Pushing Reactive Services to XML Repositories using Active Rules

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Outline

- Problem Definition
  - The need of prompt e-services over the Internet
- Solution
  - Distributed reactive services enabled by XML technology
  - Rules are installed on remote systems and promptly monitor the changes
- Architectural framework
- Implementation
- Conclusions

Problem Definition

- Push technology is a convenient solution to deliver updated information to end-users
- So far “Pushing logic” has been broadly applied in IS but only with local mechanisms
- Internet services offer an infrastructure for the implementation of many different architectures
- XML and XML-based protocols are a central component of Internet services
- XML active rules permit the construction of distributed push technology

Our solution in a nutshell

- ECA paradigm on XML documents to bear notification services
- Rules located close to the data (remote installation)
- A simple subscription protocol for rule negotiation and a suitable application scenario
- The broadening XML technologies to cook up our framework
  - XML, XQuery, DOM Level 2, SOAP

The renewed ECA Paradigm

- Active rules for Notification Services follow the ECA paradigm:
  - Events: DOM mutating events generated whenever the XML docs are modified;
  - Conditions: queries on the document base, using a suitable XML query language (e.g.: XQuery);
  - Actions: invocations of SOAP methods implementing calls to a message delivery system

Active Rules at work

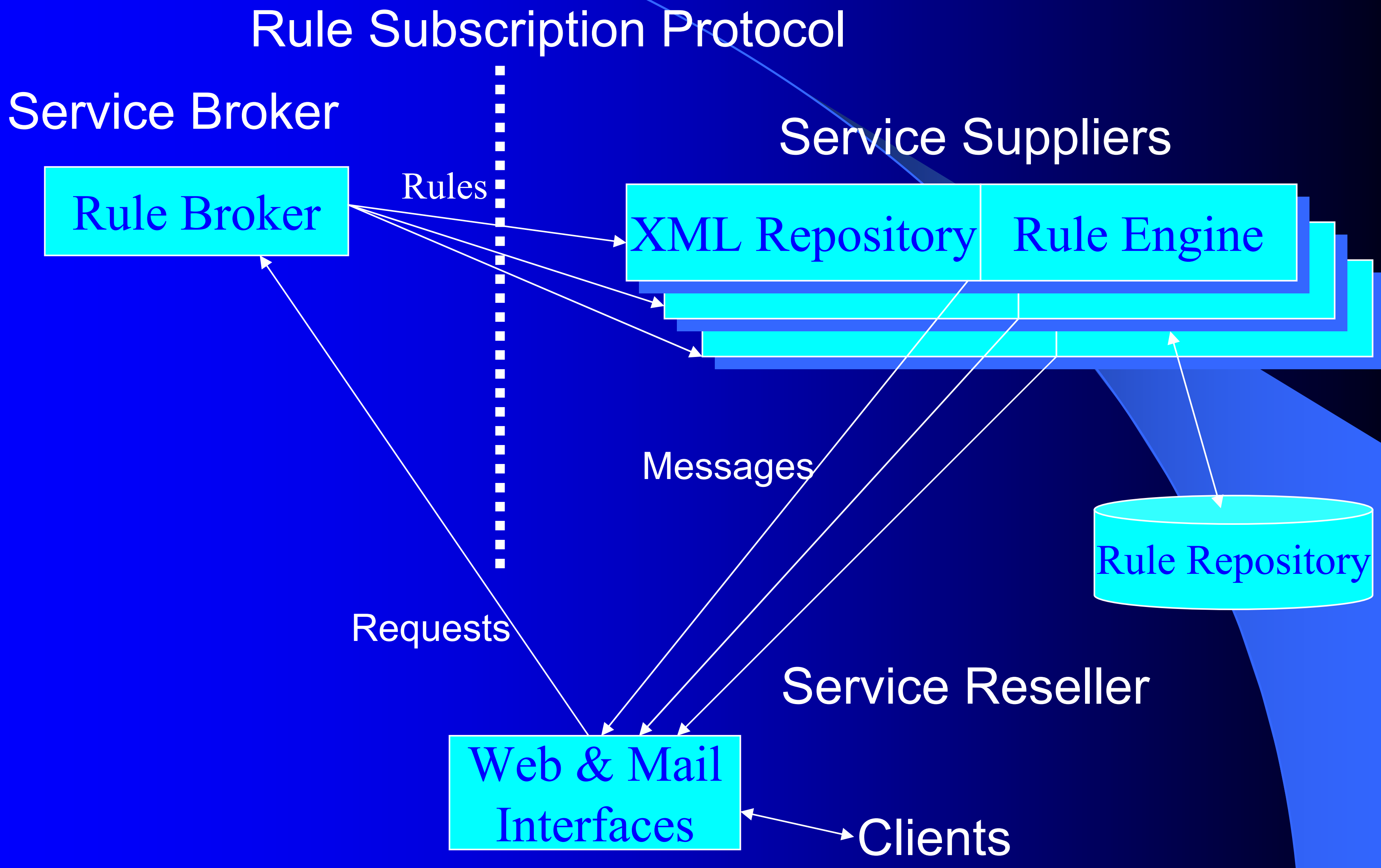
- The event specification is expressed by the DOM Level 2 API and generates the data bindings to be passed to the *condition-action* part
- In the Condition, predefined variables **new** and **old** are declared in a similar way to transition variables in databases
- In the Action, SOAP methods implement the transfer of information to recipients;
- The Action is "simplicistic" and receives parameters from conditions; to prevent problems related to rule termination, updates of XML data are avoided.

A simple rule

```
<event>insert(//cd)</event>
<condition> FOR $a IN //cd
            WHERE $a=$new AND
            $a/price < 20 AND
           contains($a/author,"Milli
                                Vanilli")
            RETURN $a
</condition>
<action>
  <soap-header>
    <uri>/notification</uri>
    <host>131.175.16.105</host>
    <soap-action>notify</soap-action>
  </soap-header>
  <SOAP-ENV:Envelope
    xmlns:SOAP-
   ENV="http://schemas.xmlsoap.org/
   soap/envelope"
```

```
SOAP-ENV:encodingStyle="http://
  schemas.xmlsoap.org/soap/encoding">
   <SOAP-ENV:Body>
    <m:Notify xmlns:m="http://
              131.175.16.105/methods">
     <cdfound>
        $a//*
     </cdfound>
    </m:Notify>
   </SOAP-ENV:Body>
  </SOAP-ENV:Envelope>
</action>
```

Architectural framework



Actors

- Service Reseller
  - Focus: interaction with the final user
  - Recipient of messages produced by rule actions
- Service Broker
  - Focus: Construction of rules satisfying the user needs
  - Intermediary between resellers and suppliers
- Service Supplier
  - Focus: Management of XML information
  - Internet site equipped with a rule execution engine

An example:
the real estate agency (1)

- Consider a real estate agency application:
  - **example of request**: *a furnished four-bedroom (or more), two-bathrooms (or more) Victorian house, which costs $1,500,000 or less, located in the Marina area in San Francisco*
- No matching is found on the house agency Web sites!

An example:
the real estate agency (2)

- A reactive service is invoked:
  - *A request is sent from the Service Reseller to the Service Broker*
  - *A set of rules are agreed by defining their contract and by setting the proper authorization through the Rule Subscription Protocol*
  - *The rules are installed into several house agency XML Servers (Service Suppliers)*
  - *When the targeted house appears on the market, the rules produce the response messages, which are delivered from the XML Server to the Service Reseller*

Pieces of XML/SOAP code

```
<event>
  update($a) OR insert($a)
</event>
<condition>
  FOR $a IN document( )//housestobuy/house,
  WHERE $a//cost < 1500000 AND
      contains($a//style,"victorian") AND
      contains($a//description,"furnished") AND
      $a//nr_of_bedrooms >= 4 AND
      $a//nr_of_bathrooms >= 2 AND
      $a//city="San Francisco" AND
      $a//area="Marina" AND
      empty($a//sold_to)
  RETURN $a
 </condition>
```

```
<action>
 <SOAP-ENV:Envelope
    xmlns:SOAP- ENV="http://schemas.xmlsoap.org/
                              soap/envelope"
    SOAP-ENV:encodingStyle="http://
          schemas.xmlsoap.org/soap/encoding">
    <SOAP-ENV:Body>
     <m:DeliverHouseNews xmlns:m="http://
           housemediator.com/soap/methods">
      <foundthehouse>
        $a//*
      </foundthehouse>
      <server>
        www.expensivehousesincalifornia.com
      </server>
      <localHouseId>
        $a/@Id
      </localHouseId>
     </m:DeliverHouseNews>
    </SOAP-ENV:Body>
  </SOAP-ENV:Envelope>
 </action>
```

The B2B interface

- The Rule Broker and the Service Supplier communicate through a B2B protocol, which is both technical and business-oriented
- This protocol is based upon four SOAP primitives, that are invoked by the Service Broker and supported by the Service Supplier
- The Service Broker is required to know well how to write rules and how to submit them to the Service Supplier
- The Service Reseller can be the final user of the notification server or a mediator which interacts with the final user through a friendly interface

The SOAP primitives (1)

- **Connect:**
  - Instead of using a stateless connection a-la HTTP, this SOAP primitive warrants a connection to manage more than a single request-response:

```
ConnectionId Connect (in AuthenticatedUser user,
                      in ServerProfile requestedProfile)
```

- **Subscribe:**
  - This primitive permits the submission of a rule to a server with a specified contract:

```
SubmissionId Subscribe (in ConnectionId openCon,
                        in Rule ruleToSub, in Contract conProp)
```

The SOAP primitives (2)

- **Unsubscribe:**
  - This primitive is invoked when a submitted rule must be removed from the Service Supplier:

```
void Unsubscribe (in ConnectionId openCon, in
                                   SubmissionId SubId)
```

- **Disconnect:**
  - This primitive closes the connection created by the Connect primitive and frees the resources that were allocated for the connection:

```
void Disconnect (in ConnectionId openCon)
```

Rule Packaging

- The Subscribe primitive presents a *ProposedContract* parameter, which specifies the contract to be agreed by each part in the transaction
- The contract should include the remuneration information and the guarantees of each rule

From the real estate ex.:

```
<contractProposed>
     <cost>0</cost>
     <guarantee>none</guarantee>
</contractProposed>
```

- The contract is the “sine qua non” of a B2B initiative
- In our solution, the contract is application-dependent and has to be defined rule per rule.

Implementation

- Needed components: an XML system supporting the DOM Event Model, an XQuery engine, a SOAP implementation:
  - The DOM permits the definition of event listeners, that are attached to each node to be monitored
  - When the event is captured, the XQuery processor evaluates the XQuery condition, possibly returning an XML fragment
  - The SOAP call is built from the query result and executed by the server
- Much simpler rule engine than in database trigger systems

DOM Event detection

- Two main strategies:
  - *centralized*: a single event listener associated with the root of the document
  - *fragmented*: a set of event listeners, associated with every node instance on which events need to be monitored
- Impact on system performance

Conclusions

- Active rules for pushing reactive services has a great potential
- The reuse of current Web standards makes the implementation relatively easy
- Some obstacles remain:
  - pre-knowledge of the schema of XML resources
  - risks of external rule execution
  - scalability issues