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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 August 2016 (04.08.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/122448 A1

(51) International Patent Classification:
H04L 12/911 (2013.01)

(21) International Application Number:
PCT/US2015/012926

(22) International Filing Date:
26 January 2015 (26.01.2015)

(25) Filing Language: English

(26) Publication Language: English

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(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, BN, 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, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, 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, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

[Continued on next page]

(54) Title: RESOURCE ALLOCATION

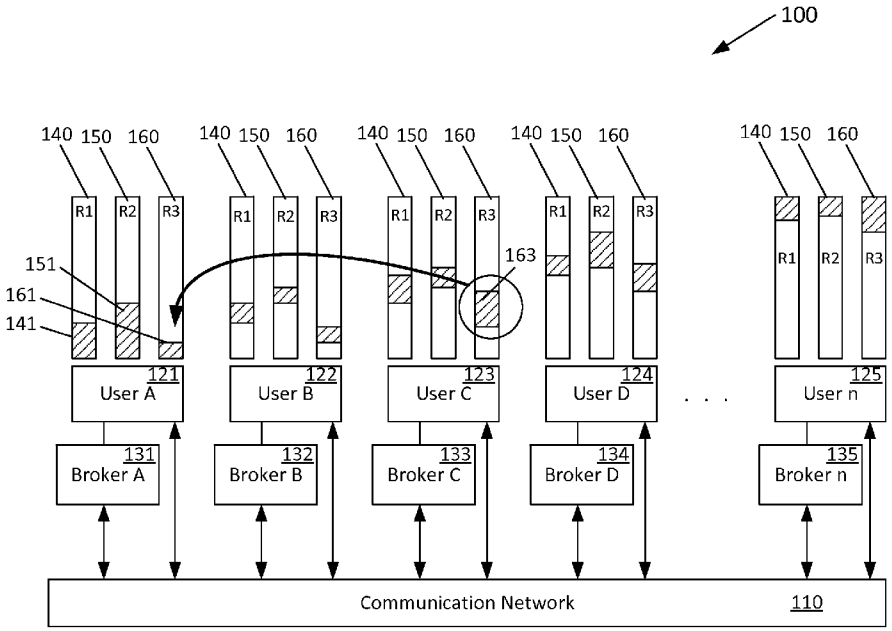


Figure 2

(57) Abstract: An example system includes one or more users, each user having an allocation of each of one or more resources; and one or more resource brokers, each of the one or more users being associated with one of the one or more resource brokers. A first resource broker of the one or more resource brokers, upon detecting an insufficient allocation of a resource to an associated user, obtains additional allocation of the resource from another user of the one or more users through a second resource broker associated with the another user.

WO 2016/122448 A1

Published:

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

RESOURCE ALLOCATION

BACKGROUND

[0001] Computer systems and computer networks include a variety of resources. The resources may include various hardware or software components. The hardware resources may include storage and computing devices, and the software resources may include various applications or services, for example. Additional resources may include internet protocol (IP) addresses, for example. Resources may be allocated to a user at, for example, a starting point of a system (e.g., a launch or boot-up of the system). A user's allocation may be randomly assigned or may be based on a predicted usage, for example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] For a more complete understanding of various examples, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

[0003] Figure 1 is a schematic illustration of an example resource federation;

[0004] Figures 2 and 3 schematically illustrate an example transfer of an allocation of a resource in the example resource federation of Figure 1;

[0005] Figure 4 schematically illustrates the example resource federation of Figure 1 with a user leaving the example federation; and

[0006] Figure 5 illustrates an example method for resource allocation.

DETAILED DESCRIPTION

[0007] Various examples described below provide a federation of users in which responsibility for re-allocation of resources is shared by the users, rather than by an administrator. Placing responsibility for allocation of resources (e.g., transfer of an allocation of resources between users) with the various users eliminates the inefficiencies associated with each re-allocation going through an administrator. Further, a possible single point of failure (e.g., the administrator) is removed from the process of re-allocation of resources.

[0008] Referring now to Figure 1, an example resource federation is schematically illustrated. The example resource federation 100 includes a communication network 110 which

allows various entities in the example federation 100 to communicate with one another. In various examples, the communication network 110 may take the form of a public network, such as the Internet, or a private intranet network. In other examples, the communication network 110 may be replaced with, for example, a dedicated communication bus. Of course, various other arrangements for providing communication between the various entities are possible and are contemplated within the scope of the present disclosure.

[0009] The example federation 100 may include any number of users, such as users 121-125. In various examples, the users 121-125 may include computing devices, such as management processors, servers, laptops, desktops, smart phones, personal digital assistants or the like. The users 121-125 may also include user accounts which may be accessed through one or more computing devices, for example.

[0010] Each user 121-125 may be provided with an allocation of each of one or more resources. In the illustrated example of Figure 1, each user 121-125 of the example federation 100 is provided with an allocation of each of three resources 140, 150, 160. In various examples, the resources 140, 150, 160 may include any of a variety of resources such as, for example, hardware or software. As a non-limiting example, the resources 140, 150, 160 may include physical storage memory, licenses for use of software packages, and internet protocol (IP) addresses. Various other types of resources are possible and are contemplated within the scope of the present disclosure.

[0011] Each user 121-125 in the example federation 100 of Figure 1 may be provided with a certain allocation of each resource. For example, each user 121-125 may be provided with an allocation of a physical storage memory which may be a portion of a large-capacity storage device, an allocation of licenses which may include a certain number of user licenses, or IP addresses which may include a range of addresses which are a subset of the entire range of addresses available to the example federation 100.

[0012] An initial allocation of each resource 140, 150, 160 may be provided to each user by, for example, an administrator (not shown in Figure 1). In the example of Figure 1, User A 121 is provided with an allocation 141 of Resource 1 140, an allocation 151 or Resource 2 150, and an allocation 161 of Resource 3 160. Similarly, User B 122 is provided with an allocation 142 of Resource 1 140, an allocation 152 or Resource 2 150, and an allocation 162 of Resource 3 160;

User C 123 is provided with an allocation 143 of Resource 1 140, an allocation 153 or Resource 2 150, and an allocation 163 of Resource 3 160; and so forth.

[0013] In accordance with various examples, in some cases, a user 121-125 may require additional capacity of a particular resource. For example, User A 121 may run low on the amount of storage space available to it, develop a need for additional IP addresses or otherwise need additional allocation of a resource. Various examples of the present disclosure provide for users in such cases to obtain additional allocation from other users in the federation without the involvement of an administrator to re-allocate the resources. Instead, responsibility for allocation of resources, including transfer of allocation of resources between users, may be shared by the users.

[0014] In this regard, as illustrated in the example of Figure 1, each user 121-125 of the example federation 100 may be associated with a resource broker 131-135, respectively, to facilitate the allocation of resources among the users 121-125. Each resource broker 131-135 may have the ability to request from other users through a resource broker 131-135 associated with the other users 121-125. Thus, each resource broker 131-135 may transfer or allocate resources to a user 121-125 associated with the resource broker 131-135.

[0015] In various examples, the resource brokers 131-135 may be separate entities from the users 121-125, as illustrated in the example of Figure 1. In other examples, each resource broker 131-135 may be a service that is a part of each user 121-125. In this regard, the resource broker 131-135 may be a service running on a processor associated with the user 121-125. As illustrated in the example of Figure 1, each resource broker 131-135 is associated with a single user 121-125. Conversely, each user 121-125 may be associated with a single dedicated resource broker 131-135. In other examples, a service broker 131-135 may support multiple users 121-125.

[0016] Referring now to Figures 2 and 3, an example transfer of an allocation of a resource in the example federation 100 of Figure 1 is schematically illustrated. In the example of Figure 2, User A 121 may develop a need for an additional allocation of Resource 3 160. For example, the allocation 161 of Resource 3 160 allocated to User A 121 may be a range of IP addresses. The insufficiency of the allocation 161 of Resource 3 160 of User A 121 may be resolved by transfer of allocation from another user, such as User C 123. In this regard, at least a portion of the allocation 163 of Resource 3 160 of User C 123 may be transferred to User A 121. As

illustrated in Figure 3, in some examples, only a portion of the allocation 163 may be transferred from User C 123, leaving User C 123 with a reduced allocation 163 of Resource 3 160. The transfer of the allocation may result in User A having its original allocation 161, as well as a transferred allocation 161', of Resource 3 160. In various examples, any portion or all of the allocation of one user (e.g., User C 123) may be transferred to another user (e.g., User A 121).

[0017] As noted above, in various examples, the transfer of an allocation of a resource may be achieved without the involvement of an administrator. In this regard, responsibility for allocation of the resources may be shared by the various users 121-125 of the example federation 100. For example, when a user runs low on, or anticipates a greater need for, a particular resource, that user may arrange or negotiate obtaining additional allocation of the resource from another user. In some examples, the user may negotiate an exchange of allocation of resources. For example, a first user may transfer one resource to a second user, and the second user may transfer another resource to the first user. In other examples, the transfer of allocation of resources may flow in only one direction.

[0018] In accordance with various examples, as described above, the transfer of an allocation is facilitated by a resource broker, such as resource brokers 131-135, associated with a user. Each resource broker 131-135 associated with a user 121-125 may be a service which provides communication with other resource brokers 131-135 associated with other users 121-125 to obtain an allocation of resources.

[0019] In the example of Figures 2 and 3, the Broker A 131 associated with User A 121 may detect that an allocation 161 of a resource 160 to User A 121 is insufficient. In various example, various parameters or policies may be used to determine insufficiency of a parameter. For example, if the resource is physical memory storage, insufficiency of the allocation may be triggered when there is less than a certain amount or percentage of the allocation that is free. As a further example, if the resource includes licenses for a software package, insufficiency may be detected when more than the allocated number of licenses is attempted for use. Those skilled in the art will appreciate that, depending on the nature of the resource, various parameters and values of the parameters may be used to trigger detection of an insufficiency of the allocation.

[0020] In some examples, the detection of the insufficiency by the resource broker may include monitoring of usage of the resource by the resource broker. In the example of Figures 2 and 3, the Broker A 131 may monitor usage of the resource 160 by User A 121. The Broker A

131 may use policies or thresholds to trigger an insufficiency detection based on the usage of the resource 160.

[0021] In other examples, the detection of the insufficiency by the resource broker may be based on a signal from the user (e.g., an alert from the user or a processor of a device associated with the user). Again, the user may base the signal on various policies, parameters and/or values of the parameters that relate to the resource and the user's allocation of that resource.

[0022] Referring again to the example of Figures 2 and 3, upon detection of the insufficiency of the allocation 161 of the resource 160 by Broker A 131, Broker A 131 may identify another user in the federation 100 which may have excess allocation of the same resource 160. In this regard, Broker A 131 may poll other brokers 132-135 that are associated with the other users 122-125 of the federation 100. In one example, Broker A 131 may send a broadcast signal identifying the resource for which allocation is sought.

[0023] In another example, each broker 131-135 may regularly monitor the availability of resources from each user in the federation. For example, Broker A 131 may poll each of the other brokers 132-135 to obtain usage and allocation values for each resource 140, 150, 160 at each user 122-125 at regular intervals. In this regard, Broker A 131 may easily identify a candidate user 122-125 with excess allocation of a resource.

[0024] Broker A 131 may then facilitate transfer of the allocation of the resource 160 from the identified user with excess allocation to User A 121. In the example of Figures 2 and 3, Broker A 131 may identify User C 123 as having excess allocation 163 of Resource 3 160. As noted above, at least a portion of the allocation 163 of Resource 3 160 of User C 123 may be transferred to User A 121. The transfer of the allocation may result in User C 123 having a reduced allocation 163 of Resource 3 160. The transfer of the allocation may result in User A having its original allocation 161, as well as a transferred allocation 161', of Resource 3 160.

[0025] The transfer of allocation of a resource may be governed by one or more rules or policies. In one example, transfer of allocation is governed by transfer size policy. In this regard, the policy may dictate a minimum and/or maximum amount of allocation of each resource that may be transferred between users. For example, in the case of IP addresses, each transfer of allocation may be limited to no more than ten addresses.

[0026] In another example, transfer of an allocation of a resource may be governed by a reserved-capacity policy. In this regard, a transfer of an allocation may be limited to ensure that

the user from which an allocation is being transferred (e.g., User C 123 in the example of Figures 2 and 3) retains a predetermined minimum amount of allocation of the resource. Such a policy may prevent a user from giving up too much of an allocation, thereby reducing the likelihood that another transfer will be required when that user later needs an allocation of that resource.

[0027] Similarly, the reserved-capacity policy may limit a transfer of the allocation to ensure that the user to which an allocation is being transferred (e.g., User A 121 in the example of Figures 2 and 3) does not, intentionally or unintentionally, horde allocation of a resource. In this regard, the reserved-capacity policy may place an upper limit on the amount of allocation of each resource a single user may have.

[0028] In another example, transfer of an allocation of a resource may be governed by a policy which limits which users may exchange resources. For example, in some cases, one set of users within a federation may belong to a first organization, while another set of users within the same federation may belong to a second organization. In accordance with the policy, users in the first organization may only exchange resources with other users in the same organization, but may not be allowed to exchange resources with users in the second organization. In one example, the limitation may apply to only certain resources. For example, users in the first organization may exchange allocation of IP addresses with only users in the same organization, but may exchange physical memory storage allocation with users in the first or second organizations.

[0029] Referring now to Figure 4, an example illustrates a case in which one of the users 121-125 leaves the example federation 100. In the example illustrated in Figure 4, User B 122 is shown removed from the example federation 100. Removal of a user, such as User B 122, may be the result of a variety of scenarios. For example, User B 122 may have left an organization, thus requiring removal from the example federation 100. In other examples, the removal of a user may be the result of a larger re-organization of the example federation 100.

[0030] When a user, such as User B 122, leaves a federation, the allocation of resources belonging to that user may remain in the example federation. In one example, the allocation of the resources of User B 122 may be transferred, either in part or in entirety, to one of the other users. In the example illustrated in Figure 4, the entirety of the allocation of each resource of User B 122 is transferred to another user, User D 124. In various examples, a user to which the allocation is to be transferred may be selected based on one or more policies. For example, the

selection may be based on which user is currently using the largest percentage of its allocated resources. This may be indicative of a user which is approaching a threshold for detection of an insufficiency of an allocation, for example.

[0031] In one example, upon the departure of a user, ownership of the allocation of resources of that user is transferred to another user. For example, in the example of Figure 4 described above, the allocations 142, 152, 162 of User B 122 are transferred in their entirety to User D 124. User D 124 now becomes the owner of those allocations. In another example, the allocations 142, 152, 162 of User B 122 may be assigned to User D 124, but the allocations may be maintained in a quarantine. In this regard, ownership of the allocations 142, 152, 162 is not transferred to User D 124 but remains with the departing User B 122 Quarantine allows ongoing tracking of the allocations 142, 152, 162 within the federation 100. If User B 122 returns and rejoins the example federation 100 with allocations 142, 152, 162, the quarantined representations of these allocations may be dropped by User D 124.

[0032] Referring now to Figure 5, an example method for resource allocation is illustrated. In accordance with the various examples described herein, the method 500 of Figure 5 may be performed by a broker 131-135 of the example federation 100. The method 500 includes detecting an insufficient allocation of a resource to a first user (block 510). As described above with reference to Figures 2 and 3, the detection of the insufficiency may be based on a determination by the broker 131-135 or on a signal received from the user 121-125, for example. Further, as also noted above, the triggering of the insufficiency may be based on a policy, various parameters and/or values of certain parameters.

[0033] Upon detecting the insufficiency of the allocation to the first user, the resource broker 131-135 associated with the first user may identify a second user with an excess allocation of the resource (block 520). As noted above, in some examples, the resource broker 131-135 associated with the first user may poll other brokers 131-135 that are associated with other users 121-125 for availability of an excess allocation of the resource.

[0034] The resource broker 131-135 associated with the first user may then obtain additional resource allocation from a second user through a resource broker 131-135 associated with the second user. In this regard, the resource broker 131-135 may facilitate transfer of an allocation of a resource to the first user. As described above, transfer of an allocation between users may be governed by one or more policies, such as a transfer size policy, a reserved-capacity policy, or

a policy which limits which users may exchange resources. Of course, those skilled in the art will appreciate that a variety of other policies are possible and are contemplated within the scope of the present disclosure.

[0035] Thus, various examples described herein provide an efficient management of resources in a federation of users without the need for administrator involvement. Responsibility for allocation of resources (e.g., transfer of an allocation of resources between users) is shared by the various users. This eliminates the inefficiencies associated with each re-allocation going through an administrator. Further, a possible single point of failure (e.g., the administrator) is removed from the process of re-allocation of resources.

[0036] Various examples described herein are described in the general context of method steps or processes, which may be implemented in one example by a software program product or component, embodied in a machine-readable medium, including executable instructions, such as program code, executed by entities in networked environments. Generally, program modules may include routines, programs, objects, components, data structures, etc. which may be designed to perform particular tasks or implement particular abstract data types. Executable instructions, associated data structures, and program modules represent examples of program code for executing steps of the methods disclosed herein. The particular sequence of such executable instructions or associated data structures represents examples of corresponding acts for implementing the functions described in such steps or processes.

[0037] The various examples set forth herein are described in terms of example block diagrams, flow charts and other illustrations. Those skilled in the art will appreciate that the illustrated examples and their various alternatives can be implemented without confinement to the illustrated examples. For example, block diagrams and their accompanying description should not be construed as mandating a particular architecture or configuration.

WHAT IS CLAIMED IS

1. A system, comprising:

one or more users, each user having an allocation of each of one or more resources; and

one or more resource brokers, each of the one or more users being associated with one of the one or more resource brokers,

wherein a first resource broker of the one or more resource brokers, upon detecting an insufficient allocation of a resource to an associated user, obtains additional allocation of the resource from another user of the one or more users through a second resource broker associated with the another user.

2. The system of claim 1, wherein each resource broker of the one or more resource broker is associated with a single user of the one or more users.

3. The system of claim 1, wherein the detecting an insufficient allocation of the resource to the associated user is based on one or more policies associated with the user or the resource.

4. The system of claim 1, wherein the detecting an insufficient allocation of the resource to the associated user is based on a notification from the associated user.

5. The system of claim 1, wherein obtaining additional resources includes an exchange of resources between users.

6. The system of claim 5, wherein the exchange of users is governed by one or more policies.

7. A method, comprising:

detecting an insufficient allocation of a resource to a first user;

identifying a second user with an excess allocation of the resource;

obtaining additional allocation of the resource for the first user from the second user through a resource broker associated with the second user.

8. The method of claim 7, wherein the detecting an insufficient allocation of the resource to the first user is based on one or more policies associated with the first user or the resource.

9. The method of claim 7, wherein the detecting an insufficient allocation of the resource to the first user is based on a notification from the first user.

10. The method of claim 7, wherein obtaining additional resources includes an exchange of resources between the first user and the second user.

11. The method of claim 10, wherein the exchange of resources is governed by one or more policies.

12. A computer program product, embodied on a non-transitory computer-readable medium, comprising:

computer code to detect an insufficient allocation of a resource to a first user;

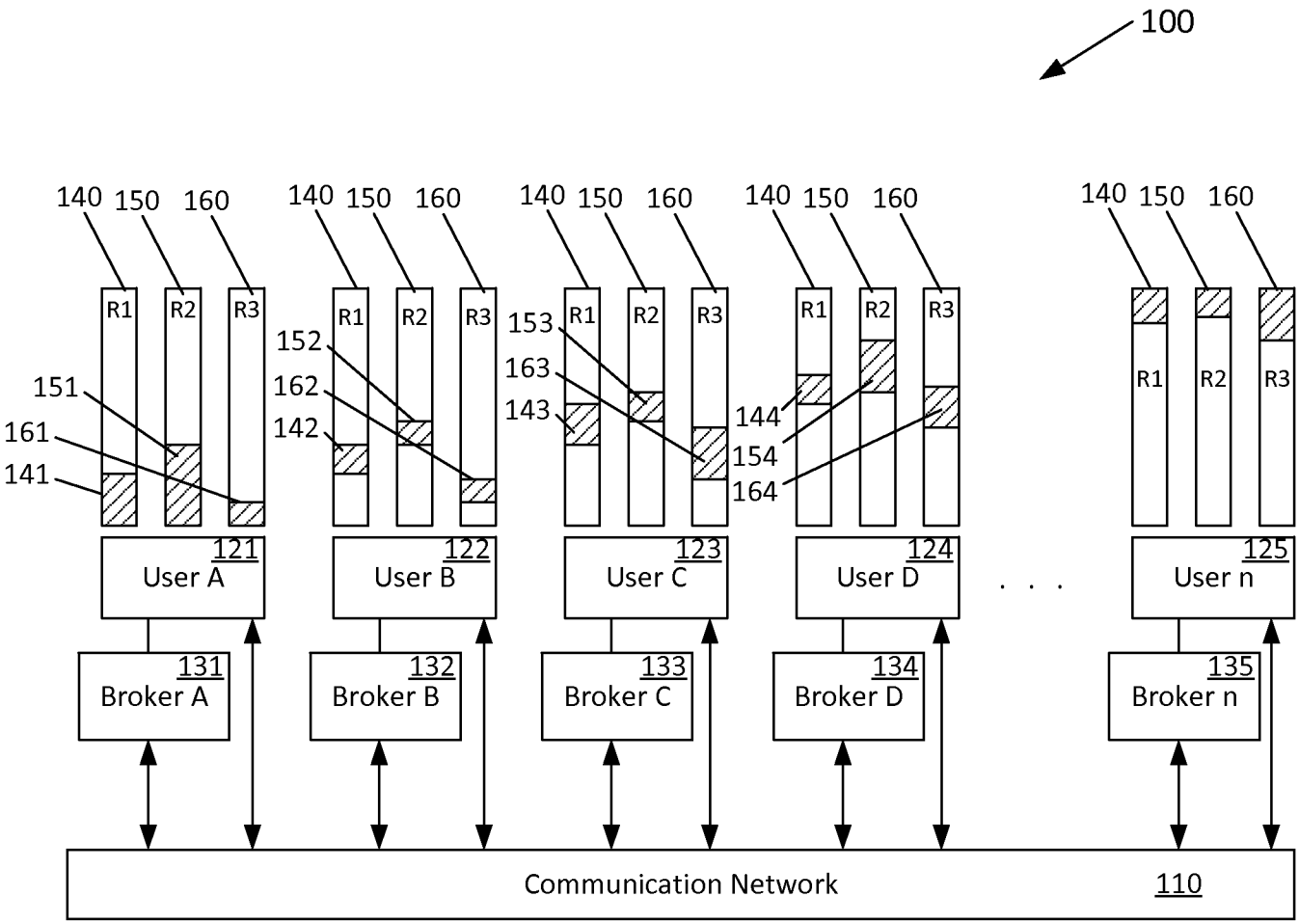
computer code to identify a second user with an excess allocation of the resource;

computer code to obtain additional allocation of the resource for the first user from the second user through a resource broker associated with the second user.

13. The computer program product of claim 12, wherein the computer code to detect an insufficient allocation of the resource to the first user is based on one or more policies associated with the first user or the resource.

14. The computer program product of claim 12, wherein the computer code to detect an insufficient allocation of the resource to the first user is based on a notification from the first user

15. The computer program product of claim 12, wherein the computer code to obtain additional resources includes an exchange of resources between the first user and the second user.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150
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R1
R2
R3
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161
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142
153
163
143
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154
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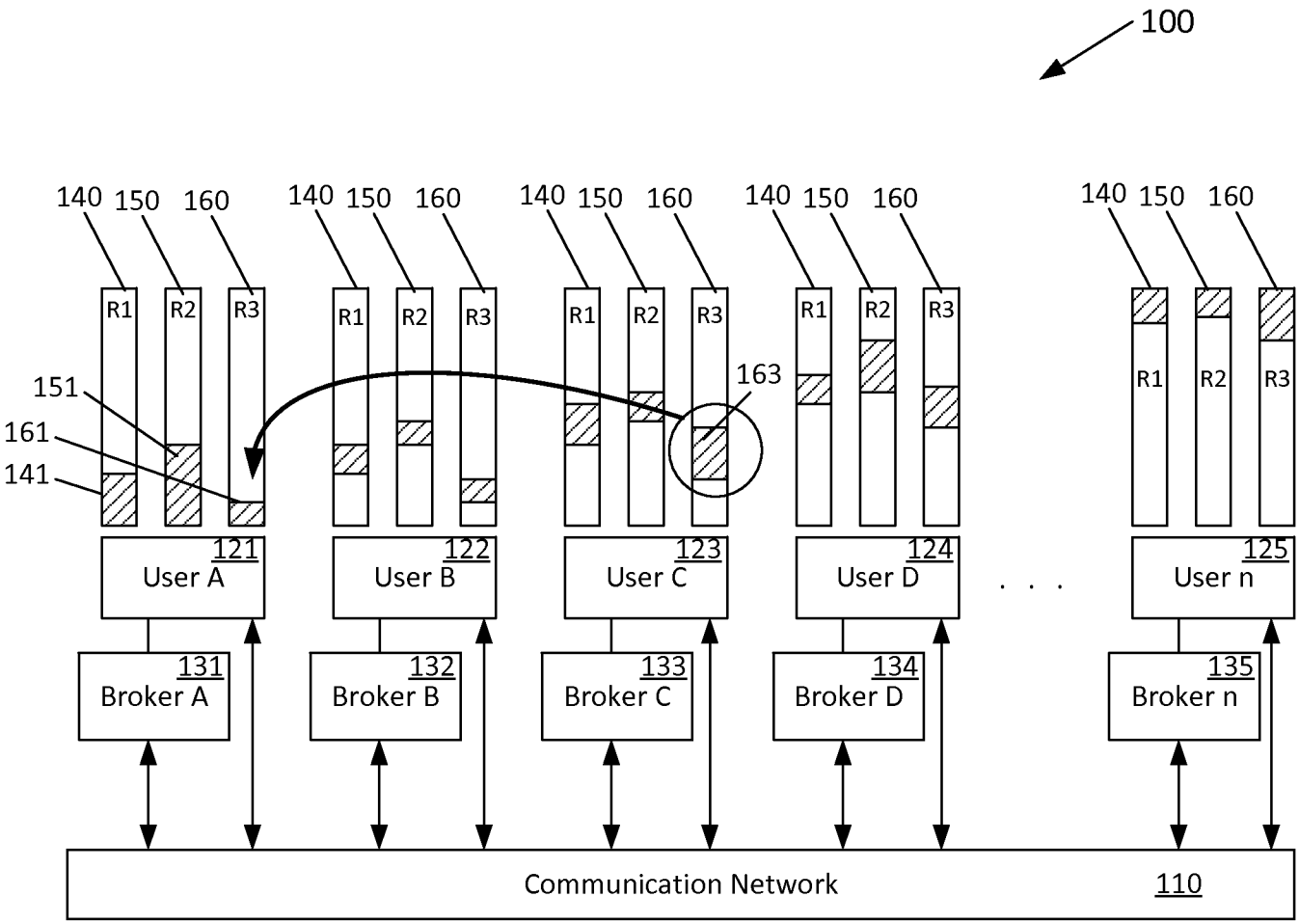
121
User A
122
User B
123
User C
124
User D
125
User n
131
Broker A
132
Broker B
133
Broker C
134
Broker D
135
Broker n
Communication Network
110

Figure 1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User D
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Broker D
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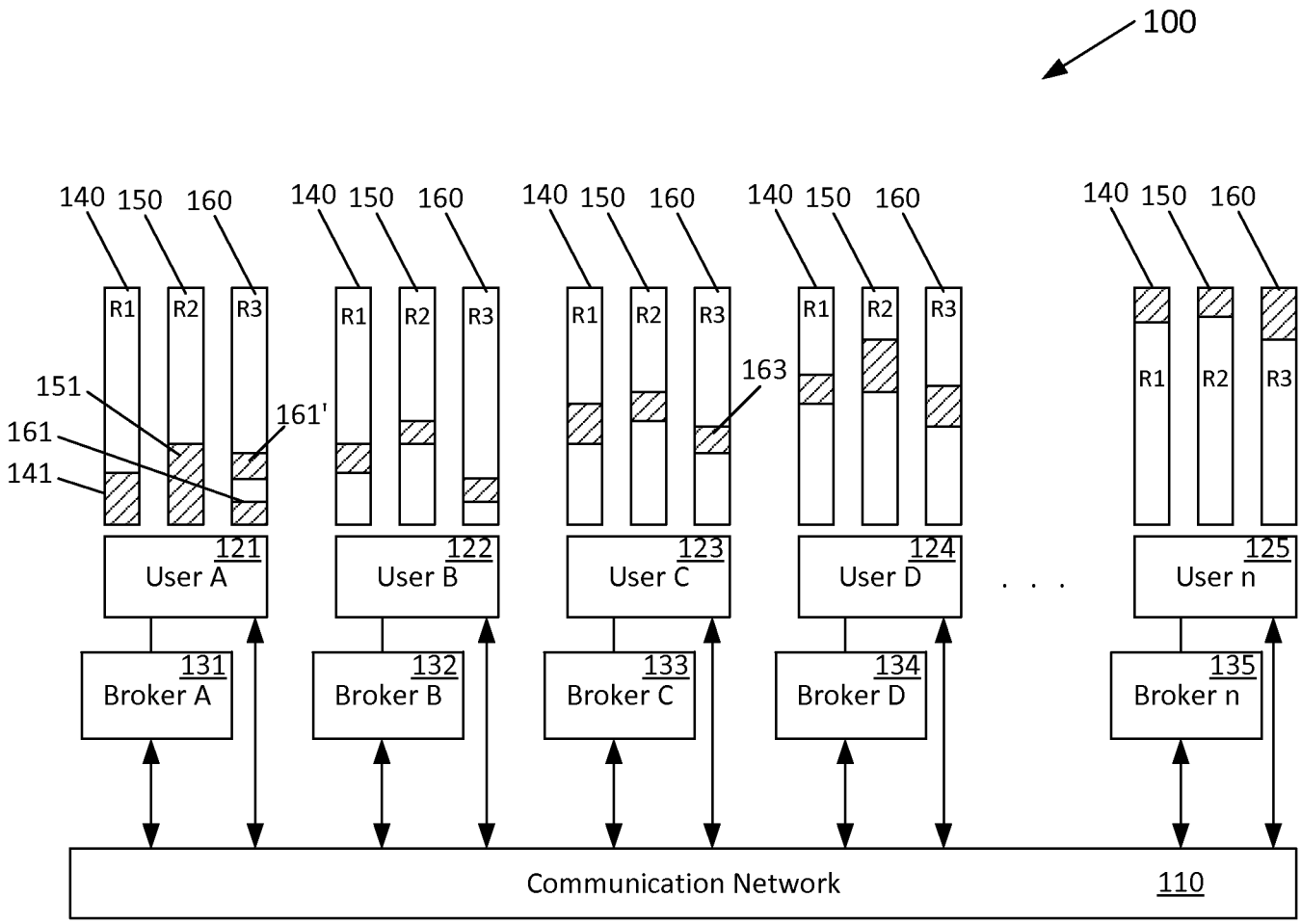
Broker n
Communication Network
110

Figure 2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User B
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User C
123
User D
124
User n
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Broker B
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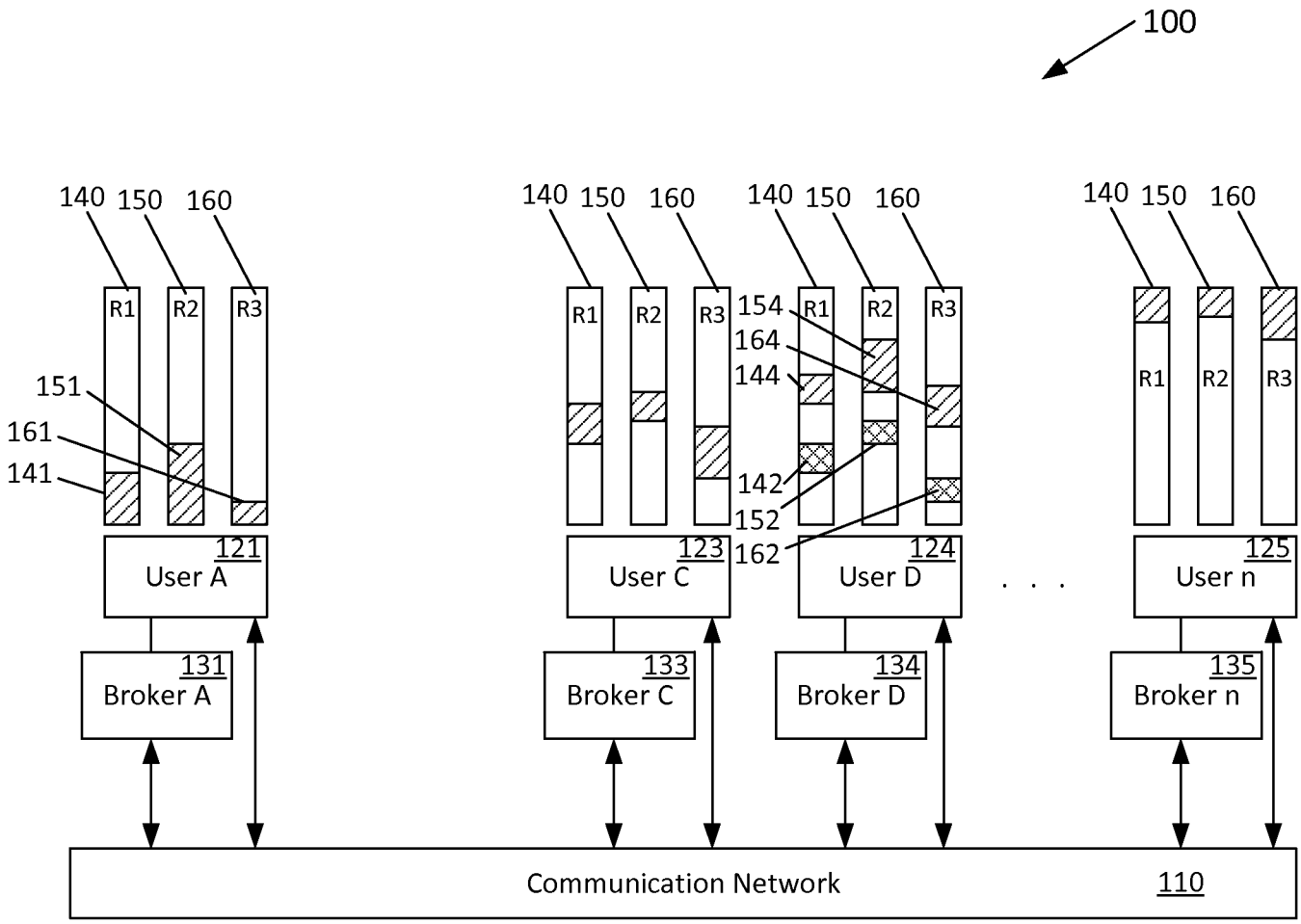
Broker C
133
Broker D
134
Broker n
135
Communication Network
110

Figure 3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Broker D
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Broker n
Communication Network
110

Figure 4

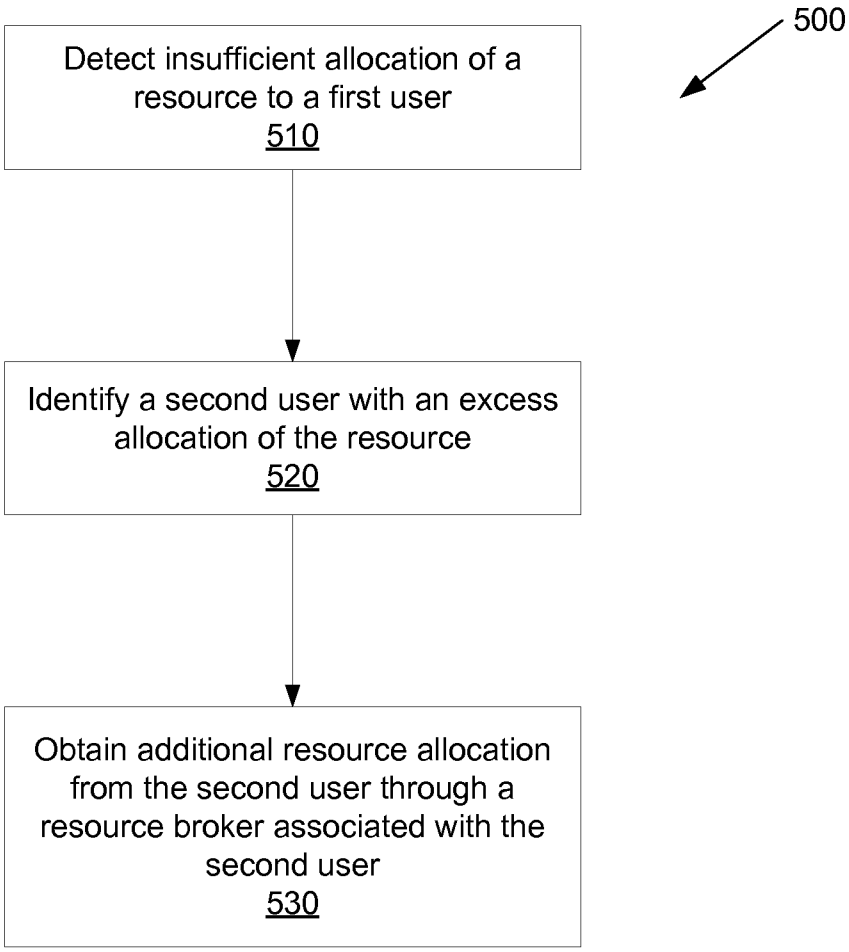
500
Detect insufficient allocation of a resource to a first user
510
Identify a second user with an excess allocation of the resource
520
Obtain additional resource allocation from the second user through a resource broker associated with the second user
530

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/012926

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/911(2013.01)i

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 12/911; G06F 15/16; G06F 15/173; H04L 12/24; H04L 12/26; H04Q 7/20; G06F 1/26; G06F 9/50; G06F 11/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: resource broker, excess, insufficient, allocate.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010-0110886 A1 (ANTTI S. SORRI et al.) 06 May 2010 See paragraphs [0027], [0039]-[0042]; claims 1-2, 9-12; and figure 2.	1-15
A	US 2007-0266083 A1 (HIROMICHI KOKBASHI et al.) 15 November 2007 See paragraphs [0010]-[0012], [0067]-[0073]; claim 1; and figures 1-12B.	1-15
A	US 6865393 B1 (KEVIN LYNN BAUM et al.) 08 March 2005 See column 2, line 9 - column 4, line 20; claim 1; and figures 1-5B.	1-15
A	US 2009-0119673 A1 (HEAD BUBBA) 07 May 2009 See paragraphs [0090]-[0102]; claims 1-9; and figures 1-2.	1-15
A	US 2014-0013153 A1 (JES KIRAN CHITTIGALA et al.) 09 January 2014 See paragraphs [0030]-[0043]; claim 12; and figures 1-3.	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
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"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
08 October 2015 (08.10.2015)	**23 October 2015 (23.10.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
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Facsimile No. +82-42-472-7140

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Telephone No. +82-42-481-3348

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2015/012926

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