

Optimisation Service Provider (OSP) Project:

From Web-based Applications to Web-Services

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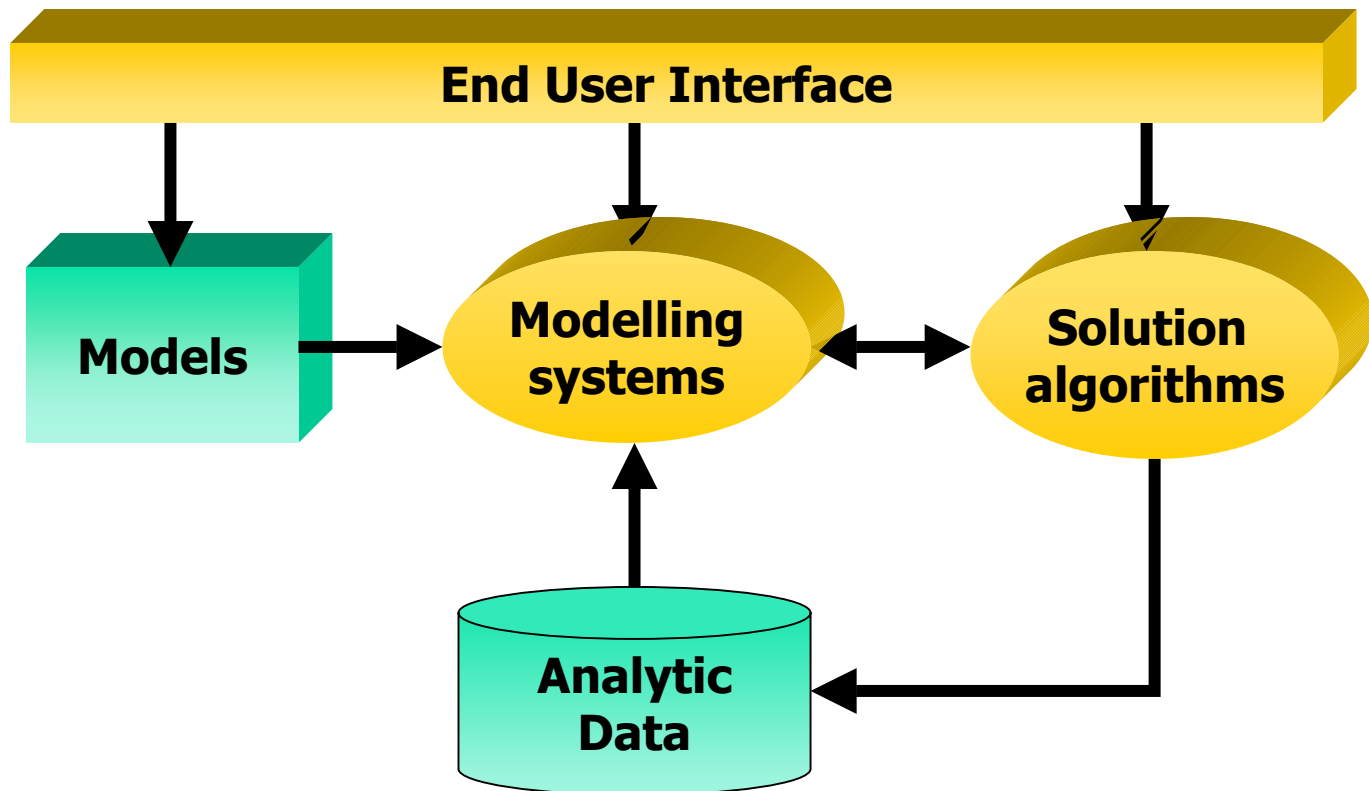
AIRO 2003, 2-5 September, Venice, Italy

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, not 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

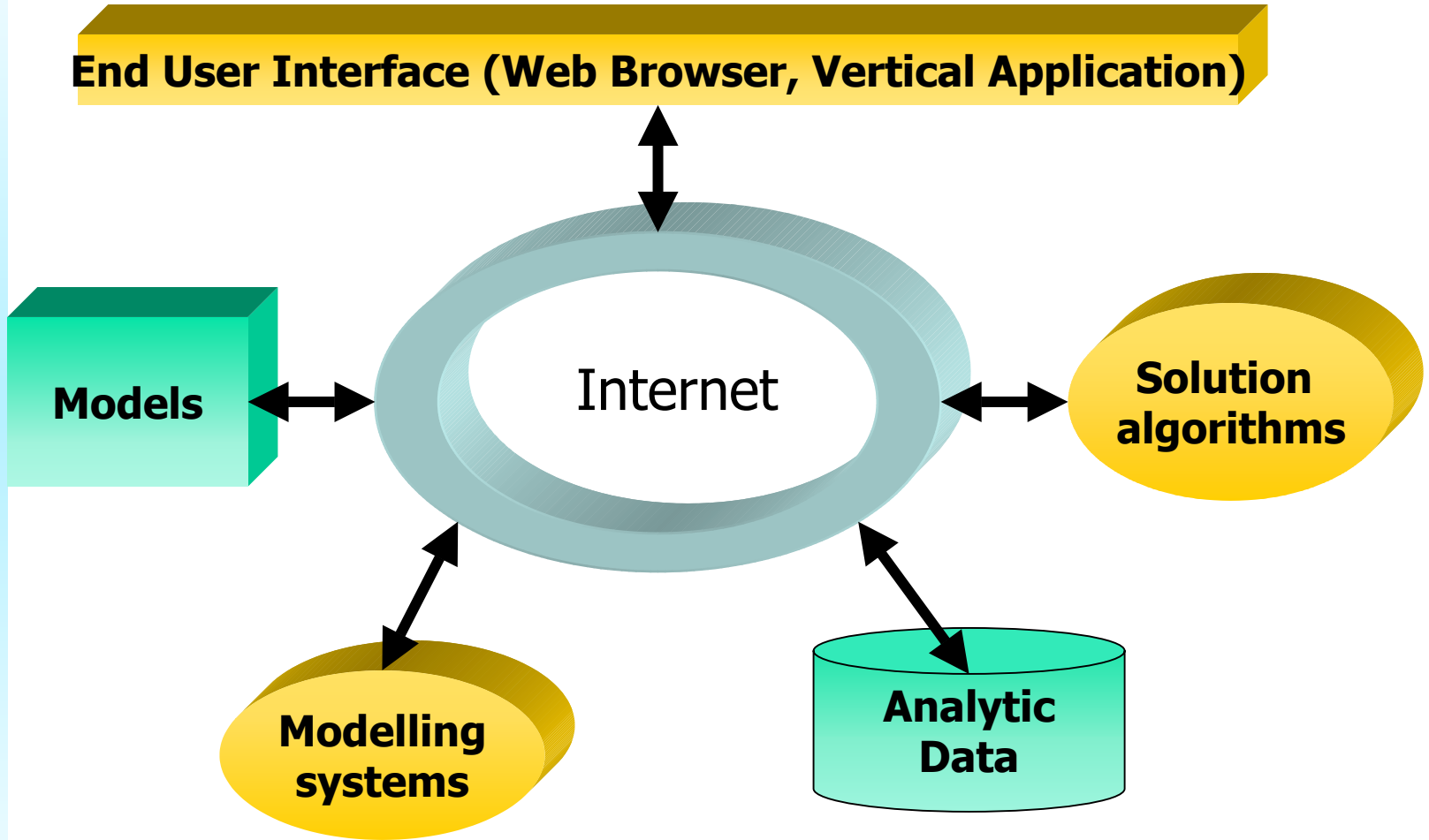
Cons:

- 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

Distributed optimisation



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

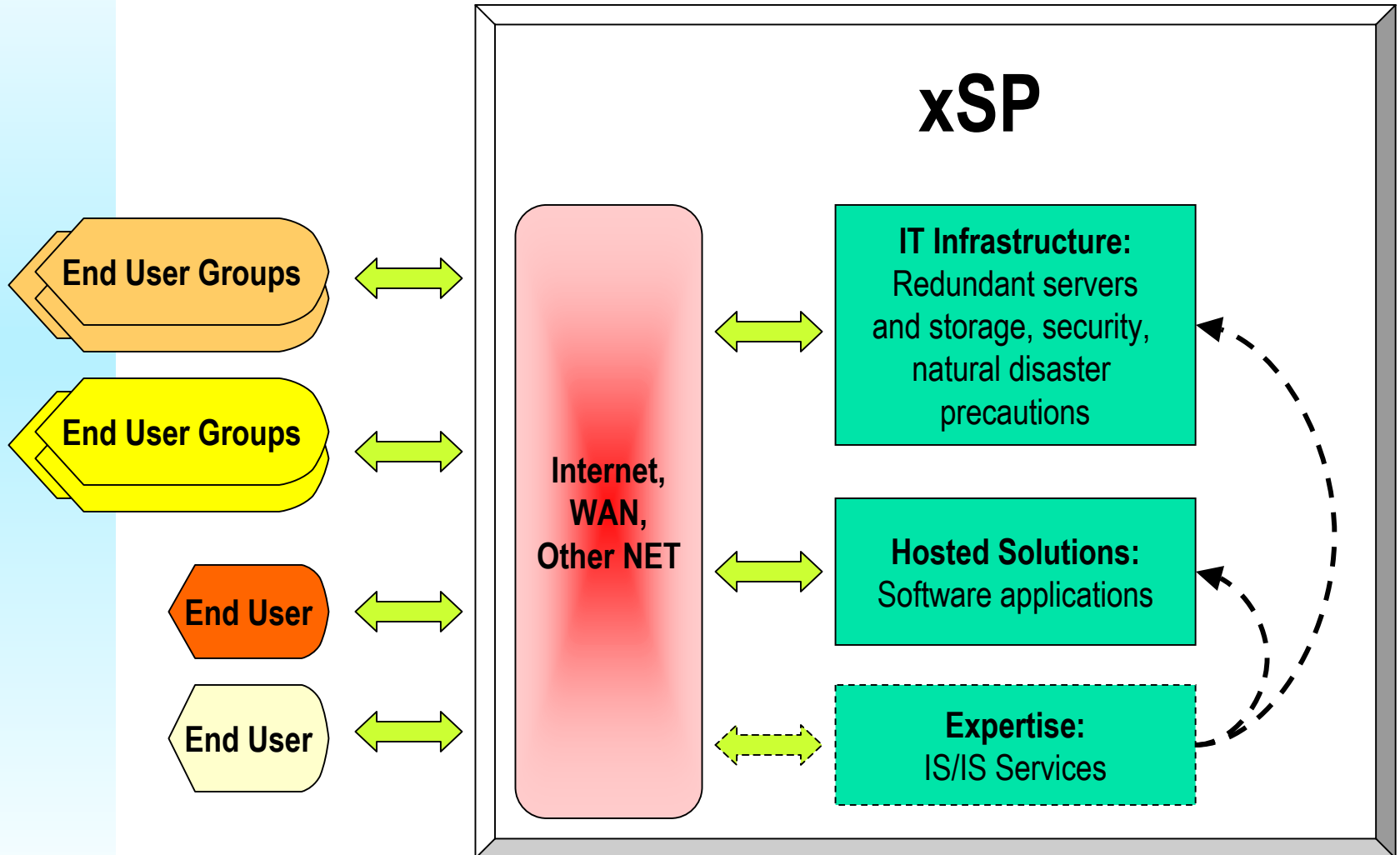
Application Service Provision (ASP)

- Application Service Provision (ASP) promises 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 Service Providers)

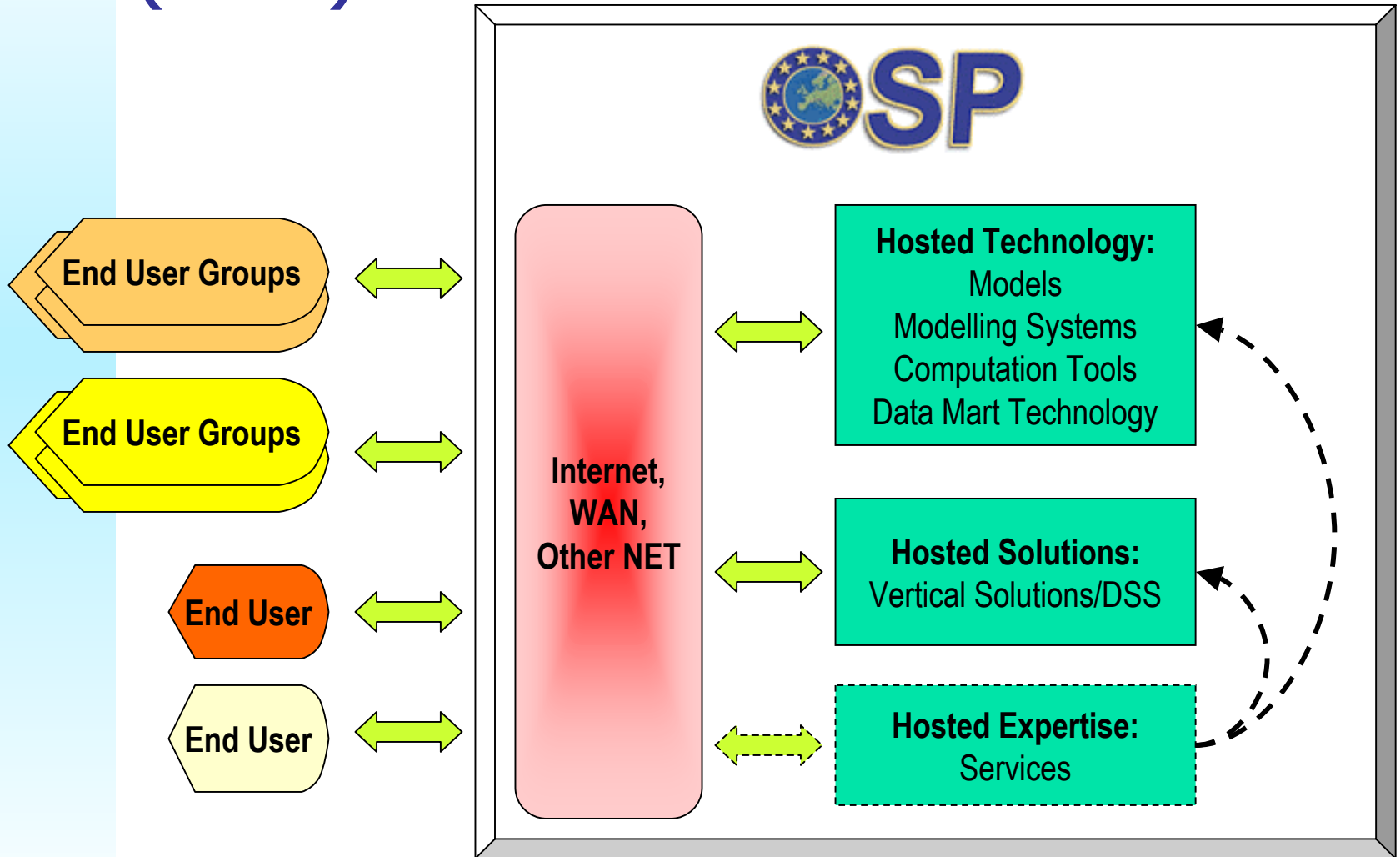
Typical xSP Solution



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)

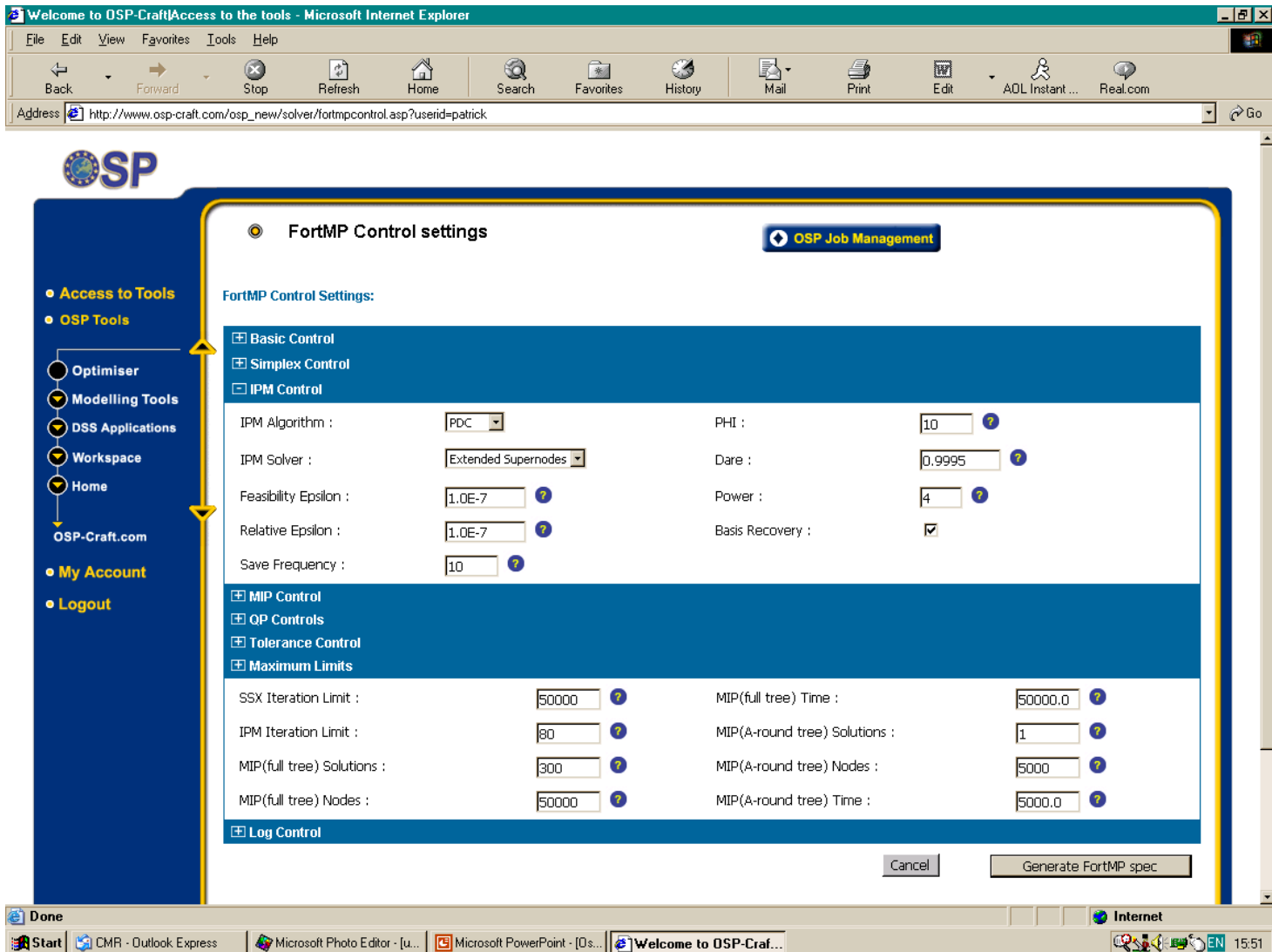
Optimisation Service Provision (OSP)



OSP components

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

Solver Engines: FortMP



Welcome to OSP-Craft (Access to the tools - Microsoft Internet Explorer)

Address: http://www.osp-craft.com/osp_new/solver/fortmpcontrol.asp?userid=patrick

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

Solver Engines: CPLEX

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Address http://www.osp-craft.com/osp_new/solver/cplex1.asp?app=CPLEX%20Solver%20Parameters&userid=patrick Go

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- Modelling Tools
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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"/>		

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 : ?

Modelling systems: AMPL

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Address http://www.osp-craft.com/osp_new/modellingampel.asp?action=open&val=steel.mod

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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]

Start | Optirisk - Outlook E... | Microsoft Photo Edit... | Microsoft PowerPoi... | Welcome to OS... | 20/20 | Media Browser | RealOne Player: Lazy | Internet | 16:03

Modelling systems: MPL

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Address http://www.osp-craft.com/osp_new/modelling.asp?action=open&val=Prodplan.mpl

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Modelling Tools [MPL]

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

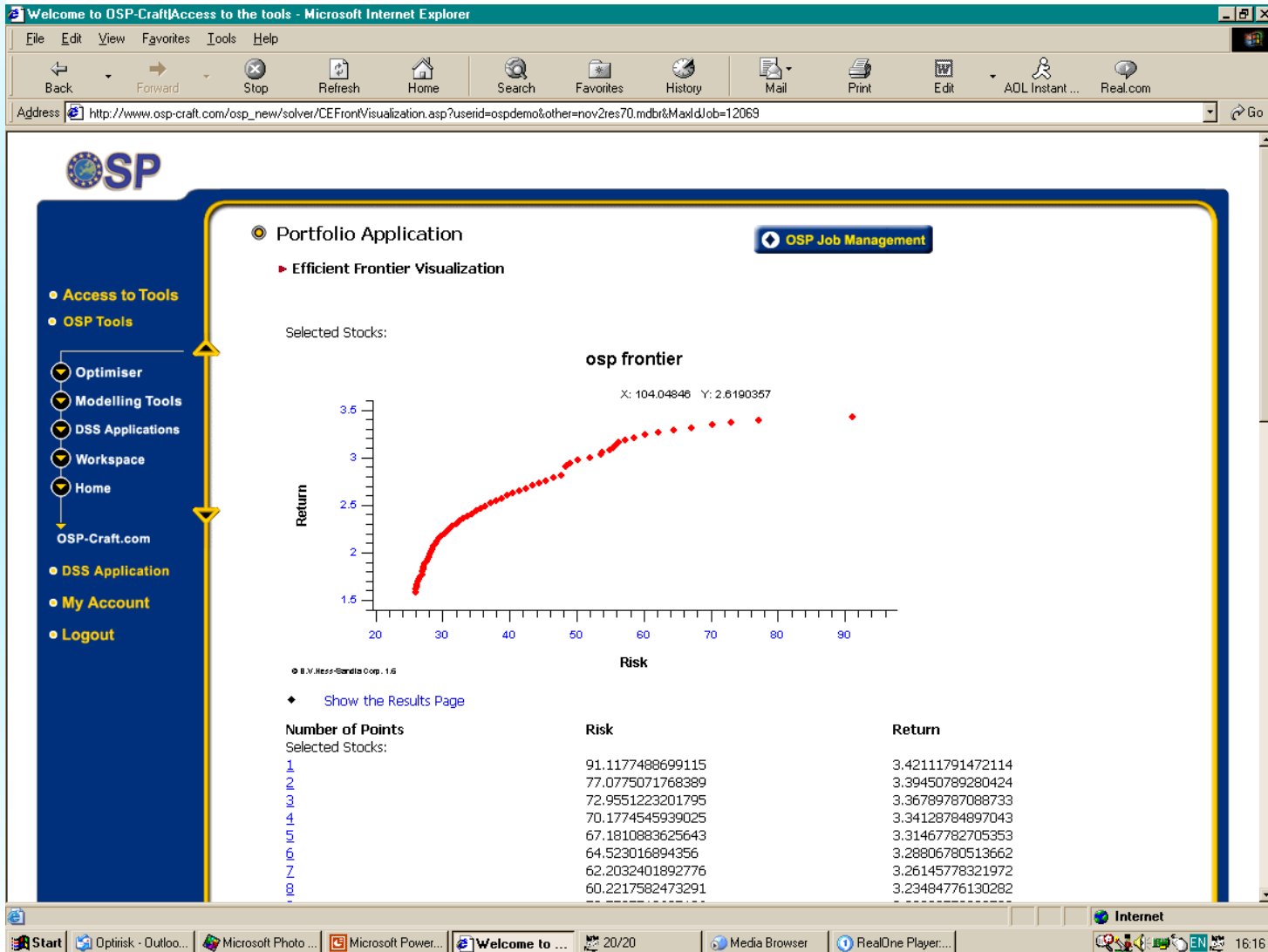
Download

Clear All

-Load Model-

Vertical applications: Portfolio

(Discrete Efficient Frontier Visualisation)



Vertical applications: SCM

(Discrete Efficient Frontier Visualisation)

OSP

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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
- Scenario 2
- Scenario 3
- Scenario 4
- Scenario 5
- Scenario 6
- Scenario 7
- Scenario 8
- Scenario 9
- Scenario 10

NEOS

- Provides access to several classes of solvers
 - Linear Programming
 - Mixed Integer Programming
 - Mixed Integer Nonlinearly Constrained Optimisation
 - Nonlinearly Constrained Optimisation
 - Stochastic Programming
 - Complementarity Problems
 - Others
- Can be used as remote solver using the kestrel client for AMPL
- Website: <http://www-neos.mcs.anl.gov/neos>


NEOS

NEOS Server: FortMP 3.2e WWW Interface - Microsoft Internet Explorer

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Address <http://www.neos.mcs.anl.gov/neos/solvers/LP.FORTMP-AMPL/solver-www.html> Go



WWW Interface

FortMP 3.2e

The user must submit a model in [AMPL format](#) or [MPS format](#) to solve a linear, mixed integer or quadratic mixed integer optimization problem. Examples of models in AMPL format can be found in the [netlib collection](#).

In AMPL, the model is specified by a model file, and optionally, a data file and a commands file.

If the command file is specified, it must contain the AMPL `solve` command. Do not use the `model` or `data` commands with file names. Your model and data files will be loaded before the commands file is run. The commands file can contain any other AMPL command or set options for FORTMP. Printing directed to standard out is returned to the user with the output.

[FORTMP solver options](#) can be set using:

```
option afortmp_options 'option=value';
```

Enter the AMPL model

AMPL model(local file):

Enter the AMPL data (optional).

AMPL data(local file):

Internet

Other distributed systems for optimisation

- AURORA / Financial GRID (Vienna Univ.)
- Open Optimization Framework (Imperial College)
- WebOpt (CARISMA et al.)

e-Services

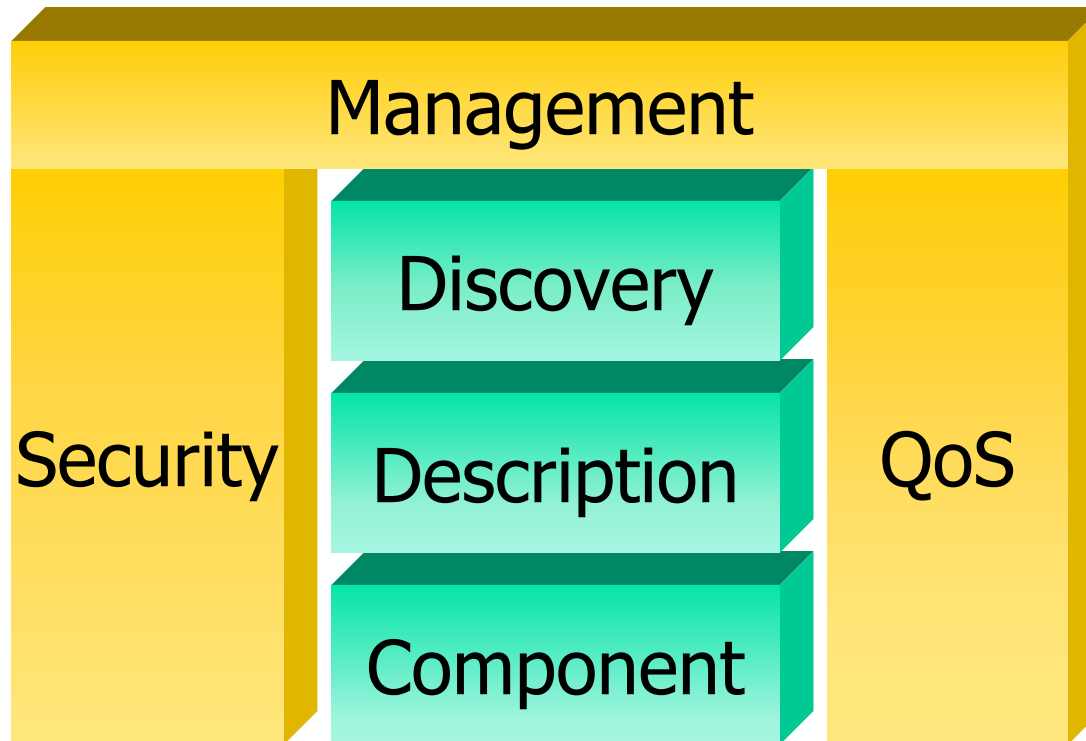
- According to the definition:
 - The provision of **services** over an electronic network

- 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!**

e-Services and optimisation

- The main ideas:
 - Provide each individual optimisation tool as an independent service
 - Enable remote interaction between the optimisation components
 - Take advantage of the e-Service paradigm for support and security

Web service

- Software system running on a server and providing a service by exposing a set of functions and methods.
- Concepts:
 - UDDI provides a worldwide registry for advertisement, discovery and integration of web services
 - WSDL describes the public interface of the service
 - SOAP is used to invoke methods provided by the web services
 - XML is used as the underlying representation format for the above and for the data sent to and from the web 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

WebOpt: solver web services

- Requirements:
 - Common calling interface
 - Common representation standard for
 - Input models
 - Optimum solutions
 - Messages

COIN based solver web service

- Based on the OSI Solver Interface
- Provides a set of methods to:
 - Upload and manipulate models
 - Set algorithmic parameters
 - Solve a model (using SSX, IPM, B&B...)
 - Extract the solution
- Methods are invoked using SOAP messages
- Uses (which?)ML to represent the MP model format and the results

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

Thank You



<http://www.optirisk-systems.com>

<http://carisma.brunel.ac.uk>

<http://www.osp-craft.com>

<http://www.webopt.org>