



(43) International Publication Date
17 December 2015 (17.12.2015)

- (51) International Patent Classification:
G06F 9/50 (2006.01) *G06F 17/30* (2006.01)
- (21) International Application Number:
PCT/US2015/035614
- (22) International Filing Date:
12 June 2015 (12.06.2015)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/012,256 13 June 2014 (13.06.2014) US
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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.

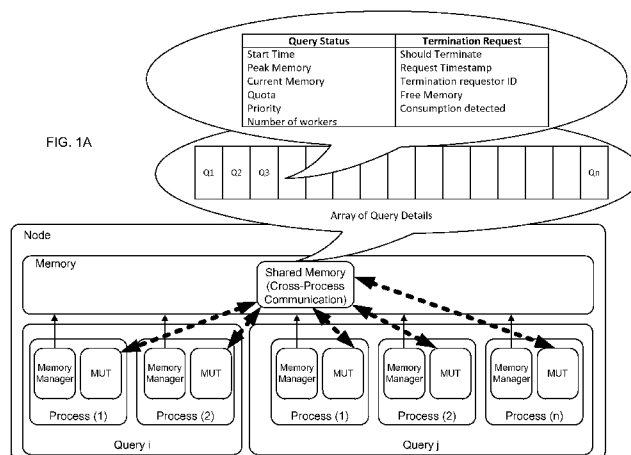
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, 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).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:
18 February 2016

(54) Title: PRECISELY TRACKING MEMORY USAGE IN MULTI-PROCESS COMPUTING ENVIRONMENT



(57) Abstract: Methods, systems, and apparatus, including computer programs encoded on computer storage media, for precisely tracking memory usage in a multi-process computing environment. One of the methods includes implementing an instance of a memory usage tracker (MUT) in each process running in a node of a computer system. A MUT can maintain an account of memory usage for each of multiple logical owners running on a process on which the MUT is running. The MUT can determine an actual memory quota for each owner, and enforce the actual memory quota of the owner. Enforcing the actual memory quota of the owner can include receiving each memory allocation request, checking each allocation request and a current state of the account against the actual quota, approving or rejecting each allocation request, communicating the approval or rejection to an underlying memory manager, and updating the owner account for each approved allocation request.

WO 2015/192045 A3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/035614

A. CLASSIFICATION OF SUBJECT MATTER
 INV. G06F9/50 G06F17/30
 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)
 G06F

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 practicable, search terms used)
 EPO-Internal, 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 2010/161909 A1 (NATION GEORGE [US] ET AL) 24 June 2010 (2010-06-24) abstract figures 3,5a,7a,7b paragraphs [0071] - [0075], [0092] paragraph [0040] | 1-5,16, 17,19,20 |
| A | ----- US 2005/193023 A1 (ISMAIL LABEED K [US]) 1 September 2005 (2005-09-01) abstract paragraph [0005]; claim 3 ----- | 1-5,16, 17,19,20 |

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 application or patent 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

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| Date of the actual completion of the international search 28 September 2015 | Date of mailing of the international search report 21/12/2015 |
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| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016 | Authorized officer Uhlmann, Nikolay |
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/035614

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-5, 16, 17, 19, 20

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 16, 17, 19, 20

Apparatus with memory usage tracker which maintain an account of memory usage for owners, each tracker enforcing a memory quota for the owner upon memory allocation requests, wherein sub-accounts for polymorphic owners are maintained

2. claims: 6, 7

Apparatus with memory usage tracker which maintain an account of memory usage for owners, each tracker enforcing a memory quota for the owner upon memory allocation requests, wherein ownership of an account is switched from an original owner of an account to a rollover account.

3. claims: 8, 9

Apparatus with memory usage tracker which maintain an account of memory usage for owners, each tracker enforcing a memory quota for the owner upon memory allocation requests, wherein upon a low memory condition in a node a task or an owner are terminated.

4. claims: 10-15, 18, 21

Apparatus with memory usage tracker which maintain an account of memory usage for owners, each tracker enforcing a memory quota for the owner upon memory allocation requests, wherein data representing a SQL query plan tree is received and the account of memory usage for the each owner is maintained according to an account tree structure corresponding to the query plan tree.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/035614

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|--------------------------|
| US 2010161909 | A1 | 24-06-2010 | NONE |
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| US 2005193023 | A1 | 01-09-2005 | CA 2557770 A1 06-10-2005 |
| | | US 2005193023 A1 | 01-09-2005 |
| | | US 2015319105 A1 | 05-11-2015 |
| | | WO 2005091773 A2 | 06-10-2005 |
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