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Forecasting Performance Metrics using the IBM Tivoli Performance Analyzer

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Abstract

The IBM Tivoli Performance Analyzer (ITPA) is a component of the IBM Tivoli Monitoring Infrastructure that analyzes data stored in the Tivoli Data Warehouse to forecast future trends and values, using both linear and non-linear forecasting models. This session walks through the technical installation and usage of ITPA for both product provided and custom data forecasting, and shows how it can be applied against both z/OS and distributed data to aid performance and capacity planning efforts.

Agenda

- IBM Tivoli Performance Analyzer (ITPA) overview and architecture
- Solution requirements and implementation
- Solution usage
  - Product provided
  - Custom forecasts
  - Report examples

Overview and Architecture

What is the IBM Tivoli Performance Analyzer (ITPA)?

- A component included in IBM Tivoli Monitoring (ITM) version 6.23 and later that provides predictive capabilities
- Analytic engine for linear and nonlinear forecasting and basic transformation analysis
- Produces short, medium and long term forecasts
- Uses the Tivoli Enterprise Portal (TEP) interface for
  - Creating and modifying analytical tasks
  - Defining trending/forecasting for any metrics stored in the ITM Tivoli Data Warehouse (TDW)
- Provides workspaces, tasks situations, and Tivoli Common Reporting (TCR) reports

Uses of ITPA

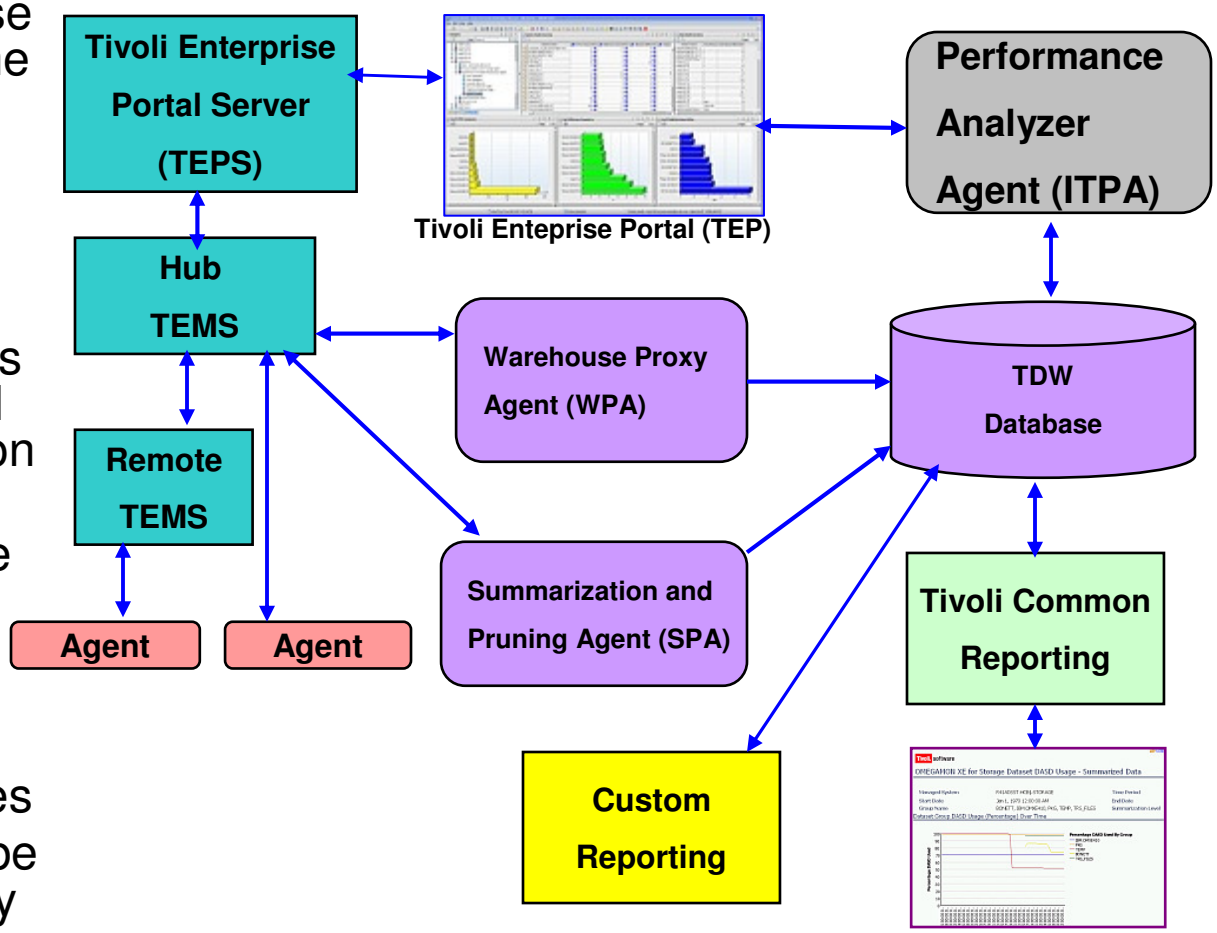
- To forecast data to determine future resource usage
  - Example: what is the expected CPU trend for a virtualization host?
- To estimate when warning or critical thresholds may occur in the future
  - Example: How many days until workload throughput hits a constraint level
- To calculate new metrics not directly provided by an agent
  - Example: new metric = metric1/metric2
- To determine if a linear or non-linear forecasting best matches a monitored metric

ITPA Requirements

- Provided in ITM 6.23 and later
  - 6.23 fp1 required for non-linear forecasting (also requires IBM SPSS Statistics Server)
- Execution platform: Linux Intel, Windows, AIX
  - If SPSS is used, it must be installed on same system
- Tivoli Data Warehouse enabled
- Historical collection active for desired metrics
  - Predefined forecasting provided by ITPA
    - Operating System (Unix, Linux, Windows)
    - DB2 (distributed)
    - Oracle
    - IBM Composite Application Management (ITCAM) Response Time
    - VMware
    - pSeries
  - Any metric provided by any agent (requires custom built forecast model)
- Optional
  - Tivoli Common Reporting (reports provided)

Architecture

1. Agents enabled for historical collection notify a Warehouse Proxy Agent (WPA) when the data is to be offloaded.
2. The WPA obtains data from agent and stores into the TDW.
3. The Summarization and Pruning Agent (SPA) creates summarization tables based on the desired summarization level(s).
4. ITPA analyzes data from the appropriate warehouse summarization tables and creates forecasts.
5. The forecast results are displayed in TEP workspaces
6. The forecasted results can be stored in the TDW for use by Tivoli Common Reporting or a custom reporting mechanism.

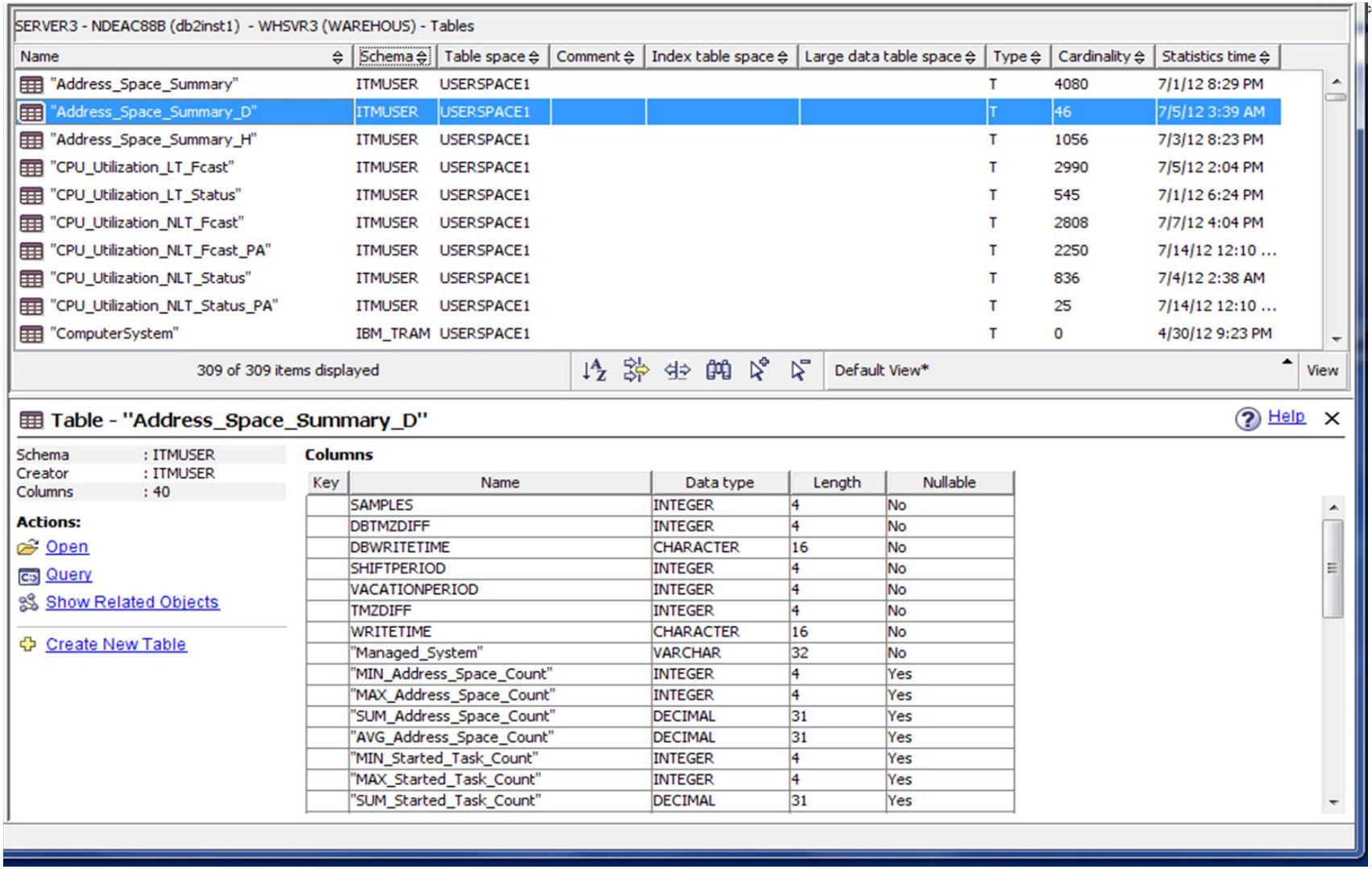


Solution Requirements and Implementation

Tivoli Data Warehouse Considerations

- The TDW is a relational database containing tables populated with data (attribute groups) from agents in the ITM Infrastructure
- Supported database environments are DB2 (distributed and z/OS), Oracle, SQL Server
- Table types in the TDW
  - "Raw" data – metric attribute groups sent from agents to a Warehouse Proxy Agent (WPA), which creates tables and inserts data
  - Summarized data – created by the Summarization and Pruning agent from the raw data tables
    - Hourly, daily, weekly, monthly, quarterly, yearly summarization options
    - Average/sum/minimum/maximum values created for numeric data for each summarization period
- The tables should be pruned to control TDW growth
- Metrics to be analyzed must be collected and summarized

TDW Database View



SERVER3 - NDEAC88B (db2inst1) - WHSVR3 (WAREHOUS) - Tables

Name	Schema	Table space	Comment	Index table space	Large data table space	Type	Cardinality	Statistics time
"Address_Space_Summary"	ITMUSER	USERSPACE1				T	4080	7/1/12 8:29 PM
"Address_Space_Summary_D"	ITMUSER	USERSPACE1				T	46	7/5/12 3:39 AM
"Address_Space_Summary_H"	ITMUSER	USERSPACE1				T	1056	7/3/12 8:23 PM
"CPU_Utilization_LT_Fcast"	ITMUSER	USERSPACE1				T	2990	7/5/12 2:04 PM
"CPU_Utilization_LT_Status"	ITMUSER	USERSPACE1				T	545	7/1/12 6:24 PM
"CPU_Utilization_NLT_Fcast"	ITMUSER	USERSPACE1				T	2808	7/7/12 4:04 PM
"CPU_Utilization_NLT_Fcast_PA"	ITMUSER	USERSPACE1				T	2250	7/14/12 12:10 ...
"CPU_Utilization_NLT_Status"	ITMUSER	USERSPACE1				T	836	7/4/12 2:38 AM
"CPU_Utilization_NLT_Status_PA"	ITMUSER	USERSPACE1				T	25	7/14/12 12:10 ...
"ComputerSystem"	IBM_TRAM	USERSPACE1				T	0	4/30/12 9:23 PM

309 of 309 items displayed | Default View* | View

Table - "Address_Space_Summary_D" Help

Schema : ITMUSER
Creator : ITMUSER
Columns : 40

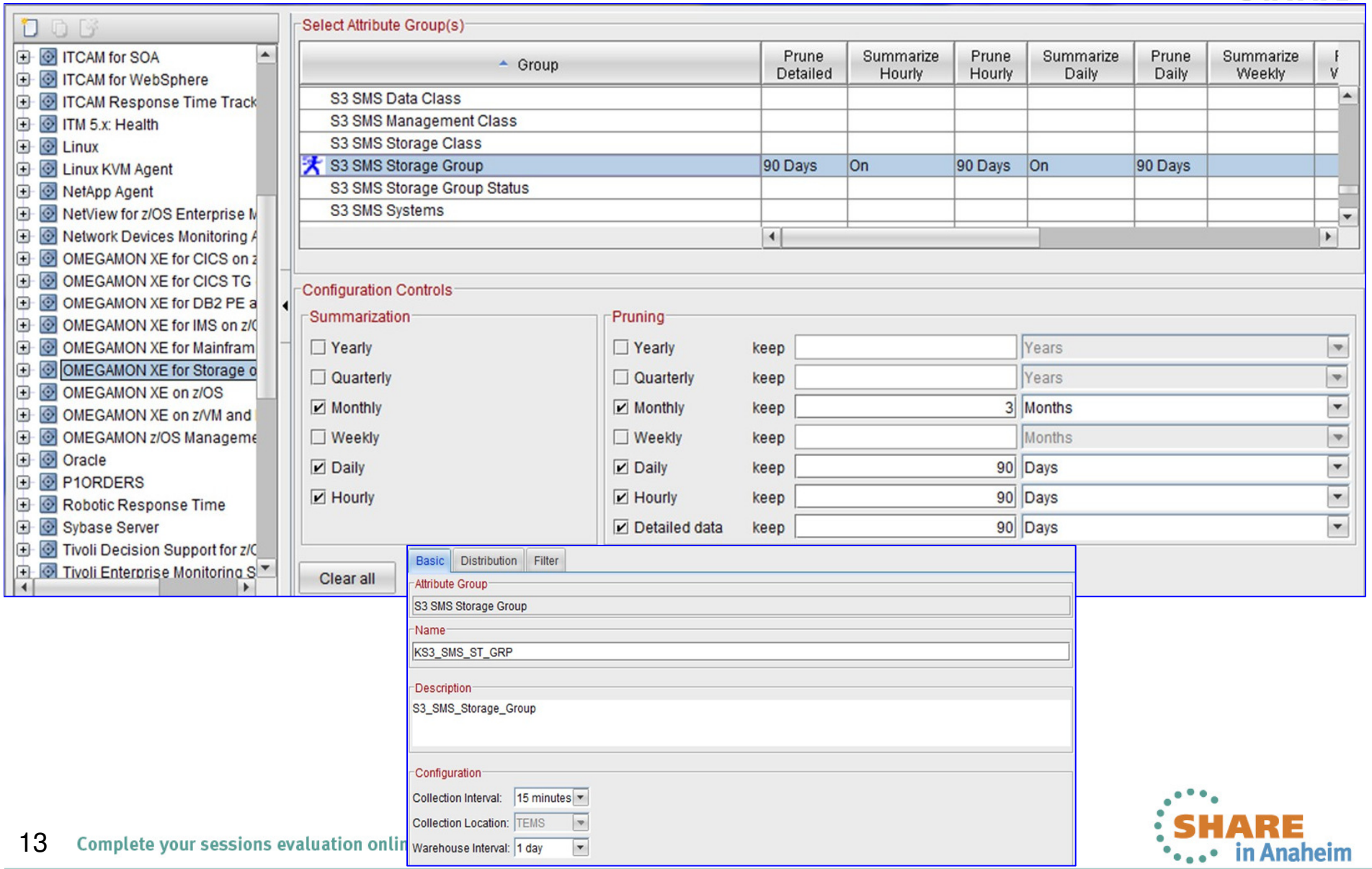
Actions:

Open
Query
Show Related Objects
Create New Table

Columns

Key	Name	Data type	Length	Nullable
	SAMPLES	INTEGER	4	No
	DBTMZDIFF	INTEGER	4	No
	DBWRITETIME	CHARACTER	16	No
	SHIFTPERIOD	INTEGER	4	No
	VACATIONPERIOD	INTEGER	4	No
	TMZDIFF	INTEGER	4	No
	WRITETIME	CHARACTER	16	No
	"Managed_System"	VARCHAR	32	No
	"MIN_Address_Space_Count"	INTEGER	4	Yes
	"MAX_Address_Space_Count"	INTEGER	4	Yes
	"SUM_Address_Space_Count"	DECIMAL	31	Yes
	"AVG_Address_Space_Count"	DECIMAL	31	Yes
	"MIN_Started_Task_Count"	INTEGER	4	Yes
	"MAX_Started_Task_Count"	INTEGER	4	Yes
	"SUM_Started_Task_Count"	DECIMAL	31	Yes

TDW Collection and Summarization Options

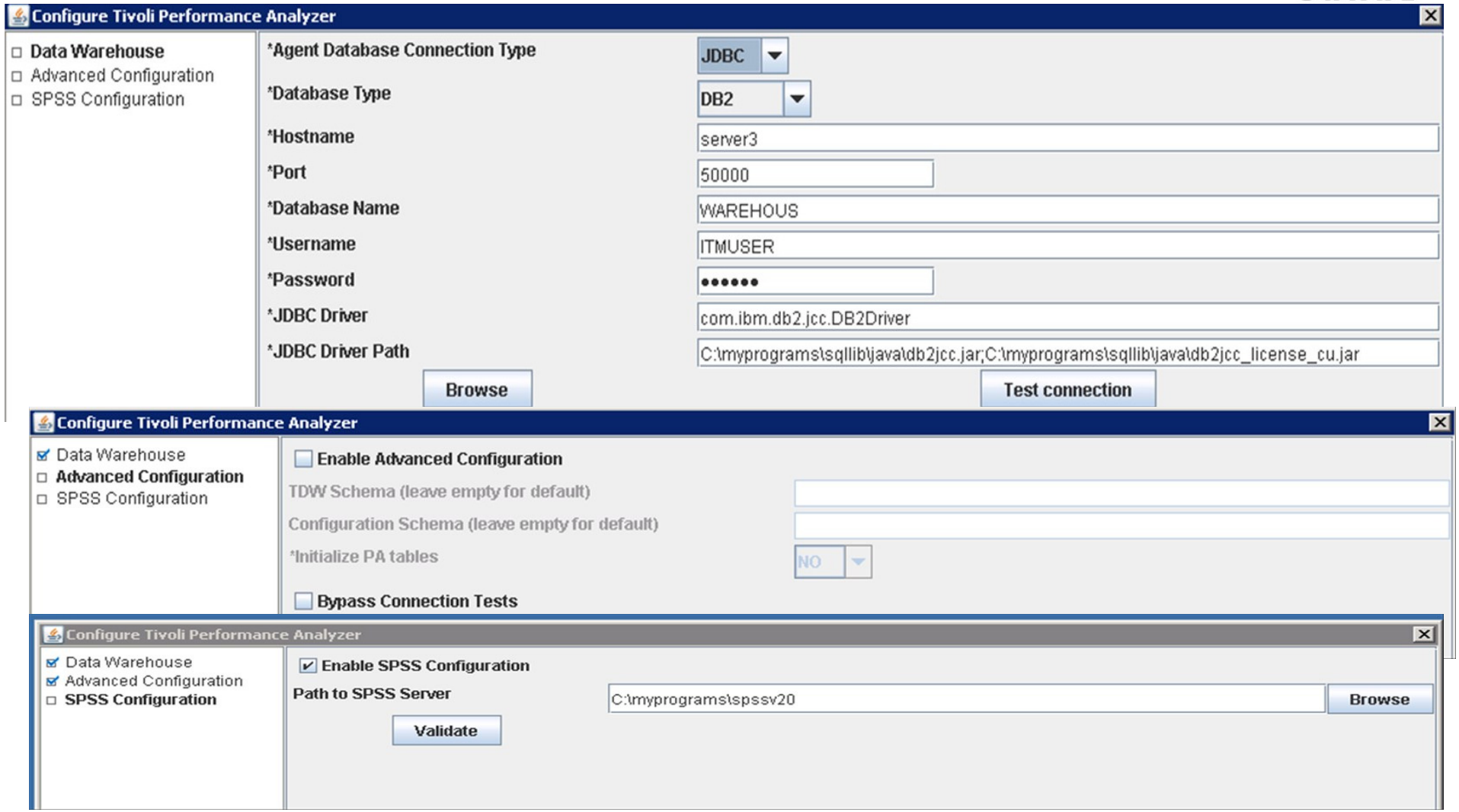


ITPA Agent

- Installation
  - Agent
  - Desired product provided forecast environments (“domains”)
    - ITPA Tasks, TEP Workspaces, TEP queries, TDW attribute groups, situations, and TCR Reports
  - Application support for agent and desired domains on TEPS, Hub TEMS, Remote TEMS

Domain	Required agent
DB2	ITM for Databases (DB2)
Oracle	ITM for Databases (Oracle)
Operating System	ITM Windows, AIX, or Linux OS
ITCAM RT	ITCAM for Response Time (V7.2 or higher)
System p Series	AIX/VIOS Premium
VMware	ITM for Virtual Servers/Virtualized Environments (VMware)

ITPA Agent Customization



Optional Components

- **SPSS Statistics Server (separate purchase)**
  - Version 20
  - Provides non-linear forecasting models (ITPA 6.23 fp1 and higher)
  - Must be installed on same platform with ITPA
  - No special customization needed (install and start server)
  - ITPA will analyze data against provided non-linear models and select one which provides the best fit
- **Tivoli Common Reporting Server (part of ITM)**
  - Provided with ITM
  - Supported on Windows, AIX, or Linux (Intel and System z)
  - WAS CE + Cognos 8 reporting engine under the covers
  - Connects to TDW to access data for reports
  - ITPA provides canned reports, and custom reports can be built

TCR Reports

Domain	# of Reports	Names
DB2	4	**Databases Forecast** **Databases Daily Status** **Instances Forecast** **Table Spaces Forecast**
Operating System	6	**Overall System Health** **Available Memory Utilization** **CPU Workload Forecast** **Outbound Network Traffic Forecast** **Inbound Network Traffic Forecast** **Hard Disk Utilization Forecast**
Oracle	4	**Databases Forecast** **Table Spaces Forecast** **Databases Daily Status** **Namespaces Forecast**
System pSeries	3	**Logical Partitions Forecast** **Networking Forecast** **Storage Forecast**
ITCAM	3	**Client Response Time Forecast** **Robotic Response Time Forecast** **Web Response Time Forecast**
VMware	5	**CPU Utilization** **Disk Utilization Forecast** **Memory** **Network** **Predicted Critical and Warning States**

Solution Usage

Terminology Level Set

- Linear trending
  - Least Squares Regression Method (y=mx + k)
- Nonlinear trending
  - Uses SPSS Expert Modeler Algorithm to automatically select best model
    - Various Exponential Smoothing models or ARIMA models
- Forecast periods
  - 7, 30, 90 days used as defaults
- Confidence
  - Indicates forecast accuracy
    - Correlation coefficient (R-squared) * 100
  - 0 = no confidence, 100 = perfect forecast

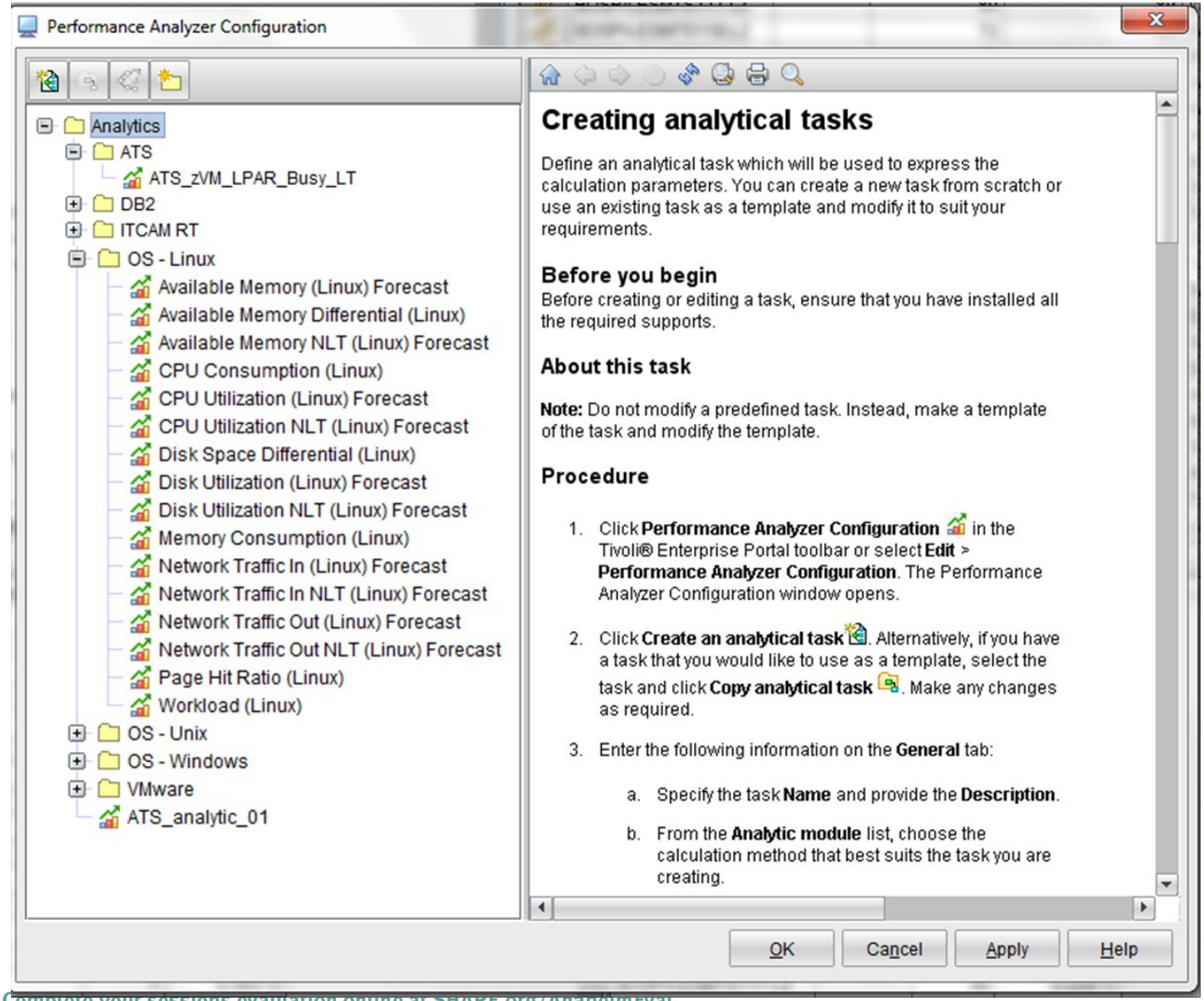
Terminology Level Set…

- Direction (linear only)
  - Upward trend (1) downward trend (-1) or no trend (0)
- Samples
  - Sample range used to forecast can be controlled
- Strength
  - Based on Confidence + Number of Samples
    - 1 (Weak): confidence < 50, samples <10
    - 2 (Moderate): confidence >= 50, samples >=10
    - 3 (Strong): confidence >=65, samples >=25
- Time to threshold
  - Predicted number of days in future when threshold is reached (or NEVER)

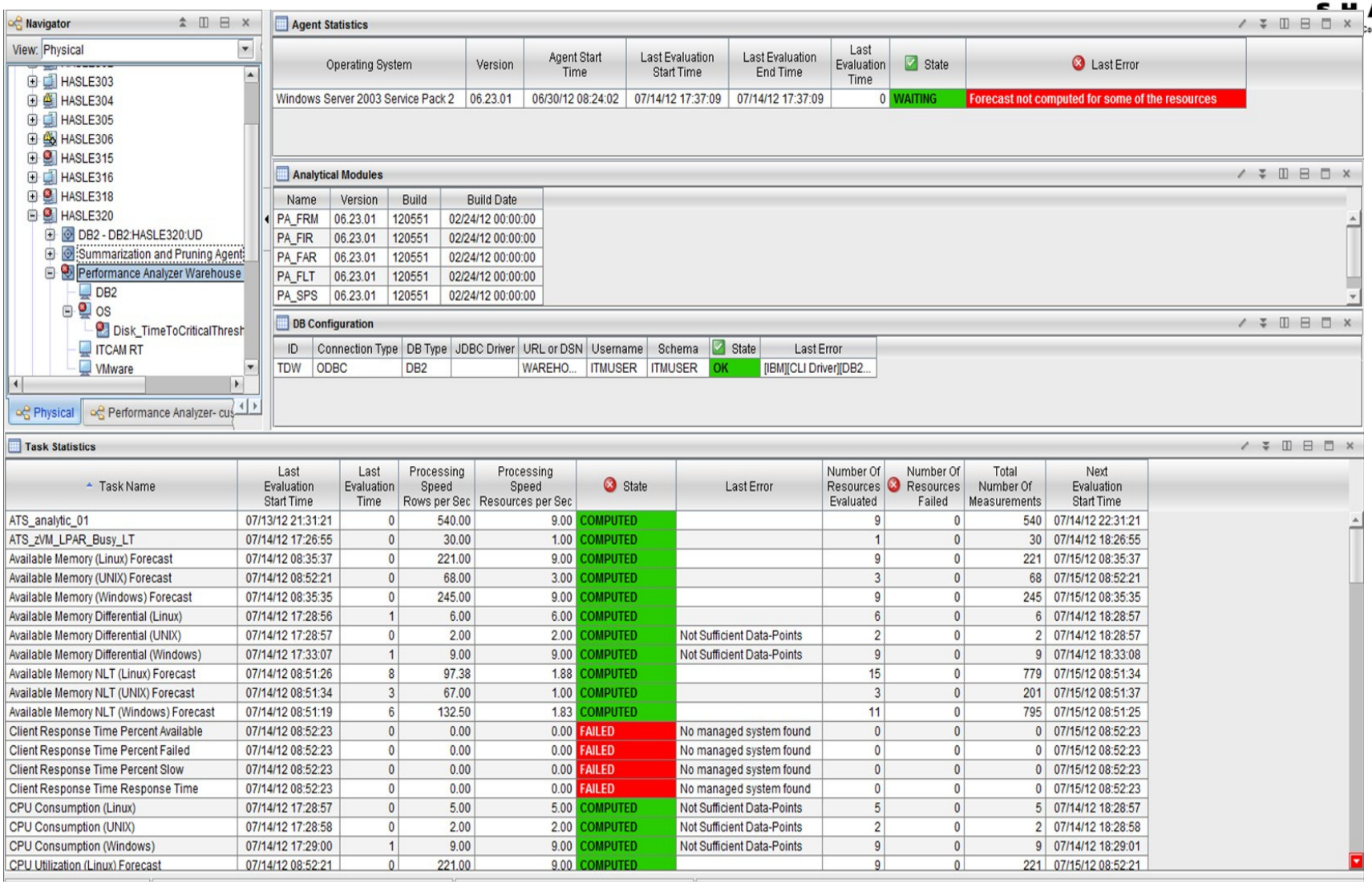
Analytic Tasks

- A task defines the TDW data to be analyzed, how it will be analyzed, how frequently the analysis will be done, and where the results will be stored
- Three types
  - Arithmetic – calculate a new metric based on existing metrics
  - Linear trending
  - Nonlinear trending
- Tasks are stored in TEPS database and managed through the Tivoli Enterprise Portal
  - Performance Analyzer Configuration icon 
  - Edit->Performance Analyzer Configuration
- Tasks provided for domains which can be copied and modifed
- Tasks can be built from scratch
- Task output
  - Workspaces (for pre-defined Domains)
  - Attribute tables (Build custom workspaces to view)
  - TDW for historical collection (to see forecast trends)

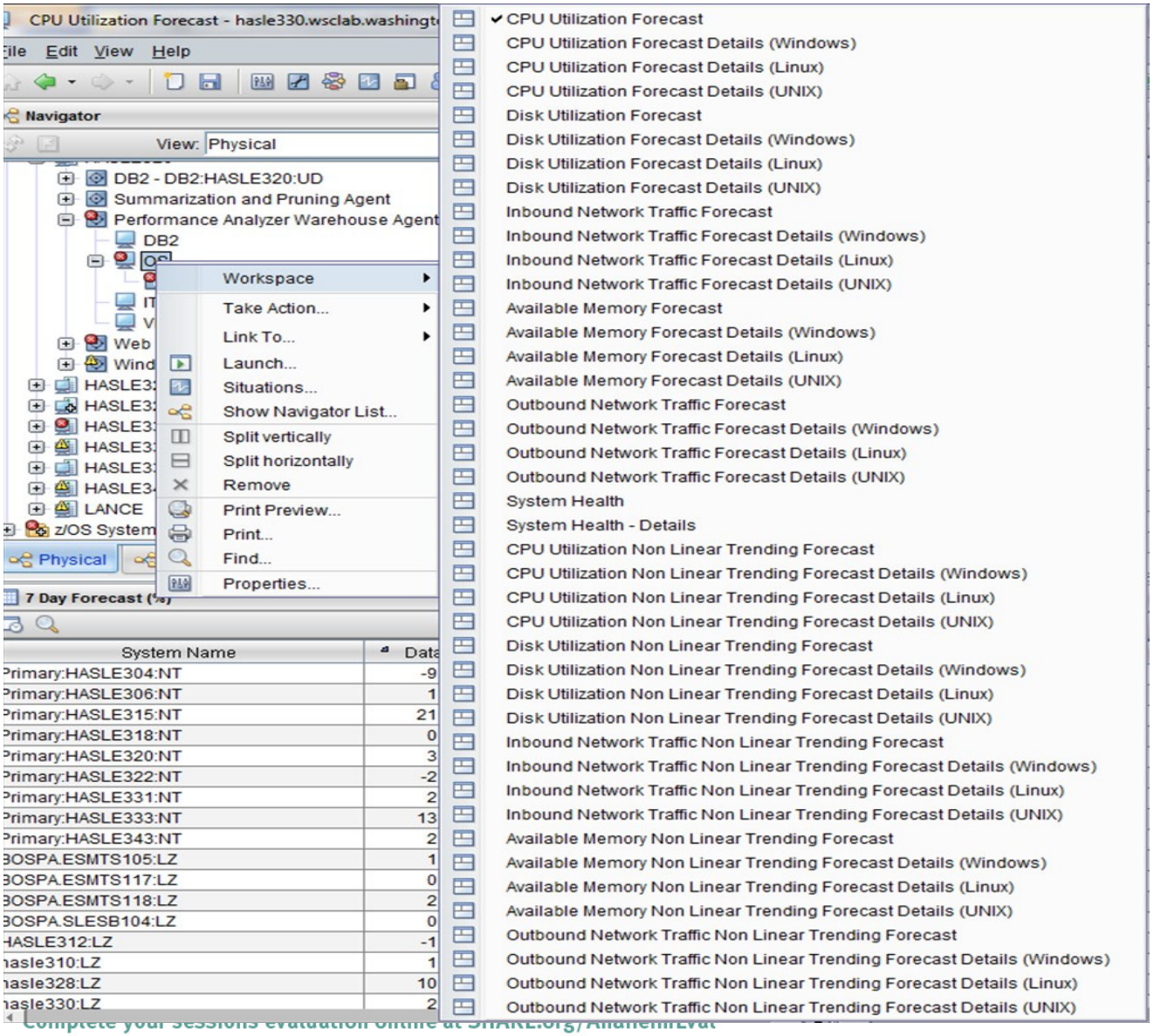
Viewing and Creating Tasks



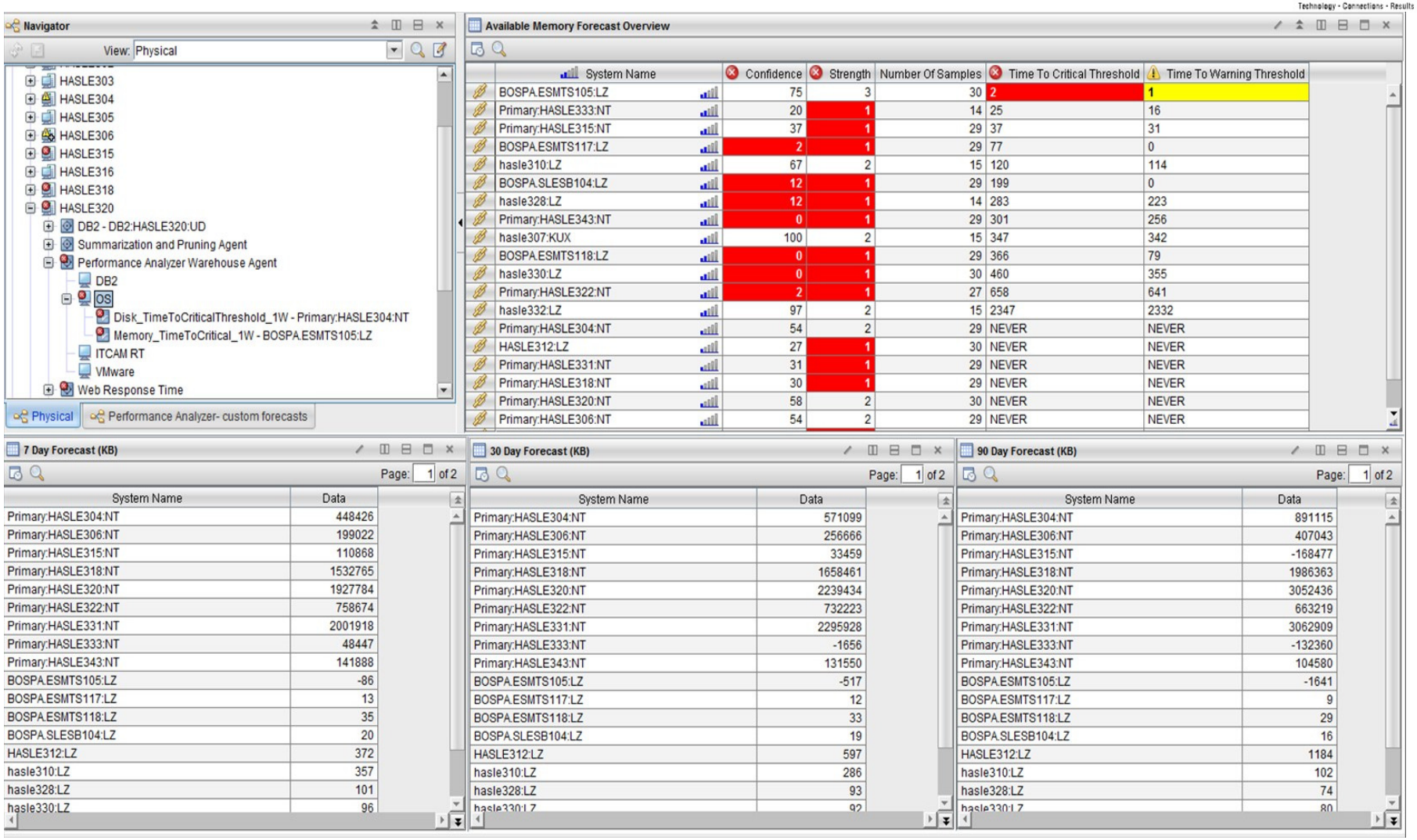
Product Workspaces



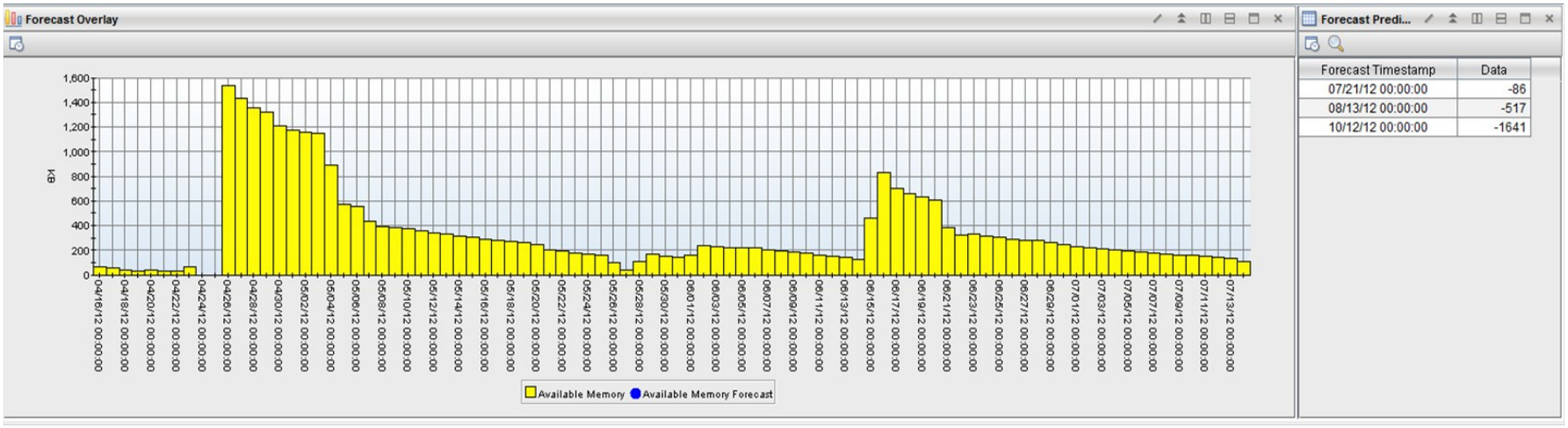
Product Workspaces – Operating System

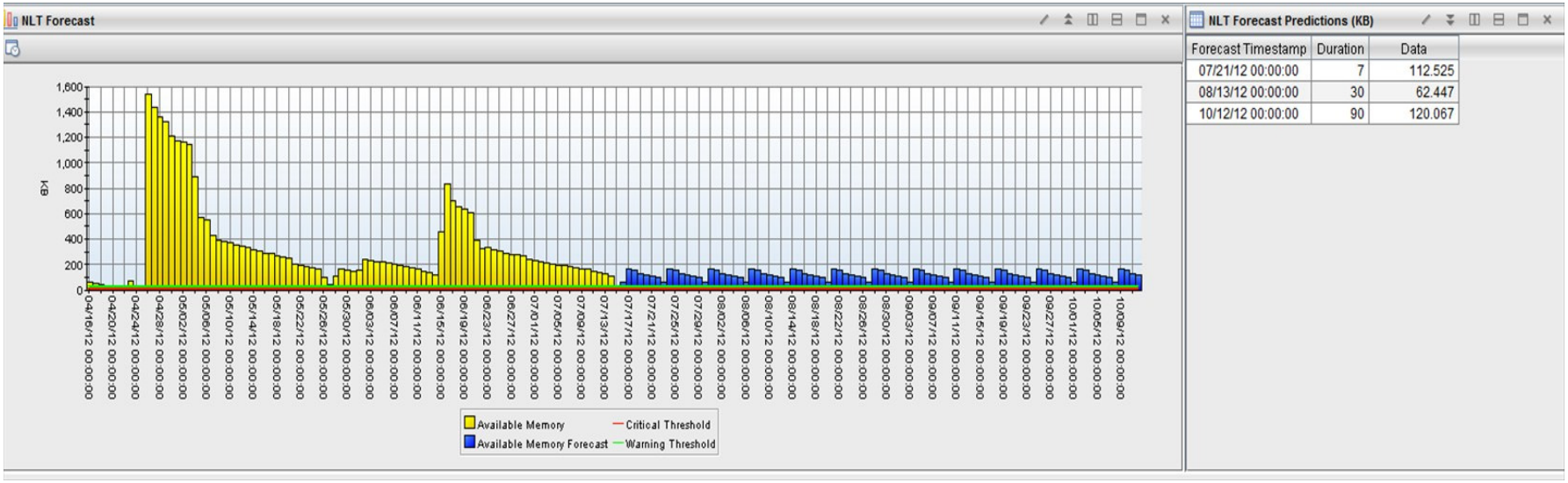


Product Workspaces – OS Memory



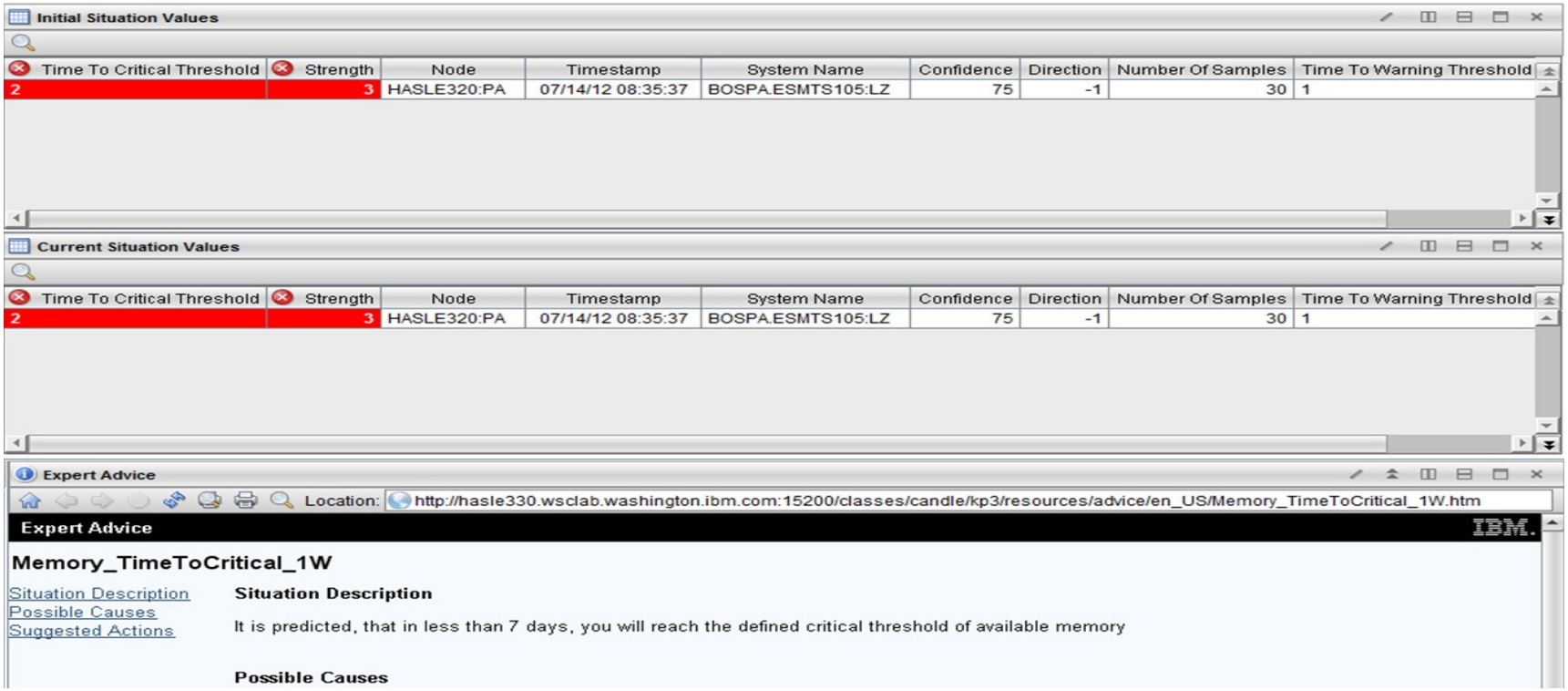
Linear and Nonlinear Memory Forecast



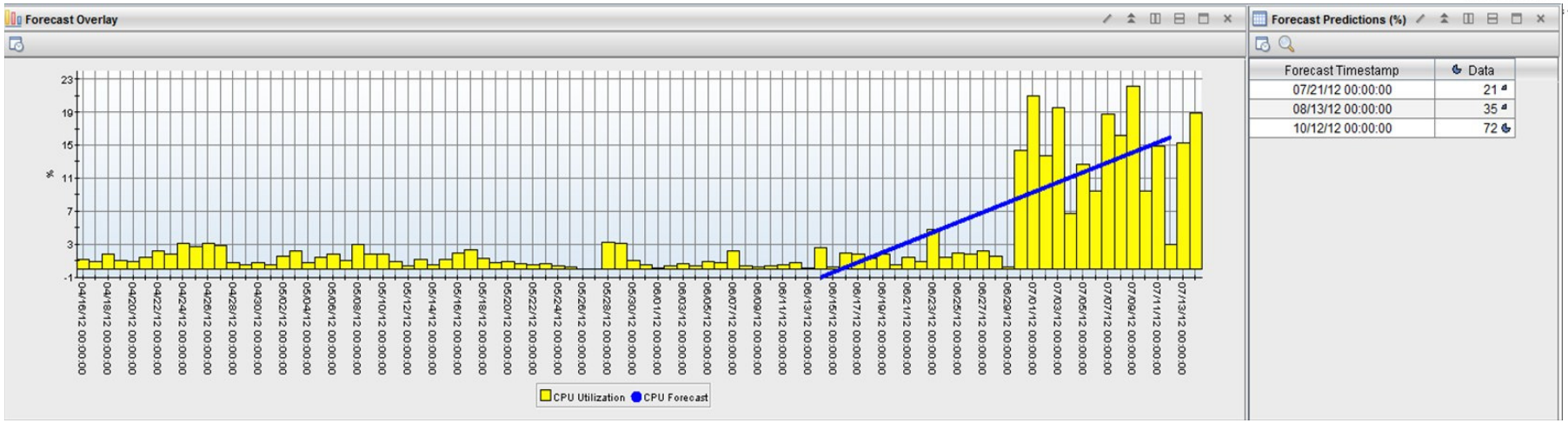


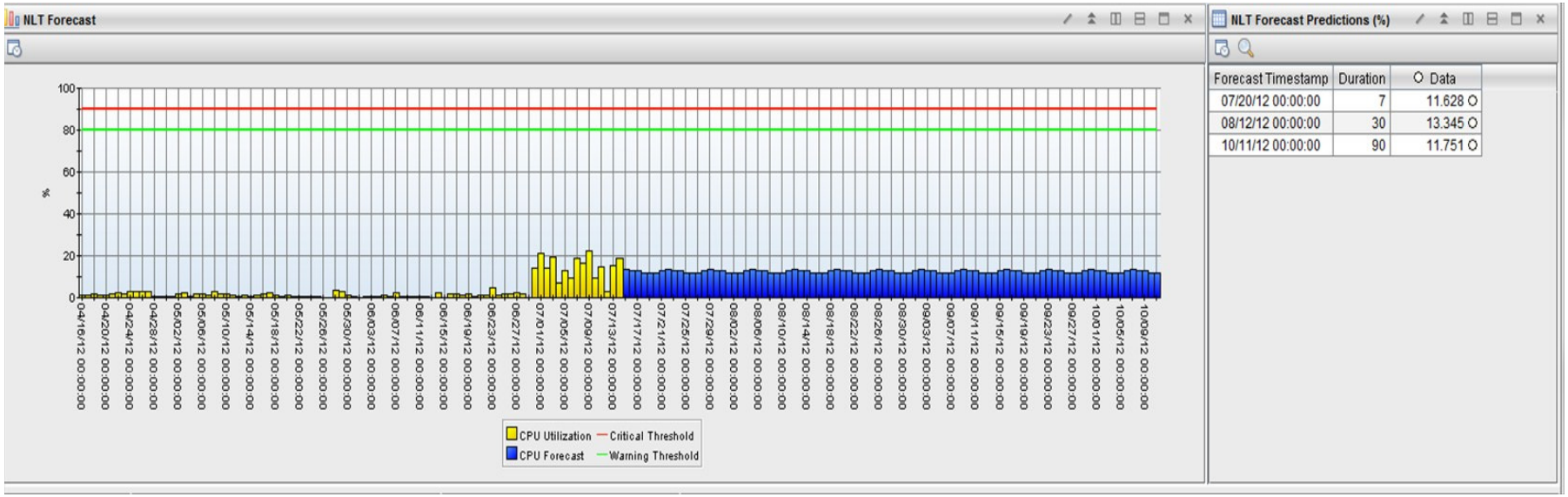
Situations

- Over 80 situations provided
  - Raise alerts when resource usage trends start approaching critical/warning thresholds
- Custom situations can be created for custom analytic tasks

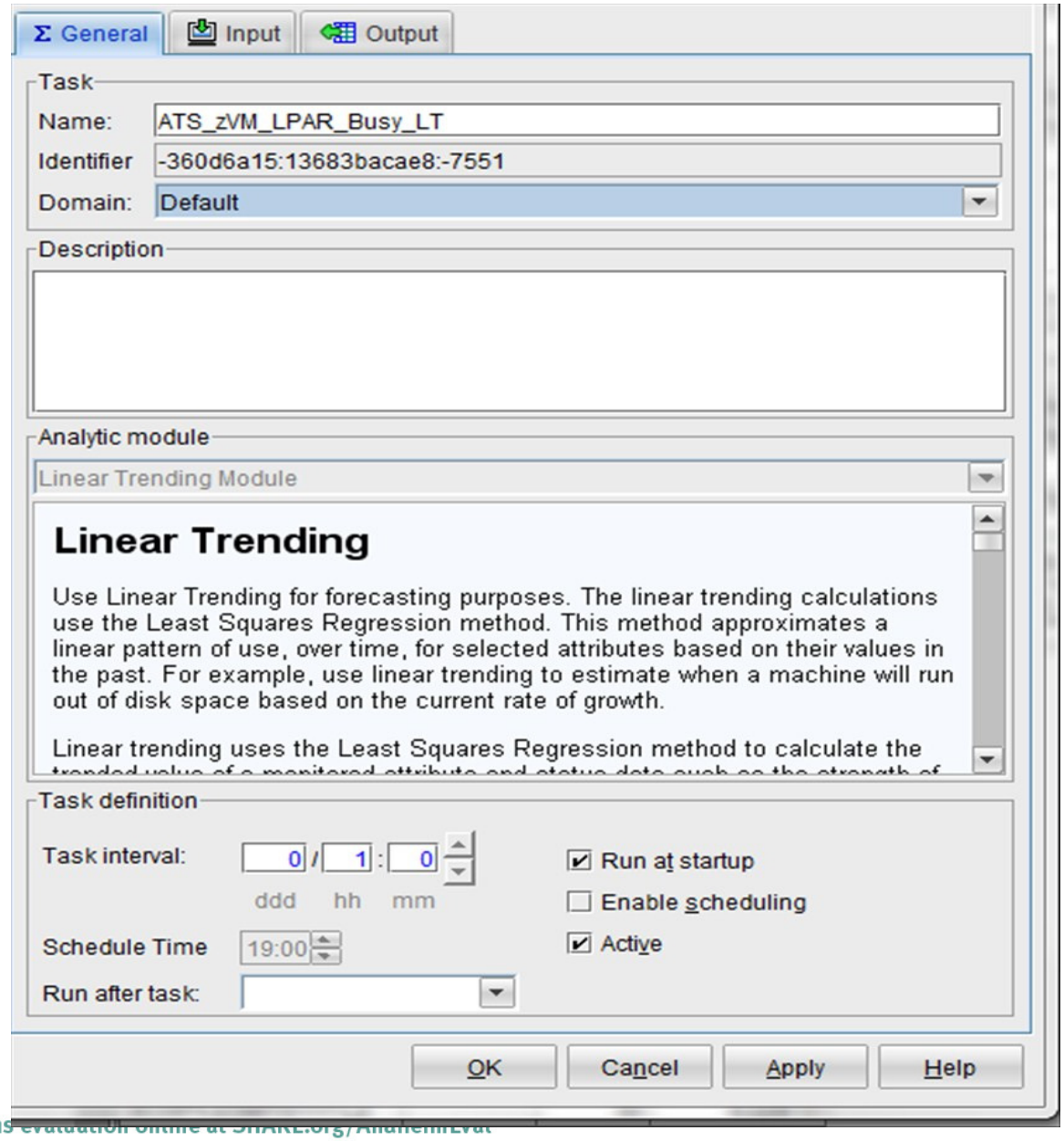


Linear and Nonlinear CPU Forecast

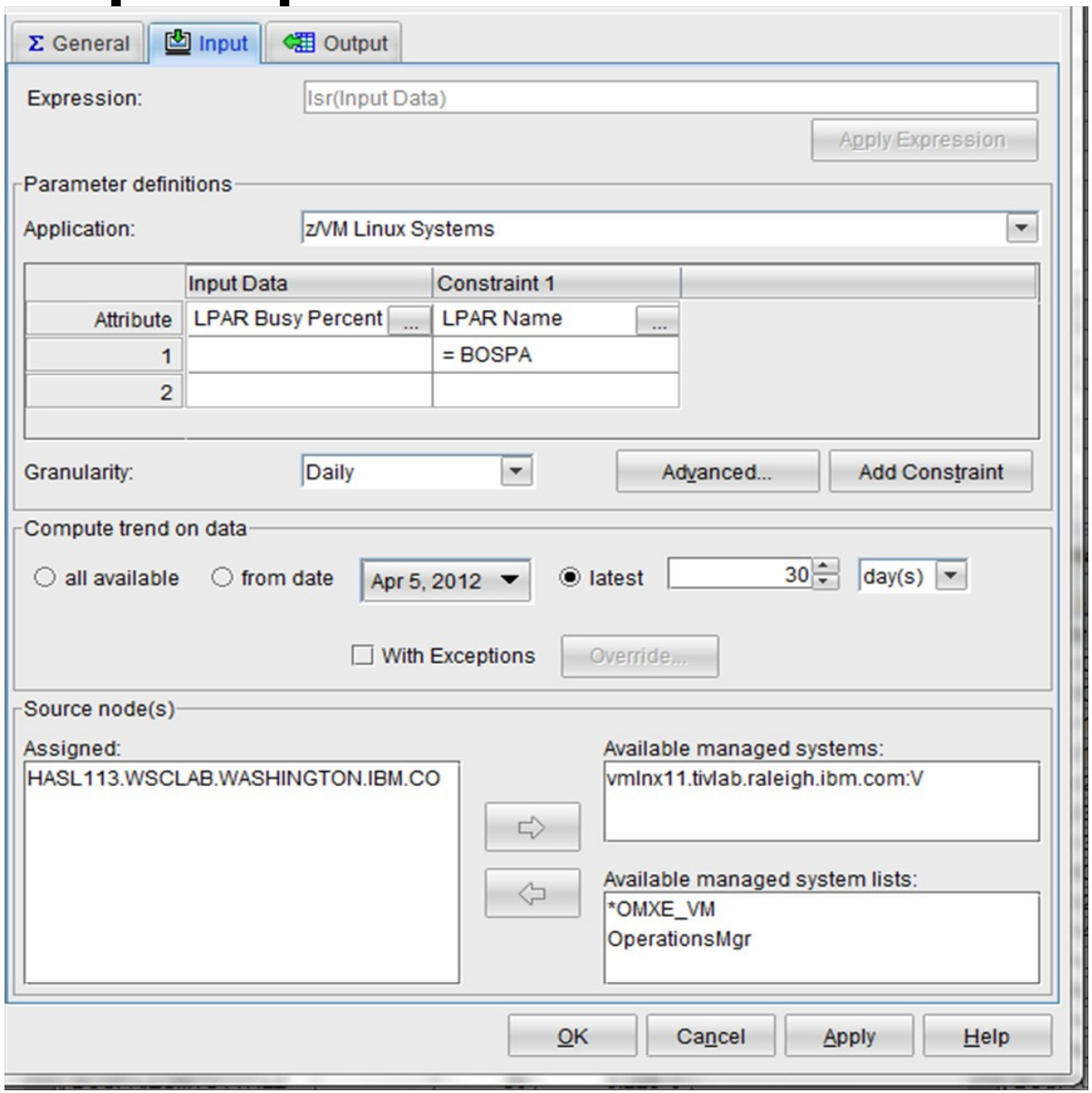




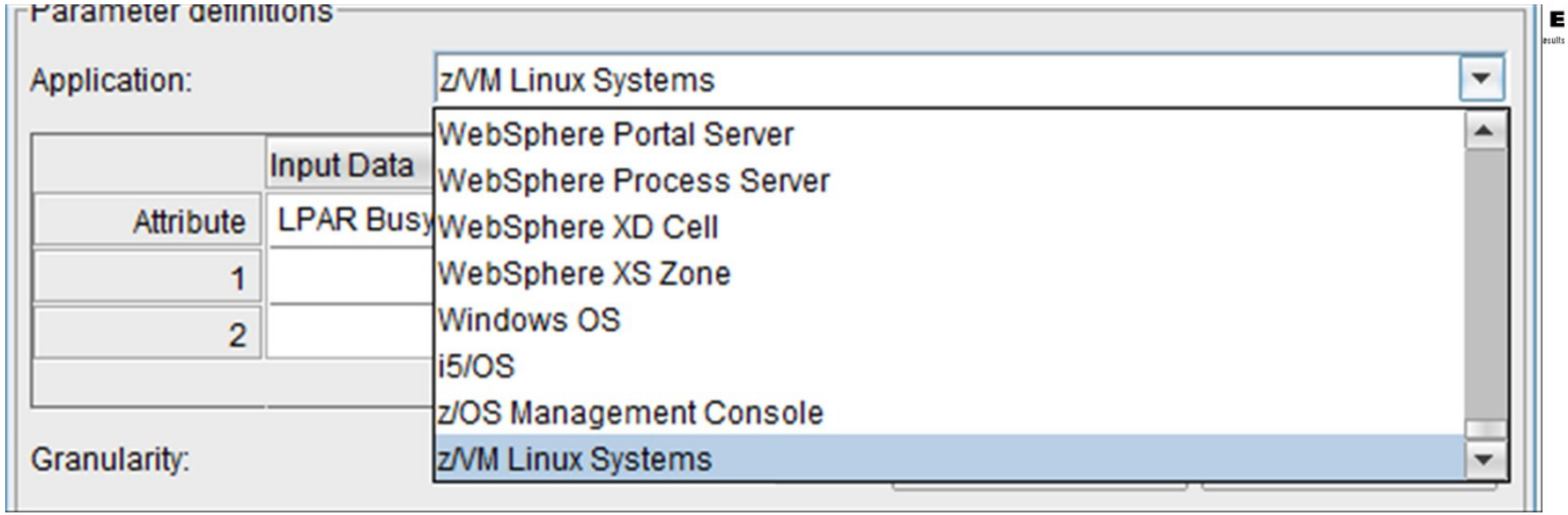
Custom Forecast: z/VM LPAR Utilization

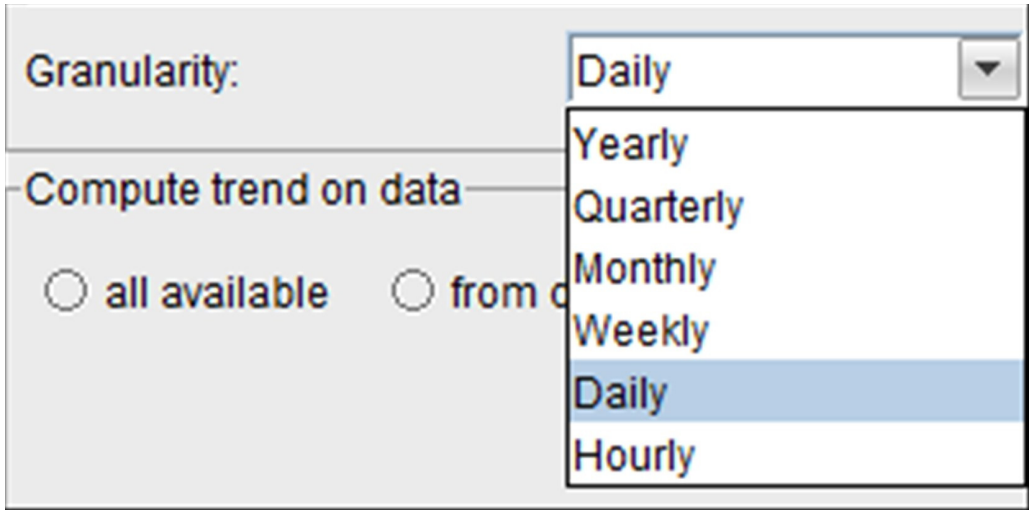


Task Input Specifications

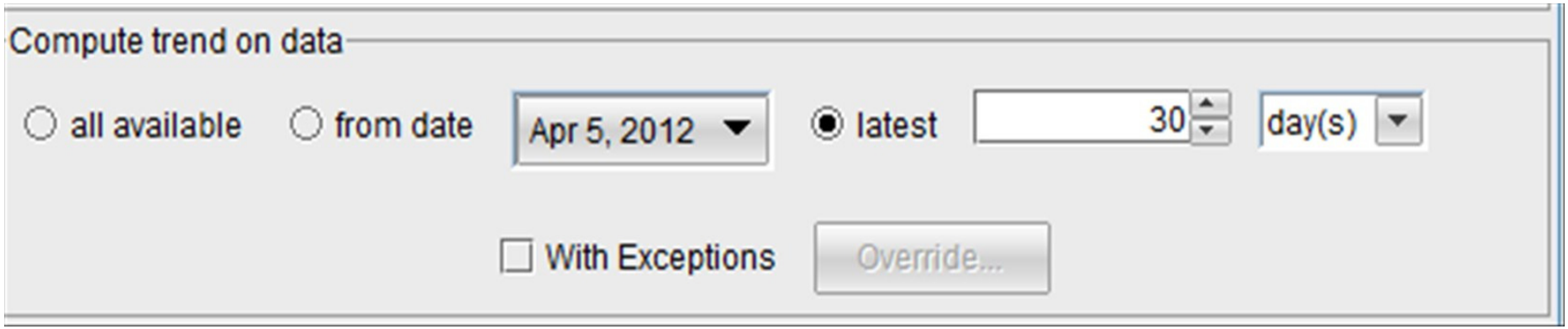


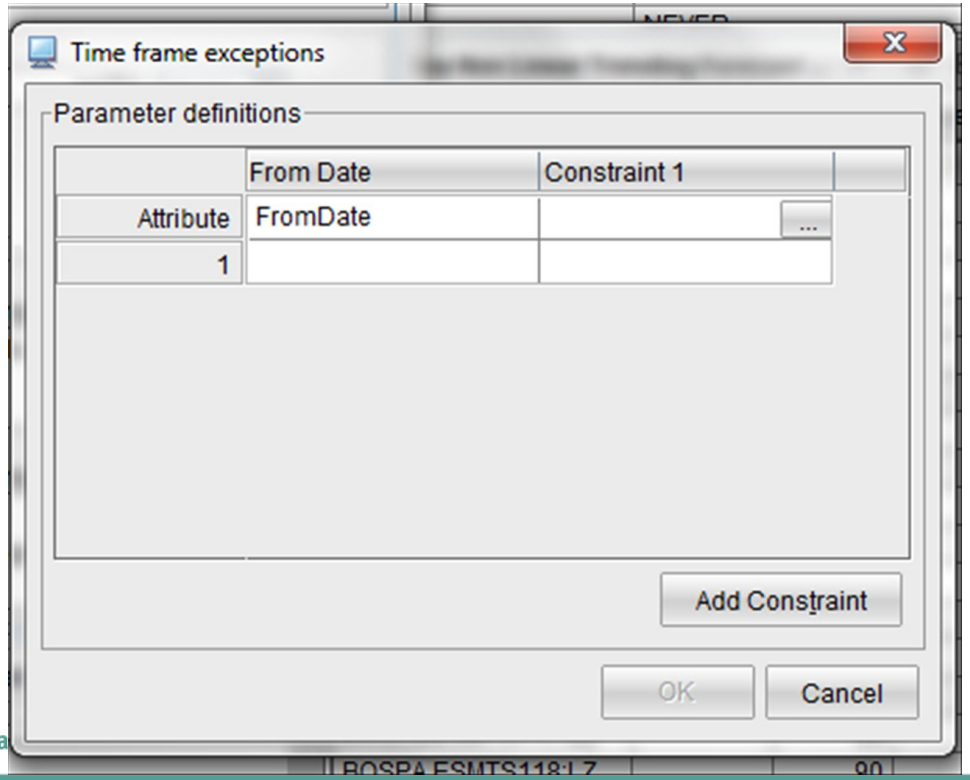
Agent and Summarization Level



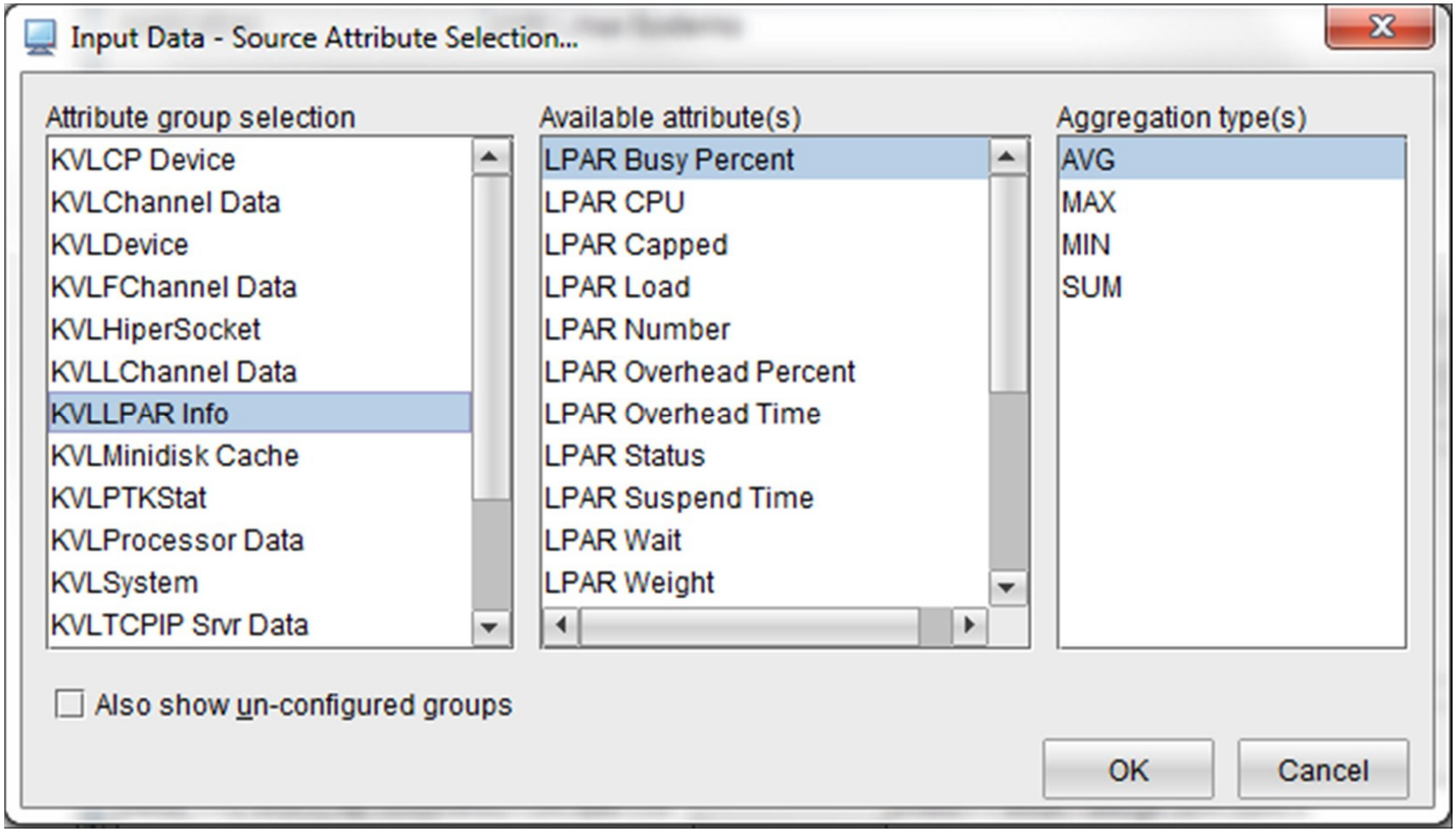


Sampling Data Specifications

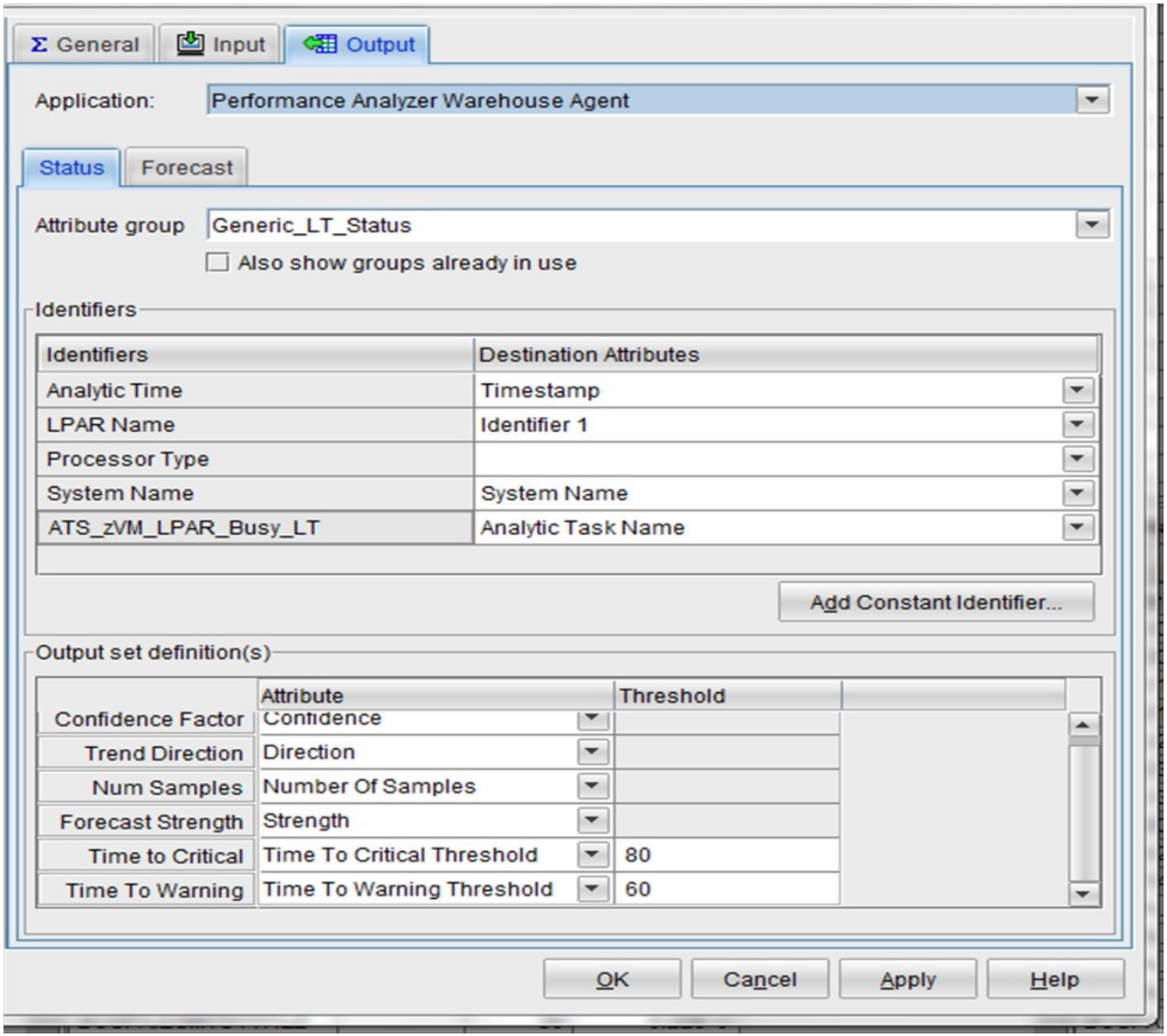




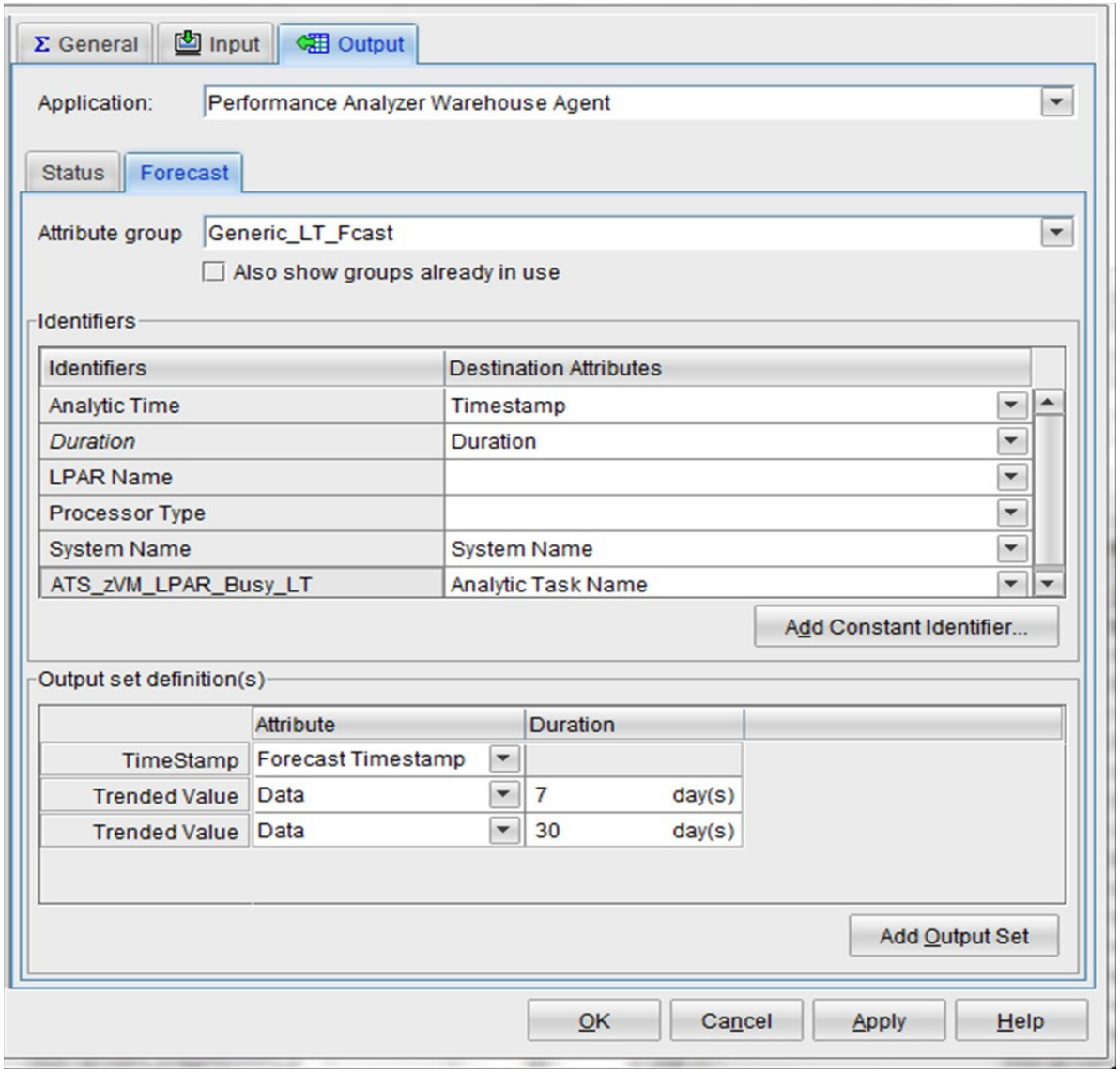
Attribute Selection



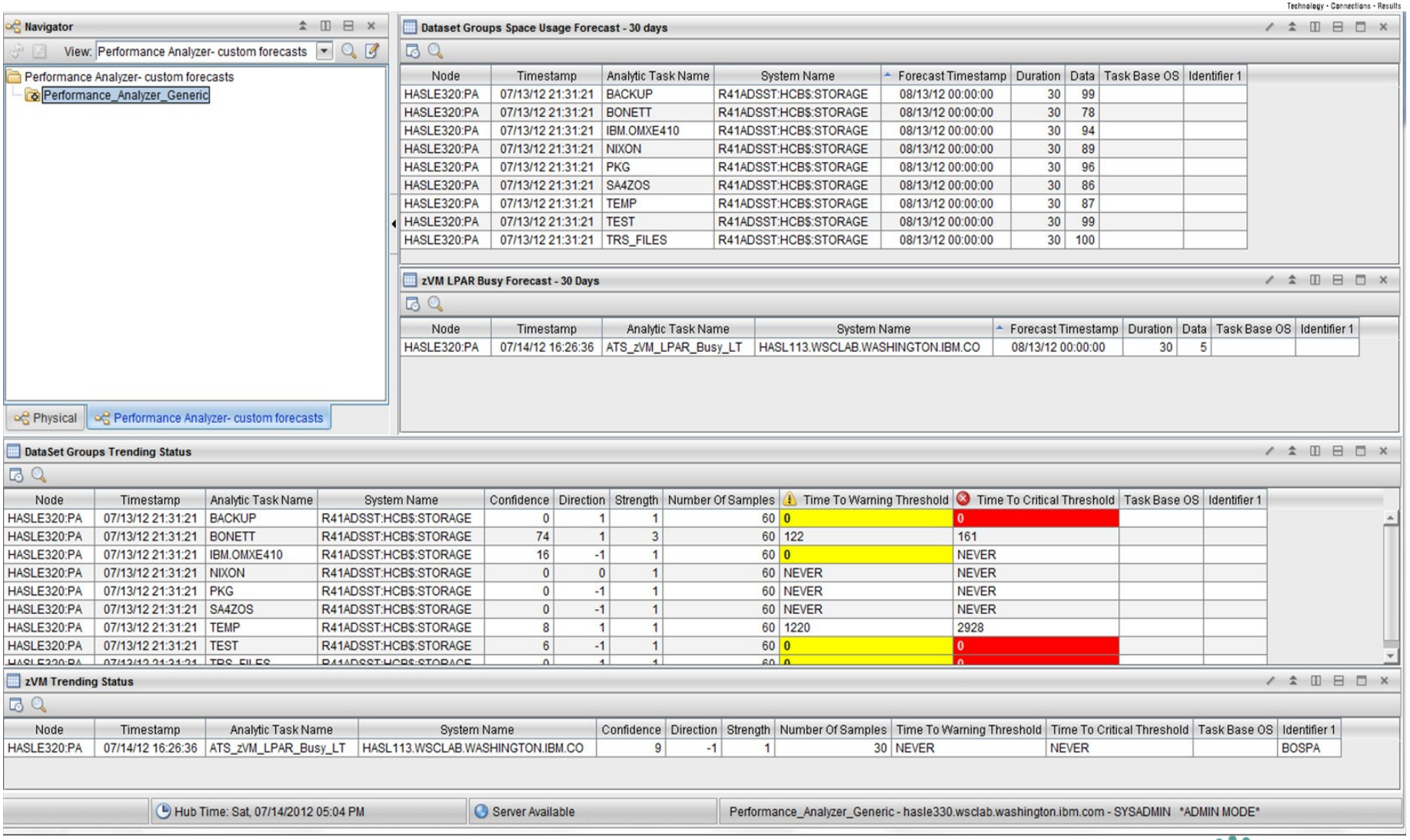
Task Output Status Specification



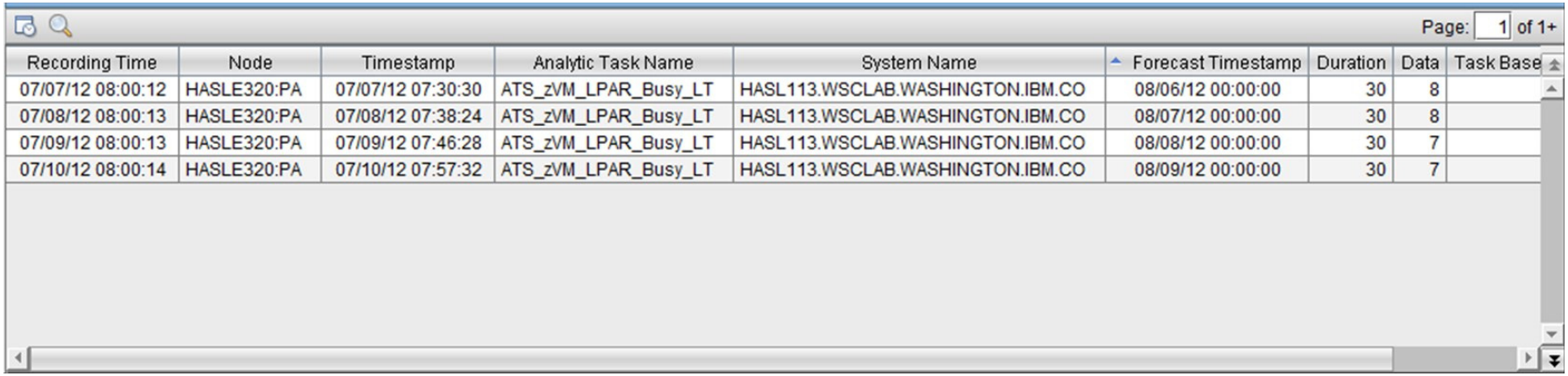
Task Output Forecast Specification



Custom Forecast Workspace



Custom Forecast Workspace - Historical



Page: 1 of 1+

Recording Time	Node	Timestamp	Analytic Task Name	System Name	Forecast Timestamp	Duration	Data	Task Base
07/07/12 08:00:12	HASLE320:PA	07/07/12 07:30:30	ATS_zVM_LPAR_Busy_LT	HASL113.WSCLAB.WASHINGTON.IBM.CO	08/06/12 00:00:00	30	8	
07/08/12 08:00:13	HASLE320:PA	07/08/12 07:38:24	ATS_zVM_LPAR_Busy_LT	HASL113.WSCLAB.WASHINGTON.IBM.CO	08/07/12 00:00:00	30	8	
07/09/12 08:00:13	HASLE320:PA	07/09/12 07:46:28	ATS_zVM_LPAR_Busy_LT	HASL113.WSCLAB.WASHINGTON.IBM.CO	08/08/12 00:00:00	30	7	
07/10/12 08:00:14	HASLE320:PA	07/10/12 07:57:32	ATS_zVM_LPAR_Busy_LT	HASL113.WSCLAB.WASHINGTON.IBM.CO	08/09/12 00:00:00	30	7	

Reports

Tivoli Performance Analyzer

IBM

Memory Utilization per Operating System

Operating system Linux

Forecast Overview

System name	Timestamp	Confidence	Strength	Number of samples	Time to critical theshold (days)	Time to warning threshold (days)
BOSPA.ESMTS105:LZ	Jul 17, 2012 8:38 AM	74	3	30	4	2
BOSPA.ESMTS117:LZ	Jul 17, 2012 8:38 AM	0	1	29	2147483647	0
BOSPA.ESMTS118:LZ	Jul 17, 2012 8:38 AM	0	1	29	2147483647	2147483647
BOSPA.SLESB104:LZ	Jul 17, 2012 8:38 AM	9	1	29	216	0
HASLE312:LZ	Jul 17, 2012 8:38 AM	14	1	30	2147483647	2147483647
hasle310:LZ	Jul 17, 2012 8:38 AM	93	2	12	223	211
hasle328:LZ	Jul 17, 2012 8:38 AM	10	1	11	228	178
hasle330:LZ	Jul 17, 2012 8:38 AM	1	1	30	157	119
hasle332:LZ	Jul 17, 2012 8:38 AM	95	2	12	2251	2236

Brief Forecasts

7 Day Forecast

System name	7 day forecast
BOSPA.ESMTS105:LZ	-40
BOSPA.ESMTS117:LZ	15
BOSPA.ESMTS118:LZ	37
BOSPA.SLESB104:LZ	20
HASLE312:LZ	322
hasle310:LZ	386
hasle328:LZ	98
hasle330:LZ	89
hasle332:LZ	3063

Reports

Tivoli Performance Analyzer

System name	30 day forecast
BOSPA.ESMTS105:LZ	-366
BOSPA.ESMTS117:LZ	15
BOSPA.ESMTS118:LZ	38
BOSPA.SLESB104:LZ	19
HASLE312:LZ	478
hasle310:LZ	346
hasle328:LZ	89
hasle330:LZ	77
hasle332:LZ	3032

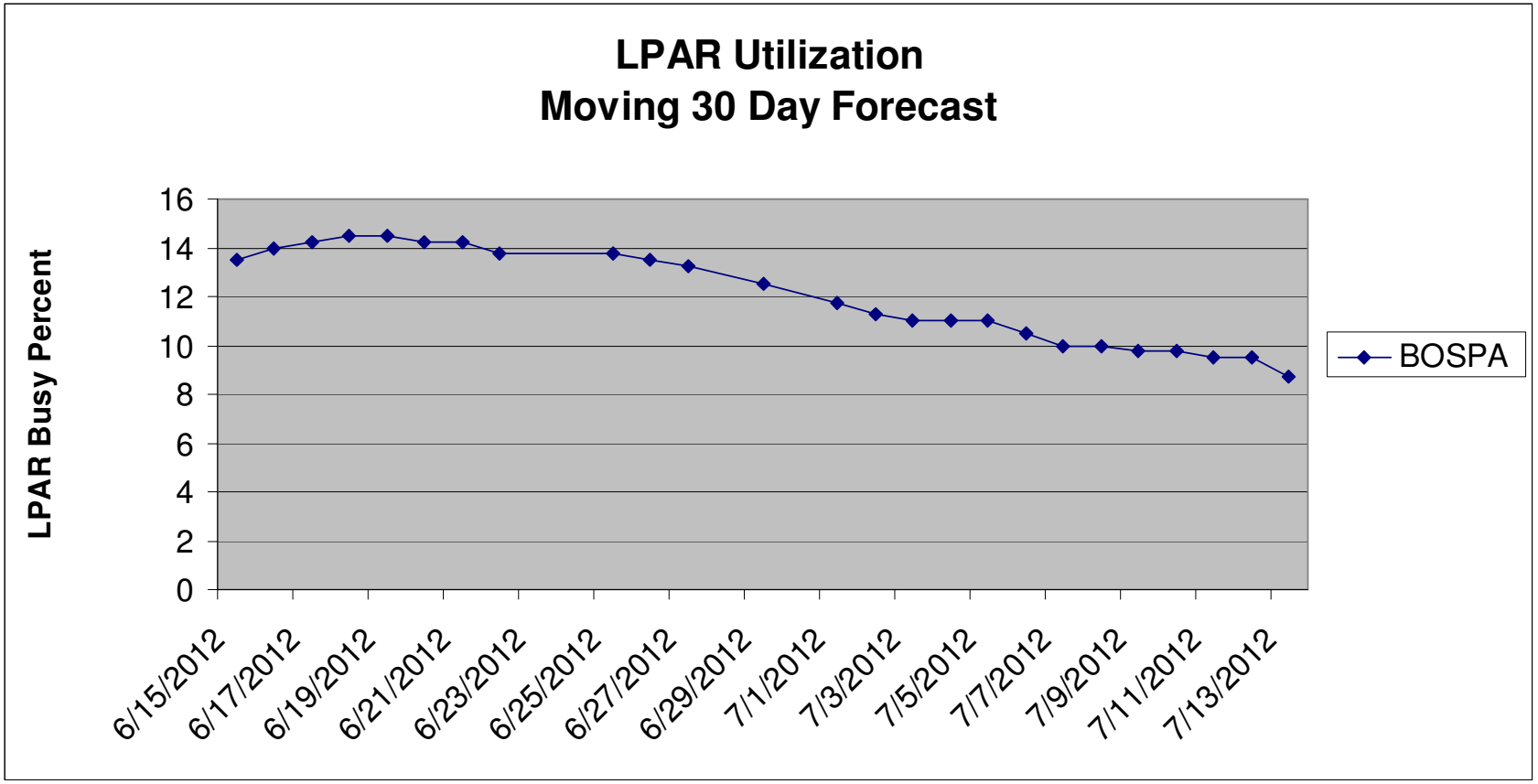
90 Day Forecast

System name	90 day forecast
BOSPA.ESMTS105:LZ	-1217
BOSPA.ESMTS117:LZ	16
BOSPA.ESMTS118:LZ	41
BOSPA.SLESB104:LZ	16
HASLE312:LZ	884
hasle310:LZ	241
hasle328:LZ	65
hasle330:LZ	45
hasle332:LZ	2950

This report presents the forecast overview of available memory utilization followed by the brief forecasts for each monitored system. The top table (Forecast Overview) displays the general trend information, for example ' Number of samples' on which a given trend is calculated, 'Confidence' showing how certain the outcome is, or 'Time to critical/warning threshold' that indicates when a particular limit will be exceeded. Brief Forecasts section comprises three tables presenting the values for 7, 30 and 90 day forecast.

Roll Your Own Report

Rolling 30 day forecast from ITPA historical data (SQL Query->Import to Spreadsheet)



ITPA Domain Generator

- "AS-IS" tool available from the Integrated Service Management (ISM) Library website
- Allows created of custom ITPA domains
- Uses templates to generate ITPA task definitions for linear trending and all objects needed to present it in TEP and in TCR (workspaces, reports, situations, queries, attribute groups),
- Generates domain deployment packages that may be deployed in any ITM 6.2.2 or 6.2.1 environment supported by ITPA (Windows, Linux, Aix, Solaris) 6.2.2 or 6.1.1 FP3
- Generates the standard TCR report set that can be deployed using TCR tools
- Requires ITM TEP/TEMS/ITPA installed on single Windows system for development (package can be later deployed to "production" environments
- ***CURRENTLY NOT SUPPORTED FOR ITM 6.2.3***

For More Information

- IBM Developerworks
  - https://www.ibm.com/developerworks/wikis/display/tivolidoccentral/Tivoli+Performance+Analyzer
    - Links to product documentation and related information
- Getting started with the IBM Tivoli Performance Analyzer 6.1
  - http://www.redbooks.ibm.com/abstracts/sg247478.htm

Tivoli System z Session at SHARE

Monday

•11:00	11207: Automating your IMSplex with System Automation for z/OS	Platinum 7
•1:30	11832: What's New with Tivoli System Automation for z/OS	Elite 1
•3:00	11886: Improve Service Levels with Enhanced Data Analysis	Elite 1

Tuesday

•9:30	11792: What's New with System z Monitoring with OMEGAMON	Elite 1
•11:00	11791: Tuning Tips To Lower Costs with OMEGAMON Monitoring	Platinum 8
•1:30	11900: Understanding Impact of Network on z/OS Performance	Grand Salon A

Wednesday

•9:30	11835: Automated Shutdowns using either SA for z/OS or GDPS	Elite 1
•1:30	11479: Predictive Analytics and IT Service Management	Grand Salon E/F
•1:30	11899: Top 10 Tips for Network Perf. Monitoring w/ OMEGAMON	Platinum 9
•4:30	11836: Save z/OS Software License Costs with TADz	Elite 1

Thursday

•9:30	11905: Using NetView for z/OS for Enterprise-Wide Mgmt and Auto	Grand Salon A
•11:00	11909: Get up and running with NetView IP Management	Grand Salon A
•11:00	11887: Learn How To Implement Cloud on System z	Grand Salon E/F

Friday

•9:30	11630: Getting Started with URM APIs for Monitoring & Discovery	Elite 1

System z Social Media

- System z official Twitter handle:
  - @ibm_system_z
- Top Facebook pages related to System z:
  - Systemz Mainframe
  - IBM System z on Campus
  - IBM Mainframe Professionals
  - Millennial Mainframer
- Top LinkedIn Groups related to System z:
  - Mainframe Experts Network
  - Mainframe
  - IBM Mainframe
  - System z Advocates
  - Cloud Mainframe Computing
- YouTube
  - IBM System z
- Leading Blogs related to System z:
  - Evangelizing Mainframe (Destination z blog)
  - Mainframe Performance Topics
  - Common Sense
  - Enterprise Class Innovation: System z perspectives
  - Mainframe
  - MainframeZone
  - Smarter Computing Blog
  - Millennial Mainframer