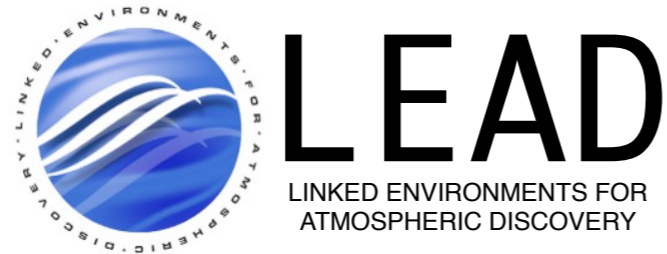


# Dynamic Job Migration

## FTR rescheduling when unexpected state detected



# A c k n o w l e d g m e n t s



T h a n k   y o u   f o r   y o u r   a t t e n t i o n !