

Optimisation and the Internet:

From Web-based Applications to Web-Services

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Gautam Mitra

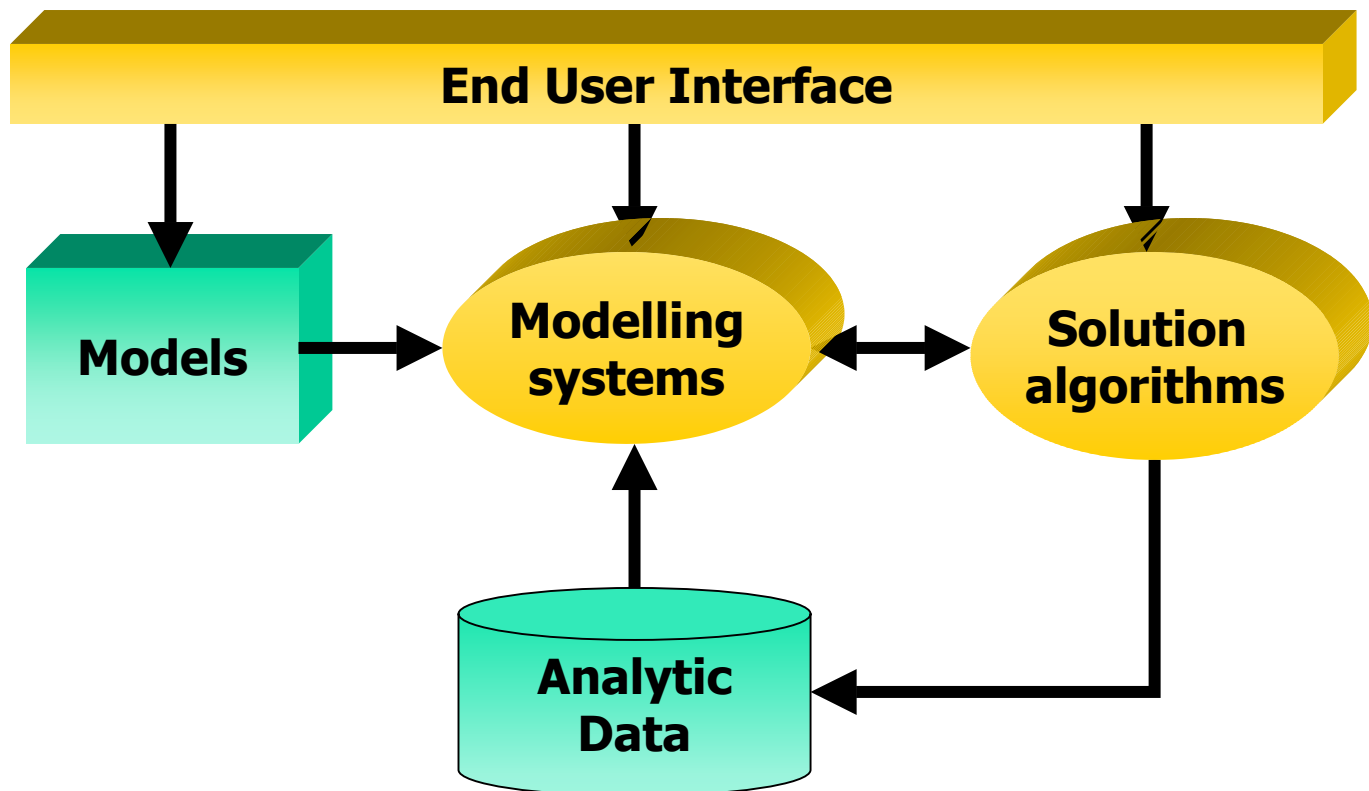
Triphonas Kyriakis

Outline

- Optimisation tools: evolution
- The ASP model
- Optimisation Service Provision (OSP)
- e-Services
- WebOpt
- Conclusions

Optimisation tools interaction

Traditionally, optimisation based applications comprise models, optimisers and analytical data, connected via a model management system.



Evolution: until the 1990s

- Proprietary tools. Optimisation routines and models are hard coded into the system
- Pros:
 - Close match to application requirement
 - Computational Efficiency
 - Customised data mart and reporting facilities
- Cons:
 - Expensive and time consuming to build
 - Poor connectivity to other applications
 - In general, non-flexible and hard to adapt when the application changes

Evolution: the 1990s

- Off-the shelf tools: Optimisers and Modelling Systems
- Variety of modelling systems possess database and solver connectivity
- Pros:
 - Rapid prototyping can be achieved
 - Industry standard connectivity to other applications such as databases and reporting tools
 - Models can be communicated in file form between different analysts and users

Cons:

- Customised DSS still developed using proprietary technology
- Reliability of the tool associated with the vendor
- Incompatibility between different tools

Evolution: nowadays

- Optimisation increasingly used as an inference engine
- Modelling systems and solvers are becoming available in **component form**
- Optimisation tools now allow more MP paradigms (QMIP and SP)
- Internet technology has facilitated the creation of distributed applications

Application Service Provision (ASP)

- According to the definition:
 - The provision of applications over an electronic network
- In practice:
 - Delivery of software programs via Web browsers or other internet-based clients
- Underlying idea:
 - Outsourcing of (computation) resources

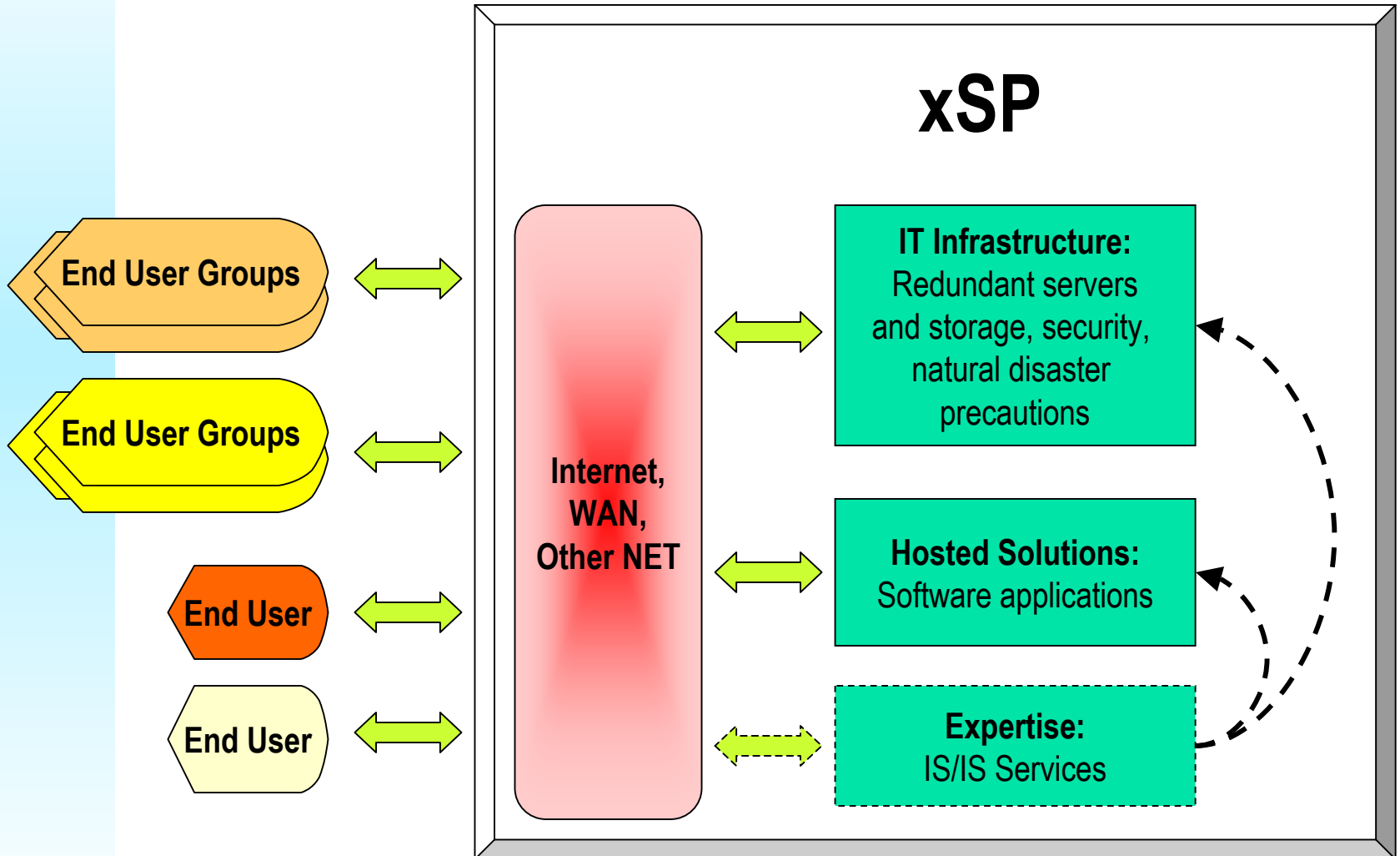
Application Service Provision (ASP)

- Application Service Provision (ASP) is promising to reduce the costs of acquiring state-of-the-art IT
- ASP ensures robustness, uptime and upgrade paths
- ASP take up the cost of acquiring, securing, configuring, and maintaining, on behalf of a client, all necessary IT infrastructure, in return of a pay-as-you-go fee

xSP

- The idea of application service provision is extended to include the provision of other IT and IS features:
 - MSP (Managed Service Providers)
 - NSP (Network Service Providers)
 - VSP (Vertical Application Providers)

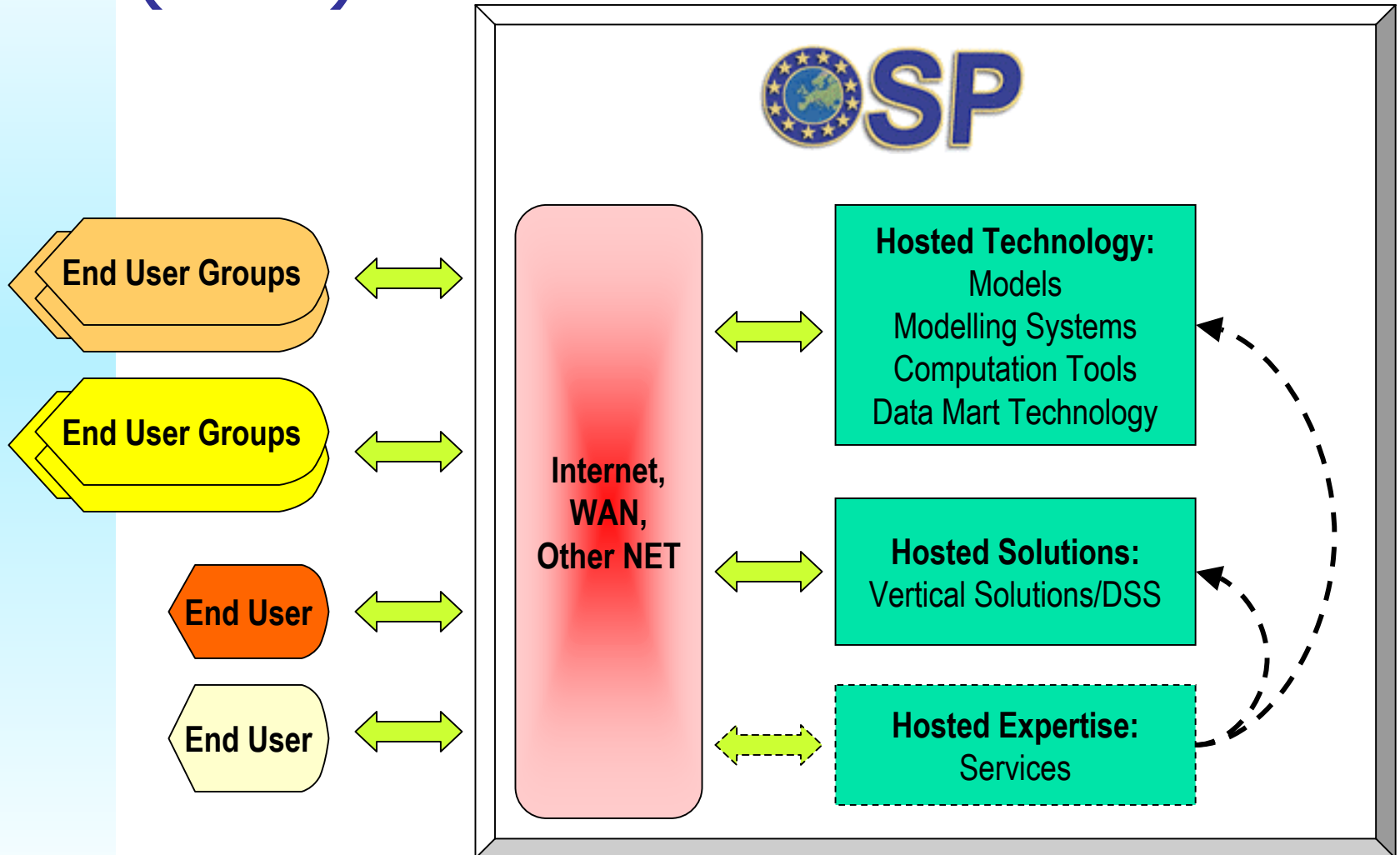
Typical xSP Solution



OSP: Overview

- Optimisation Service Provider
- EU craft project IST-1999-56410
- Adopts the xSP model specifically for the delivery of:
 - Optimisation tools
 - Vertical applications (Optimisation based DSS)
 - Expertise (Training material)
- Other approaches: NEOS,GRID

Optimisation Service Provision (OSP)



OSP components

- Solvers
 - CPLEX
 - OSL
 - FortMP
 - FortSP (SPInE's stochastic programming solver)
- Modelling systems
 - MPL
 - AMPL
- Vertical applications
 - Portfolio
 - Supply chain


Solver Engines: FortMP

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FortMP Control settings

OSP Job Management

FortMP Control Settings:

- Basic Control
- Simplex Control
- IPM Control

IPM Algorithm :	<input type="text" value="PDC"/>		PHI :	<input type="text" value="10"/>	?
IPM Solver :	<input type="text" value="Extended Supernodes"/>		Dare :	<input type="text" value="0.9995"/>	?
Feasibility Epsilon :	<input type="text" value="1.0E-7"/>	?	Power :	<input type="text" value="4"/>	?
Relative Epsilon :	<input type="text" value="1.0E-7"/>	?	Basis Recovery :	<input checked="" type="checkbox"/>	
Save Frequency :	<input type="text" value="10"/>	?			

- MIP Control
- QP Controls
- Tolerance Control
- Maximum Limits


SSX Iteration Limit :	<input type="text" value="50000"/>	?	MIP(full tree) Time :	<input type="text" value="50000.0"/>	?
IPM Iteration Limit :	<input type="text" value="80"/>	?	MIP(A-round tree) Solutions :	<input type="text" value="1"/>	?
MIP(full tree) Solutions :	<input type="text" value="300"/>	?	MIP(A-round tree) Nodes :	<input type="text" value="5000"/>	?
MIP(full tree) Nodes :	<input type="text" value="50000"/>	?	MIP(A-round tree) Time :	<input type="text" value="5000.0"/>	?

- Log Control

Done

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Solver Engines: CPLEX

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Control Settings CPLEX
OSP Job Management

Control Settings for CPLEX :

- [-] Simplex
- [-] Limits
- [-] Preprocessing
- [-] MIP Strategy, MIP Tolerance and MIP CUTS
- [-] Barrier and Network

Barrier Algorithm:	<input type="text" value="Default primal/dual log barrier"/>	Network Simplex pricing algorithm:	<input type="text" value="Automatic"/>
Barrier ordering algorithm :	<input type="text" value="Automatic"/>	Simplex network extraction level :	<input type="text" value="Try reflection scaling"/>
Barrier starting point algorithm :	<input type="text" value="Dual is zero"/>	Network feasibility tolerance :	<input type="text" value="1e-006"/>
Barrier column nonzeros :	<input type="text" value="0"/>	Network optimality tolerance :	<input type="text" value="1e-006"/>
Barrier maximum correction limit :	<input type="text" value="-1"/>	Network Simplex iteration limit :	<input type="text" value="2100000000"/>
Barrier iteration limit :	<input type="text" value="200"/>		
Barrier growth limit :	<input type="text" value="10000000"/>		
Barrier objective range :	<input type="text" value="1e+020"/>		
Variable upper limit :	<input type="text" value="1e+020"/>		
Convergence tolerance :	<input type="text" value="1e-008"/>		

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Solver Engines: OSL

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Control Settings OSL

[OSP Job Management](#)

Control Settings for OSL : [LP Simplex based]

Log / Output

The Log frequency: ? Log File : ?

The log level: ? Export Basis : ?

Preprocessing

Create a starting basis of all slack variables : ? Parametric analysis of a LP problem : ?

Crash processing : ? Pre-Solve : ?

Crossover from the interior point solver to the simplex solver : ? Scaling : ?

Decompose Crash : ?

LP Simplex

The maximum number of iterations before a refactorization : ? The allowed amount of dual infeasibility : ?

The maximum number of iterations : ? The weight of the linear objective : ?

The type of Devex pricing : ? The multiplier of the feasible objective : ?

The fast iteration switch : ? The proportion of the feasible objective : ?

The allowed amount of primal infeasibility : ? The rate of change for Rpweight or Rdweight : ?

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Modelling systems: AMPL

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Modelling Tools [AMPL]
OSP Job Management

Model File Name (eg: test.mod)

```

set PROD; # products

param rate {PROD} > 0; # tons produced per hour
param avail >= 0; # hours available in week

param profit {PROD}; # profit per ton
param market {PROD} >= 0; # limit on tons sold in week

var Make {p in PROD} >= 0, <= market[p]; # tons produced

maximize total_profit: sum {p in PROD} profit[p] * Make[p];

# Objective: total profits from all products

subject to Time: sum {p in PROD} (1/rate[p]) * Make[p] <= avail;


# Constraint: total of hours used by all
# products may not exceed hours available
          
```

Load Model :

To run the model Select Data File : [if required]

To run the model Choose solver : [Required when you run the model]

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Modelling systems: MPL

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OSP

Modelling Tools [MPL] [OSP Job Management](#)

Model File Name (eg: test.mpl)

```
{ ProdPlan.mpl }

TITLE
  Production_Planning;

INDEX
  product = 1..5
  month   = (Jan, Feb, Mar, Apr, May, Jun)
  machine = (Grind, Vdrill, Hdrill, Boring, Planing) : 2

DATA
  price[product]          = SPARSEFILE(price.dat);
  time[machine, product] = 1/100 DATAFILE(time.dat);
  MaxSales[month, product] = DATAFILE(sales.dat);
```

[Save Model](#) [Write Model](#)
[Check Syntax](#) [Upload](#)
[Solve](#) [Download](#)
[Clear All](#)

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Vertical applications: Portfolio


(Discrete Efficient Frontier Visualisation)

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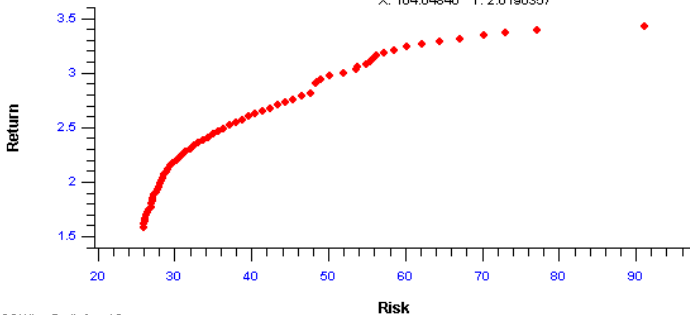
Portfolio Application

Efficient Frontier Visualization

Selected Stocks:

osp frontier

X: 104.04846 Y: 2.6190357



Return

Risk

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Show the Results Page

Number of Points	Risk	Return
1	91.1177488699115	3.42111791472114
2	77.0775071768389	3.39450789280424
3	72.9551223201795	3.36789787088733
4	70.1774545939025	3.34128784897043
5	67.1810883625643	3.31467782705353
6	64.523016894356	3.28806780513662
7	62.2032401892776	3.26145778321972
8	60.2217582473291	3.23484776130282

OSP Job Management

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Vertical applications: SCM

(Discrete Efficient Frontier Visualisation)



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SCM Application
OSP Job Management

► View Profits Data

Costs per Scenario:

(+) Scenario	(+) Time Period	Production Cost	Extra Capacity Cost	Inventory Cost	Extra Inventory Costs	Shortage Costs	Configuration Change Costs
AVG	ALL	67					

► Scenario Summary

1 View Scenario

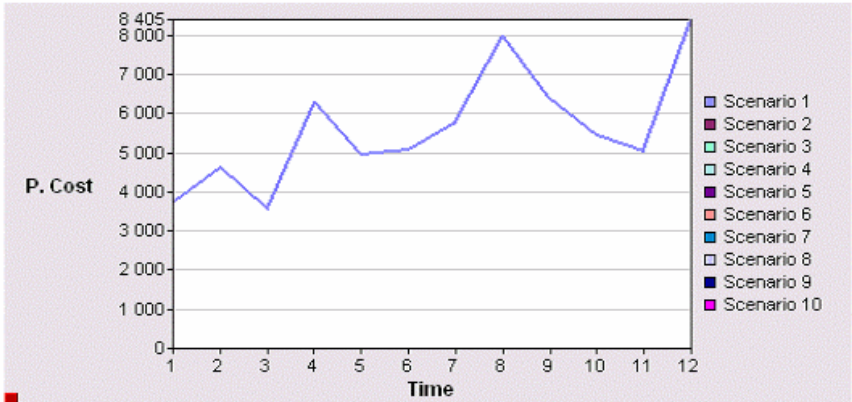
► Costs Distribution

[Distribution of Costs](#)

► Individual Costs

[Production Cost](#) [Extra Cap](#)

Production Cost per Time Period



Legend: Scenario 1 (Blue), Scenario 2 (Red), Scenario 3 (Green), Scenario 4 (Cyan), Scenario 5 (Purple), Scenario 6 (Orange), Scenario 7 (Teal), Scenario 8 (Light Blue), Scenario 9 (Dark Blue), Scenario 10 (Pink)

e-Services

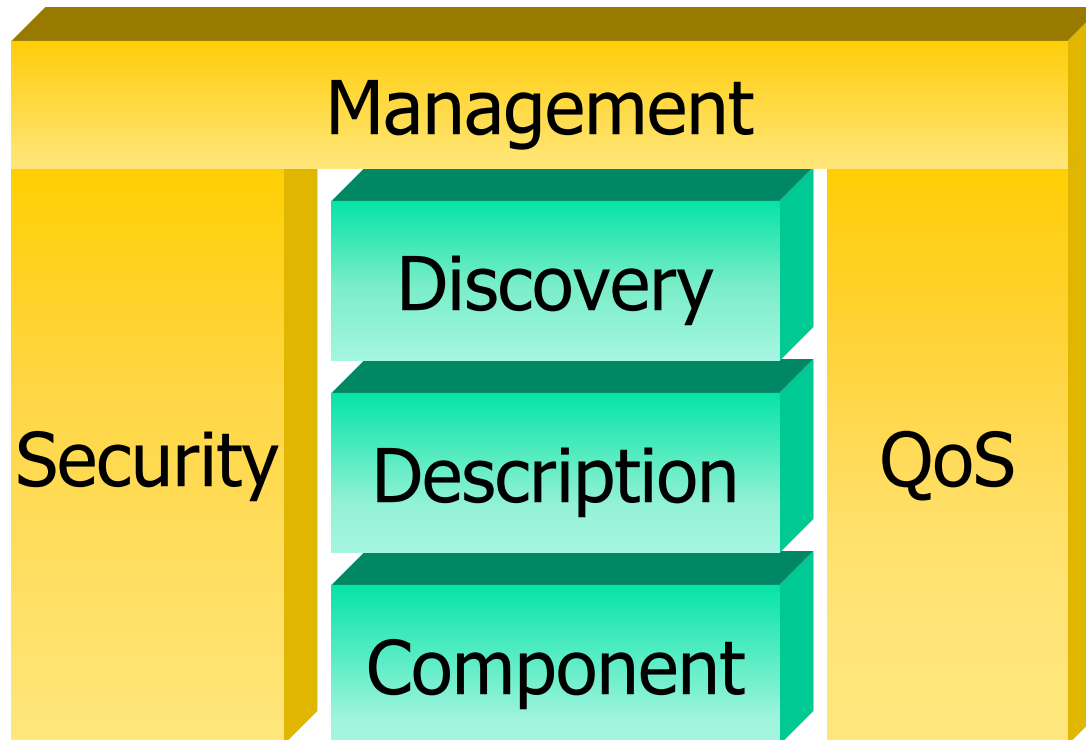
- According to the definition:
 - The provision of **services** over an electronic network

- In practice:
 - Extends ASP by enriching the underlying application with support infrastructure
 - Merge several xSP's into one

- Underlying ideas:
 - Components and customer focus

e-Services

- Technology based on the concept of web-service



e-Services and optimisation



**This is an
e-Service!**

WebOpt

- EU-sponsored ASIA IT&C project
- Promotes knowledge transfer and collaboration between Europe and Asia
- Extends OSP by implementing optimisation web-services
- The aim is to develop complete optimisation e-Services

Conclusions

- ASP is a viable model for optimisation (See OSP)
- Optimisation components are becoming all the more important in DSS
- Deployment of optimisation in BPM requires DSS with extended features
- E-Services are a natural direction for the provision of optimisation tools