Puna InterOp 20/10/2011

A new working grammar for describing parameters (and their constraints) within the Virtual Observatory

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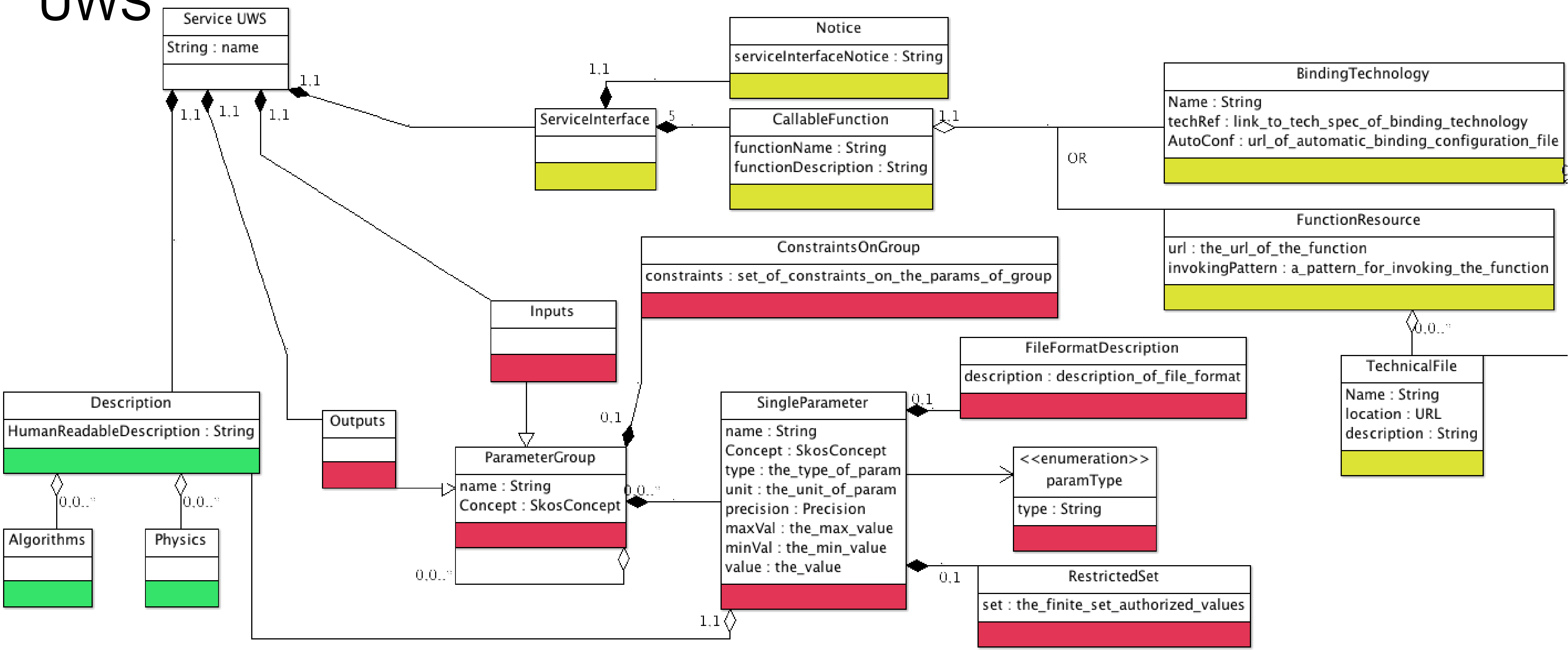

Grouped by:

What the service do (and how)

How to interact with the service (medium)

Explain the 'language' used for interacting with service

Which service should be chosen to meet given needs...

How to reach the service functions...

How to build the arguments for calling service functions and understanding the output results

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- Our needs comes from the requirements of Theory Group: they would like to deploy online codes with complex sets of in(out)put data .

Building our solution

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Input:

- $\boldsymbol{p}_1$ is a m/s vector speed and $\|\boldsymbol{p}_1\| < c$
- p_2 is a Kelvin temperature and $p_2 > 0$
- p_3 is a kg mass and $p_3 \geq 0$

Output:

- p_4 is a Joule Energy and $p_4 \geq 0$

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Input:

- $\mathbb{R} \ni p_1 > 0; p_2 \in \mathbb{N}; p_3 \in \mathbb{R}$
- if $p_1 \in]0, \pi/2]$ then
  $p_2 \in \{2; 4; 6\}$, $p_3 \in [-1, +1]$ and $(|\sin(p_1)^{p_2} - p_3|)^{1/2} < 3/2$.
- if $p_1 \in]\pi/2, \pi]$ then
  $0 < p_2 < 10$, $p_3 > \log(p_2)$ and $(p_1 \cdot p_2)$ must belong to $\mathbb{N}$.

Output:

- $\boldsymbol{p}_4, \boldsymbol{p}_5 \in \mathbb{R}^3$
- Always $\frac{\|\boldsymbol{p}_5\|}{\|\boldsymbol{p}_4\|} \leq 0.01$.

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Our ideas lead to a working solution fitting our requirements.

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- The grammar and syntax for building parameters description are fixed in a XML schema:

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- In practice:
  - Service providers (unless they want) don't need to handle directly the XSD file

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    - All the possible mathematical expressions involving parameters
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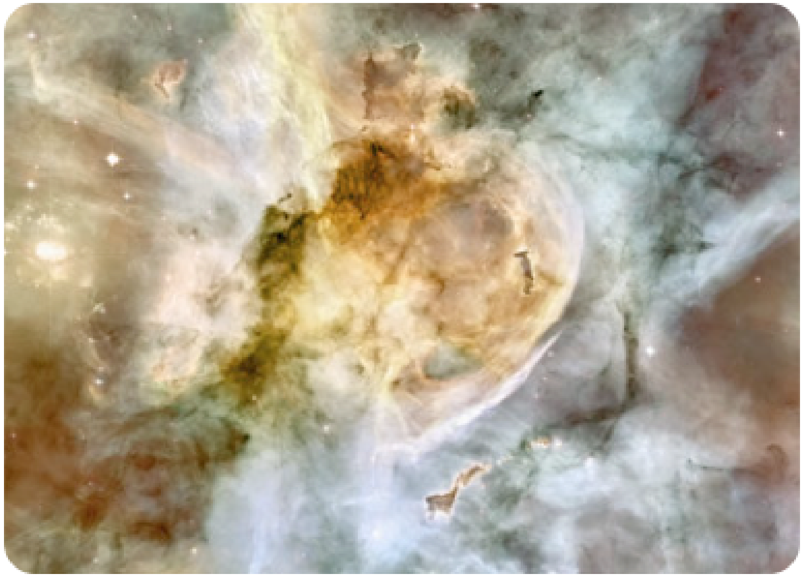
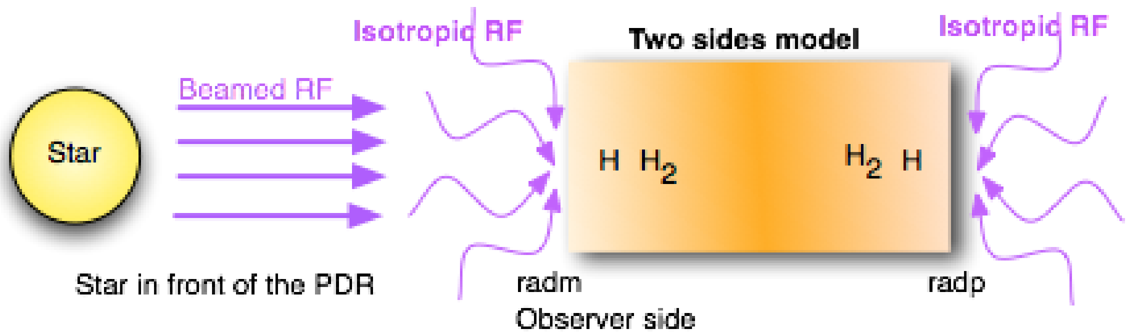
  - With our protocol, one could easy express
    - All the possible mathematical expressions involving parameters
    - All the possible conditional sentences (provided they have a logical sense)
  - All the following examples are automatically generated from Java code using the JaxB Api.

A working example : the PDR code



- Code modeling the micro-physics of interstellar clouds (used to interpret HERSCHEL observations)

- Already Implemented in Astrogrid (CEA) in 2007.



- Incident radiation field
- observer and back side
- ISRF intensity
- Type of stellar spectrum
- distance of the star
- ...

- State equation
- isochore (density)
- isobare (pressure)
- specific user density profile
- ...

- Grains properties
- R min and max
- Extinction properties
- ...

Non trivial relationships between parameters

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<UWS_Service xmlns="http://www.ivoa.net/xml/Parameter/v0.1"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://www.ivoa.net/xml/Parameter/v0.1 UWS2-V1.1.xsd">
      <ServiceId>PDR_ONLINE</ServiceId>
      <serviceName>PDR-1D</serviceName>
      <Description>Description layer of the PDR code</Description>
      <ParameterList>
            <parameter>
                  <Name>F_ISRF</Name>
                  <ParameterType>integer</ParameterType>
                  <Unit>None</Unit>
                  <Precision>0</Precision>
            </parameter>
            <parameter>
                  <Name>radm</Name>
                  <ParameterType>real</ParameterType>
            </parameter>
            <parameter>
                  <Name>radp</Name>
                  <ParameterType>real</ParameterType>
            </parameter>
            <parameter>
                  <Name>d_sour</Name>
                  <ParameterType>real</ParameterType>
            </parameter>
            <parameter>
                  <Name>srcpp</Name>
                  <ParameterType>string</ParameterType>
            </parameter>
            <parameter>
                  <Name>srcpp_spectrum</Name>
                  <ParameterType>Spectrum</ParameterType>
            </parameter>
            ...
```

Parameter list

```xml
<ParameterGroup>
    <Name>RadiationFieldAndGeometry</Name>
    <parameterRef parameterName="F_ISRF" />
    <parameterRef parameterName="radm" />
    <parameterRef parameterName="radp" />
    <parameterRef parameterName="d_sour" />
    <parameterRef parameterName="srcpp" />
    <parameterRef parameterName="srcpp_spectrum" />
</ParameterGroup>
```

Parameter groups

```xml
<conditionalStatement xsi:type="IfThenConditionalStatement">
    <if>
        <Criterion xsi:type="Criterion">
            <expression xsi:type="AtomicParameterExpression">
                <parameterRef parameterName="d_sour" />
            </expression>
            <conditionType xsi:type="ValueDifferentOf">
                <Value>0</Value>
            </conditionType>
            <logicalConnector xsi:type="and">
                <criterion xsi:type="Criterion">
                    <expression xsi:type="AtomicParameterExpression">
                        <parameterRef parameterName="srcpp" />
                    </expression>
                    <conditionType xsi:type="BelongToSet">
                        <Value>spectro1</Value>
                        <Value>spectro2</Value>
                        <Value>spectroN</Value>
                    </conditionType>
                </criterion>
            </logicalConnector>
        </Criterion>
    </if>
    <then>
        <Criterion xsi:type="Criterion">
            <expression xsi:type="AtomicParameterExpression">
                <parameterRef parameterName="srcpp_spectrum" />
            </expression>
            <conditionType xsi:type="IsNull" />
        </Criterion>
    </then>
</conditionalStatement>
```

Constraints

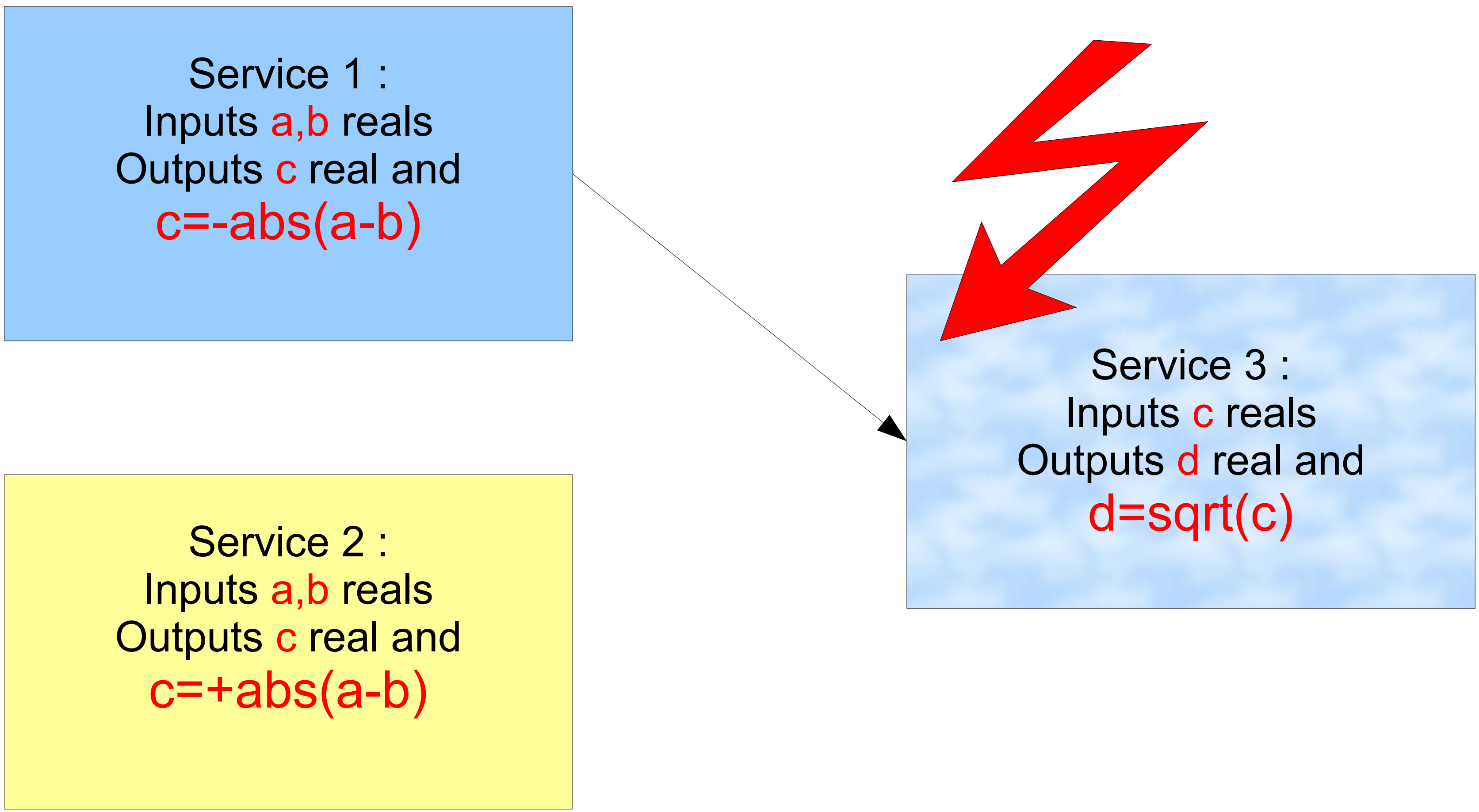
About the interoperability

Service 1 :
Inputs a,b reals
Outputs c real and
c=-abs(a-b)

Service 2 :
Inputs a,b reals
Outputs c real and
c=+abs(a-b)

Service 3 :
Inputs c reals
Outputs d real and
d=sqrt(c)

About the interoperability



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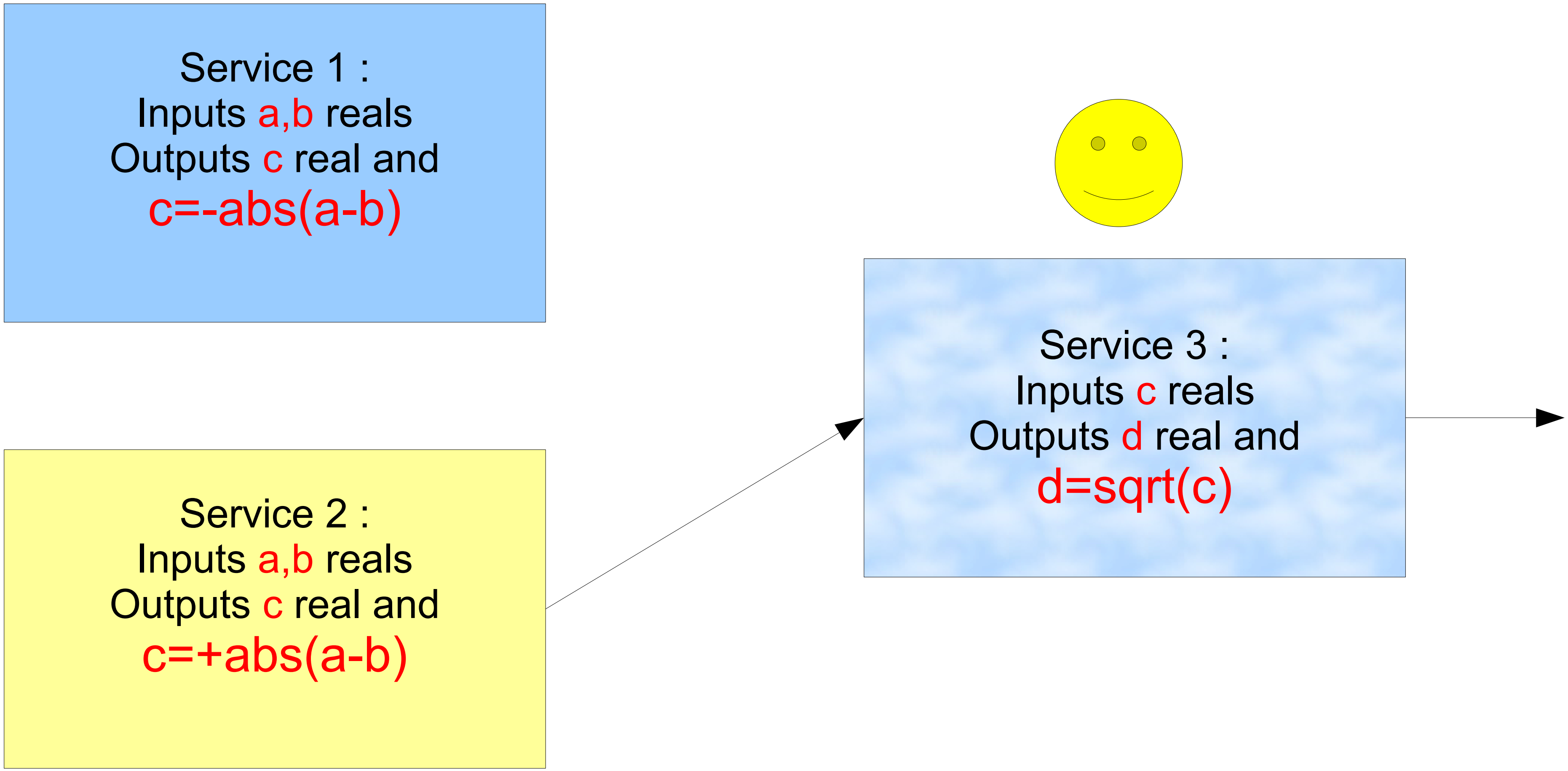

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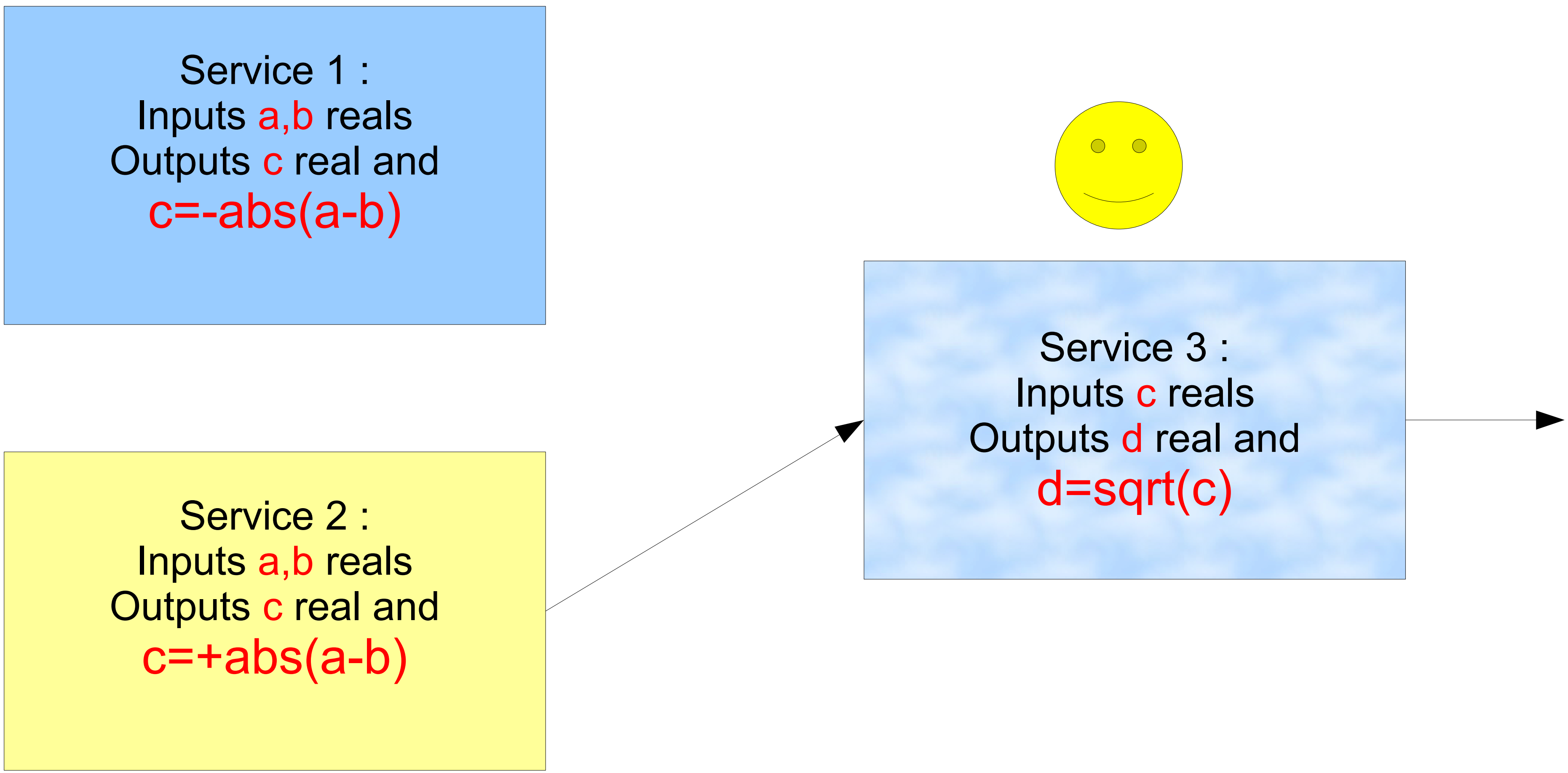

Adding the constraints with our formalism...

About the interoperability

Service 1 :
Inputs a,b reals
Outputs c real and
c=-abs(a-b)
Always c < 0

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Always c > 0

Service 3 :
Inputs c reals
Always c > 0

Outputs d real and
d=sqrt(c)
Always d > 0

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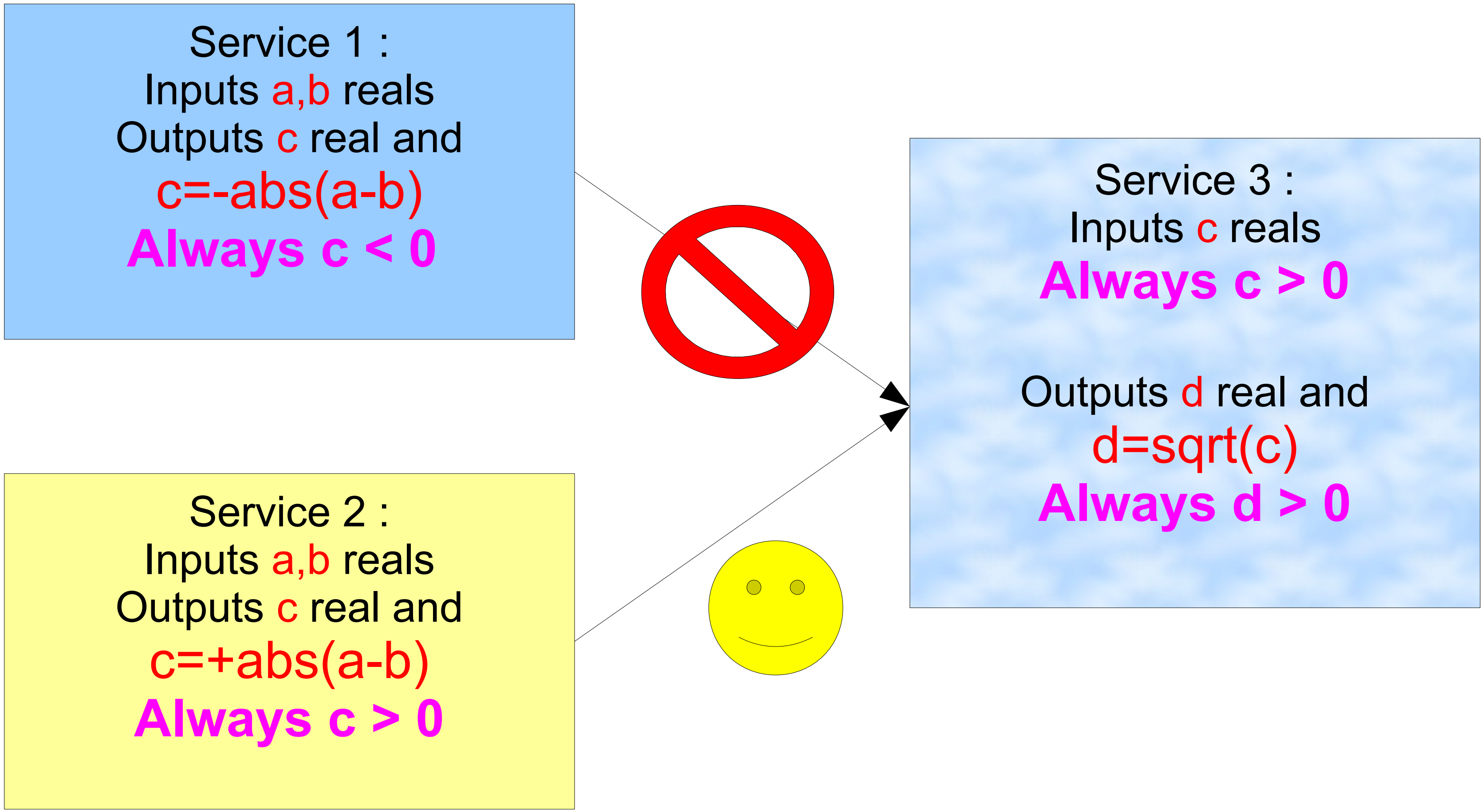

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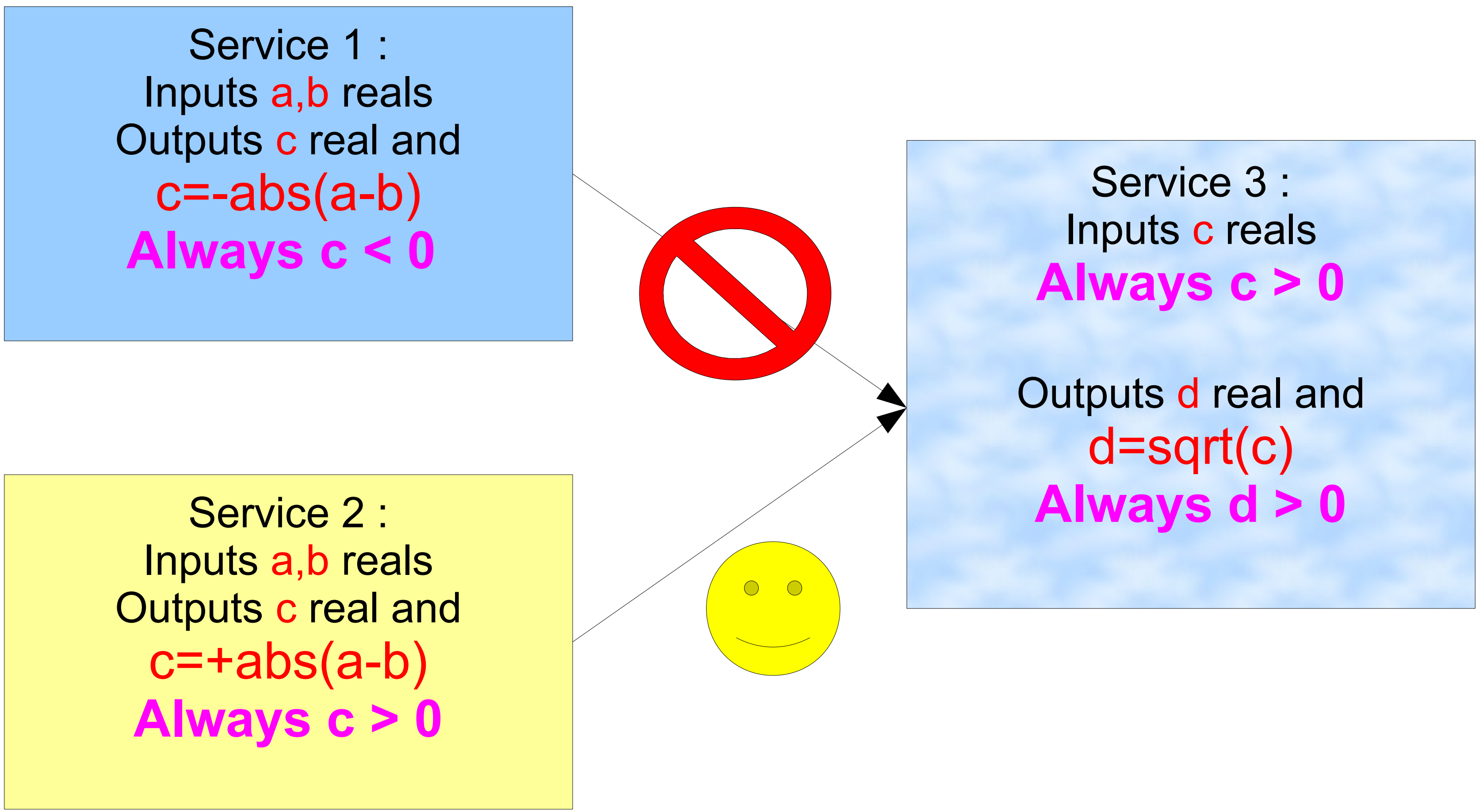

More generally we can formalize this as following...

About the interoperability

Let

- S_1 and S_2 be two services.
- $p^j(S_i)$ be the jth parameter of S_i.
- $\mathcal{I}(S_i)$ (resp. $\mathcal{O}(S_i)$) be the set of input (resp. output) parameters of S_i.
- $\mathcal{C}^{p^j}_{\mathcal{I}(S_i)}$ (resp. $\mathcal{C}^{p^j}_{\mathcal{O}(S_i)}$) the set of all constraints on $\mathcal{I}(S_i)$ (resp. $\mathcal{O}(S_i)$) involving p^j.

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S_2 could follow S_1 into a workflow iff $\forall p^k(S_2) \in \mathcal{I}(S_2)\, \exists\, p^l(S_1) \in \mathcal{O}(S_1)$ such that:

- $p^k(S_2) = p^l(S_1)$
- $p^l(S_1)$ satisfies $\mathcal{C}^{p^l}_{\mathcal{O}(S_1)} \Longrightarrow p^k(S_2)$ satisfies $\mathcal{C}^{p^k}_{\mathcal{I}(S_2)}$

- The equality is in the sense that parameters have same
  - UCDs
  - UTypes
  - SkossConcepts
  - Units

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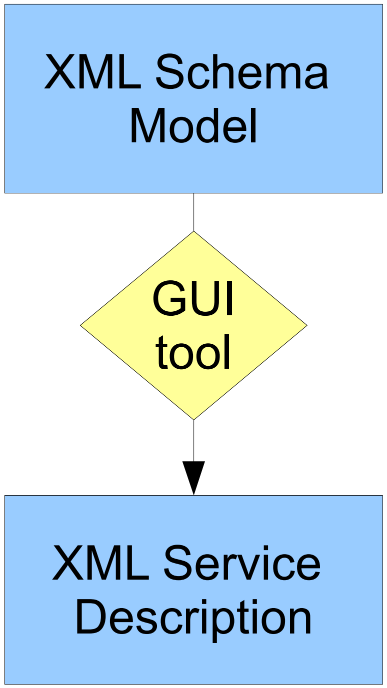
- If the difference is on units, the services are still **compatibles**: we can build a third service performing the unit change, making interoperability possible.

Sketch of the integral solution



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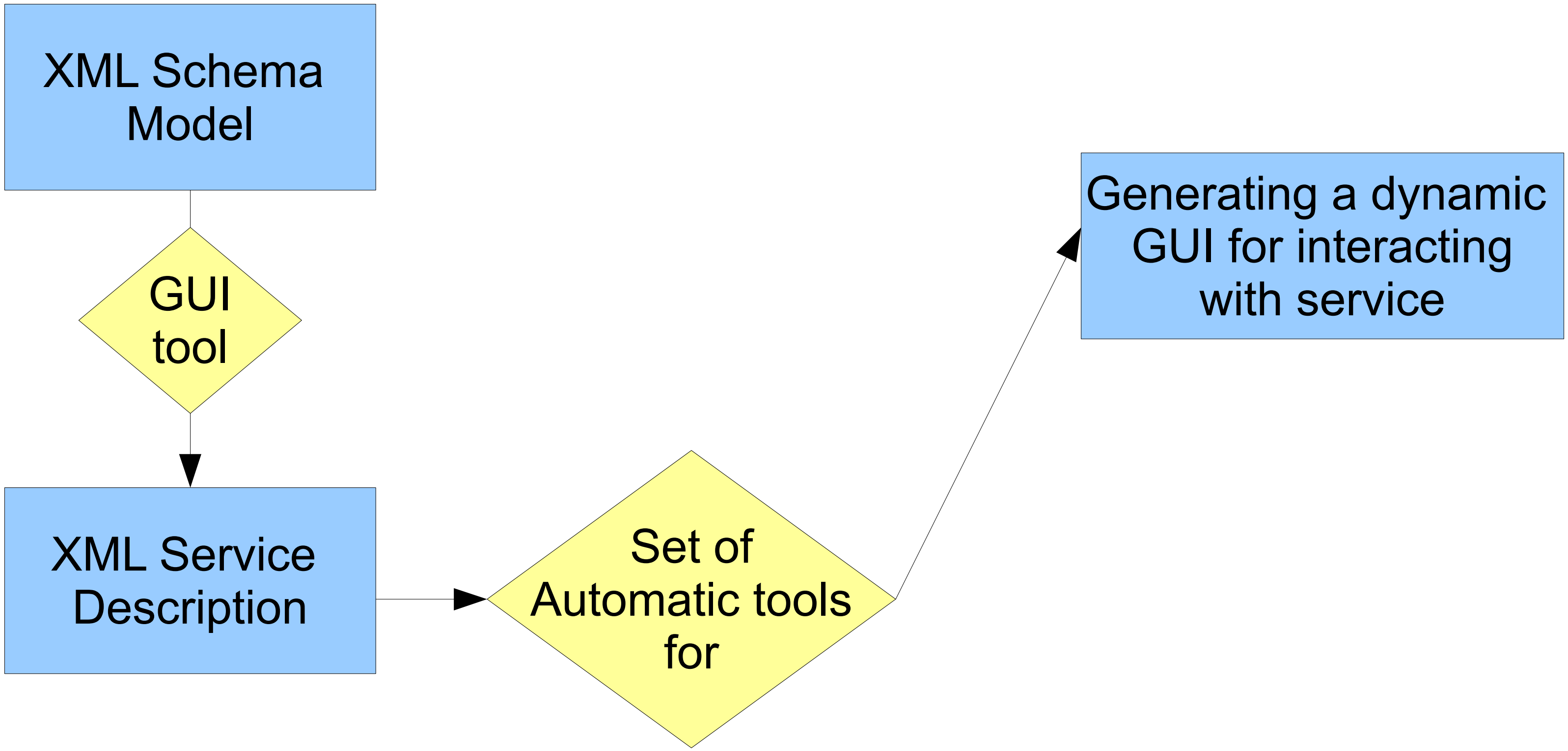

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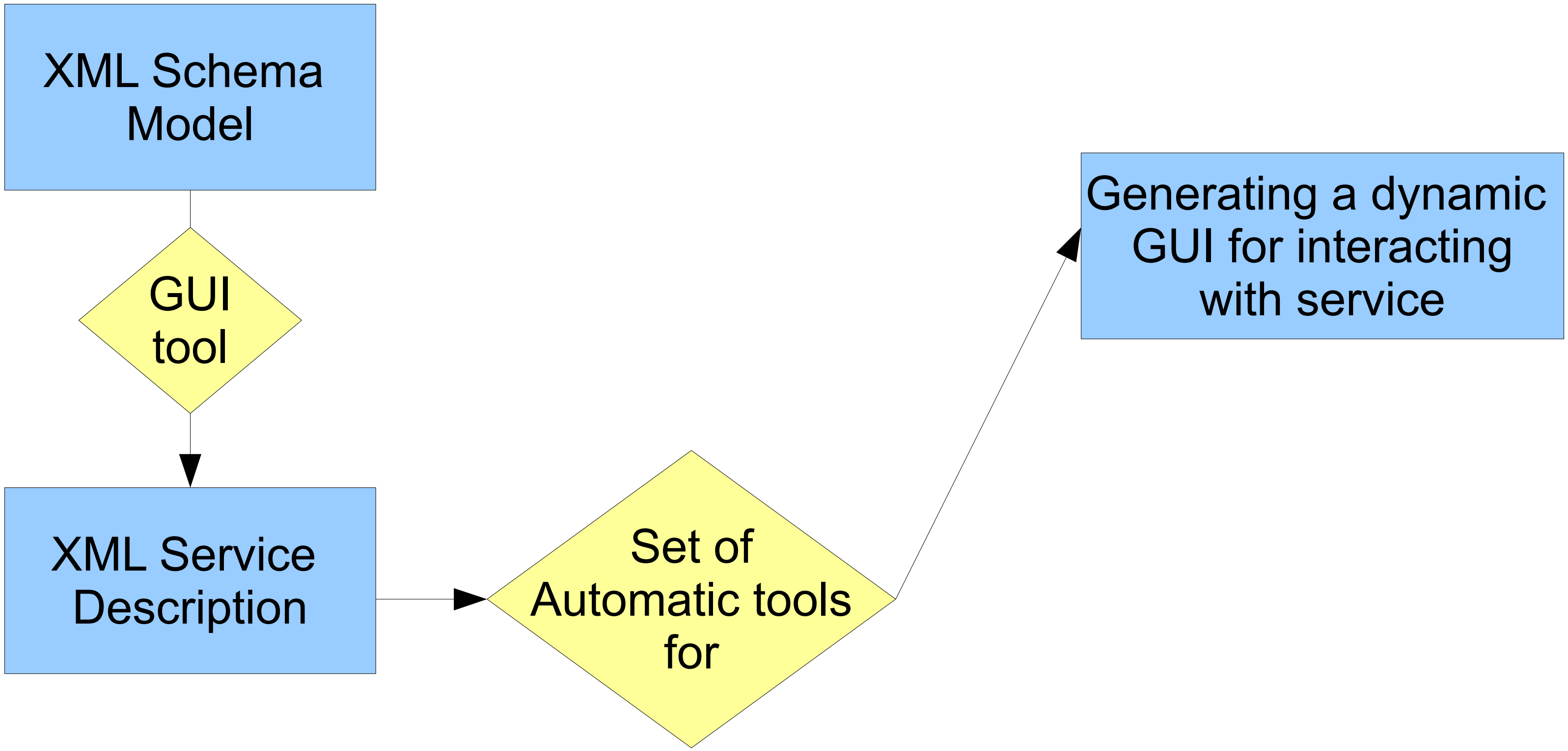

Service description:

- $p_1 \in \mathbb{R}$, $p_2 \in \mathbb{N}$ and p_3 is boolean.
- if $p_1 > 0 \implies p_2 \in \{2; 4; 6\}$ and p_3 must be false.
- if $p_1 < 0 \implies p_3$ must be true.

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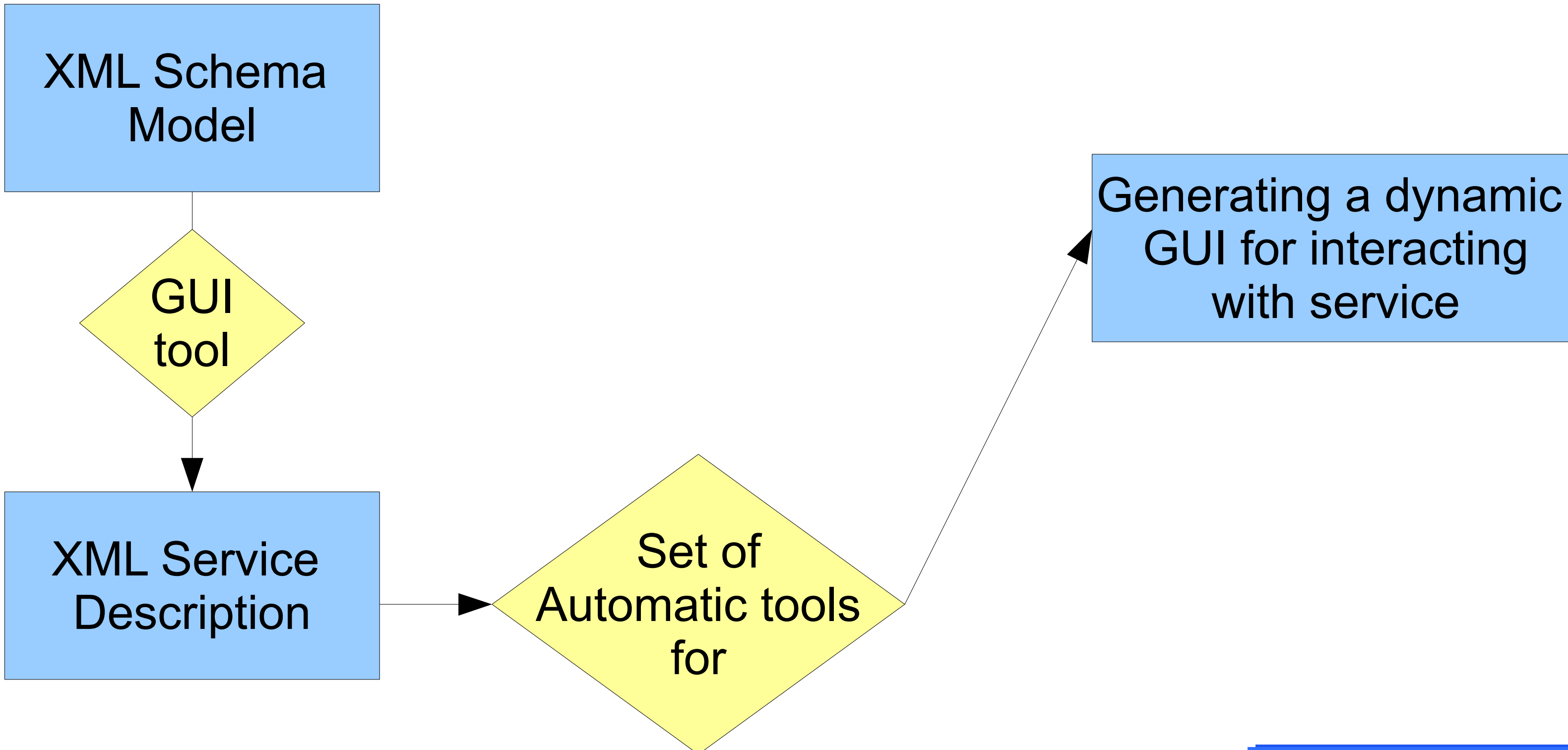

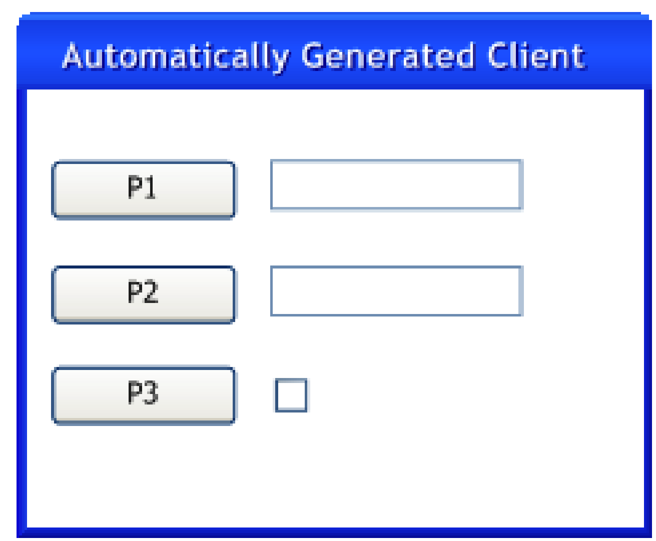

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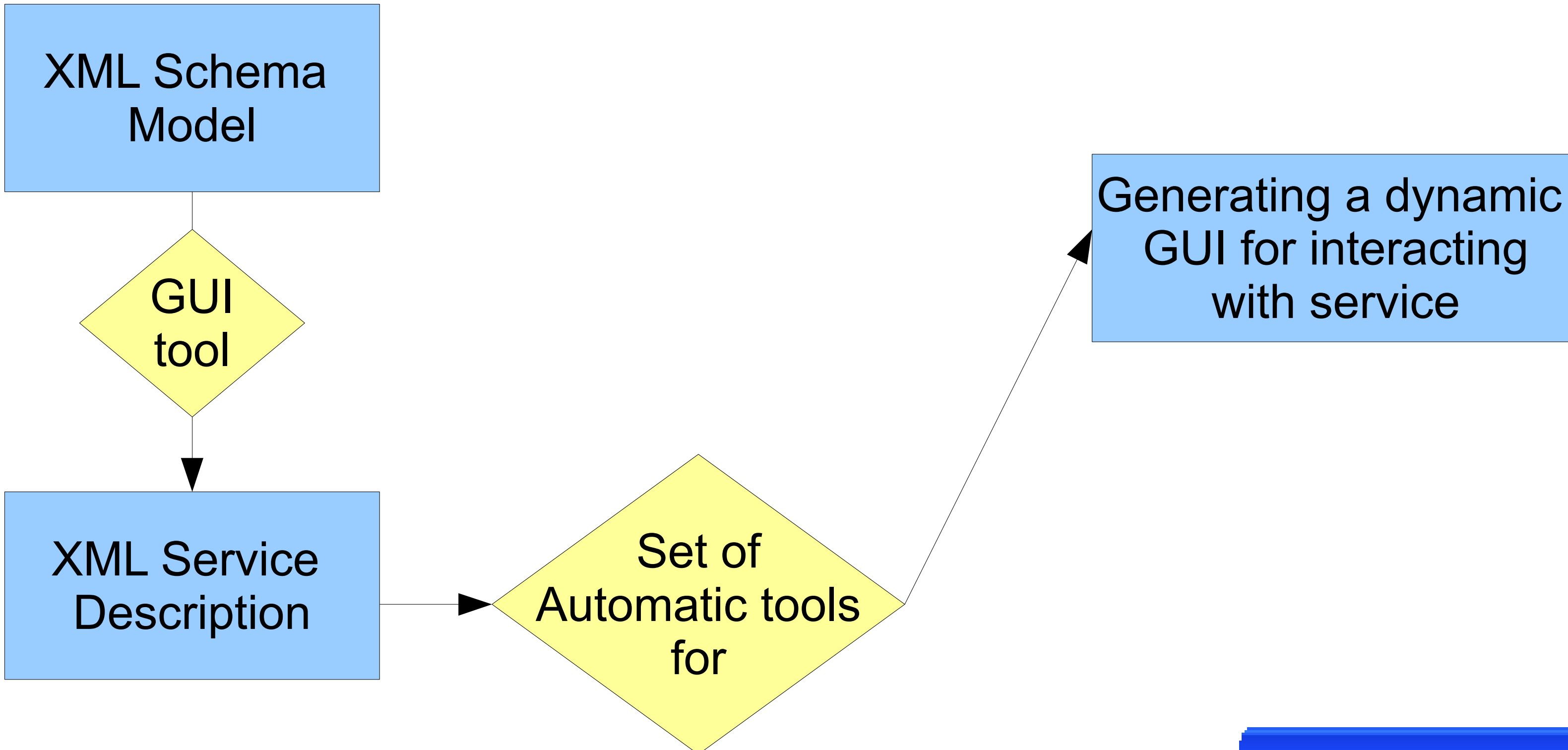

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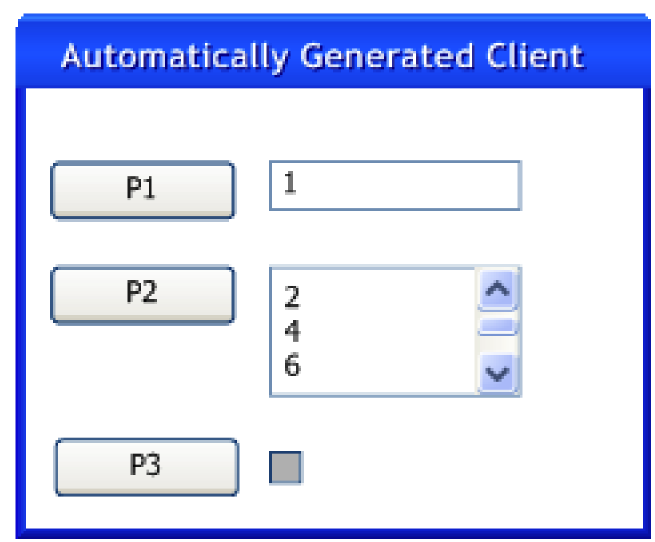

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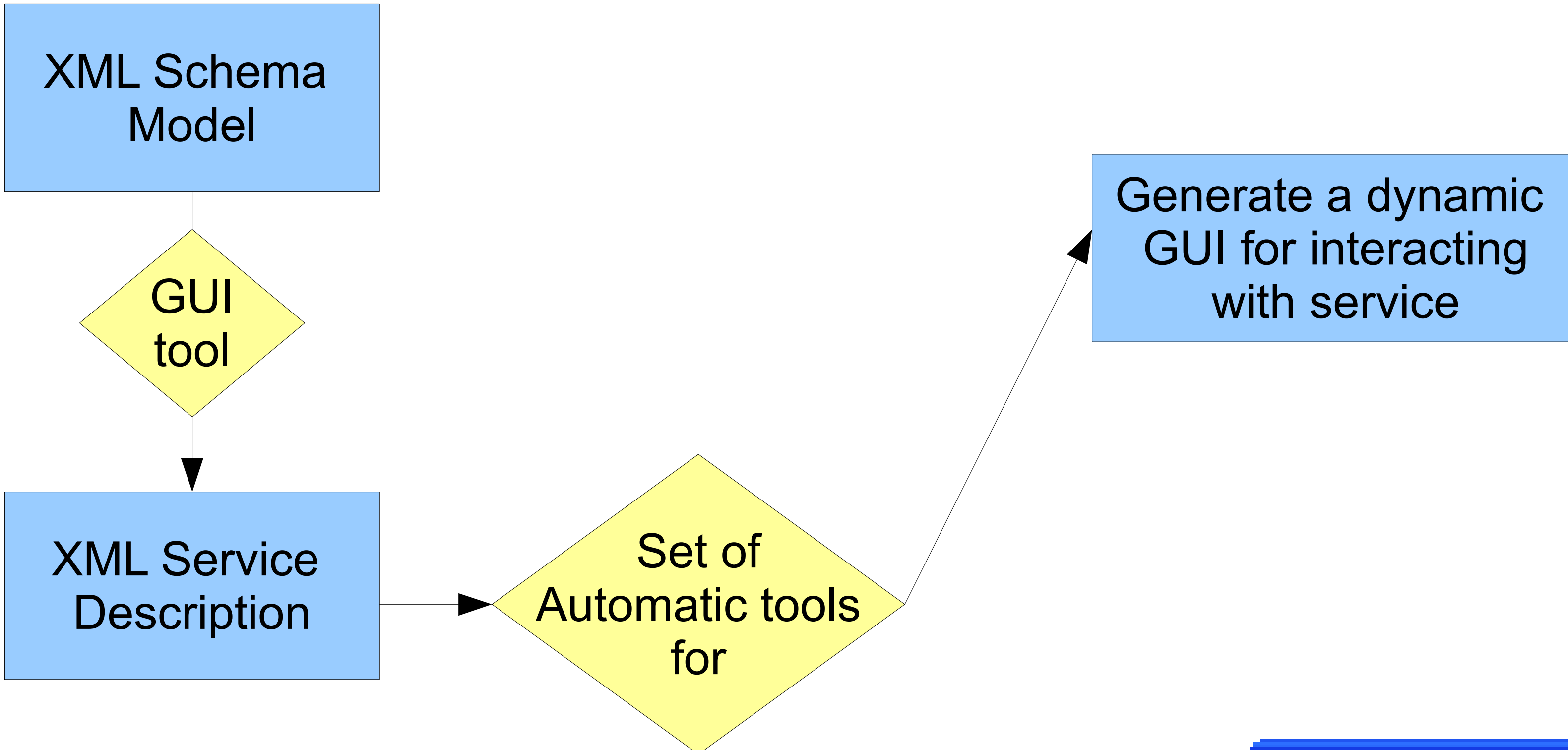

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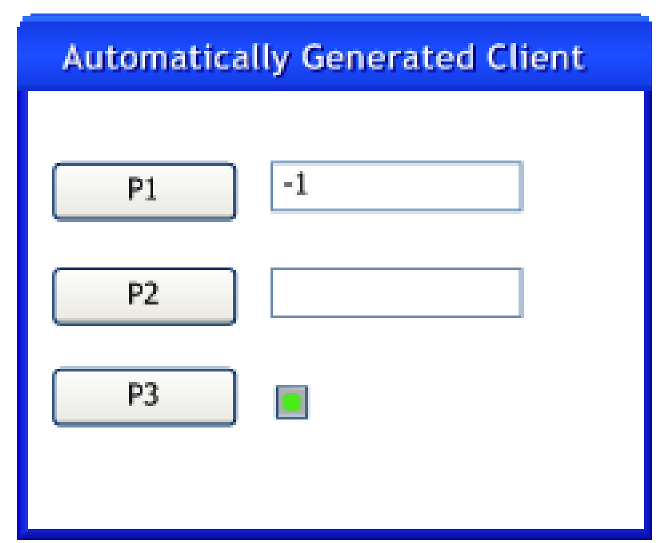

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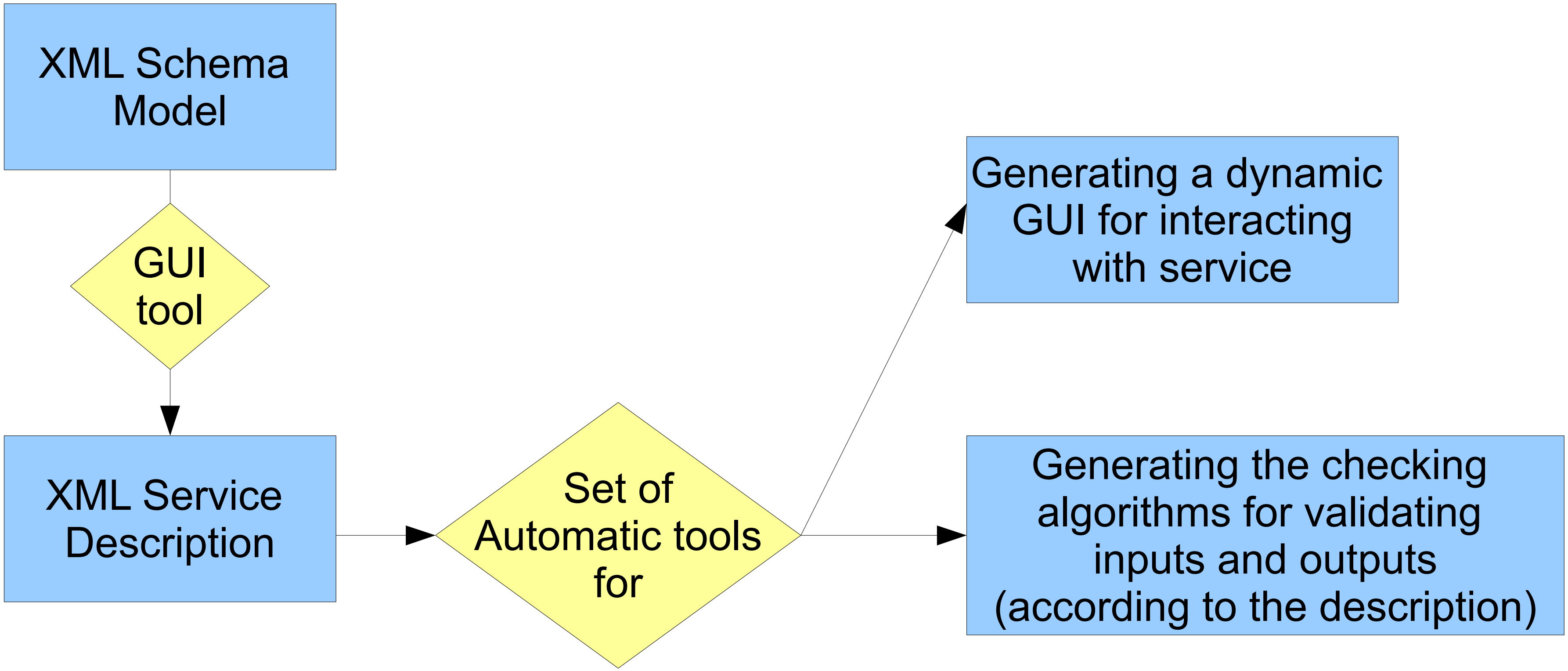

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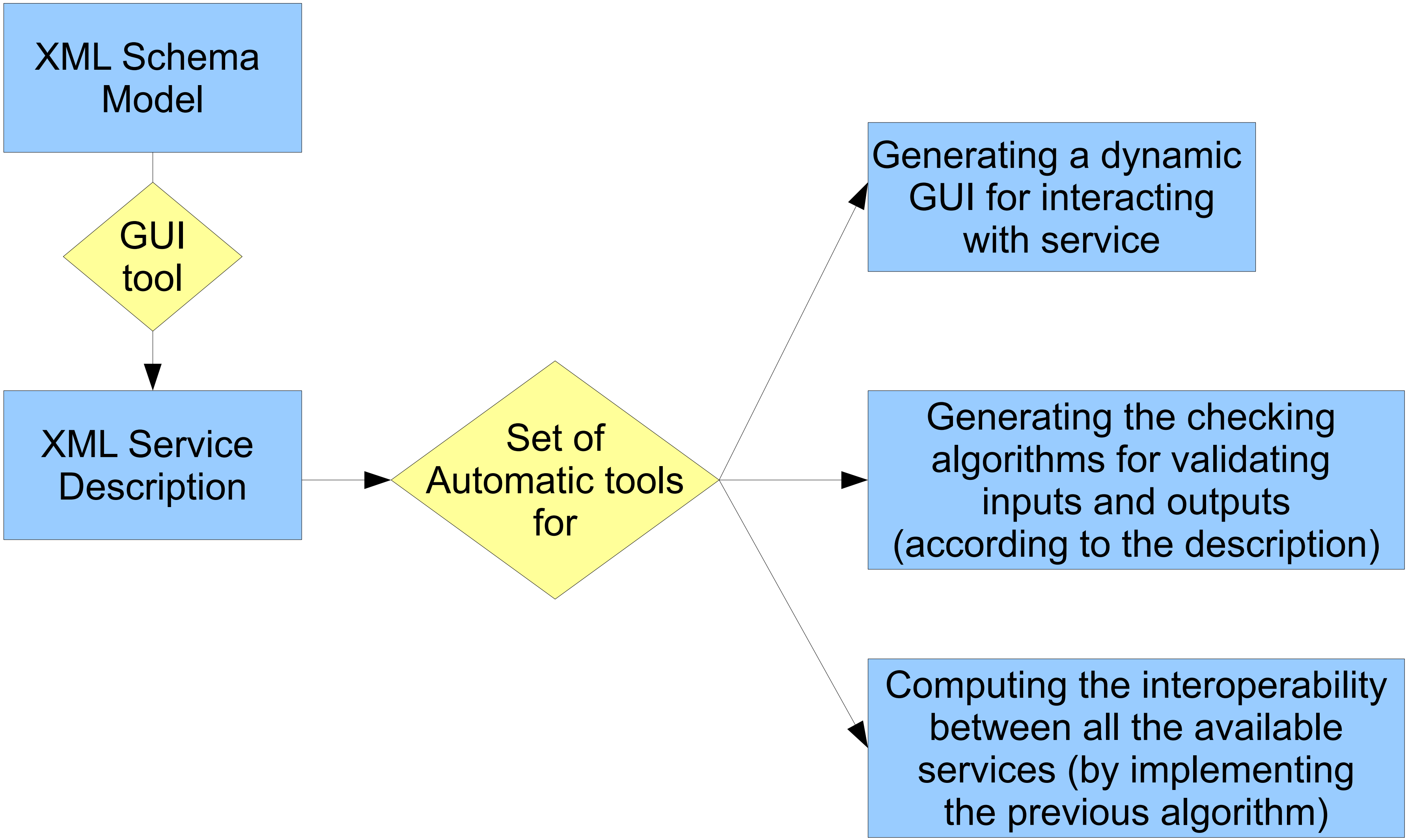

Concluding remarks

With our formalism:

- Users can easily describe parameters and overall their constraints in a **unified way**
- Descriptions are human readable and could be understood by computers.

Interoperability graphs connecting services can be computed *a priori* automatically

It is a consistent step towards a real and integrated interoperability in the VO.

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Thank you for your kind attention.