(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 November 2010 (04.11.2010)

PCT

(10) International Publication Number
WO 2010/124921 A1

(51) International Patent Classification:
*H04L 12/26* (2006.01) *H04L 29/06* (2006.01)

(21) International Application Number:
PCT/EP2010/054245

(22) International Filing Date:
30 March 2010 (30.03.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09158809.5 27 April 2009 (27.04.2009) EP

(71) Applicant *(for all designated States except US)*: **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, NY 10504 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BITTLES, William** [GB/GB]; IBM United Kingdom Limited, M/D 208, Hursley Park, Hursley, Winchester Hampshire SO21 2JN (GB). **GRANSHAW, David** [GB/GB]; IBM United Kingdom Limited, M/D 211, Hursley Park, Hursley, Winchester Hampshire SO21 2JN (GB). **PICKERING, John, Brian** [GB/GB]; IBM United Kingdom Limited, c/o Intellectual Property Department, Hursley Park, Hursley, Winchester Hampshire SO21 2JN (GB).

(74) Agent: **SEKAR, Anita**; IBM United Kingdom Limited, Intellectual Property Law, Hursley Park, Winchester Hampshire SO21 2JN (GB).

*[Continued on next page]*

(54) Title: MESSAGE SWITCHING

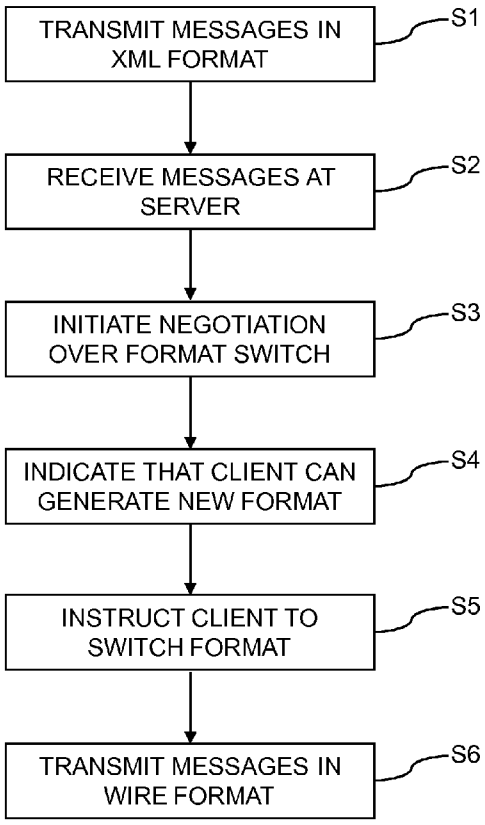


Fig. 4

(57) Abstract: A method of operating a communication system, the system comprising a server and a client, the method comprising the steps of transmitting messages from the client, the messages of a first format comprising data and descriptive tags, receiving the messages at the server, initiating a negotiation between the server and client relating to message format switching, indicating that the client can accept message format switching, instructing the client to switch message format, and transmitting further messages from the client, the further messages of a second format consisting of data.

WO 2010/124921 A1

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published**:

— *with international search report (Art. 21(3))*

# MESSAGE SWITCHING

## DESCRIPTION

This invention relates to a method of operating a communication system, and to the system itself. The method and system allow dynamic switching of message formats.

In computer technology, reference to a client and server describes the operation of two computers or programs in which one, the client, requests services and/or information from the other, the server. Standard networked functions such as email exchange, web access and database access, are based on the client and server model. Although client-server architectures are perhaps the most common, other modes of co-operation are possible. For instance, if neither computer holds the main data and applications but rather each is responsible for its own workings, then the two computers or computer programs are said to be peers in a peer-to-peer relationship.

Communication between computers, irrespective of their behavioural relationship is governed by a set of rules, called a protocol. Typical examples include http (hypertext transfer protocol) used for many World Wide Web applications, and ftp (file transfer protocol) used when one computer requests and receives a file from another. As well as the protocol, or set of rules, controlling communication, actual communication objects, or messages, also conform to a set of formatting rules which define how they are to be interpreted by the recipient. Typical formats include HTML (Hypertext Markup Language) which is the basic format for World Wide Web pages and XML (eXtensible Markup Language), a flexible tagging language used for many different and varied application message types. Such markup languages are useful in defining system interfaces and message formats. But they do have drawbacks: with a busy workload when lots of messages are passed between computers or computer programs, they will typically affect performance detrimentally.

According to a first aspect of the present invention, there is provided a method of operating a communication system, the system comprising a server and a client, the method comprising

the steps of transmitting messages from the client, the messages of a first format comprising data and descriptive tags, receiving the messages at the server, initiating a negotiation between the server and client relating to message format switching, indicating that the client can accept message format switching, instructing the client to switch message format, and transmitting further messages from the client, the further messages of a second format consisting of data.

According to a second aspect of the present invention, there is provided a communication system comprising a server and a client, wherein the client is arranged to transmit messages, the messages of a first format comprising data and descriptive tags, the server is arranged to receive the messages and to initiate a negotiation between the server and client relating to message format switching, the client is arranged to indicate that it can accept message format switching, the server is arranged to instruct the client to switch message format, and the client is arranged to transmit further messages, the further messages of a second format consisting of data.

According to a third aspect of the present invention, there is provided a computer program product on a computer readable medium for operating a server, the product comprising instructions for receiving messages from a client, the messages of a first format comprising data and descriptive tags, initiating a negotiation between the server and the client relating to message format switching, receiving an indication that the client can accept message format switching, instructing the client to switch message format, and receiving further messages from the client, the further messages of a second format consisting of data.

Owing to the invention, it is possible to improve the performance of complex computer systems that use XML as a message format. This invention allows the server and client to switch message formats, which allows the system to benefit from all the flexibility of a system designed using markup languages, but at the same time take advantage of the performance improvements of using more efficient message format.

Preferably, the method further comprises monitoring message workload from the client, performing a statistical analysis on the message workload and initiating the negotiation

between the server and client according to the statistical analysis. The server can use performance statistics to determine when to switch to the second message format. This ensures that the switch to the simpler message format only takes place when it is actually efficient to do so. The performing of the statistical analysis on the message workload can comprise determining that the workload from the client is above a predetermined threshold. The server can use a methodology in which it is monitoring the workload from each connected client, and when a predetermined threshold is reached, such as a specific message count per second, this can be used as the trigger for switching to the second message format. This results in the switching only occurring when there is sufficient throughput to justify the overhead of negotiating and changing protocols.

Ideally, the method further comprises transmitting a description of the second format to the client. In a first embodiment, the client may already be aware of the structure of the second message format that is to be used after the switch is agreed. However, the client may be unaware of the second message format, but nevertheless is sufficiently flexible that it has the capability to switch away from the current message format. In this case, the server will provide to the client a description of the second message format, and the client will configure itself according to this description. This improves the overall performance of the system, as the system will be able to incorporate some clients who are unaware of the message switching functionality of the server. This will decrease the size of more of the messages flowing in the system.

Advantageously, the method further comprises verifying that the messages are not being modified between the client and the server. Depending upon the nature of the communication system, the routing between the client and server may not be direct. Other intermediate components may receive and transmit the messages that flow between the client and server. In this case, it is important that the server verify that the messages received from the client are not modified by any intermediate component. This will ensure that the change to the second message format, which removes some of the information from the message, with respect to the first message format, does not create a problem for any intermediate component. If the server cannot verify that the messages are not being modified between the client and the server, or discovers that they are being modified, then the server will not

initiate the switch to the second message format. A server can safely request to switch if it is the final server or if the next server in the chain has already switched.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 and 2 are schematic diagrams of a communication system,
Figure 3 is a diagram showing communication flow with the system,

Figure 4 is a flowchart of a method of operating the communication system, and

Figure 5 is a schematic diagram of a further embodiment of the communication system.

An example of a communication system is shown in Figure 1. The system comprises a client 10, a server 12 and an intermediate component 14. The client 10 is operable to send a message 16 to the server 12. The various machines 10, 12 and 14 form part of a large communication network such as an Intranet, where multiple machines are interconnected by some suitable network technology. It should be noted that the designation of a machine as a client or server in this communication system is a logical designation. The machine 10 that originates the message 16 is the client, and the receiving machine 12 is the server, but any machine can be a client if they are making a request of another machine, which becomes the server.

The structure of the message 16 is determined by the specific protocol that is being used by the communication system. This could be XML, for example. The message format comprises data and descriptive tags. The tags describe the data that is being carried in the message 16. For example, the message 16 may contain <location> PARIS </location>, where the "PARIS" part is the data in the message, the "<location>" part defines the start of some specific type of data, and the "</location>" part defines the end of that specific type of data; in this case, the data type is defined as "location". The latter two parts of the message 16 are the descriptive tags in the message 16. The presence of the descriptive tags assists the receiving server 12 in the understanding and handling of the message 16.

The communication system shown in Figure 1 could be part of a backend system that supports a commercial website. As users of the website purchase goods on the website, messages 16 will flow round the system to and from different machines. For example one machine may be operating principally as a database storing client account details. When a user with an account makes a purchase, then one or more messages 16, in the XML format, will be sent to the particular machine for processing by that machine. For a busy website, this will result in a large number of messages 16 being produced.

Figure 2 shows part of the communication system with a client 10 and a server 12, in which a large number of messages 16 flow from the client 10 to the server 12. In many applications, the number of messages 16 that are being transmitted from the client 10 to the server 12 could be of the order of many thousands per second. Each of these messages 16 will use bandwidth between the client 10 and server 12. In a network situation, the usable bandwidth of the network will be reduced, and/or the latency of the network will increase, both of which have performance implications for the operation of the communication system or any other system dependent on the network.

According to a preferred embodiment, to alleviate the problem of overloading on the communication channel between the client 10 and the server 12 and thereby the network as a whole, the communication system has the ability to switch message format. In the right circumstances, the communication system switches from the first format of using data and descriptive tags to a second, simpler, format of just data, or wire format. The descriptive tags are stripped from the messages 16, by the client 10, before they are transmitted to the server 12. This will reduce the size of the messages 16, and therefore the bandwidth used by the messages 16. The larger XML messages are replaced with wire format messages which do not contain the descriptive tags. The wire format version is a single set of bytes with XML tags removed.

The changeover to the second message format occurs when the communication system determines that it is advisable to do so. Information about the message workload between the client 10 and server 12 is obtained in order to make this determination. For example the communication system monitors the message workload from the client 10, performs a statistical analysis on the message workload and initiates a negotiation between the server 12

and client 10 according to the result of the statistical analysis. In one preferred embodiment, the performing of the statistical analysis on the message workload comprises determining that the workload from the client 10 is above a predetermined threshold. A specific message count per time period can be used as the trigger for switching to the second message format. This ensures the switching occurs when the bandwidth required will be reduced by the switch to the second message format.

In the communication system environment, a typical client 10 has no way of knowing what has happened to any request messages 16 that have been produced by the client, once they have been transmitted. The messages 16 could have been mediated and handled beyond all recognition, for example by an intermediate component 14, and the client 10 is unaware of this. Therefore, message format switching may only be initiated by a server 12; if the intermediate component 14 acts as a server to the client 10, then it may request format switching. Logically, it may then function as a client to server 12. In that case, server 12 must initiate the request for the intermediate component 14 to switch its format. However, if the intermediate component 14 functions only as an intermediary between client 10 and server 12, it may not request client 10 to format switch. The protocol for format switching negotiation consists of the basic steps described below, and shown in Figure 3. The client 10 transmits messages to the server 12, for example in the XML format, and the server 12 is able to communicate back with the client 10.

The server 12 tracks the workload from each client 10, and using empirical statistical analysis techniques, the server 12 decides which client's message workload is significant enough to benefit from a switch from XML messages to wire format messages. The server 12 tracks this client's messages 16 as they pass through, to verify that they are not being modified by another process which expects the message 16 in the current format. When the server 12 has verified that the message format can indeed be switched, because any code that touches the message can support the new wire format, then the server 12 can negotiate with the client 10.

In a negotiation, the server 12 initiates a handshake with the client 10 to verify that the client 10 supports protocol switching. The client 10 may already have the wire format support

defined, or if the client 10 can switch dynamically, for instance in an interpreted language environment, then the server 12 will send a description of the format to which it expects the client 10 to switch. Once the wire format has been agreed and instantiated, the server 12 informs the client 10 of when to switch, and each party switches to the new wire format. The server 12 can invalidate the agreement at any time, by simply informing the client 10 to switch back to the original format. Once the switch has been made, then future messages will be of the wire format.

Figure 4 summarises the method of operating the communication system. The method comprises the steps of, firstly, step S1 of transmitting messages 16 from the client 10, the messages 16 of a first format comprising data and descriptive tags and secondly, step S2 of receiving the messages 16 at the server 12. At step S3, the server 12 initiates a negotiation between the server 12 and the client 10, from whom the messages 16 are being received, in relation to the issue of message format switching. This negotiation can take the form of a handshake between the server 12 and client 10, according to any protocol that both machines will support.

At step S4, the client 10 indicates that it can accept message format switching, and generate messages according to a new format, either because the client 10 is already aware of the second message format or the client 10 can support dynamic format switching. If the client 10 is of the latter case, then the server 12 will send a description to the client 10 of the new format which the server 12 wishes the client 10 to adopt. The client 10 will then store this description locally. At step S5, the server 12 instructs the client 10 to switch message format, and at step S6 the client 10 transmits any further messages to the server 12 in the second format, where the messages consist solely of data.

The method of Figure 4 can further comprise monitoring the message workload from the client 10, performing a statistical analysis on the message workload and initiating the negotiation between the server 12 and client 10 according to the result of the statistical analysis. The performing of the statistical analysis on the message workload comprises determining that the workload from the client 10 is above a predetermined threshold. Therefore prior to the step S3, the server 12 must make a determination that the client 10 is a

candidate for a switch to the second, more efficient, message format. This can be done by monitoring the workload provided by the relevant client 10.

The Web Services Description Language (WSDL) is an XML-based language that provides a model for describing Web services. WSDL defines services as collections of network ports and provides an XML format. Messages are abstract descriptions of data being exchanged, and port types are abstract collections of supported operations. The protocol and data format specifications for a particular port type constitute a reusable binding, where the operations and messages are then bound to a network protocol and message format. In this way, WSDL describes the public interface to the web service. WSDL is often used in combination with the Simple Object Access Protocol (SOAP) and XML schema to provide web services over the Internet. A client program connecting to a web service can read the WSDL to determine what functions are available on the server. Any special data types used are embedded in the WSDL file in the form of XML schema. The client can then use SOAP to actually call one of the functions listed in the WSDL.

Figure 5 shows how WSDL can be deployed into an intermediate component 14 (a bus) that transforms the internal WSDL 24 into a form more suitable for use by external clients 10, by at least removing actual physical machine and ports for security reasons. The new external WSDL is downloaded by clients 10 who use it to generate a stub 18 that allows the client 10 to invoke the Web Service 12 as it would any other language method. This stub 18 works by taking the binary parameters and wrapping them into the XML SOAP structure and sending them to the predefined target (HTTP Port, or Java Messaging Service [JMS] Queue for example) that was defined by the external WSDL 22.

When the WSDL arrives at the bus 14, the user has the opportunity to intercept the message and change the content of the message or re-route it to a completely different service 12. The message passes through the bus 14 until it reaches the invoker 20, which converts the SOAP message back into a binary form that allows the actual invocation of the binary functionality described by the WSDL. A binary result is built into a SOAP response and sent back through the bus to the client 10.

To benefit from the possibility of format switching, the system will either allow an administrator to configure the service 12 so that it uses wire format from the start, or allow the bus 14 to monitor the workload of a particular service 12 and determine whether it would be beneficial to switch formats for performance reasons. The bus 14 can follow some easy rules to decide if it is possible to switch formats, for instance by comparing the WSDL port of the external WSDL 22, with the WSDL port of the internal WSDL 24, to verify that the message was not changed en route. If a component were "mediating" the message, the mediation could be queried to see if it could support a wire format message.

Once the decision has been made to switch to a wire format, the stub 18 that the client 10 is using is sent a message informing it not to wrap the client binary data into a SOAP message but to send the message directly to the bus 14. The bus 14 would then forward the message straight to the invoker 20, which would use the original data to call the target service 12 directly. If the system were changed, for instance a mediation were added to the system for this service, then the client stub 18 can be sent a message informing it to switch back to the SOAP format of the message.

# CLAIMS

1. A method of operating a communication system, the system comprising a server and a client, the method comprising the steps of:

- transmitting messages from the client, the messages of a first format comprising data and descriptive tags,
- receiving the messages at the server,
- initiating a negotiation between the server and client relating to message format switching,
- indicating that the client can accept message format switching,
- instructing the client to switch message format, and
- transmitting further messages from the client, the further messages of a second format keep data.

2. A method according to claim 1, and further comprising monitoring message workload from the client, performing a statistical analysis on the message workload and initiating the negotiation between the server and client according to the statistical analysis.

3. A method according to claim 2, wherein the performing of the statistical analysis on the message workload comprises determining that the workload from the client is above a predetermined threshold.

4. A method according to claim 1, 2 or 3, and further comprising transmitting a description of the second format to the client.

5. A method according to any preceding claim, and further comprising verifying that the messages are not being modified between the client and the server.

6. A communication system comprising a server and a client, wherein:

- the client is arranged to transmit messages, the messages of a first format comprising data and descriptive tags,

- the server is arranged to receive the messages and to initiate a negotiation between the server and client relating to message format switching,
- the client is arranged to indicate that it can accept message format switching,
- the server is arranged to instruct the client to switch message format, and
- the client is arranged to transmit further messages, the further messages of a second format consisting of data.

7. A system according to claim 6, wherein the server is further arranged to monitor message workload from the client, perform a statistical analysis on the message workload and to initiate the negotiation between the server and client according to the statistical analysis.

8. A system according to claim 7, wherein the server is arranged, when performing the statistical analysis on the message workload, to determine that the workload from the client is above a predetermined threshold.

9. A system according to claim 6, 7 or 8, wherein the server is further arranged to transmit a description of the second format to the client.

10. A system according to any one of claims 6 to 9, wherein the server is further arranged to verify that the messages are not being modified between the client and the server.

11. A computer program product on a computer readable medium for operating a server, the product comprising instructions for:

- receiving messages from a client, the messages of a first format comprising data and descriptive tags,
- initiating a negotiation between the server and the client relating to message format switching,
- receiving an indication that the client can accept message format switching,
- instructing the client to switch message format, and

- receiving further messages from the client, the further messages of a second format consisting of data.

12. A computer program product according to claim 11, and further comprising instructions for monitoring message workload from the client, performing a statistical analysis on the message workload and initiating the negotiation between the server and client according to the statistical analysis.

13. A computer program product according to claim 12, wherein the instructions for performing of the statistical analysis on the message workload comprise instructions for determining that the workload from the client is above a predetermined threshold.

14. A computer program product according to claim 11, 12 or 13, and further comprising instructions for transmitting a description of the second format to the client.

15. A computer program product according to any one of claims 11 to 14, and further comprising instructions for verifying that the messages are not being modified between the client and the server.

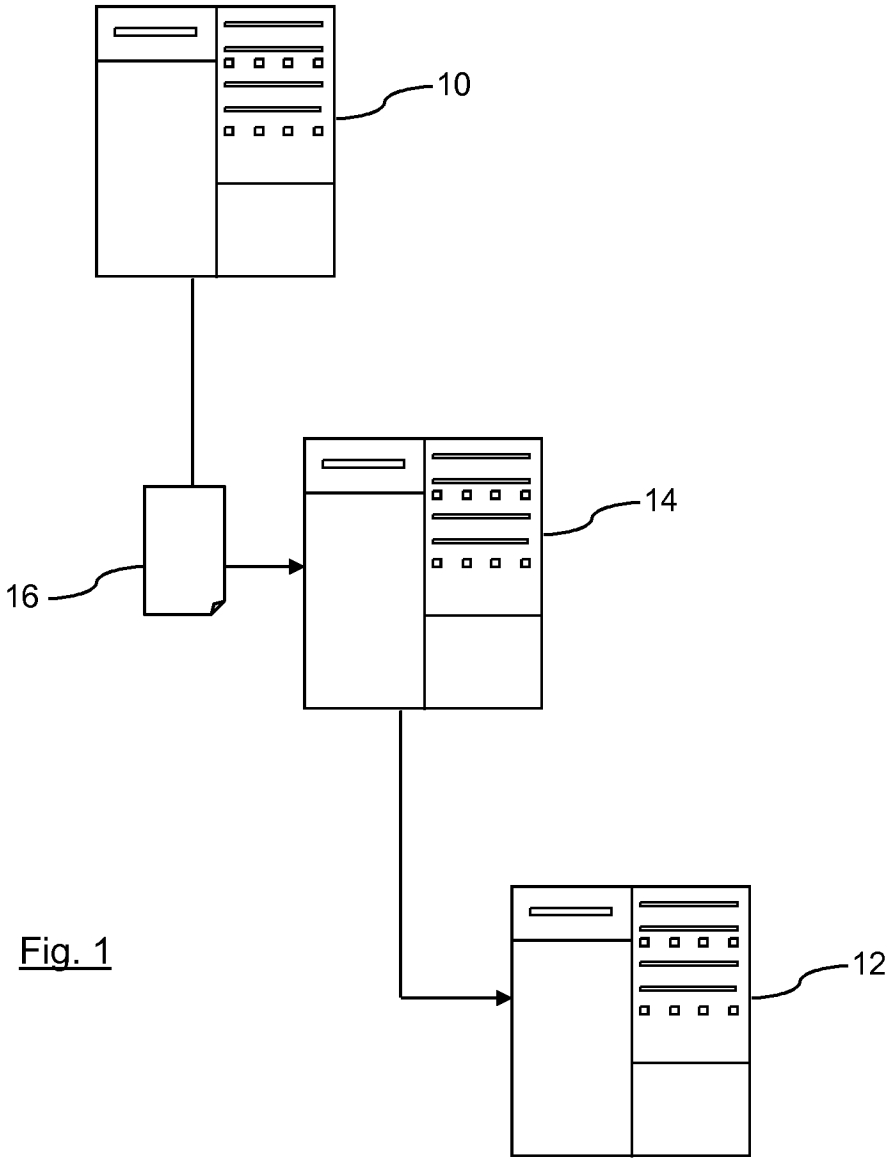


Fig. 1

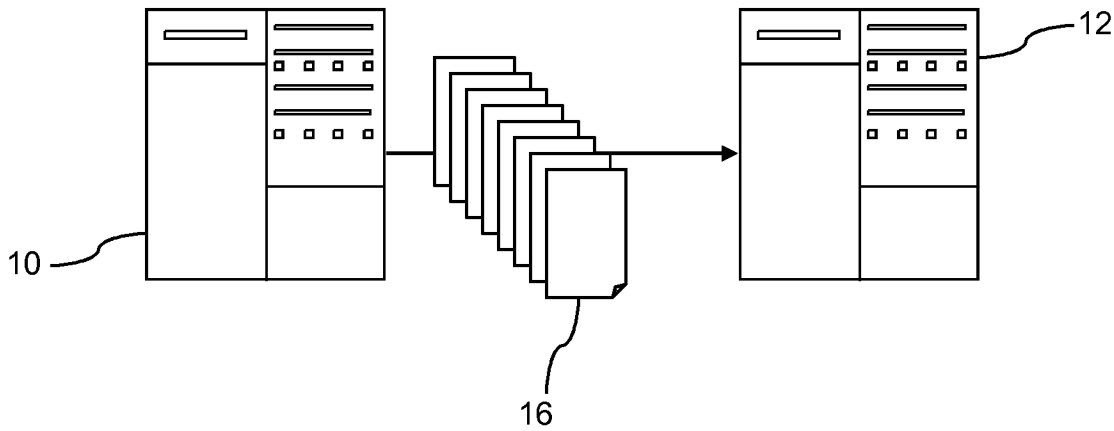


Fig. 2

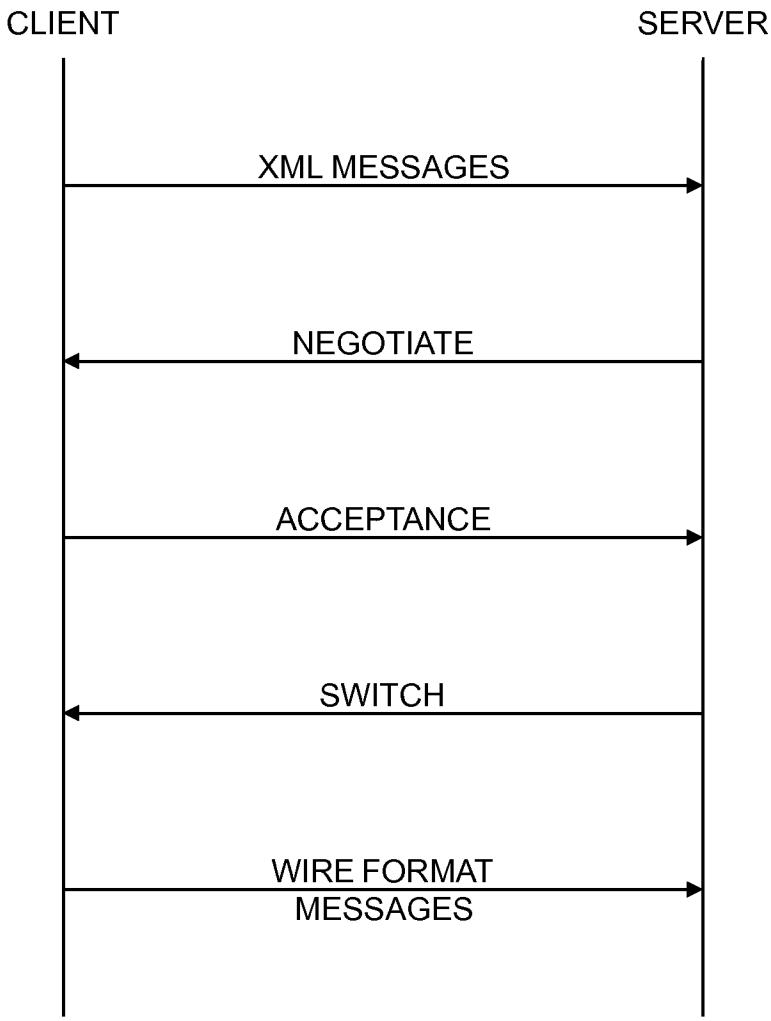
CLIENT
SERVER
XML MESSAGES
NEGOTIATE
ACCEPTANCE
SWITCH
WIRE FORMAT
MESSAGES

Fig. 3

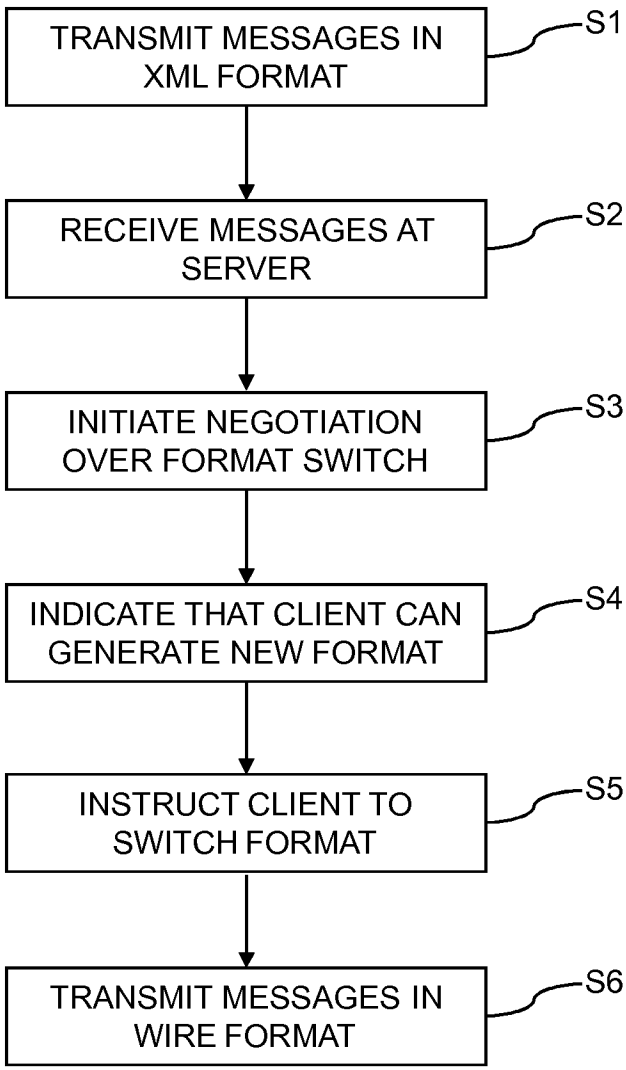
TRANSMIT MESSAGES IN XML FORMAT
S1
RECEIVE MESSAGES AT SERVER
S2
INITIATE NEGOTIATION OVER FORMAT SWITCH
S3
INDICATE THAT CLIENT CAN GENERATE NEW FORMAT
S4
INSTRUCT CLIENT TO SWITCH FORMAT
S5
TRANSMIT MESSAGES IN WIRE FORMAT
S6

Fig. 4

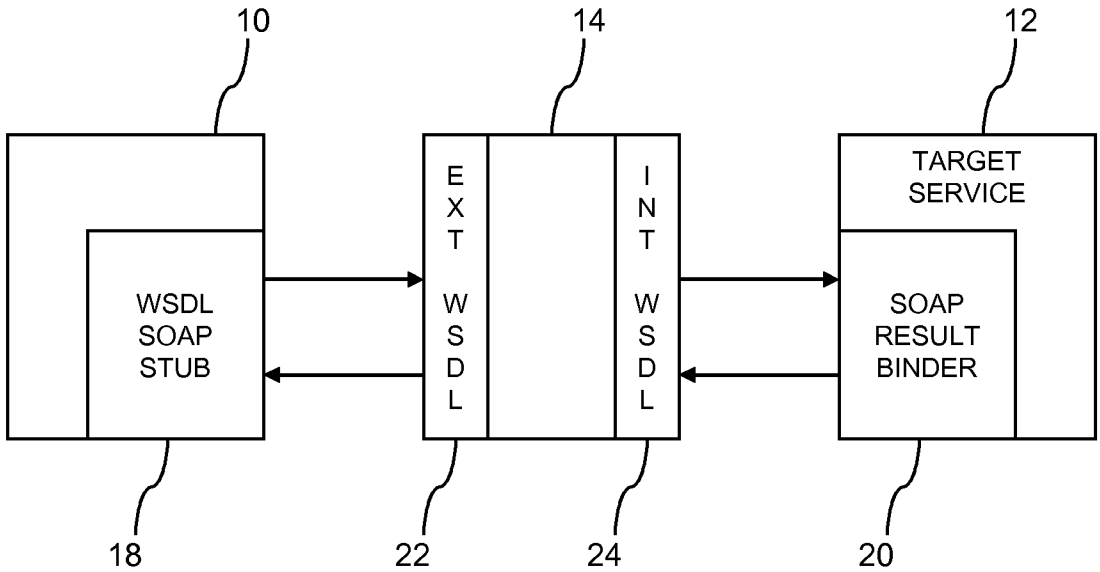
10
14
12
WSDL
SOAP
STUB
EXT WSDL
INT WSDL
TARGET
SERVICE
SOAP
RESULT
BINDER
18
22
24
20

Fig. 5

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/054245

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/26 H04L29/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 2008/168469 A1 (FEINGOLD MAX [US] ET AL) 10 July 2008 (2008-07-10)<br>figures 1, 2<br>paragraphs [0024] - [0026], [0036] - [0039], [0 42] - [0044], [ 48 ] | 1-15 |
| A | US 2004/264498 A1 (FEUERSTRAETER MARK T [US] ET AL) 30 December 2004 (2004-12-30)<br>figures 1, 6<br>paragraphs [0029], [0 42], [0 45], [0 47], [0 48], [0 54] - [0056], [ 61 ] | 1-15 |
| A | US 2004/185885 A1 (KOCK MARTIJN WILLEM MARIA [NL]) 23 September 2004 (2004-09-23)<br>figure 1<br>paragraphs [0010], [0 14] - [0023], [0 26], [0 27], [0 33], [0 51] - [052 ] | 1-15 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 3 August 2010 | 11/08/2010 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040,<br>Fax: (+31–70) 340–3016 | Tyszka, Krzysztof |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2010/054245

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2008168469 A1 | 10-07-2008 | NONE | |
| US 2004264498 A1 | 30-12-2004 | NONE | |
| US 2004185885 A1 | 23-09-2004 | NONE | |