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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 February 2016 (25.02.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/029018 A3

(51) International Patent Classification:
G06F 17/30 (2006.01)

(21) International Application Number:
PCT/US2015/046114

(22) International Filing Date:
20 August 2015 (20.08.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/040,547 22 August 2014 (22.08.2014) US
14/720,481 22 May 2015 (22.05.2015) US

(71) Applicant: **XCALAR, INC.** [US/US]; 3031 Tisch Way, Suite 306, San Jose, California 95128 (US).

(72) Inventors: **JOSHI, Vikram**; Vikram Joshi, Jerene Y3031 Tisch Way, Suite 306, San Jose, California 95128 (US). **YANG, Jerene**; 3031 Tisch Way, Suite 306, San Jose, California 95128 (US). **LIM TZE HAO, Brent**; 3031 Tisch Way, Suite 306, San Jose, California 95128 (US). **BROWN, Michael**; 3031 Tisch Way, Suite 306, San Jose, California 95128 (US).

(74) Agents: **MILLER, Daniel** et al.; Hickman Palermo Becker Bingham LLP, 1 Almaden Boulevard, San Jose, California 95113 (US).

(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:

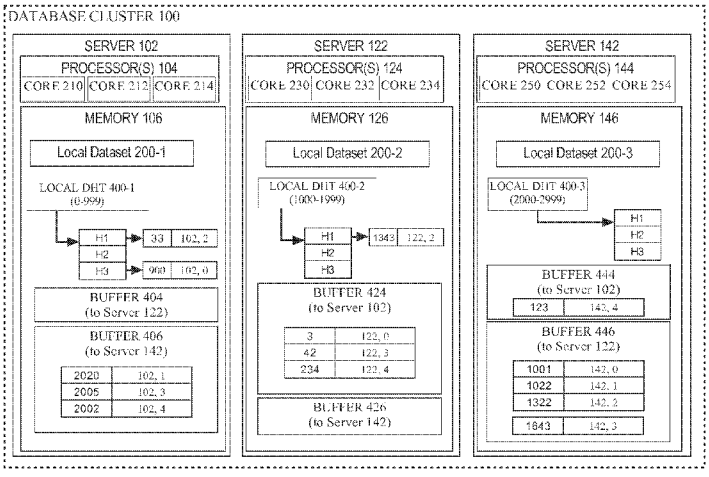
— *with international search report (Art. 21(3))*

— *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))*

[Continued on next page]

(54) Title: EXECUTING CONSTANT TIME RELATIONAL QUERIES AGAINST STRUCTURED AND SEMI-STRUCTURED DATA

FIG. 4



(57) Abstract: Techniques are described herein for performing database operations against location and access transparent metadata units called fat pointers organized into globally distributed data structures. The fat pointers are created by extracting values corresponding to a particular key and paring each value with a reference to the local location and server that has the native format record containing the value. The fat pointers may be transferred to any server in the cluster, even if the server is different from the server that has the native format record. In general, most operations are performed against fat pointers rather than the native format records. This allows the cluster to perform work against arbitrary types of data efficiently and in a constant amount of time despite the variable sizes and structures of records.

WO 2016/029018 A3

(88) Date of publication of the international search report:
14 April 2016

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/046114

A. CLASSIFICATION OF SUBJECT MATTER
INV. 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 5 551 027 A (CHOY DAVID M [US] ET AL) 27 August 1996 (1996-08-27)	1-3,12
Y	column 2, line 3 - line 23 column 5, line 2 - line 4 column 7, line 12 - line 20 column 8, line 32 - column 9, line 4 column 9, line 25 - column 10, line 24 column 11, line 6 - line 50 ----- -/--	4-11, 13-15

[X] Further documents are listed in the continuation of Box C.

[X] 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

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2016	24/02/2016

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

2

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Hector Garcia-Molina ET AL: "Database Systems, The complete book - Chapter 14 - Index Structures" In: "Database systems the complete book, second edition", 15 June 2008 (2008-06-15), Pearson Prentice Hall, XP055224094, ISBN: 978-0-13-606701-6 pages 619-700, page 648, last paragraph page 649, last paragraph - page 650, last paragraph	4-6,14, 15
Y	US 8 566 324 B1 (SACCO GIOVANNI M [IT]) 22 October 2013 (2013-10-22) column 3, line 26 - column 4, line 30	7,14,15
A	Jim Gray ET AL: "Transaction Processing: Concepts and Techniques - Chapter 14 - The Tuple-Oriented File System", Transaction processing : concepts and techniques, 1 January 1993 (1993-01-01), pages 749-827, XP055247700, San Mateo, Calif ISBN: 978-1-55860-190-1 Retrieved from the Internet: URL:- [retrieved on 2016-02-04] page 752 - page 753 page 768, paragraph 1 page 796	1-15
Y	& Jim Gray ET AL: "Transaction Processing: Concepts and Techniques - Chapter 15 - Access Paths" In: "Transaction processing : concepts and techniques", 1 January 1993 (1993-01-01), MORGAN KAUFMANN, San Mateo, Calif, XP055247708, ISBN: 978-1-55860-190-1 pages 829-913, page 863, paragraph 6 page 864, paragraph 3 - page 865, paragraph 2 page 866, paragraph 1 - paragraph 3	7

-/--

2

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	M. Tamer Özsu ET AL: "Principles of Distributed Database Systems - Chapter 16 - Peer-to-Peer Data Management" In: "Principles of Distributed Database Systems, Third Edition", 2 March 2011 (2011-03-02), Springer New York, New York, NY, XP055249846, ISBN: 978-1-4419-8834-8 pages 611-655, page 619, paragraph 2 - paragraph 3 page 637 page 641, paragraph 1 - last paragraph	8,10,11, 13-15
Y	ANANTH RAO ET AL: "Load Balancing in Structured P2P Systems", 2ND INTERNATIONAL WORKSHOP ON PEER-TO-PEER SYSTEMS (IPTPS '03), vol. 2735, 20 February 2003 (2003-02-20), pages 68-79, XP055250129, ISBN: 978-3-540-45172-3 page 69, paragraph 3 page 71, paragraph 3 - paragraph 4	9,14,15
Y	Tamer M. Özsu ET AL: "Principles of Distributed Database Systems - Chapter 14" In: "Principles of Distributed Database Systems, Third Edition", 2 March 2011 (2011-03-02), Springer New York, New York, NY, XP055190117, ISBN: 978-1-44-198834-8 pages 497-550, DOI: 10.1007/978-1-4419-8834-8,	9
A	page 508, paragraph 3 - page 511, paragraph 2 page 527, paragraph 7	1-3
Y	Hector Garcia-Molina ET AL: "DATABASE SYSTEMS The Complete Book Second Edition - Chapter 20 - Parallel and Distributed Databases", Database systems the complete book, second edition, 15 June 2008 (2008-06-15), pages 985-1034, XP055224971, ISBN: 978-0-13-606701-6 Retrieved from the Internet: URL:- [retrieved on 2015-11-02]	9
A	page 1015, paragraph 1 - paragraph 2 page 989 - page 992	8,10,11, 13-15

-/--

2

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Roshan Sumbaly ET AL: "Serving Large-scale Batch Computed Data with Project Voldemort", , 23 January 2012 (2012-01-23), XP055131224, Retrieved from the Internet: URL:https://www.usenix.org/legacy/events/fast12/tech/full_papers/Sumbaly.pdf [retrieved on 2014-07-23] page 3, right-hand column, paragraph 1 - page 4, left-hand column, paragraph 3; figure 3 page 5, right-hand column, paragraph 14 - page 7, left-hand column, last paragraph page 8, right-hand column, last paragraph - page 9, left-hand column, last paragraph	1-15
A	ROSHAN SUMBALY ET AL: "The big data ecosystem at LinkedIn", PROCEEDINGS OF THE 2013 INTERNATIONAL CONFERENCE ON MANAGEMENT OF DATA, SIGMOD '13, 22 June 2013 (2013-06-22), pages 1125-1134, XP055224173, New York, New York, USA DOI: 10.1145/2463676.2463707 ISBN: 978-1-4503-2037-5 abstract page 1125 - page 1127; figure 1	1-3,12, 14,15
A	US 2012/319876 A1 (FROEMMGEN ALEXANDER [DE]) 20 December 2012 (2012-12-20) paragraph [0044] - paragraph [0046] paragraph [0055]	7,14,15
A	GIOVANNI M SACCO ED - STEPHEN W LIDDLE ET AL: "Fast Block-Compressed Inverted Lists", 3 September 2012 (2012-09-03), DATABASE AND EXPERT SYSTEMS APPLICATIONS, SPRINGER BERLIN HEIDELBERG, BERLIN, HEIDELBERG, PAGE(S) 412 - 421, XP047014454, ISBN: 978-3-642-32599-1 page 415, paragraph 2 - paragraph 3	1,4,7

2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/046114

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.:

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: 1-3, 12(completely); 14, 15(partially)

   Claims 1-3, 12, relate to a method for storing data in a distributed database system and building distributed indices on these data, and retrieving data from the distributed database by using the distributed indices.

   ---

2. claims: 4-6(completely); 14, 15(partially)

   Claims 4-6 relate to the memory data structure used for storing the local index on a computing node.

   ---

3. claims: 7(completely); 14, 15(partially)

   Claim 7 relates to a compression format used when storing the local index data.

   ---

4. claims: 8, 10, 11, 13(completely); 14, 15(partially)

   Claims 8, 10, 11, 13, relate to operations performed on the data by making use of the index entries (i.e. fat pointers).

   ---

5. claims: 9(completely); 14, 15(partially)

   Claim 9, relates to load balancing of the index entries across the nodes of the distributed computing system.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/046114

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5551027 A	27-08-1996	JP 2583010 B2	19-02-1997
		JP H07129450 A	19-05-1995
		US 5551027 A	27-08-1996
US 8566324 B1	22-10-2013	US 8566324 B1	22-10-2013
		US 8738631 B1	27-05-2014
US 2012319876 A1	20-12-2012	US 2012319876 A1	20-12-2012
		US 2012323927 A1	20-12-2012