

Acceleration of Web Service Workflow Execution through Edge Computing.

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Main Theme of the paper

- This paper proposes Overlay Web Service Network (OWSN), a framework of integrated Web service management and execution based on CDN (Content Delivery Network).
- The WS-Cache specification is introduced so that cache proxies and service providers can incorporate various caching techniques into Web services.
- The Service Level Requirement specification is also introduced in order to allow service integrator to indicate preferences for multiple service levels provided from the proxies

Introduction of web services

- A service provider describes the interface of each service component using WSDL (Web Service Description Language).
- The service provider also publishes the service with a registry based on a standard called UDDI (Universal Description, Discovery and Integration).
- There is an emergence of an integration tier between component-service providers and integrated-service consumers.
- One of the specifications expected to be the Web service standard is BP4WS (Business Process Execution Language for Web Services) proposed by Microsoft, IBM, and BEA Systems.

Related work in this field

Web Content Delivery.

1. Edge Side Includes (ESI) is a markup language used to define Web page components for dynamic assembly and delivery of Web applications at the edge of the Internet.
2. ICAP (Internet Content Adaptation protocol) (www.icap.org) allows the proxy server to modify requests from clients and responses from Web servers in order to serve various value-added services such as content filtering, virus scanning, and format translation.
3. IETF OPES (Open Pluggable Edge Services) working group is chartered to define a framework and protocols to both authorize and invoke distributed application services deployed on proxy servers.

Related work in this field

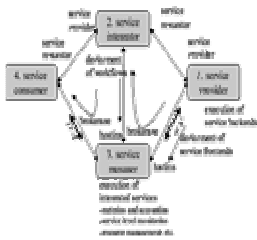
Web Service Intermediaries and Service Management.

1. WS-Routing is a specification that defines a SOAP message path. Intermediaries can route messages between service user and provider in a flexible way in order to enhance performance, availability, and security.
2. WSIF (Web Service Invocation Framework) is a Java API for invoking Web services without hardcoding protocol binding and location information. The API provides a way of coding WSDL operation invocations at the PortType level.
3. Service level agreement (SLA) of Web services is important especially when component services are integrated with workflows. The proposal of WSFL (Web Services Flow Language), describes need for definition of a business context between a workflow (WSFL) and a component service (WSDL).

Overlay Web Service Networks

- Overlay Web Service Network (OWSN), is an approach for integrated Web services based on a CDN (Content Delivery Network).
- Service integration workflows are deployed on edge servers located close to service consumers.
- Proxies (service frontend modules) are responsible to manage communication through the Internet between edge servers and the original service sources (service backend modules).
- WSDL request-response operations with specification of service level requirement including conditions of failure and priorities between multiple service level metrics (e.g., response time and data freshness).

Business Roles



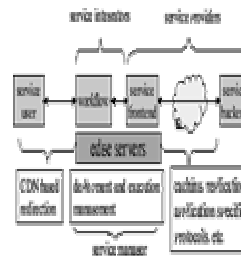
Service provider exposes service components.

Service integrator creates integrated Web services by combining service components.

Service manager hosts service integrators' workflows and service providers' frontend modules.

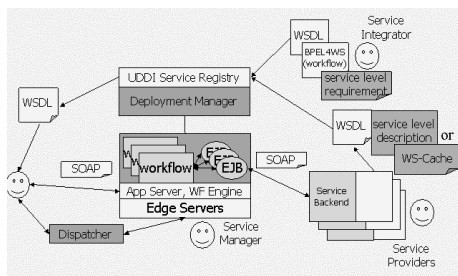
Service consumer finds an integrated service provider's service.

OWSN framework (Overlay Web Service Network)



- Service integration workflows and service frontend modules are deployed on edge servers and bound to each other according to WSDL descriptions.
- workflow invokes component services by sending messages to frontend modules.
- Between the edge server and the original server of the service provider, a frontend module and a backend module communicate with each other.
- the service integrator can specify its preferences for multiple service levels provided from the frontend modules

System Architecture



Work flow

- Work flow is a business process which consists of "activities".
- The <receive> and <reply> activities are provided for handling a service request from a client.
- An optional <sla:serviceLevelRequirement> entity specifies the required service level for this Web service invocation.
- With the combination of partner, portType, and operation, the system can identify the specific WSDL operation to invoke.

Example :

```
<invoke partner="ncname" portType="qname" operation="ncname"
inputContainer="ncname" outputContainer="ncname">
<sla:serviceLevelRequirement requirement="qname"/>
<catch faultName="qname" faultContainer="ncname">
[activity]
</catch> </invoke>
```

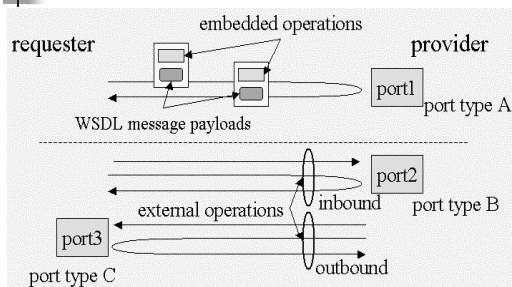
Message Cache

- There can be three levels of Web service message caching.
 - WSDL operation level : When an operation is cacheable (i.e., read-only), the proxy can cache the output message with the input message as the cache key.
 - SOAP message level : This is less reusable than the corresponding WSDL-level message since it often includes extra information such as routing (e.g., WS-Routing) in its header.
 - HTTP level: The existing HTTP caching facility is even less applicable since SOAP messaging is often implemented using the HTTP PUT method and the final product is customized.

Message Cache (cont..)

- A cache control specification, called WS-Cache, is designed for service providers to specify which operations are cacheable and what kind of cache control is supported by the service provider.
- Two types of cache control operations can be realized within the Web services framework:
 - Embedded operations.** Cache control operations are attached with messages of WSDL operations which are to be cached. The provider's port (port1) should handle cache control operations as well as the main WSDL operations which are defined in the port type A.
 - External operations.** Cache control operations are implemented as additional services provided separately from WSDL operations to be cached. There are two types of such services: inbound services and outbound services, which are provided by the provider (i.e., the source) and the requester (i.e., the proxy), respectively.

Framework of WSDL level cache control operations.



Description of overall structure of WS-Cache

```
<wsCache name="ncname" targetNamespace="uri"
  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" xmlns:xsd="http://www.
  w3.org/2000/10/XMLSchema">
  <import namespace="uri" location="uri"/>*
  <types? <xsd:schema ... />* </types>
  <controlType name="ncname">*
  <operation name="ncname">*
  <input type="qname"?>
  <output type="qname"?>
  </operation>
  <inbound name="ncname" portType="qname"/>*
  <outbound name="ncname" portType="qname"/>*
  <controlType> <controlBinding name="ncname" controlType="qname">*
  <binding name="ncname">*
  <- extensibility element -->*
  </binding>.....
```

Service Level Management.

- They focus on specification for service level preference including tradeoff between competing service level metrics (such as speed and accuracy) so that a proxy can flexibly manage execution for better performance and reliability.
- Given priorities between multiple service level metrics, the system can manage **graceful degradation of services**.
- Even when overload or faults of subsystems make the system unable to provide the perfect service, it continues to operate by providing a reduced level of service rather than failing completely.
- The priority between service level metrics can be different between different situations even for the same application

Service Level Management.

- The priority between service level metrics can be different between different situations even for the same application.
- Two specifications:
 - Service Level Description is used by a service provider to specify service level metrics available for each WSDL operation.
 - Service Level Requirement is used by a service integrator to specify requirements of service level for each WSDL operation.

Service Level Management.

- ServiceLevelDescription specification.


```
<serviceLevelDescription name="ncname"
  targetNamespace="uri">
  <serviceType name="ncname">*
  <metrics name="ncname" unit="name"?
    min="name"? max="name"?/>+
  </serviceType>
  <serviceLevel serviceType="qname"
  portType="qname" operation="qname"/>*
  </serviceLevelDescription>
```

Service Level Management.

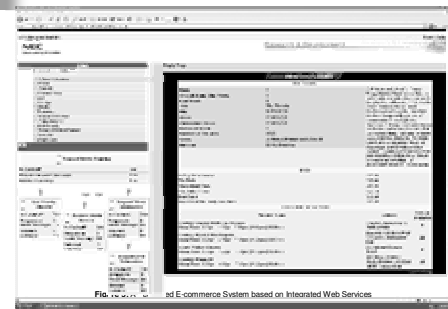
- ServiceLevelRequirement specification.


```
<serviceLevelRequirement name="ncname"
  portType="qname" operation="qname" serviceType="qname">
  <serviceLevelMatrix>
  <level value="1">
  <cond metrics="sid:Freshness" max="0"/> <cond
  metrics="sid:ResponseTime" max="100"/> </level>
  <level value="0.8">
  <cond metrics="sid:Freshness" min="0" max="1000"/>
  <cond metrics="sid:ResponseTime" max="100"/> </level>
  ....
  </serviceLevelMatrix> <fault level="0.2" faultName="qname" />
  </serviceLevelRequirement>
```

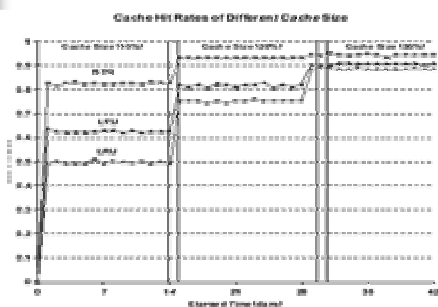
Case Study.

- They have implemented a prototype system for federated EC, which aggregates multiple EC services.
- A service integrator correlates products from multiple sellers and integrates them with other value-added service components.
- This was a federated e-commerce systems which integrates five Web services and provides users a single access point to retrieve information related to a movie category, including top movies, reviews, theater and ticket information, and DVDs of similar movies.

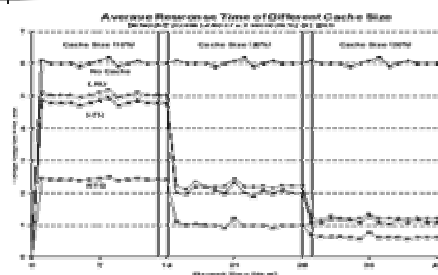
A Federated E-commerce System based on Integrated Web Services .



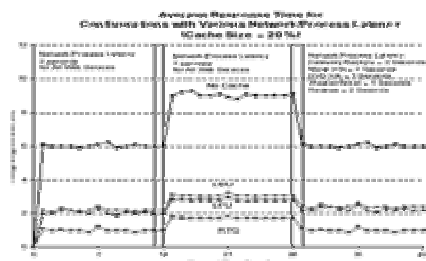
Experimental Results.



Experimental Results. (cont...)



Experimental Results. (cont...)



Conclusion.

- Integrated services are described in a standard workflow language, deployed on edge servers, and access other Web services through proxies on the edge servers.
- Performance-conscious message handling is introduced between the edge server and the original server so that the service integrator can concentrate on business logic.
- WS-Cache specification was proposed so that cache proxies and service providers can incorporate various caching techniques into Web services.
- Service Level Requirement specification was introduced in order to allow service integrator to indicate preferences for multiple service levels provided from the proxies.

Critique on the paper

- They did not tell the massive load that is incurred by message passing.
- They just said that service integrator will decide the workflow, but they have not talked about the criteria behind deciding the workflow.

Questions????

- What are Business Roles for Integrated Web Services?
- Explain the two types of cache control operations?
- How is the service level management handled?
- What are the levels of Web service message caching discussed and which level of caching is advantages?
- What is graceful degradation and how is it achieved?