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(54) SYSTEM AND METHOD FOR DYNAMIC WEB SERVICES DESCRIPTOR GENERATION USING TEMPLATES

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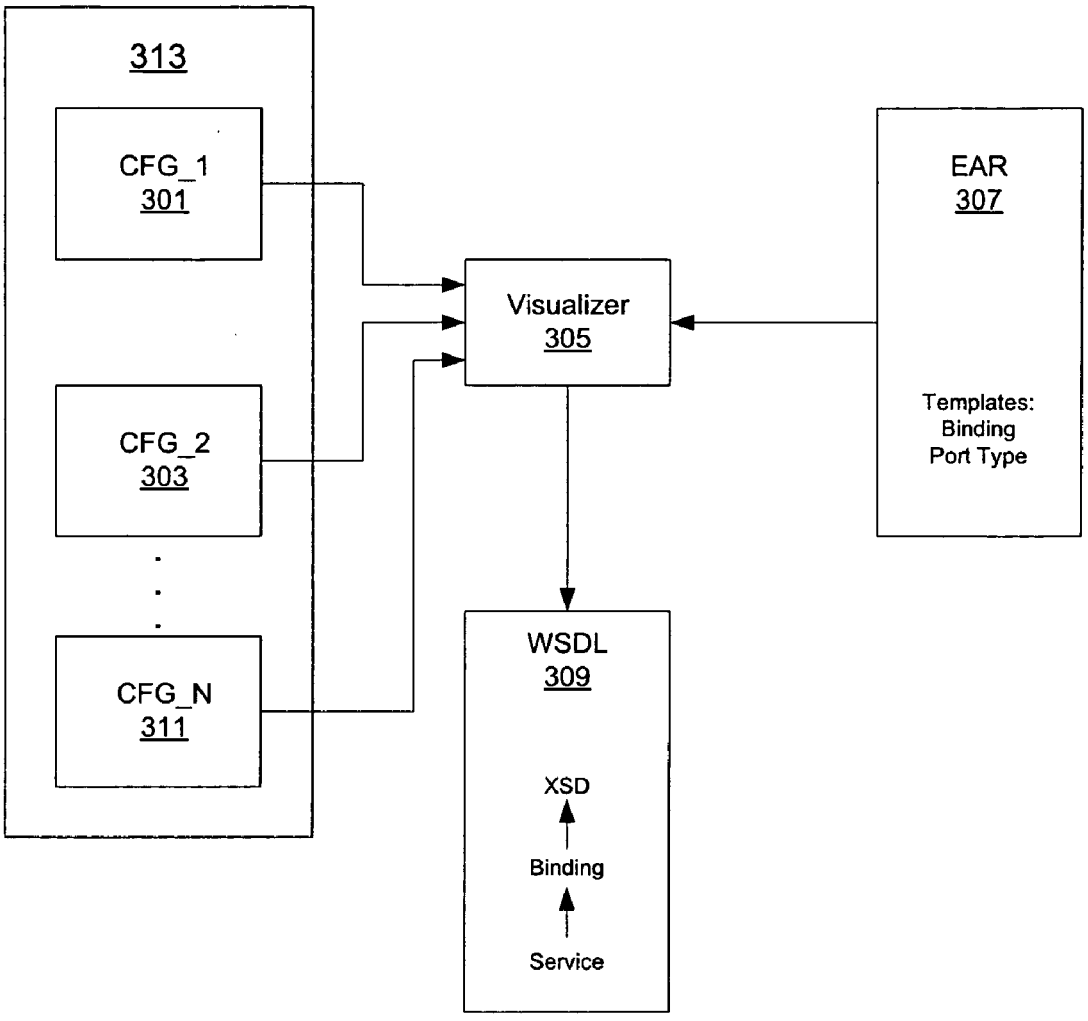
(57) ABSTRACT

A system and method for generating a Web services description file is described. In one embodiment, a visualizer process metadata from a configuration file and applies the metadata to a predefined template to generate a portion of a Web services description file. The configuration file stores metadata about a service provided by a Web service. The template file defines structure and syntax of a portion of a Web services description file.



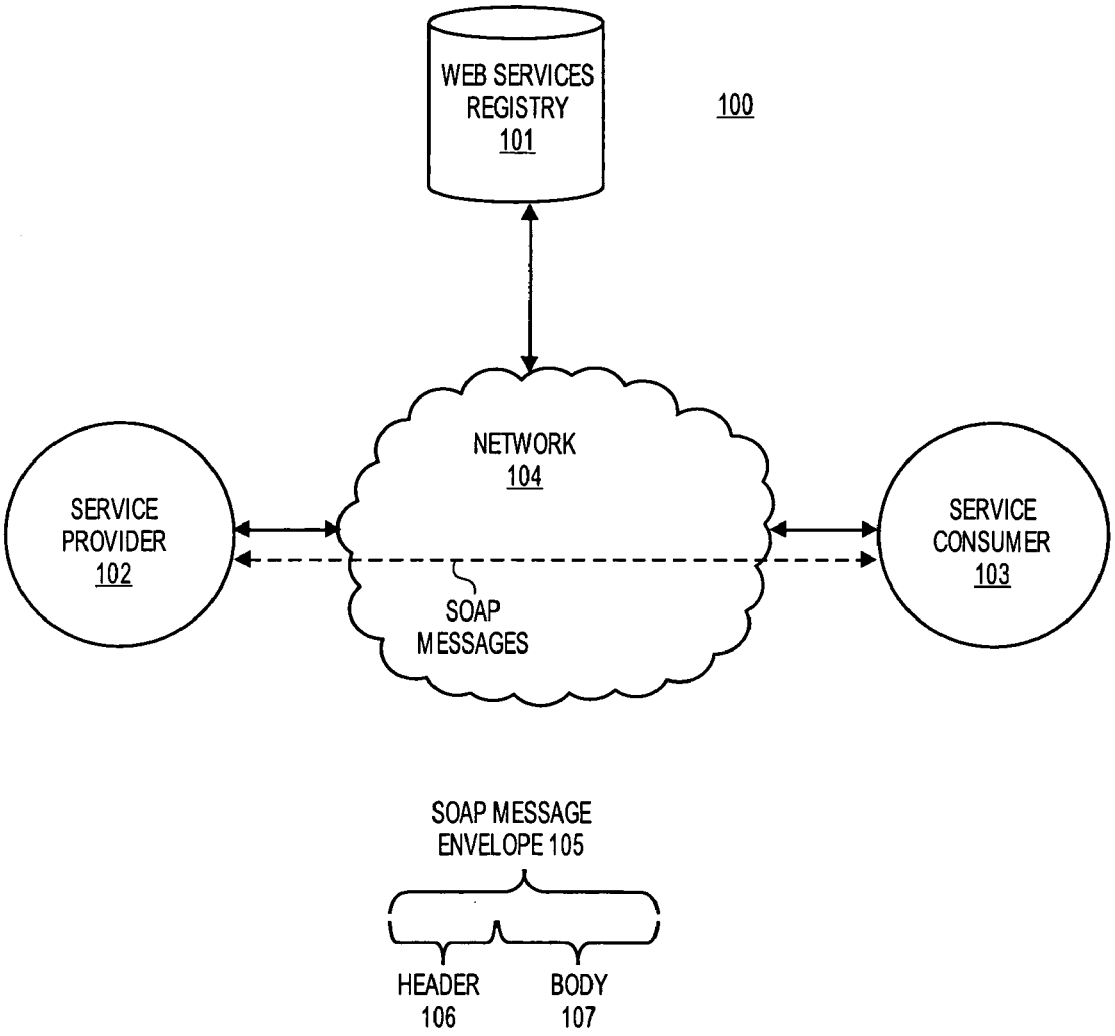


FIG. 1
(PRIOR ART)

```
<?xml version="1.0"?>
<definitions name="PatentFilings"
targetNamespace="http://bstz.com/patents.wsdl"
      xmlns:tns="http://bstz.com/patents.wsdl"
      xmlns:xsd1="http://bstz.com/patents.xsd"
      xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
      xmlns="http://schemas.xmlsoap.org/wsdl/">
  <types>
      <schema targetNamespace="http://bstz.com/patents.xsd"
        xmlns="http://www.w3.org/2000/10/XMLSchema">
       <element name="PatentAppNumber">
         <complexType>
            <all>
              <element name="AppNumber" type="string"/>
            </all>
         </complexType>
       </element>
      </schema>
  </types>

  <message name="GetStatus">
    <part name="body" element="xsd1:PatentStatus" />
  </message>

  <portType name="PatentAppPortType">
    <operation name="GetStatus">
      <input message="tns:GetStatusInput"/>
      <output message="tns:GetStatusOutput"/>
    </operation>
  </portType>

  <binding name="PatentAppSoapBinding" type="tns:PatentAppPortType">
    <soap:binding style="document" transport="http://schemas.xmlsoap.org/soap/http"/>
    <operation name="GetStatus">
      <soap:operation soapAction="http://bstz.com/GetStatus"/>
      <input>
        <soap:body use="literal"/>
      </input>
      <output>
        <soap:body use="literal"/>
      </output>
    </operation>
  </binding>

  <service name="PatentAppService">
      <port name="PatentAppPort" binding="tns:PatentAppSoapBinding">
      <soap:address location="http://bstz.com/patentapp"/>
    </port>
  </service>
</definitions>
```

Types 201

Message 203

Port Type 205

Binding 207

Service 209

FIG. 2
PRIOR ART

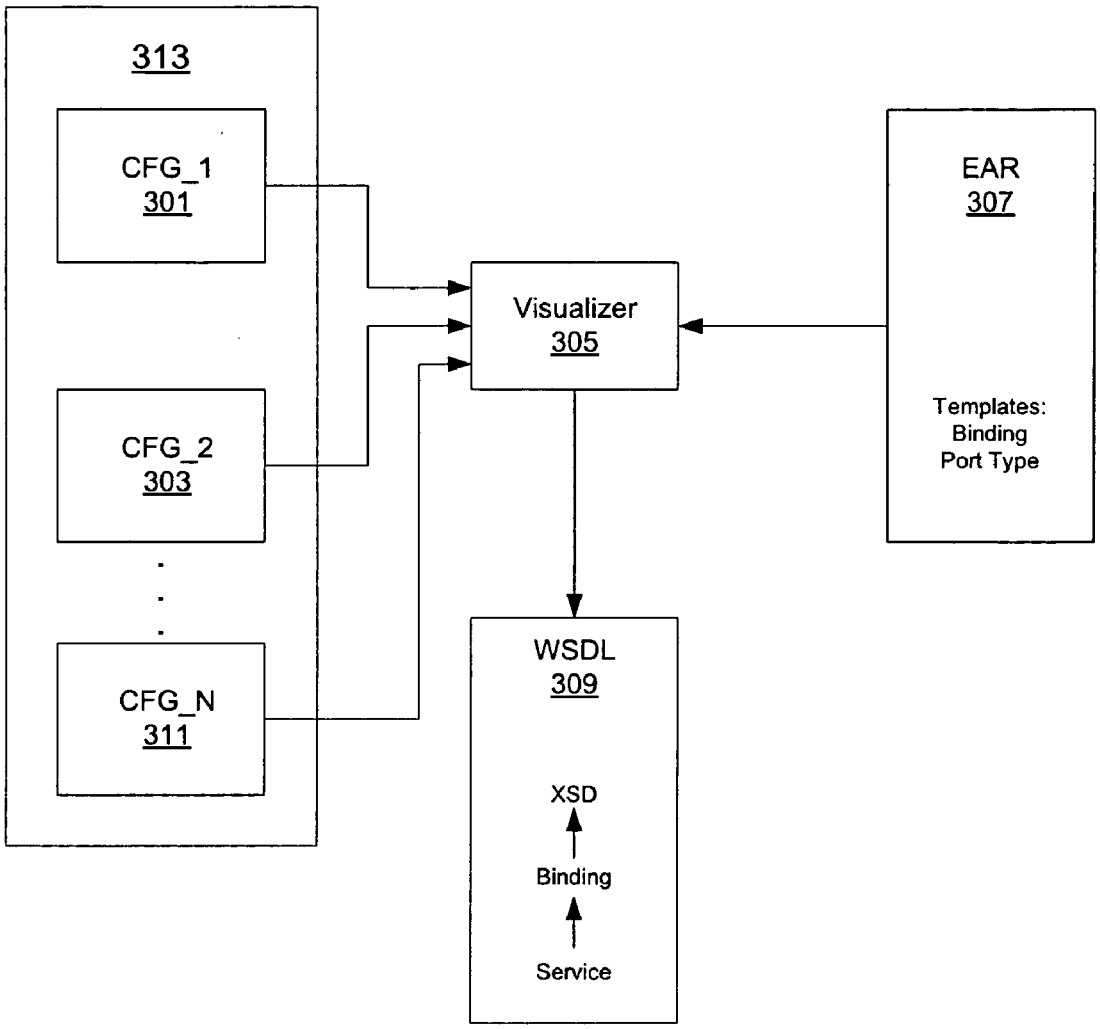

313
CFG_1
301
CFG_2
303
CFG_N
311
Visualizer
305
EAR
307
Templates:
Binding
Port Type
WSDL
309
XSD
Binding
Service

FIG. 3

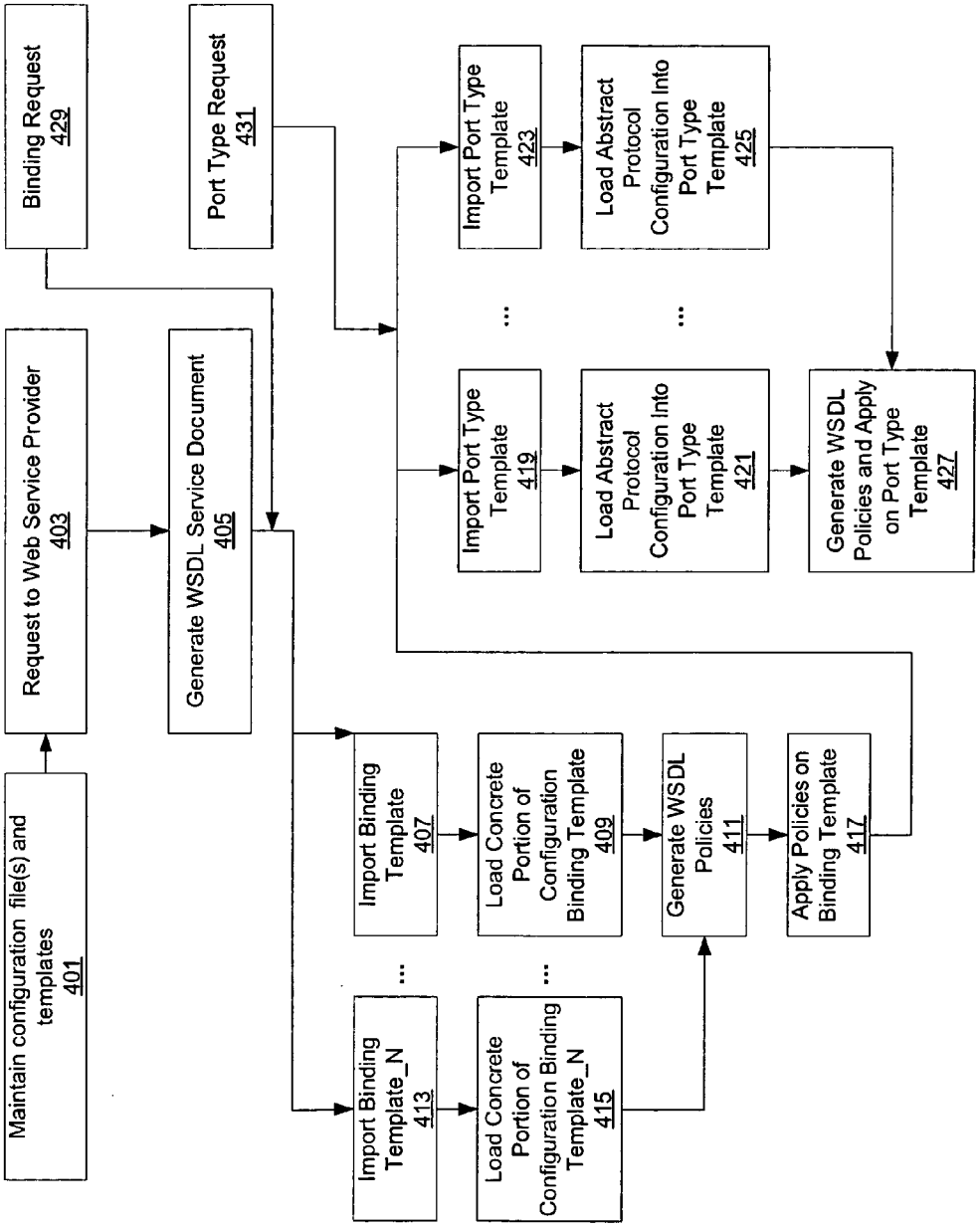

Binding Request 429
Port Type Request 431
Import Port Type Template 423
Load Abstract Protocol Configuration Into Port Type Template 425
Request to Web Service Provider 403
Generate WSDL Service Document 405
Import Port Type Template 419
Load Abstract Protocol Configuration Into Port Type Template 421
Generate WSDL Policies and Apply on Port Type Template 427
Maintain configuration file(s) and templates 401
Import Binding Template 407
Load Concrete Portion of Configuration Binding Template 409
Generate WSDL Policies 411
Apply Policies on Binding Template 417
Import Binding Template_N 413
Load Concrete Portion of Configuration Binding Template_N 415

FIG. 4

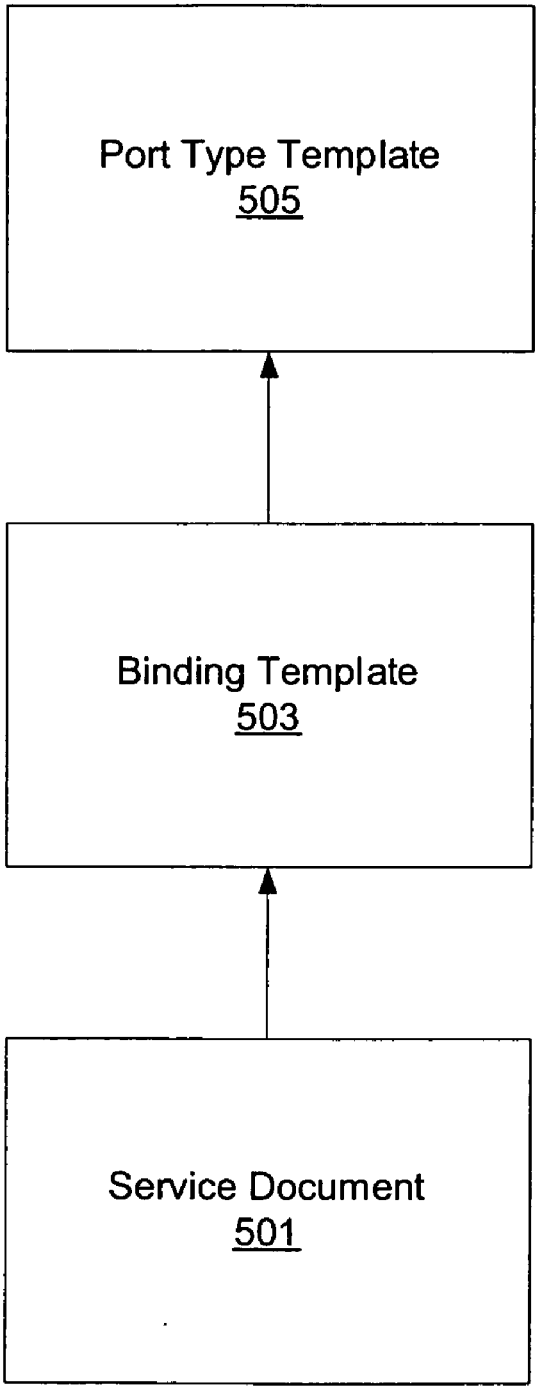

Port Type Template
505
Binding Template
503
Service Document
501

FIG. 5

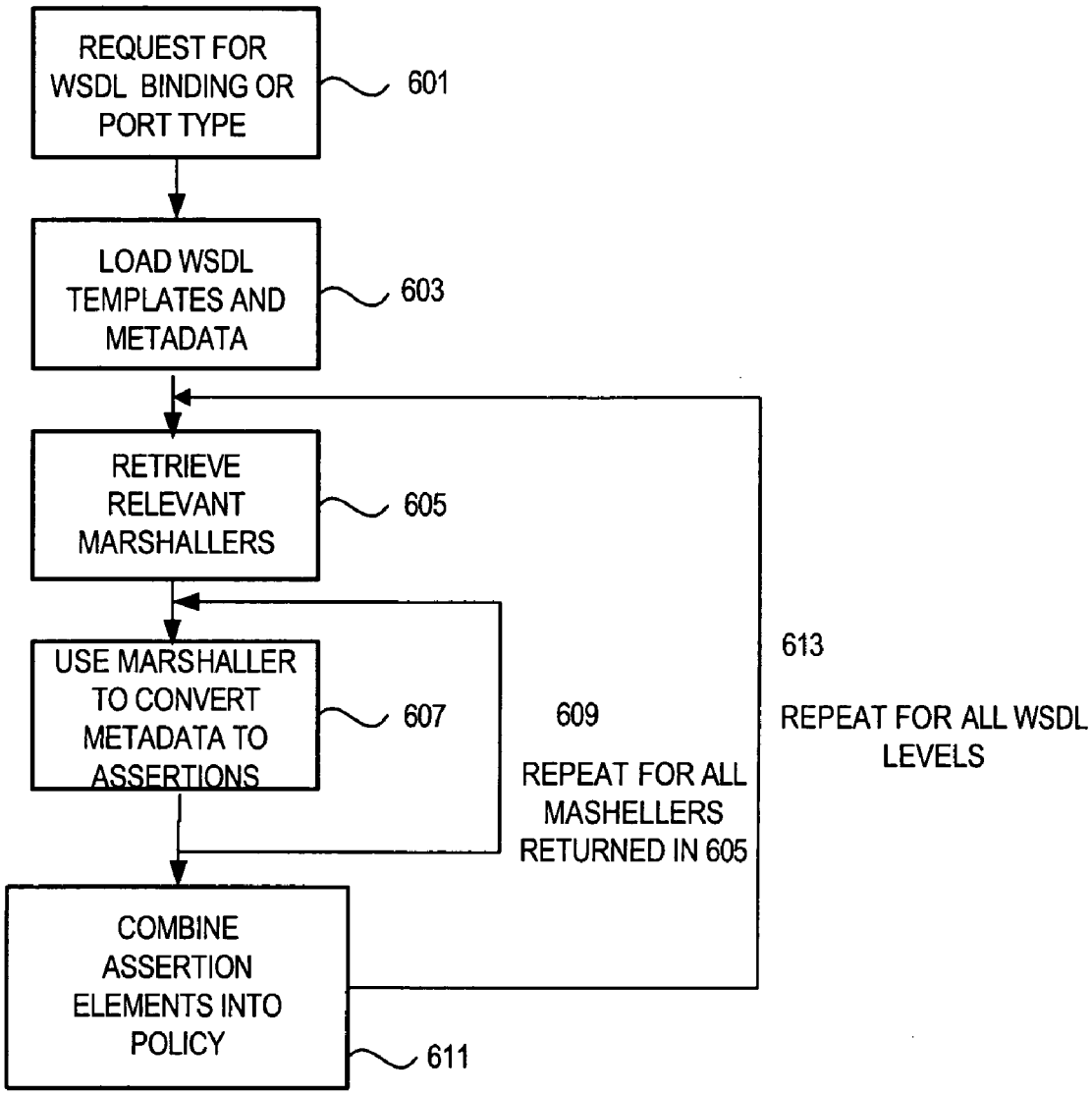

REQUEST FOR WSDL BINDING OR PORT TYPE
601
LOAD WSDL TEMPLATES AND METADATA
603
RETRIEVE RELEVANT MARSHALLERS
605
USE MARSHALLER TO CONVERT METADATA TO ASSERTIONS
607
609
REPEAT FOR ALL MASHELLERS RETURNED IN 605
613
REPEAT FOR ALL WSDL LEVELS
COMBINE ASSERTION ELEMENTS INTO POLICY
611

FIG. 6A

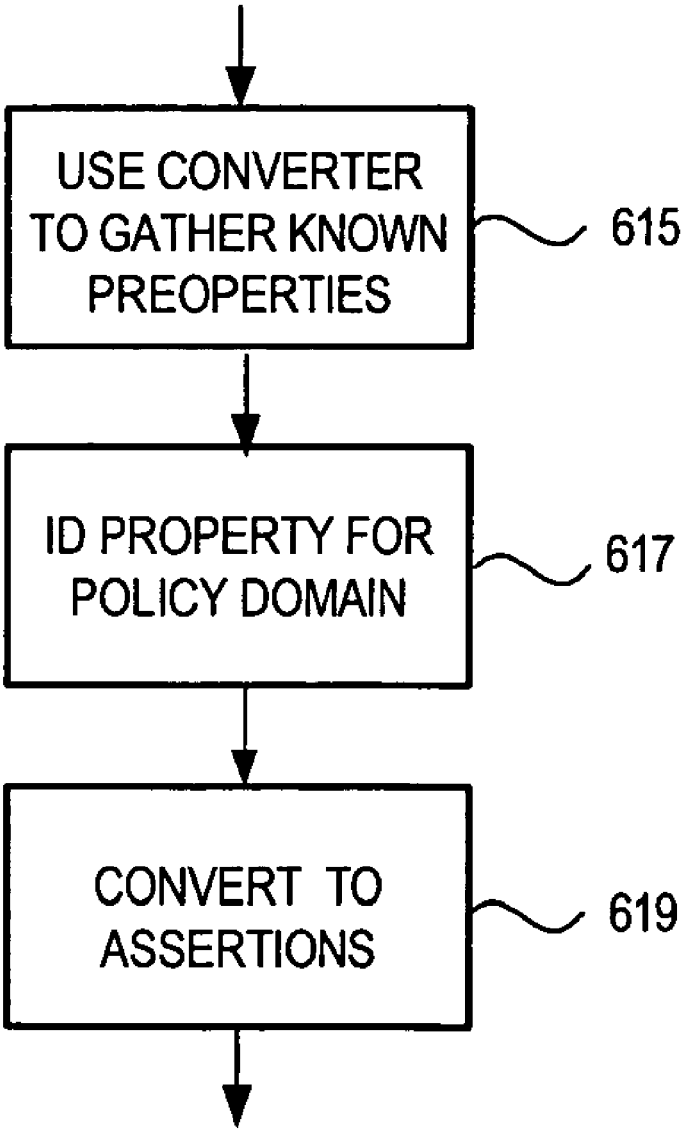

USE CONVERTER TO GATHER KNOWN PREOPERTIES
615
ID PROPERTY FOR POLICY DOMAIN
617
CONVERT TO ASSERTIONS
619

FIG. 6B

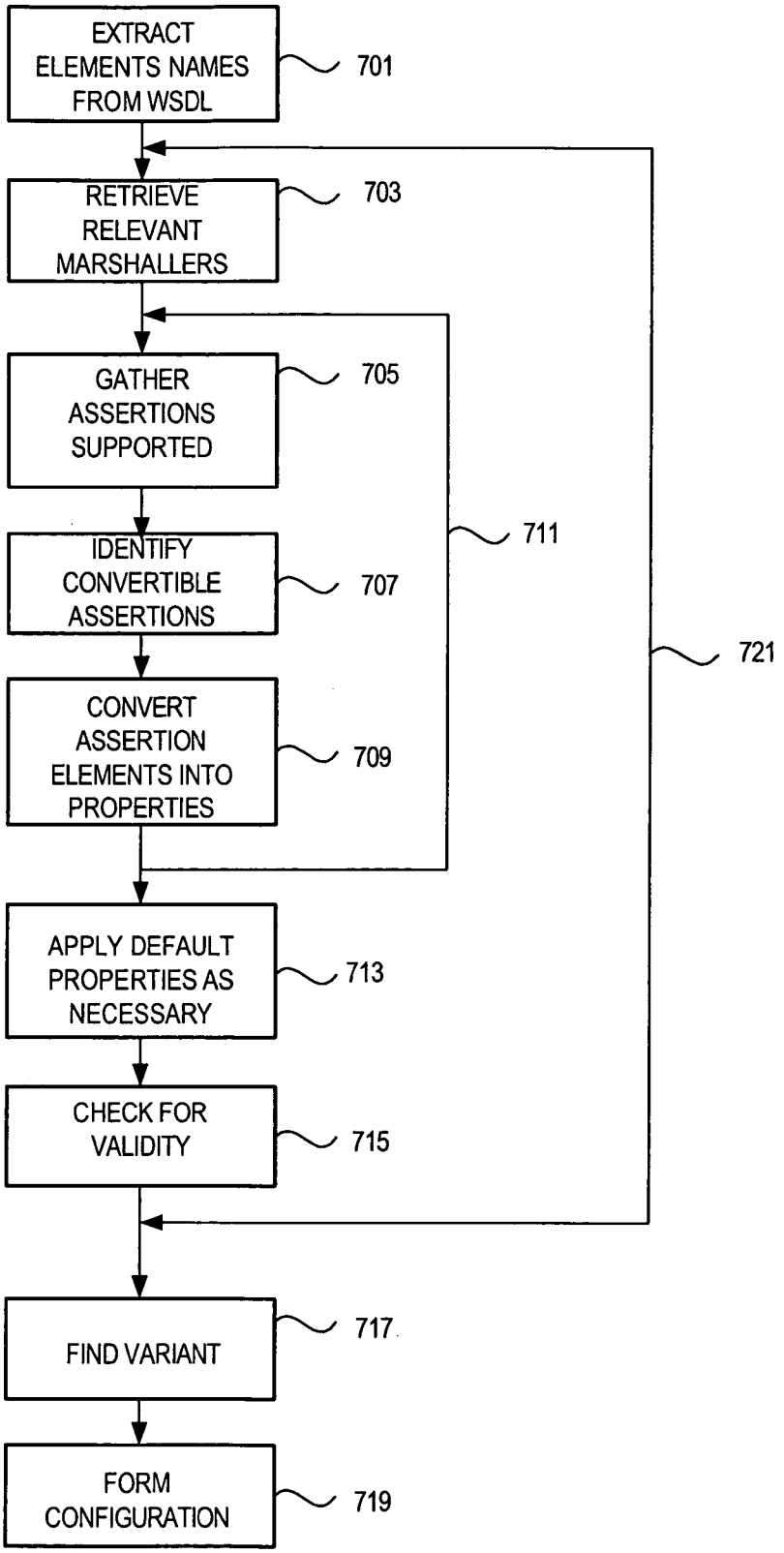

EXTRACT ELEMENTS NAMES FROM WSDL
701
RETRIEVE RELEVANT MARSHALLERS
703
GATHER ASSERTIONS SUPPORTED
705
IDENTIFY CONVERTIBLE ASSERTIONS
707
CONVERT ASSERTION ELEMENTS INTO PROPERTIES
709
711
APPLY DEFAULT PROPERTIES AS NECESSARY
713
CHECK FOR VALIDITY
715
721
FIND VARIANT
717
FORM CONFIGURATION
719

FIG. 7

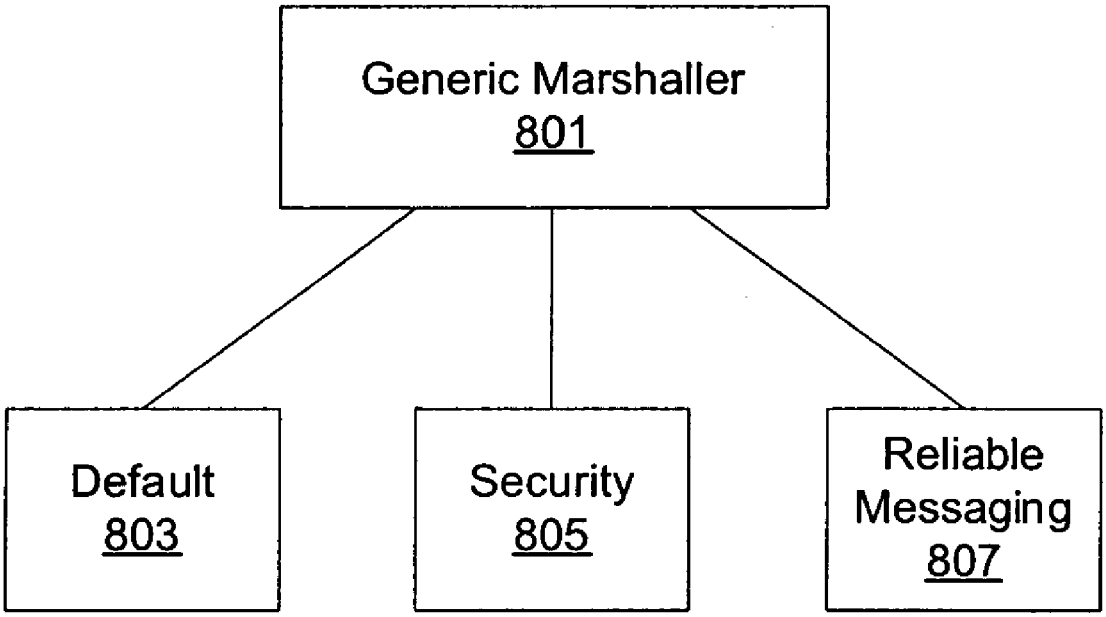

Generic Marshaller
801
Default
803
Security
805
Reliable
Messaging
807

FIG. 8

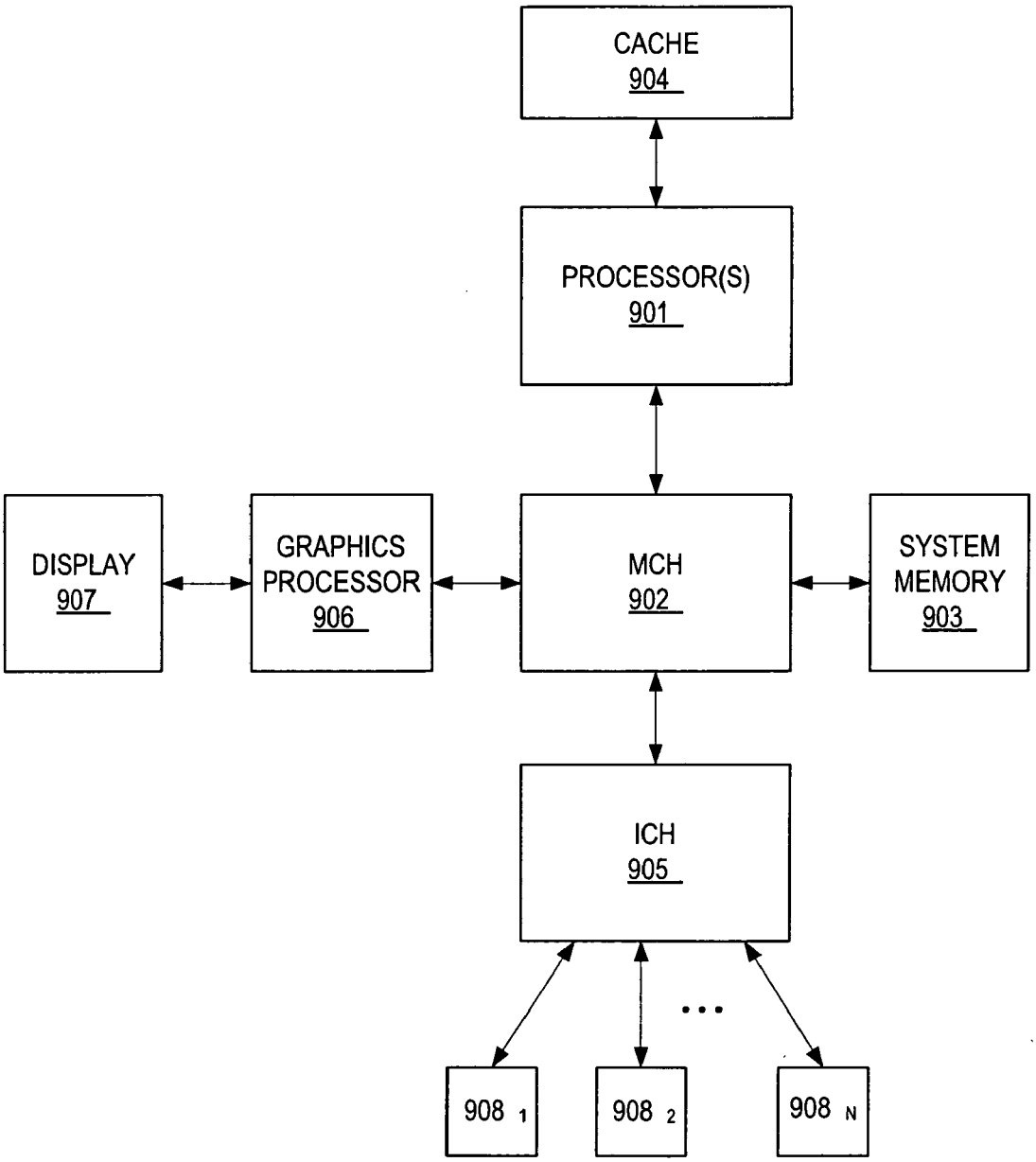

CACHE
904
PROCESSOR(S)
901
DISPLAY
907
GRAPHICS
PROCESSOR
906
MCH
902
SYSTEM
MEMORY
903
ICH
905
908 1
908 2
908 N

FIG. 9

SYSTEM AND METHOD FOR DYNAMIC WEB SERVICES DESCRIPTOR GENERATION USING TEMPLATES

BACKGROUND

[0001] 1. Field of the Invention

[0002] This invention relates generally to the field of data processing systems. More particularly, the invention relates to a system and method for improving Web services description generation and maintenance including the formation of WSDL files.

[0003] 2. Description of the Related Art

[0004] The term "web services" can be viewed as a technology for engaging in business relationships (e.g., buying and selling) in a partially or wholly automated fashion over a network such as the Internet. FIG. **1** shows a web services model **100** that includes a registry **101**, a service provider **102** and a service consumer **103**. A service consumer **103**, or "service requester", is generally understood to be an entity that seeks and (in cases where a suitable web service is found) uses a particular web service through a network **104**.

[0005] The registry **101** includes listings of various "available" services, and, may assist the service consumer **103** in searching for a suitable service provider based on the web servicing needs of the service consumer **103**. A service provider **102** is the provider of one or more web services that can be accessed over the network **104**. Because of the vast expanse of the Internet and interest in automated business engagements, many registries, service consumers and service providers may be in operation at any instant of time.

[0006] Presently, the responsibilities of the most prevalent registry function **101** that is associated with the web services effort are defined in various Universal Discovery, Description and Integration (UDDI) specifications provided by uddi.org. Besides providing listings of available services, a UDDI registry **101** may also make available to a service consumer **103** additional details that pertain to any particular web service such as: 1) the location of the web service (e.g., its URI specified by a specific network destination address or name); 2) the capabilities of the web service (e.g., specific methods that are supported by the web service and that may be called upon by the service consumer), and, 3) communication semantics needed for invoking the web service through the network **104** (e.g., the structure of a messaging format and/or protocol needed to properly communicate with the web service).

[0007] According to one widely adopted approach, such "additional details" are described in Web Services Definition Language (WSDL) text documents written in extensible Markup Language (XML). Here, for example, for each web service that the registry **101** maintains a listing of, the registry **101** also maintains a WSDL document that describes the location, capabilities and communication semantics of the web service. Presently, a WSDL document for a particular web service is expected to include an "abstract interface" description of the web service (which includes the web service's methods and the data passed between the web service provider and web service consumer) and a "concrete implementation" description of the web service (which includes specific protocol and data format specifications for communicating with the web service (referred to as a "binding") and the location of the web service (referred to as a "port")).

[0008] According to another widely adopted approach, with respect to the actual communication that occurs between the service consumer **103** and the service provider **102**, such communication is implemented through an exchange of Simple Object Access Protocol (SOAP) text messages written in XML.

[0009] WSDL files are created in the XML format that describe a Web service provider's services as a set of endpoints (or ports) operating on messages containing either document-oriented or procedure-oriented information. For example, a SOAP message may be directed toward a particular port of a Web services provider from a remote client. FIG. **2** illustrates an exemplary WSDL file.

[0010] A WSDL file generally contains information for types **201**, messages **203**, port types **205**, bindings **207**, and services **209** supported by the Web service provider. From this WSDL file a client may determine how to communicate with a Web service and what functionality the Web service provides.

[0011] A type describes for data type definitions using a type system. For example, the type system may be XSD (XML Schema Descriptor). In the example of FIG. **2**, the type **201** is an XSD file called patents.xsd. This file is located on the Web service provider's server (here bstz-.com).

[0012] Messages in a WSDL file are described abstractly and define the data being communicated between endpoints or ports. For example, the message **203** is called "GetStatus" and provides the patent status in the body of the message.

[0013] Port types are abstract collections of operations supported by a Web service. Each operation describes a function supported. The port type **205** illustrated describes the operation "GetStatus" including the input and output message format to be adhered to.

[0014] Bindings are concrete protocols and define the particular data format for a particular port type. In the example, the binding **207** associates the "GetStatus" operation with a SOAP message.

[0015] A port is defined by binding a network protocol and message format. A collection of these ports define a service. The service **209** ties the "PatentAppSoaPBinding to the port "PatentAppPort."

[0016] Current WSDL document generation requires manual intervention to describe the Web service. Either a program such as GLUE is run or the WSDL file is generated manually. In either case, these WSDL files cannot be automatically generated based upon a request to the service provider.

[0017] Additionally, WSDL files were generated from web service artifacts such as Virtual Interface, WSD and web-services-deployment-descriptor which were inside a web service archive. The WSDL generation was done at the deployment time of a web service. Accordingly, when request is made for WSDL visualization, the WSDL simply read from the file system. In this approach it is impossible

for a configuration to be edited/removed/added at runtime without editing the web service artifacts, updating the archive, and redeploying it.

SUMMARY

[0018] A system and method for generating a Web services description file is described. In one embodiment, a visualizer process metadata from a configuration file and applies the metadata to a predefined template to generate a portion of a Web services description file. The configuration file stores metadata about a service provided by a Web service. The template file defines structure and syntax of a portion of a Web services description file.

FIGURES

[0019] The present invention is illustrated by way of example, and not limitation, in the figures of the accompanying drawings in which like references indicate similar elements and in which:

[0020] FIG. **1** shows a Web services model (prior art);

[0021] FIG. **2** illustrates an exemplary WSDL file (prior art);

[0022] FIG. **3** illustrates an embodiment of a system for generating a WSDL document from templates and configuration data;

[0023] FIG. **4** illustrates an embodiment of the flow of dynamically creating a WSDL document;

[0024] FIG. **5** illustrates the reference principles of templates applied in the creation of a WSDL document according to an embodiment;

[0025] FIG. **6**A illustrates an embodiment of the flow for generating WSDL policies;

[0026] FIG. **6**B illustrates an embodiment of the flow for the conversion of metadata to assertion elements;

[0027] FIG. **7** illustrates an embodiment of the flow for generating a configuration file from a policy annotated WSDL;

[0028] FIG. **8** illustrates the inheritance properties of marshallers according to one embodiment; and

[0029] FIG. **9** is a block diagram of a computing system that can execute program code stored by an article of manufacture.

Detailed Description

[0030] Described below is a system and method for dynamically generating a WSDL document. Throughout the description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without some of these specific details. In other instances, well-known structures and devices are shown in block diagram form to avoid obscuring the underlying principles of the present invention.

[0031] One embodiment of the invention generates a WSDL document from the abstract and concrete data stored in a configuration file as applied to templates for binding and port type.

Dynamic WSDL Generation

[0032] In Web services systems, a WSDL file provides the outside world with the requirements for communicating with and utilizing the services of a service provider. As described earlier, these WSDL files are usually generated after a complete Web service has been defined by a provider and are likely to be an afterthought to the complex design process used to create a Web service. Dynamic creation and/or changing of WSDL documents allows for a Web service provider to describe new services or remove services easier. In one embodiment, as the WSDL document is updated or created without human intervention to create the WSDL document. For example, as soon as a new service is provided the WSDL document for the Web service provider is updated to reflect this change without having to manually create the new WSDL document.

[0033] FIG. **3** illustrates an embodiment of a system for generating a WSDL document from templates and configuration data. These templates and configuration data were not available in the prior art. In an embodiment, a web services archive file contains WSDL templates and configuration file(s). These templates are generated during web service design time and are packaged inside the archive. This approach allows for dynamical edition/remove/add of a web service configuration. When a request for WSDL visualization is received, a WSDL file is generated dynamically using the WSDL template and configuration data. Each template stores information regarding the structure and syntax of a portion of a WSDL document. For example, the binding template contains information relating to the protocol configurations of the service.

[0034] Upon a request (HTTP, HTTPS, FTP, etc.), a visualizer **305** uses at least one configuration file **313** which may contain multiple configuration components **301**, **303**, **311** and a template (binding, port type, etc.) stored in an archive **307** to create at least a portion of a WSDL document (for example, the port type, service, or binding section of the WSDL). In one embodiment, the template is stored in an EAR (Enterprise Archive) file. For example, an HTTP request made to the visualizer **305** causes the visualizer **305** to apply the relevant metadata configuration components **301**, **303**, **311** available to the port type template of the EAR **307** to create a service for the WSDL **309**. Likewise a binding request to the visualizer **305** creates a WSDL binding reference for the WSDL **309**. This technique may be applied to existing Web services by maintaining (or creating) configuration components or files in addition to the maintaining the EAR file(s) that is already deployed. In one embodiment, there is a template for every portion of the WSDL document. For example, there is a template for types, messages, port types, bindings, and services.

[0035] Each configuration **301**, **311**, **303** stores WSDL metadata about a service provided by the Web service provider. In an embodiment, configuration components of a configuration file are also specific to a particular policy domain such as security, reliable messaging, etc. For example, configuration component CFG_**1301** contains metadata regarding the security protocol that is to be used by the Web service for a particular service. The policy domain for security may include the type of encryption used and/or the type of signature required. A client that has retrieved the WSDL file that was created using this configuration file will

be able to ascertain the security protocol is being utilized by the provider and how to properly construct messages from the client to the provider using this protocol. Other configuration components **303**, **311** contain other metadata about a service provided. For example, CFG_**2311** contains session data and CFG_N **303** contains security and reliable messaging data about a service. Configuration components may be dynamically added, removed, or modified depending upon the services that are to be provided by the Web service.

[**0036**] There are two types of data available in most WSDL implementations: abstract and concrete data. Abstract data is design time configuration data and is associated with a port type, type, and/or message. Runtime configuration data (concrete data) is associated with a binding, service, and/or port. In one embodiment, each configuration is associated with only a single port. The use of configuration files allows for the separation of abstract and concrete WSDL data which was not possible in prior art systems. This separation allows for the dynamic creation and/or changing of a WSDL document. A WSDL document could be separated into abstract (porttype) and concrete (binding) parts. The configuration data from the configuration file(s) is additional metadata which again could be separated to abstract and concrete. This configuration metadata represents additional information, which cannot be described by the standard WSDL elements (types, messages, porttypes, bindings, services, ports) such as specific kinds of securities (signature, encryption), quality of service for message delivery (exactly one, exactly one in order, etc.), etc. An example of abstract configuration data is "I want encryption" with the concrete configuration data being "the encryption will be DES."

[**0037**] FIG. **4** depicts an embodiment of the flow of dynamically creating (visualizing) a WSDL document. Of course it should be understood that the WSDL document may already exist and is modified accordingly. Template and configuration files and/or components for a Web service are maintained at **401**. Throughout the life of the Web service these files are updated, including being added, removed, or modified, to reflect the current requirements for accessing and using the service.

[**0038**] A service request to the Web service provider from a client is made at **403**. In an embodiment, exemplary requests include HTTP requests, HTTPS requests, binding requests, etc.

[**0039**] The service portion of the WSDL document is generated at **405** if a service request has been made by the client connecting to the provider. During the generation of a service document, a service data is obtained from a service data registry of the provider. This data includes the correct binding and port names are gathered from a based on the URI provided by the client. For example, the visualizer **305** of FIG. **3** obtains binding and port names from the templates of the EAR **307**.

[**0040**] A binding request is made from the client to the provider for a specific port at **409**. This binding request initiates the importing of a stored binding template at **407**, **413**. As illustrated in FIG. **4**, several ports may have their relevant binding template imported. In this example, Binding Template_**1** is associated with port **1** and Binding Template_N is associate with the Nth port of the provider's service. Accordingly, a binding request for port **1** initiates the importing of Binding Template_**1**.

[**0041**] With the appropriate binding template imported, the concrete portion of the configuration file associated with that binding template is loaded at **409**, **415**. For example, the protocol(s) definitions described in a configuration file associated with Binding Template_**1** are imported into the WSDL service document.

[**0042**] WSDL policies are generated using the concrete data loaded at **411**. An embodiment of this generation will be described in detail later in FIGS. **6**A and **6**B. WSDL policies may be Web service specific (for example, a policy may be a feature of a particular Web service implementation such as those deployed by IBM, SAP, Microsoft, etc.) or generic (for example, a policy may apply to a Web service specification like WS-Security or WS-ReliableMessaging). For ease of understanding, the term policy or policies encompasses both policy types unless otherwise noted.

[**0043**] These generated WSDL policies are then applied to the binding template at **417** to create the binding elements of the WSDL file.

[**0044**] A request for port type initiates the importing of a port type template at **431**. Like binding, several port type templates may be imported **419**, **423** based on the particular request.

[**0045**] The abstract portion of the relevant configuration file is loaded at **421**, **425** into a port type template. The abstract portion describes the set of operations supported by the port. For example, in FIG. **2** the "GetStatus" operation is supported by the bstz.com Web service.

[**0046**] WSDL policies are generated by applying these abstract portions on the port type template at **427** to create the port type portion of the WSDL file. In one embodiment, this generation is done in a manner similar to that of WSDL policy generation for binding at **411**. An embodiment of this generation will be described in detail later in FIGS. **6**A and **6**B.

[**0047**] A WSDL document is created or modified when the port types, bindings, and services have been created and/or modified. The service document imports one or more binding WSDL documents. By reading the import data from service WSDL document the WS consumer "understands" on what URL to request the binding WSDL document(s). Each binding WSDL document imports only one port type WSDL document. By reading the import data from the binding WSDL document the WS consumer "understands" on what URL to request the port type WSDL document. Thus, a complete WSDL document consists of at least three separate WSDL files which are downloaded from different URLs and which relate to one another via WSDL import elements as described below.

[**0048**] FIG. **5** illustrates the import principles of templates applied in the creation of a WSDL document according to an embodiment. At least three documents and/or templates are used to create a WSDL file. A service document **501** is generated upon request. The service document describes services and their ports and addresses.

[**0049**] Binding templates **503** describe protocol configurations used in a Web service implementation. The binding template(s) **503** imports a port type WSDL document. The port type **505** template imports nothing.

[0050] Of course it should be understood that requests for service, binding, or port type may come in any order.

Server Side Policy Generation

[0051] Policy domains are sets of assertions for a particular protocol. Each assertion is an XML element defined by a particular Web services specification (for example, WS-Security, WS-ReliableMessaging, etc.) having some specific semantic and syntax. For example, in the security policy domain the assertions are the types of encryption or signatures used by the particular Web services provider. Configuration file information is converted into policies (non-implementation specific) or features (implementation specific) during the creation of WSDL documents.

[0052] FIG. **6**A illustrates an embodiment of the flow for generating WSDL policies. A request for a WSDL binding or port type component is made to a visualizer at **601**. The relevant WSDL template associated with the request is loaded along with metadata from at least one configuration file at **603** (ror example, configurations of a configuration file is loaded with the request).

[0053] The set of relevant marshallers (converters) needed to process a configuration file is retrieved from a registry (marshaller factory) or other storage location on the Web services provider at **605**. Each marshaller provides functionality to convert configuration file properties into assertion elements. There is at least one marshaller per each policy domain.

[0054] A marshaller from the set is used to convert configuration metadata into assertion elements at **607**. An embodiment of this conversion is described in greater detail in FIG. **6**B.

[0055] Each converter from the set performs the conversion of **607** at **609**. In other words, the conversion process should be repeated for each policy domain. The results of all of the conversions, assertion elements, are combined to form a policy element at **611**. This policy element is applied to the WSDL template loaded at **603** to create the WSDL component requested at **601**.

[0056] This conversion from metadata to a policy element may be repeated at **613** for the other WSDL levels until a complete policy annotated WSDL is formed. For example, if the request at **601** was for a port type, the conversion may be repeated for binding. Of course, it should be understood that if the policy annotated WSDL is being updated for a particular component (binding, port type, etc.) then the other components may not need to be updated and the conversion from metadata to policy element does not need to occur.

[0057] FIG. **6**B illustrates an embodiment of the flow for the conversion of metadata to assertion elements. Each marshaller is aware of a few properties that a particular policy domain supports. In other words, each marshaller may only process properties that it supports. The names of these known properties for a specific policy domain are gathered by a marshaller from the configuration file that the marshaller is associated with at **615**.

[0058] These property names are compared to the configuration metadata to identify which properties are stored in the metadata and therefore convertible by the marshaller at **617**. In other words, the marshaller not only has the capability to process a particular metadata but the configuration file contains the metadata. In one embodiment, this comparison is done by a so-called configuration builder. This builder is also responsible for gathering the marshallers from the registry.

[0059] The identified metadata is then converted into assertion elements by the marshaller at **619**. This process of retrieving property names that the marshaller supports the conversion of, identifying the metadata that is available to be converted by this particular marshaller, and converting this metadata into assertion elements is repeatable for each marshaller from the set of marshallers of the marshaller factory.

[0060] In one embodiment, there is a single generic marshaller to perform operations on every type policy domain. Therefore, certain tasks described above may be eliminated. For example, the comparison at **617** may be eliminated.

Client Side Configuration Creation

[0061] As described earlier, clients retrieve WSDL documents from Web service providers. These WSDL documents need to be "converted" into an understandable form (WS metadata) for the client. A part of this conversion is to create metadata property names from assertions in the XML (WSDL) document.

[0062] FIG. **7** illustrates an embodiment of the flow for generating a configuration from a policy annotated WSDL. From one WSDL, a configuration file is generated, which file could contain serveral configurations, depending how many endpoints (ports) the WSDL has. Assertion element names for a specific WSDL level (for example, port type, binding, etc.) are gathered from the policy annotated WSDL at **701**. Each marshaller provides functionality to convert WSDL assertions into metadata properties. In one embodiment, there is one marshaller per each assertion. Each marshaller is aware of a few properties that a particular assertion supports. In other words, each marshaller may only process assertions that it supports.

[0063] Using these assertion element names, the associated marshallers are retrieved from a registry or other storage location of the client, such as a marshaller factory, at **703**. For a particular marshaller retrieved at **703**, the marshaller gathers the set of assertions that the marshaller supports at **705**. In other words, this set identifies which assertions the marshaller is able to process into metadata properties.

[0064] These assertion element names are compared to the WSDL to identify which assertions are in the WSDL and are therefore convertible by the marshaller at **707**. In other words, the marshaller not only has the capability to process a particular assertion but the WSDL contains the assertion. In one embodiment, this comparison is done by a so-called configuration builder. This builder is also responsible for gathering the marshallers from the registry.

[0065] The marshaller used at **703** converts the assertion elements of the WSDL into metadata properties at **709**. Each marshaller from the set performs the conversion of **709** at **711**. The results of all of the conversions, metadata properties, are combined to form a property list. Because there are properties for which no match could be found at **707**, default properties of the marshaller are applied to the property list at **713**.

[0066] It is possible that two or more properties cannot be combined into the same metadata. In other words, the property list may have conflicting entries. For example, the property list may show that the for security purposes a signature is required but later in the list shows that a signature is not required. For this reason, the updated property list is checked for validity at **715** and any problems are reported to the client. If there are problems, the processing is stopped and requires further investigation to determine the proper course of action. For example, the property list may need to be manually adjusted. Each WSDL level should perform the above operations at **721**.

[0067] The marshaller checks for abstract properties that correspond to a specific concrete property and returns a list of possible abstract configurations (variants) at **717**. This relates a specific concrete portion of the WSDL to a specific abstract property. For example, specific type of encryption is a concrete portion of the WSDL and this relates to the abstract configuration of overall security.

[0068] Abstract configuration alternatives may exist as different marshallers may return valid configuration alternatives. Because of this the configuration alternatives are intersected to form a single abstract configuration that applies to the complete WSDL at **719**. For example, a security marshaller may return configurations for two different types of RSA encryption (HTTP and SSL). A reliable messaging marshaller may only have one type of RSA encryption (HTTP). While each of these alternatives provided by each respective marshaller is valid, only one configuration alternative is common to all marshallers, RSA HTTP.

[0069] In one embodiment, there is a single generic marshaller to perform operations on every type of assertion. Therefore, certain tasks described above may be eliminated. For example, the creation of the assertion array at **707** may be eliminated with a single generic marshaller.

[0070] In one embodiment, marshallers on both the client and provider side have the same basic functionality that stems from a generic parent marshaller. FIG. **8** illustrates the inheritance properties of marshallers according to one embodiment. The generic marshaller **801** provides functions for: 1) getting the known assertion names from a WSDL; 2)getting known property names from a configuration file; 3) converting assertions into metadata; 4) converting metadata into assertions; 5) applying default properties to a listing of properties; 3) finding variants; and 7) checking a configuration file for errors. Additional functionality may be added to the generic marshaller as the Web services provider adds functionality.

[0071] This generic marshaller serves as the model for a default configuration marshaller **803** (this marshaller applies the default properties to a listing of properties), a security marshaller **805** (this marshaller knows the security rules such as encryption and/or signature type), and a reliable messaging marshaller **807** (this marshaller knows the rules associated with reliable messaging). Each of these marshallers may inherit all of or a subset of the functions provided by the generic marshaller **801**. Additional marshallers may be added as functionality is added with the Web service.

[0072] The use of common marshallers allows for easier deployment of Web services as separate marshallers do not have to be developed for the client and provider side. As the marshallers have common functionality (commands) it is also easier to program because there are no difference between commands used by each marshaller. For example, the convert metadata into assertions command of the security marshaller **805** is the same as the reliable messaging marshaller **807**.

[0073] Processes taught by the discussion above may be performed with program code such as machine-executable instructions that cause a machine that executes these instructions to perform certain functions. In this context, a "machine" may be a machine that converts intermediate form (or "abstract") instructions into processor specific instructions (e.g., an abstract execution environment such as a "virtual machine" (e.g., a Java Virtual Machine), an interpreter, a Common Language Runtime, a high-level language virtual machine, etc.)), and/or, electronic circuitry disposed on a semiconductor chip (e.g., "logic circuitry" implemented with transistors) designed to execute instructions such as a general-purpose processor and/or a special-purpose processor. Processes taught by the discussion above may also be performed by (in the alternative to a machine or in combination with a machine) electronic circuitry designed to perform the processes (or a portion thereof) without the execution of program code.

[0074] It is believed that processes taught by the discussion above may also be described in source level program code in various object-orientated or non-object-orientated computer programming languages (e.g., Java, C#, VB, Python, C, C++, J#, APL, Cobol, Fortran, Pascal, Perl, etc.) supported by various software development frameworks (e.g., NET, Mono, Java, etc.). The source level program code may be converted into an intermediate form of program code (such as Java byte code, Microsoft Intermediate Language, etc.) that is understandable to an abstract execution environment (e.g., a Java Virtual Machine, a Common Language Runtime, a high-level language virtual machine, an interpreter, etc.).

[0075] According to various approaches the abstract execution environment may convert the intermediate form program code into processor specific code by, 1) compiling the intermediate form program code (e.g., at run-time (e.g., a JIT compiler)), 2) interpreting the intermediate form program code, or 3) a combination of compiling the intermediate form program code at run-time and interpreting the intermediate form program code. Abstract execution environments may run on various operating systems (such as UNIX, LINUX, Microsoft operating systems including the Windows family, Apple Computers operating systems including MacOS X, Sun/Solaris, OS/2, Novell, etc.).

[0076] An article of manufacture may be used to store program code. An article of manufacture that stores program code may be embodied as, but is not limited to, one or more memories (e.g., one or more flash memories, random access memories (static, dynamic or other)), optical disks, CD-ROMs, DVD ROMs, EPROMs, EEPROMs, magnetic or optical cards or other type of machine-readable media suitable for storing electronic instructions. Program code may also be downloaded from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals embodied in a propagation medium (e.g., via a communication link (e.g., a network connection)).

[0077] FIG. **9** shows an embodiment of a computing system (e.g., a computer). The exemplary computing system of FIG. **9** includes: 1) one or more processors **901**; 2) a memory control hub (MCH) **902**; 3) a system memory **903** (of which different types exist such as DDR RAM, EDO RAM, etc,); 4) a cache **904**; 5) an I/O control hub (ICH) **905**; 6) a graphics processor **906**; 7) a display/screen **907** (of which different types exist such as Cathode Ray Tube (CRT), Thin Film Transistor (TFT), Liquid Crystal Display (LCD), DPL, etc.; 8) one or more I/O devices **908**.

[0078] The one or more processors **901** execute instructions in order to perform whatever software routines the computing system implements. The instructions frequently involve some sort of operation performed upon data. Both data and instructions are stored in system memory **903** and cache **904**. Cache **904** is typically designed to have shorter latency times than system memory **903**. For example, cache **904** might be integrated onto the same silicon chip(s) as the processor(s) and/or constructed with faster SRAM cells whilst system memory **903** might be constructed with slower DRAM cells. By tending to store more frequently used instructions and data in the cache **904** as opposed to the system memory **903**, the overall performance efficiency of the computing system improves.

[0079] System memory **903** is deliberately made available to other components within the computing system. For example, the data received from various interfaces to the computing system (e.g., keyboard and mouse, printer port, LAN port, modem port, etc.) or retrieved from an internal storage element of the computing system (e.g., hard disk drive) are often temporarily queued into system memory **903** prior to their being operated upon by the one or more processor(s) **901** in the implementation of a software program. Similarly, data that a software program determines should be sent from the computing system to an outside entity through one of the computing system interfaces, or stored into an internal storage element, is often temporarily queued in system memory **903** prior to its being transmitted or stored.

[0080] The ICH **905** is responsible for ensuring that such data is properly passed between the system memory **903** and its appropriate corresponding computing system interface (and internal storage device if the computing system is so designed). The MCH **902** is responsible for managing the various contending requests for system memory **903** access amongst the processor(s) **901**, interfaces and internal storage elements that may proximately arise in time with respect to one another.

[0081] One or more I/O devices **908** are also implemented in a typical computing system. I/O devices generally are responsible for transferring data to and/or from the computing system (e.g., a networking adapter); or, for large scale non-volatile storage within the computing system (e.g., hard disk drive). ICH **905** has bi-directional point-to-point links between itself and the observed I/O devices **908**.

[0082] In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

We claim:

1. A system, comprising:

a configuration file to store metadata about a service provided by a Web service;

an archive to store a template file, wherein the template file defines structure and syntax of a portion of a WSDL document; and

a visualizer to process the stored template file and metadata from the configuration file into an element of the WSDL document.

2. The system of claim 1, wherein the configuration file is associated with a single port of the Web service.

3. The system of claim 2, wherein the metadata of the configuration file is abstract data.

4. The system of claim 2, wherein the metadata of the configuration file is concrete data.

5. The system of claim 1, wherein the template of the archive file describes one of the following:

a type;

a message;

a port type;

a binding; or

a service.

6. The system of claim 1, wherein the archive file is an EAR file.

7. The system of claim 1, wherein the visualizer is a J2EE engine.

8. A computer implemented method, comprising:

receiving a request at a Web services provider; and

generating a portion of a Web services description document dynamically in response to the request.

9. The method of claim 8, wherein if the request is for a service, generating a service portion of the Web services description document.

10. The method of claim 8, wherein if the request is for binding performing the following:

importing a binding template associated with the request;

loading the metadata of the template;

generating policies from the metadata; and

applying the policies on the binding template.

11. The method of claim 10, wherein the metadata of the binding template is concrete metadata.

12. The method of claim 8, wherein if the request is for port type performing the following:

importing a port type template associated with the request;

loading the metadata of the template;

generating policies from the metadata; and

applying the policies on the port type template.

13. The method of claim 12, wherein the metadata of the port type template is abstract metadata.

14. An article of manufacture including program code which, when executed by a machine, causes the machine to perform a method, the method comprising:

receiving a request at a Web services provider; and

generating a portion of a Web services description document dynamically in response to the request.

15. The article of manufacture of claim 14 wherein said executing further includes also performing the following if the request is for a service:

generating a service portion of the Web services description document.

16. The article of manufacture of claim 14 wherein said executing further includes also performing the following if the request is for a binding performing the following:

importing a binding template associated with the request;

loading the metadata of the template;

generating policies from the metadata; and

applying the policies on the binding template.

17. The article of manufacture of claim 16, wherein the metadata of the binding template is concrete metadata.

18. The article of manufacture of claim 14 wherein said executing further includes also performing the following if the request is for port type performing the following:

importing a port type template associated with the request;

loading the metadata of the template;

generating policies from the metadata; and

applying the policies on the port type template.

19. The article of manufacture of claim 18, wherein the metadata of the port type template is abstract metadata.

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