On Dependability of Composite Web Services with Components Upgraded Online

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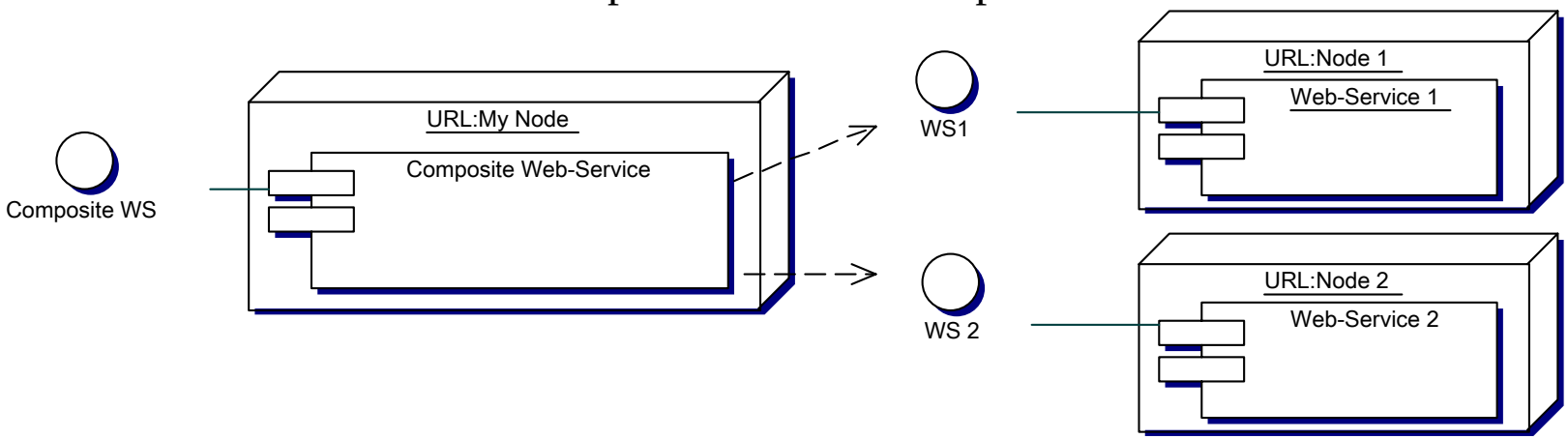
Objectives

- Confidence in correctness of Web-services
  - why
  - how
- On-line upgrade of component services and its impact on composite Web-services
  - confidence in correctness of composite service
  - architectures for on-line upgrade

Background: Web-services

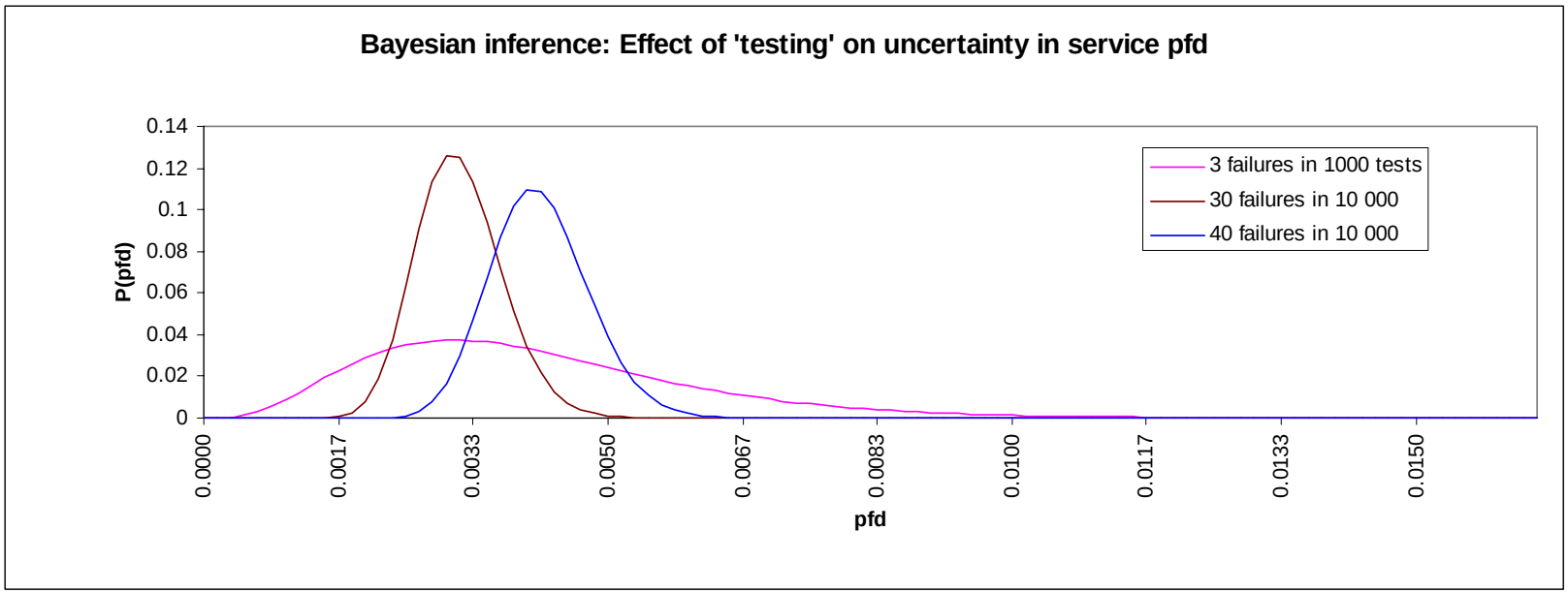
- A series of standards which made interoperability ‘easy’:
  - extendable WS descriptions kept and updated online in a registry
  - flexible binding, etc.
- Composite Web-service may depend on existing component services and on off-the-shelf (OTS) software
  - Composite web-services vs. integration of OTS software
    - similar in the absence of detailed information about their development
    - ‘locked-in’ with the provider of the component web-service



Background: Confidence in correctness

- Used in probabilistic assessment of safety-critical software:
  - done off-line (pre-deployment and periodic reviews)
  - with WS the same idea can be taken further and the confidence can be published and **updated continuously**.
- Bayesian inference (a way of calculating confidence)
  - a mathematically sound mechanism which allows one to combine the *a priori* knowledge and *new empirical evidence* (new observations)
  - detailed modelling of systems with many components leads to computational difficulties but feasible under plausible simplifications
- Confidence in system correctness can be calculated continuously
  - knowledge about the components only is NOT enough
  - solutions to this problem exist (previous work for safety-critical applications)

Bayesian inference: illustration



- pfd - probability of failure on demand.
- Probability of correct execution is a real number:

  P(correct execution on demand)=1-E[pfd]

- Slightly more complicated with several components.

Example: Confidence in correctness of WS

WSDL without confidence:

```
<types>
  <s:schema … >
    <s:element name=”Operation1Request”>
      <s:complexType>
        <s:sequence>
          <s:element minOccurs=”0” maxOccurs=”1”
           name=”param1” type=”s:int”>
          <s:element minOccurs=”0” maxOccurs=”1”
           name=”param2” type=”s:string”>
        </s:sequence>
      </s:complexType>
    </s:element>
    <s:element name=”Operation1Response”>
      <s:complexType>
        <s:sequence>
          <s:element minOccurs=”0” maxOccurs=”1”
           name=”Op1Result” type=”s:string”>
        </s:sequence>
      </s:complexType>
    </s:element>
  …
</types>
```

Confidence in correctness (2)

WSDL with confidence (1) redefining the old response:

```
<s:element name="Operation1Response">
      <s:complexType>
        <s:sequence>
          <s:element minOccurs="0" maxOccurs="1"
       name="Op1Result" type="s:string">
          <s:element minOccurs="0" maxOccurs="1"
       name="Op1Conf" type="s:double">
        </s:sequence>
      </s:complexType>
    </s:element>
```

- This may ‘break’ the existing composite services.

Confidence in correctness (3)

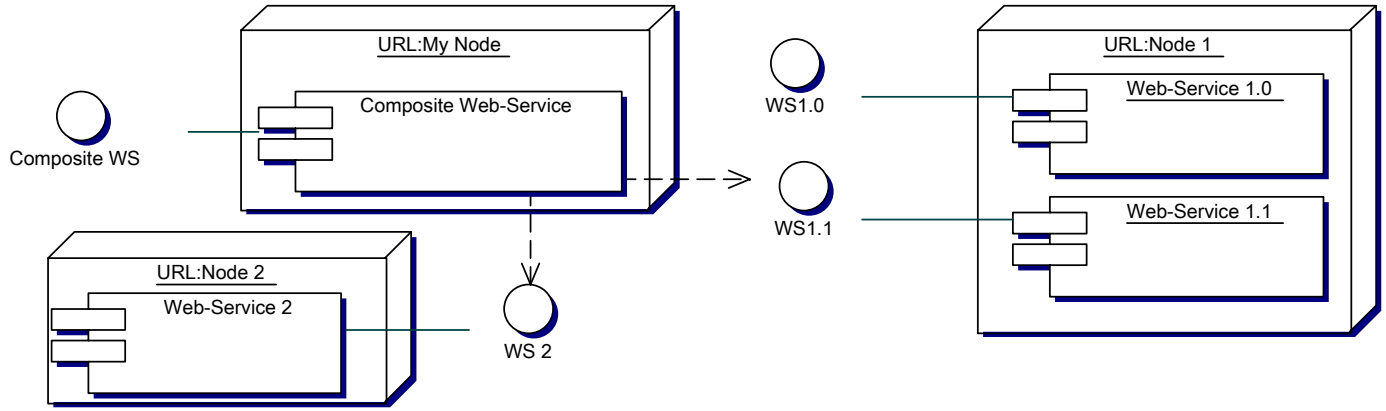
WSDL with confidence (2) a **new operation** defined:

```
<s:element name="OperationConfRequest">
    <s:complexType>
      <s:sequence>
        <s:element minOccurs="0" maxOccurs="1"
     name="operation" type="s:string">
      </s:sequence>
    </s:complexType>
  </s:element>
  <s:element name="OperationConfResponse">
    <s:complexType>
      <s:sequence>
        <s:element minOccurs="0" maxOccurs="1"
     name="Op1Conf" type="s:double">
      </s:sequence>
    </s:complexType>
  </s:element>
```

Architectural implications of calculating Confidence in WS

- Confidence (**`Op1Conf`** or **`OperationConfResponse`**) 'continuously updated':
  - the confidence of a particular user A will be **affected by the other users** of the same WS (cost of 'testing' shared between the users)
- Some performance penalty (due to continuous Bayesian inference):
  - with every invocation of the operation (may be prohibitively expensive, especially under heavy load)
  - predefined intervals to make it 'cheaper'
  - **adaptive scheme (supported by system architecture)** of changing the intervals of calculating confidence depending on the load on WS.

On-line upgrade of a component WS



- A new release of WS1 is available. Confidence in the Composite WS can be calculated after the upgrade
- Possible architectural solutions for the service upgrade:
  - Both the old and the new releases, WS1.0 and WS1.1, are available:
    - continue using WS1.0 until the confidence in WS1.1 reaches ‘acceptable’ level. The architecture of the Composite WS should cater for the ‘transitional’ period
  - The new release WS1.1 replaces WS1.0. Some drop of confidence is possible. If not acceptable switch to using a **different component** WS.

Conclusions

- On-line assessment of confidence in correctness of Web-services proposed:
  - Various ways of publishing this confidence discussed
- Architectures of Composite WSs needed that allow for management of:
  - the cost of keeping the confidence in the correctness of the service up to date (changing the frequency of updates of the confidence to minimise the performance penalty)
  - the transitional period between the releases of the component services:
    - whether to switch from the previous release of a WS to a new one or not
    - whether to switch to an alternative component service if the new release ‘not good enough’
- Questions