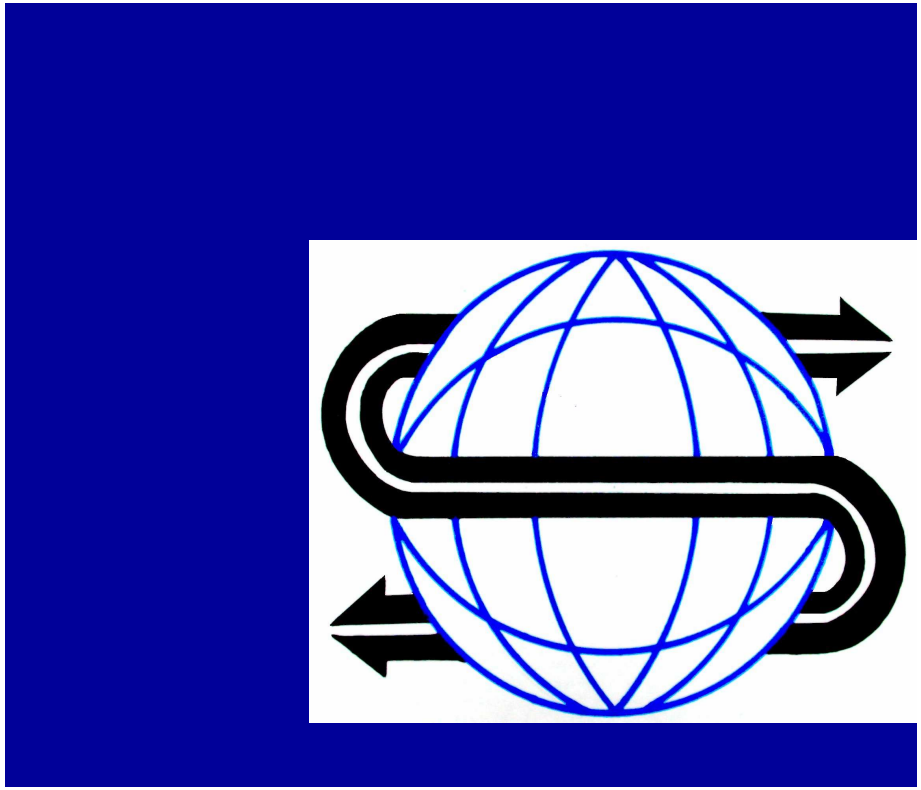

Optimization via Simulation under Optimization Services (OS)

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Industrial Engineering and Management Sciences
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IFORS, Hawaii, 07/14/2005

OUTLINE

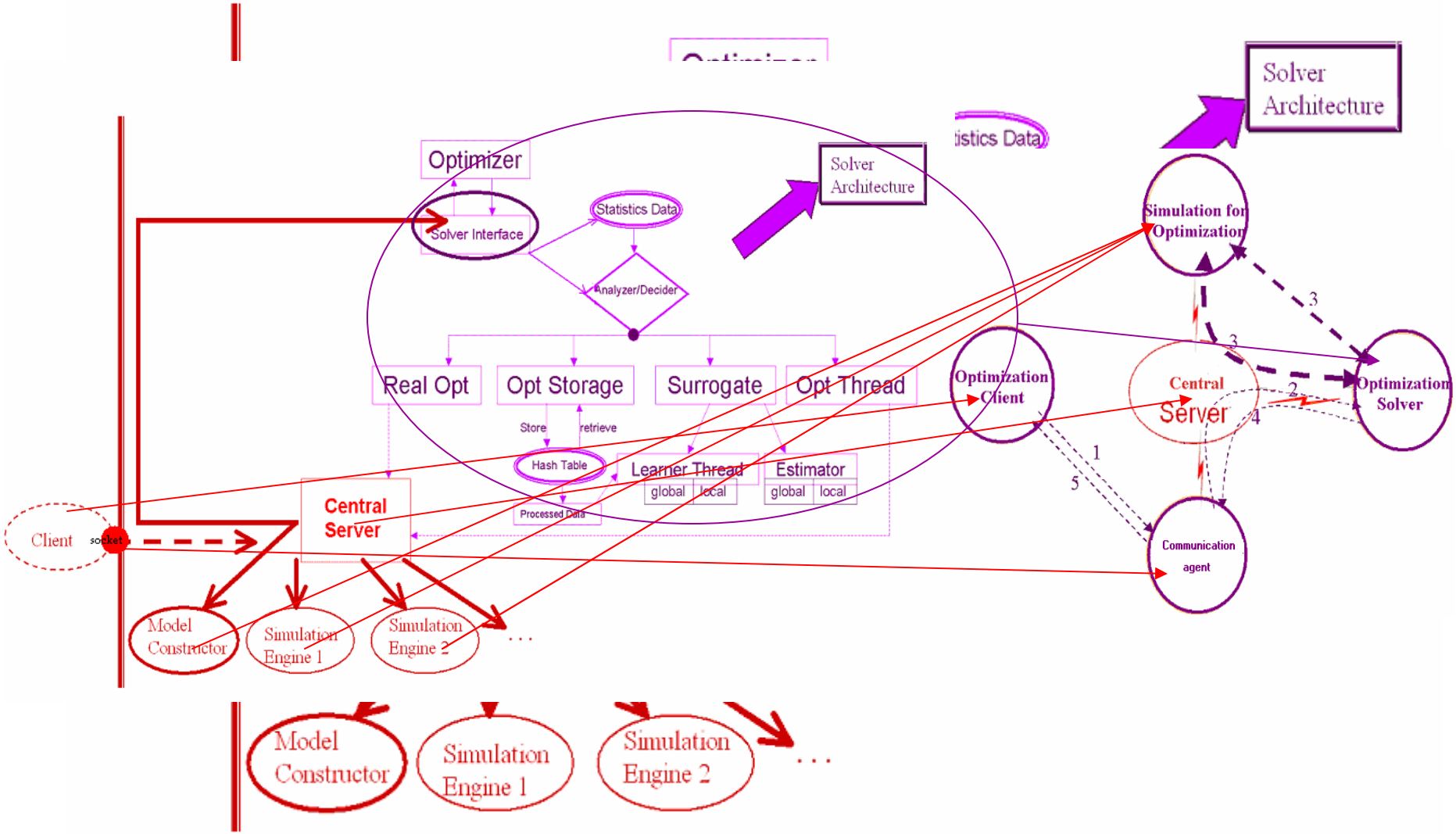
1. Optimization via Simulation – two case studies

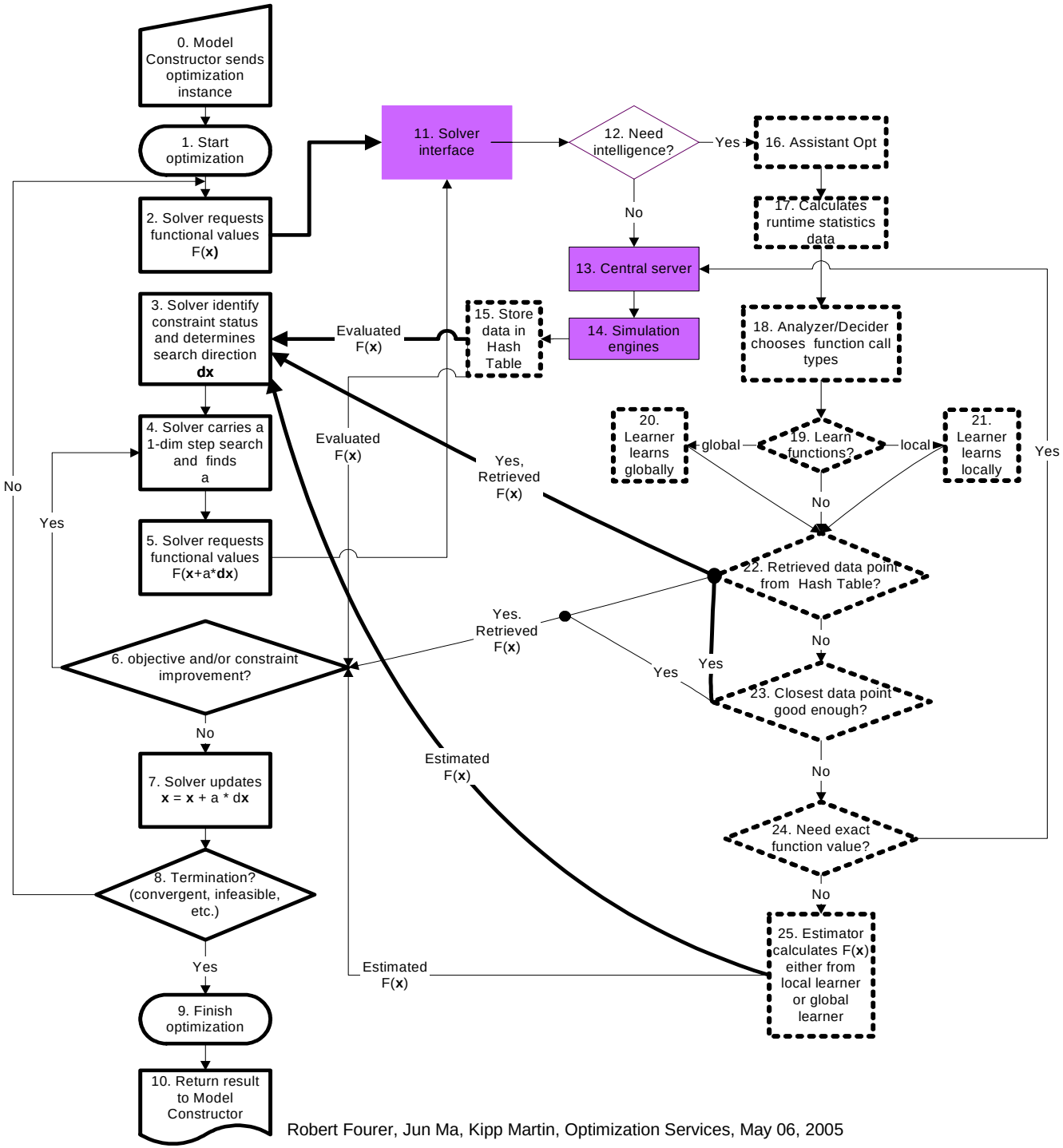
2. Optimization Services (simulation part)

3. Optimization Services via Simulation representation and communication

Optimization via Simulation

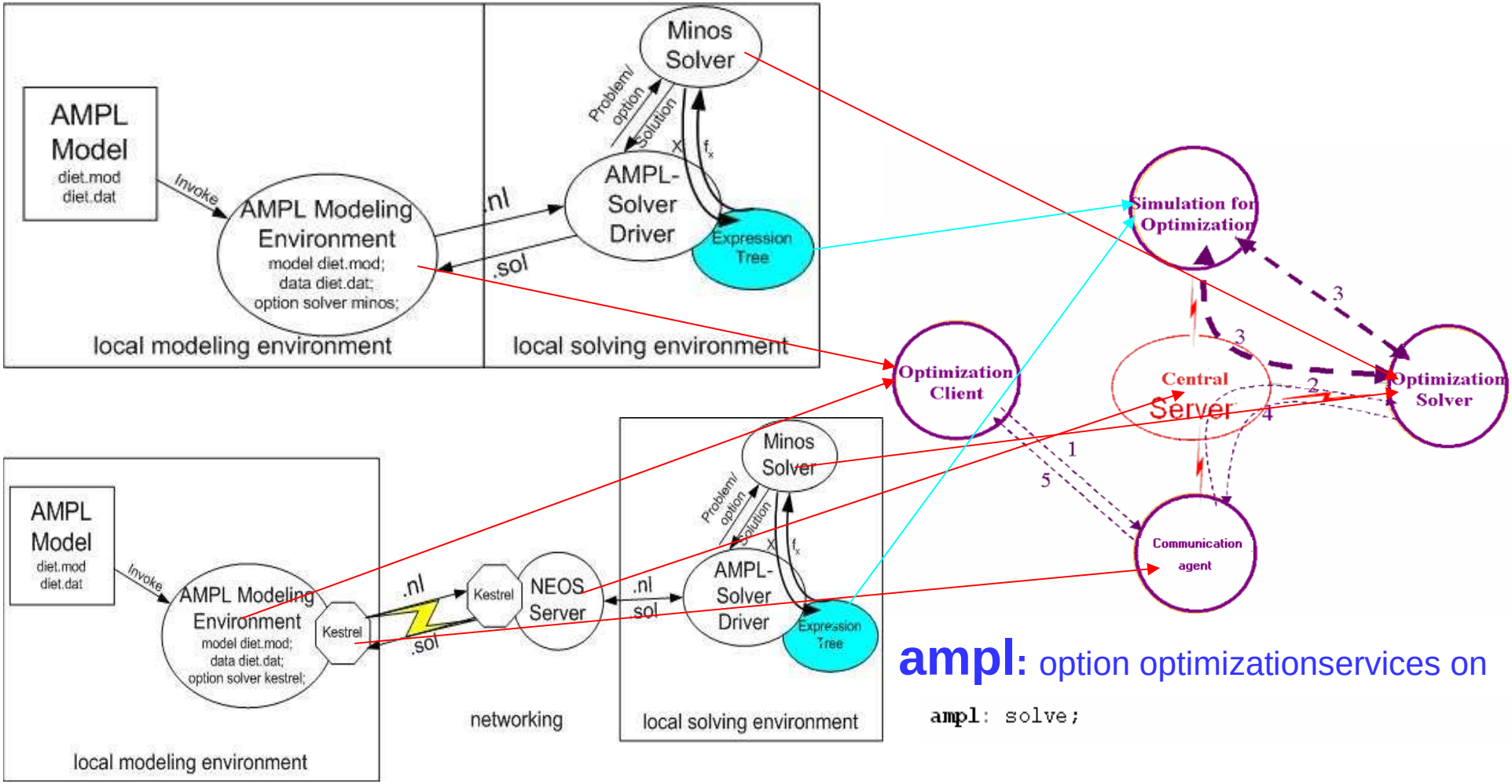
Case 1: Motorola Optimization System




0. Model Constructor sends optimization instance
1. Start optimization
2. Solver requests functional values F(x)
3. Solver identify constraint status and determines search direction dx
4. Solver carries a 1-dim step search and finds a
5. Solver requests functional values F(x+a*dx)
6. objective and/or constraint improvement?
7. Solver updates x = x + a * dx
8. Termination? (convergent, infeasible, etc.)
9. Finish optimization
10. Return result to Model Constructor
11. Solver interface
12. Need intelligence?
13. Central server
14. Simulation engines
15. Store data in Hash Table
16. Assistant Opt
17. Calculates runtime statistics data
18. Analyzer/Decider chooses function call types
19. Learn functions?
20. Learner learns globally
21. Learner learns locally
22. Retrieved data point from Hash Table?
23. Closest data point good enough?
24. Need exact function value?
25. Estimator calculates F(x) either from local learner or global learner
Yes
No
Evaluated F(x)
Yes, Retrieved F(x)
Yes. Retrieved F(x)
Estimated F(x)
global
local

Optimization via Simulation?

Case 2: MPL, NEOS and Kestrel



ampl: option optimizationservices on

```
ampl: solve;
```

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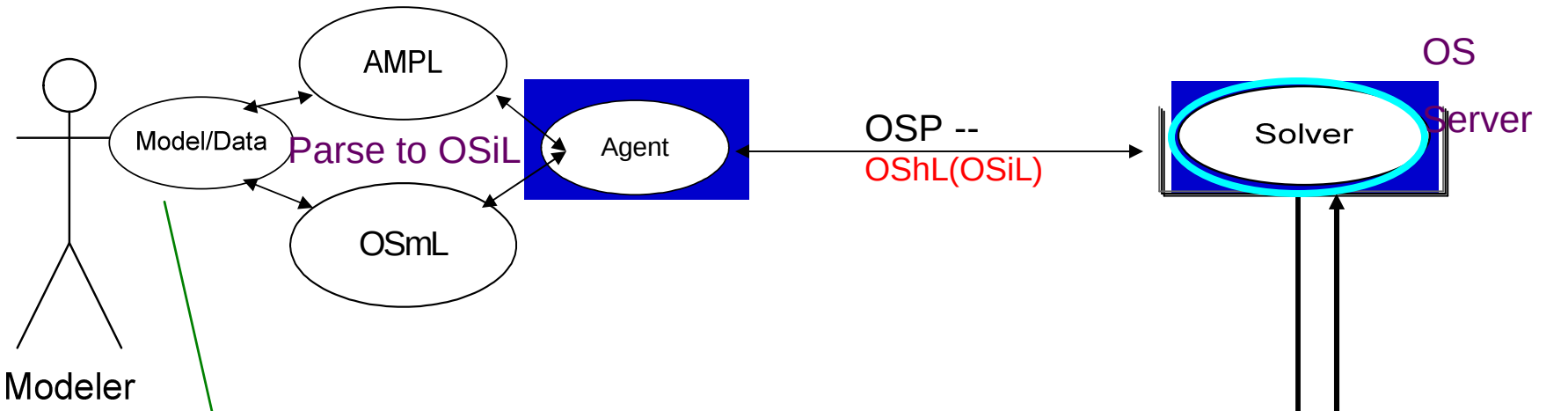
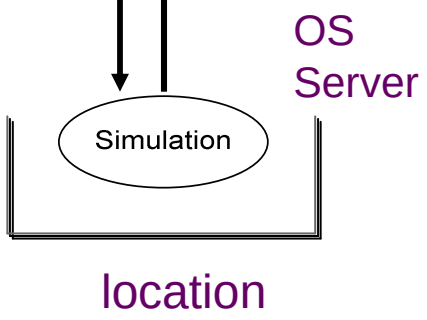
Optimization Services (OS)



Max f(x) :objective
x :variables
s.t. $lb_1 <= g_1(x) <= ub_2$:constraints
$lb_2 <= g_2(x) <= ub_2$

f(x) can be sin(x(1))+x(x(2))
$g_1(x)$ can be if(x(1)>0) then x(2) else cost(x(2))
$g_2(x)$ can be a metric from a finite element simulation
(non-closed form black box function evaluator)



OUTLINE

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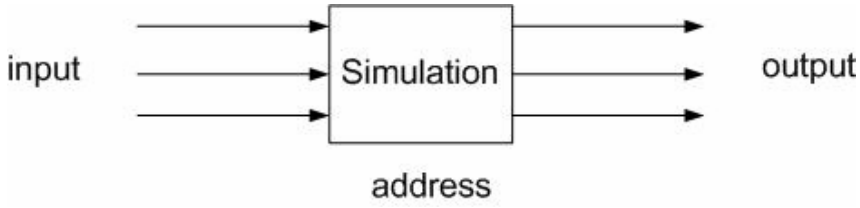
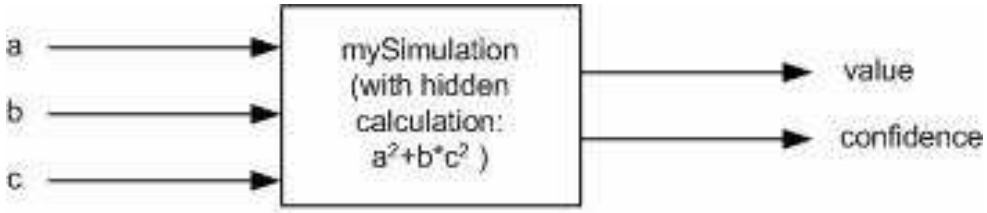
An Optimization Services View of a Simulation



$$\underset{x}{\text{minimize}} \quad x_1^2 + 2x_2^2$$

$$\text{subject to} \quad 2x_1 + 3x_2 \geq 9$$

$$x_1 \geq 0,\ x_2 \geq 0$$



http://somesite.com/mySimulation

$$\underset{x}{\text{minimize}} \quad mySimulation(x_1, 2, x_2)$$

$$\text{subject to} \quad 2x_1 + 3x_2 \geq 9$$

$$x_1 \geq 0, x_2 \geq 0$$

mySimulation{

address = http : // somesite .com / mySimulation

input :

a

b

c

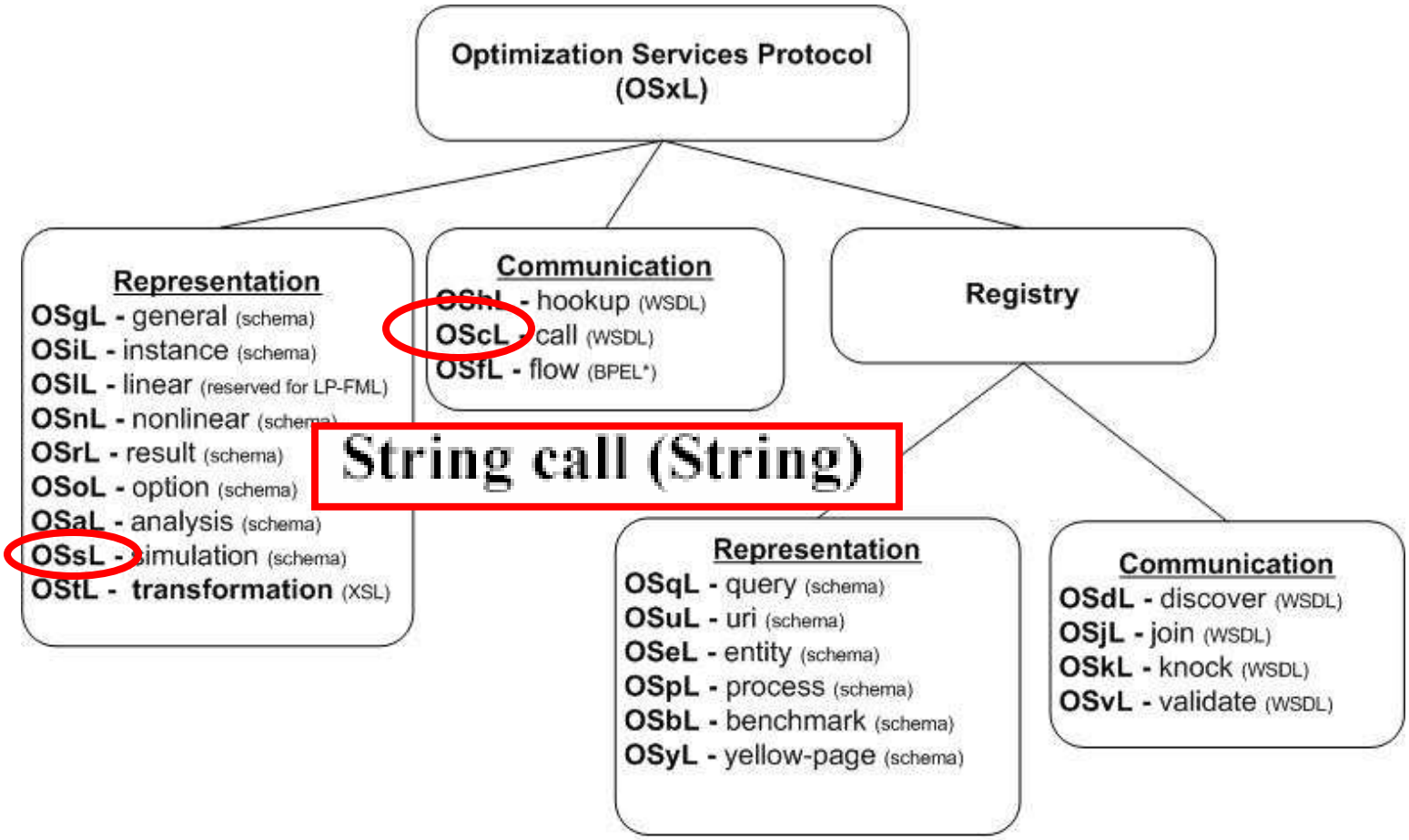
output :

*value + confidence * 0*

}

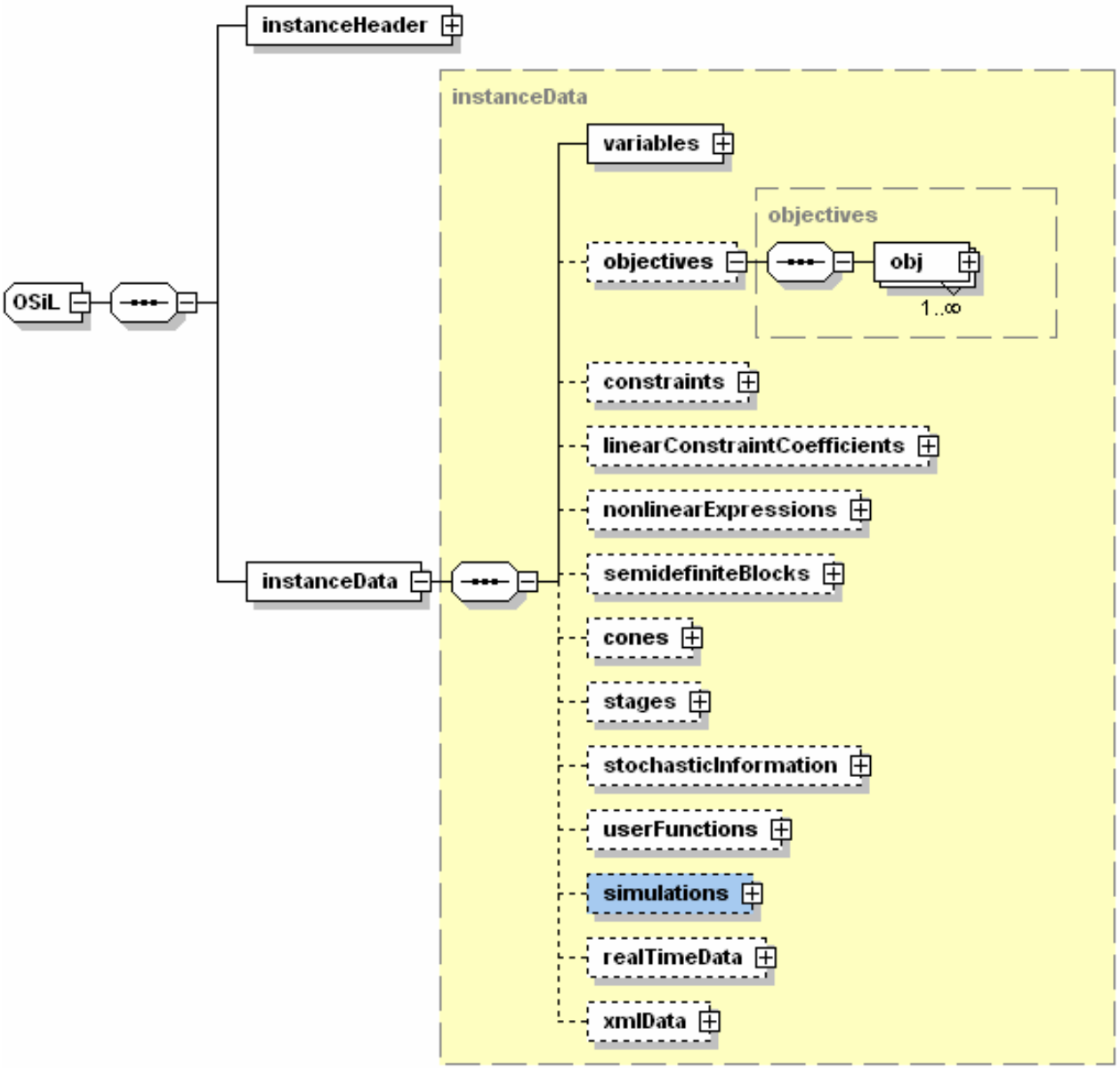
Optimization Services Protocol (OSP)

What does the protocol involve? – 20+ OSxL languages

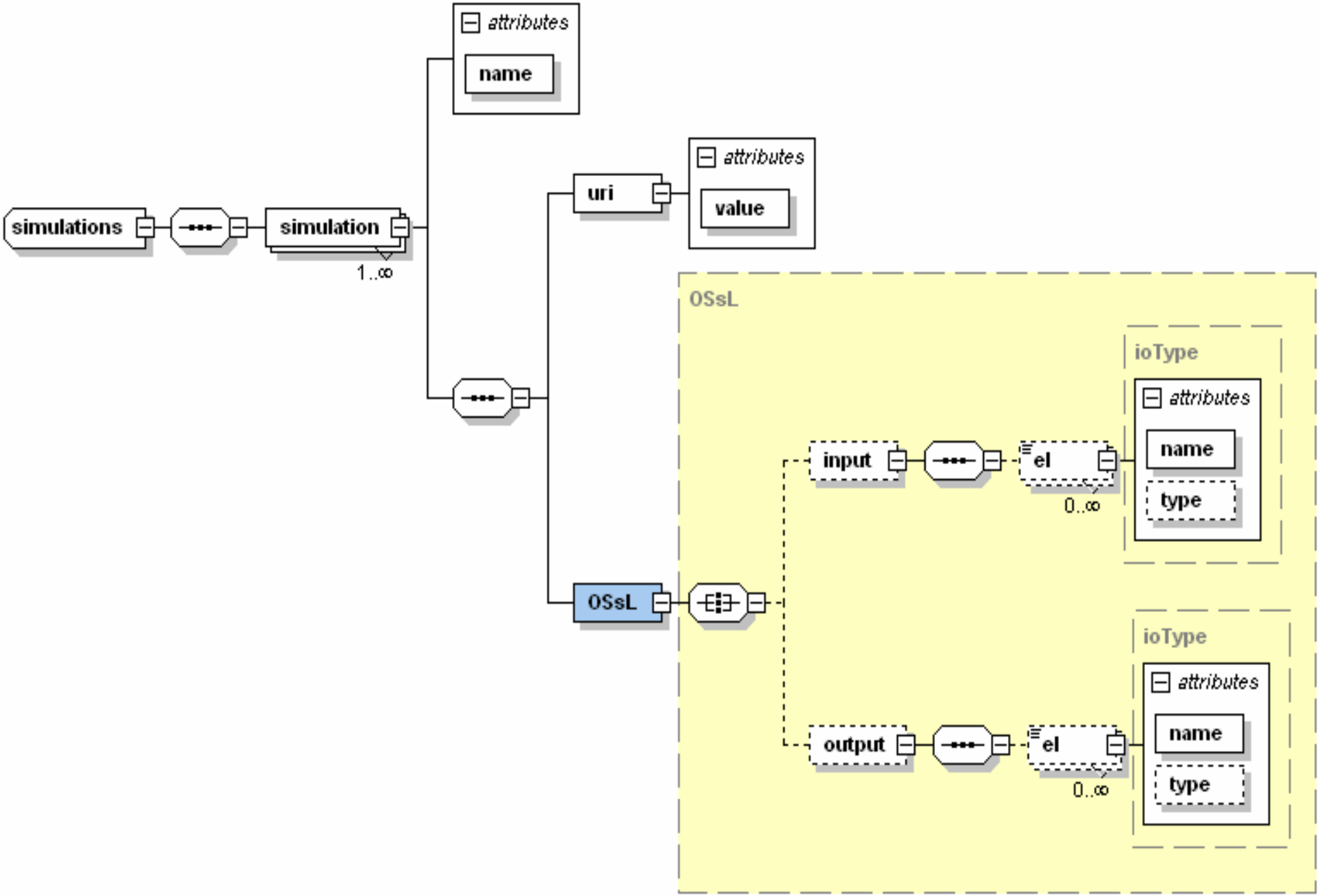


***OSmL:** a modeling language and NOT an Optimization Services Protocol
***Letters not currently used:** w, z
***BPEL:** Business Process Execution Language for flow orchestration.

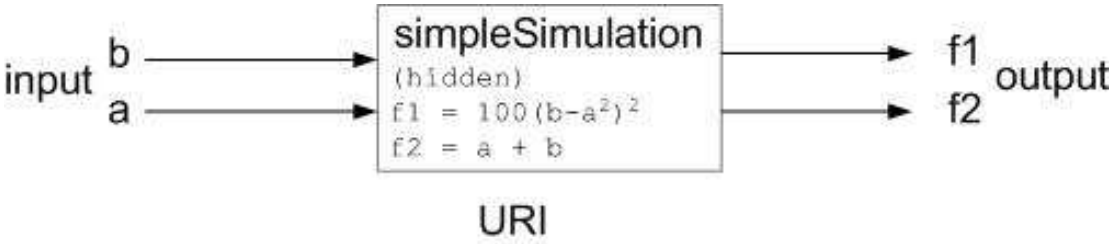
<Simulations> element in OSiL



<Simulations> element in OSiL



<Simulation> element in OSiL



$$mySimulation(x_0, x_1) : f_1 + (1 - x_0)^2 + 7x_1$$

```
<nl idx="-1">
    <plus>
        <sim name="simpleSimulation">
            <simInput inputName="a"> <var idx="0"/> </simInput>
            <simInput inputName="b"> <var idx="1"/> </simInput>
            <simOutput outputName="f1"/>
        </sim>
        <power>
            <minus>
                <number value="1"/>
                <var idx="0"/>
            </minus>
            <number value="2"/>
        </power>
    </plus>
</nl>
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    <simulation name="simpleSimulation">
        <uri value="http://www.optimizationservices.org/os/ossimulation/SimpleSimulationService.jws"/>
        <OSsL>
            <input>
            <el name="a"/> <el name="b"/>
            </input>
            <output>
            <el name="f1"/><el name="f2"/>
            </output>
        </OSsL>
    </simulation>
</simulations>
```
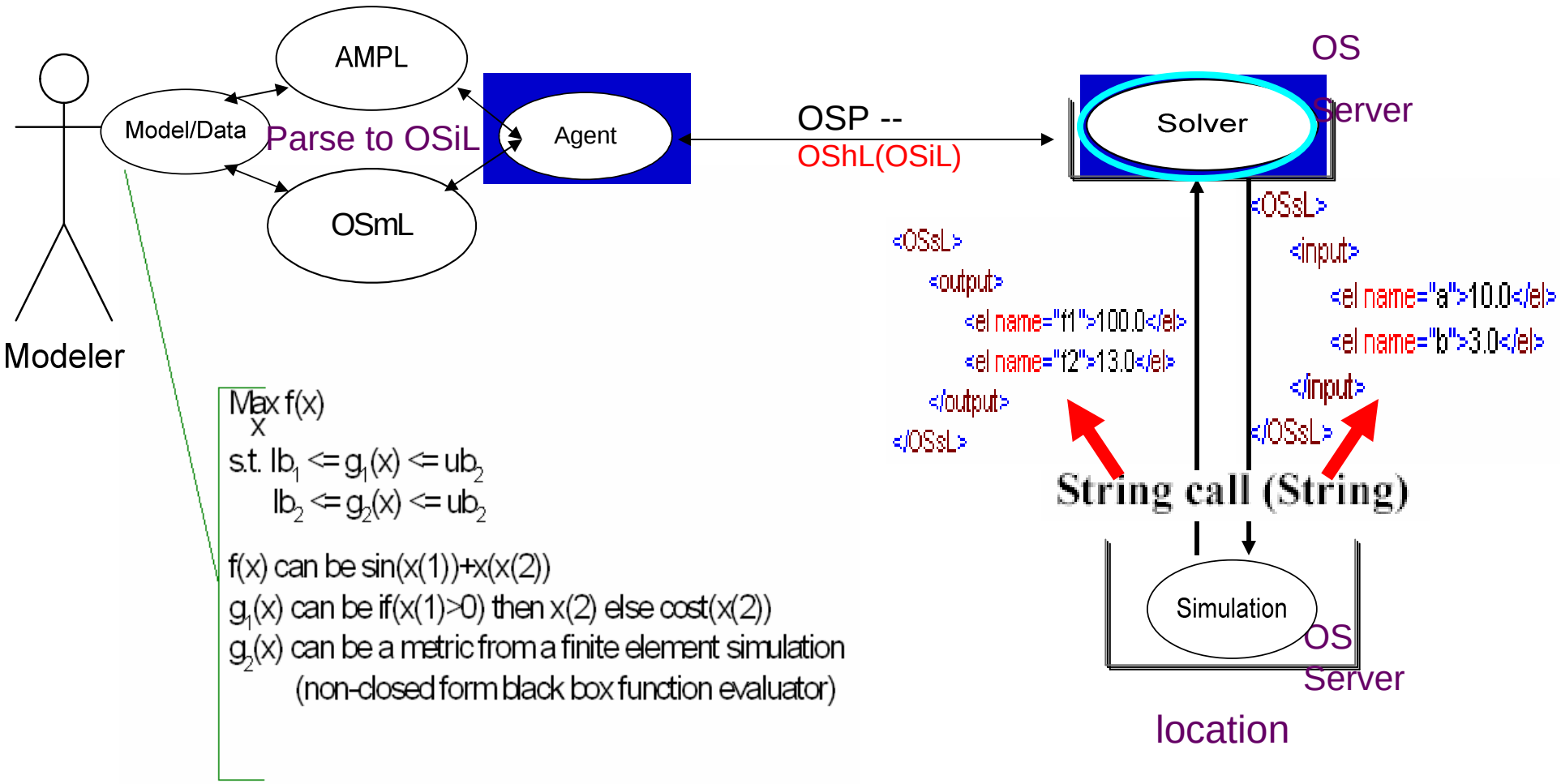
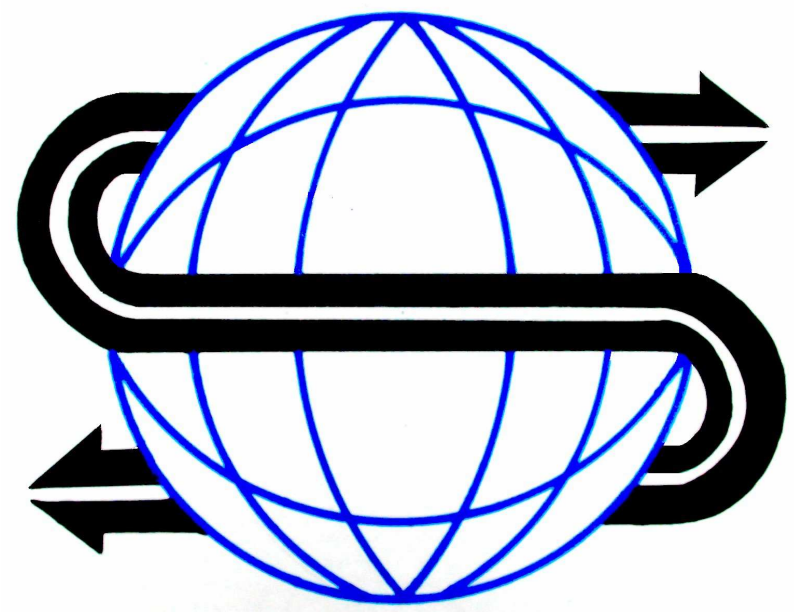

Optimization Services (OS)





http://www.optimizationservices.org