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H04L 12/717 (2013.01) H04L 12/801 (2013.01)

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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.

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(88) Date of publication of the international search report:

30 March 2017

(54) Title: ENHANCING PERFORMANCE OF MULTI-PATH COMMUNICATIONS

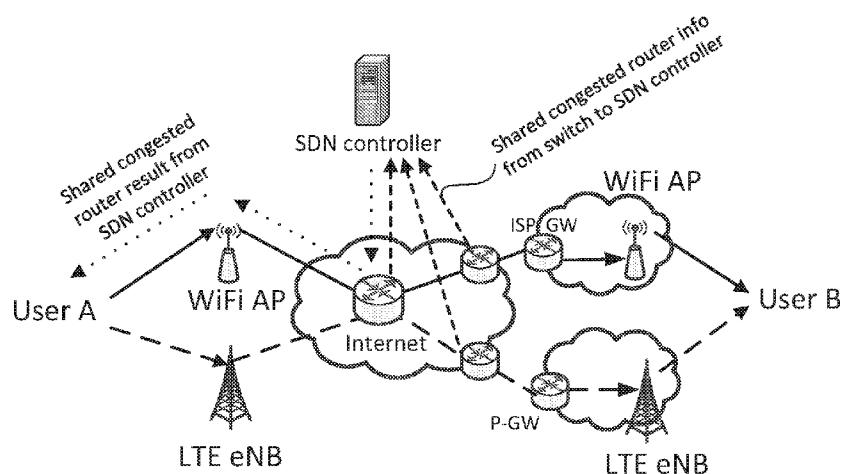


FIG. 7

(57) Abstract: Systems, methods, and instrumentalities are disclosed for enhancing performance of multi-path communications. Multi-path communication performance may be enhanced by determining whether multi-path communications share a congested router. A multi-path real-time communication protocol may provide techniques to prevent, detect, communicate and respond to a shared congested router. A shared congested router may be prevented, and/or detected using one or more detection techniques.

WO 2016/197004 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/035839

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.:

1-12, 32-40

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.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/035839

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H04L12/721 H04L12/741 H04L12/707 H04L12/717 H04L12/803
 H04L12/891 H04L12/863 H04L12/801
 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 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	COUDRON MATTHIEU ET AL: "Boosting Cloud Communications through a Crosslayer Multipath Protocol Architecture", 2013 IEEE SDN FOR FUTURE NETWORKS AND SERVICES (SDN4FNS), IEEE, 11 November 2013 (2013-11-11), pages 1-8, XP032540939, DOI: 10.1109/SDN4FNS.2013.6702535 [retrieved on 2014-01-03] abstract paragraphs [0II.], [0IV.] figures 1,2 ----- -/--	1-5,7-11

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

Date of the actual completion of the international search 17 January 2017	Date of mailing of the international search report 13/02/2017
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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 Kesting, Christiane
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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/035839

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SANDRI MARCUS ET AL: "On the Benefits of Using Multipath TCP and Openflow in Shared Bottlenecks", 2014 IEEE 28TH INTERNATIONAL CONFERENCE ON ADVANCED INFORMATION NETWORKING AND APPLICATIONS, IEEE, 24 March 2015 (2015-03-24), pages 9-16, XP032771816, ISSN: 1550-445X, DOI: 10.1109/AINA.2015.159 [retrieved on 2015-04-29]	1-5,7-11
Y	abstract paragraph [III.B.] figures 2-4	6,12
Y	----- DAN RUBENSTEIN ET AL: "Detecting Shared Congestion of Flows Via End-to-End Measurement", 20020601, vol. 10, no. 3, 1 June 2002 (2002-06-01), XP011077171, paragraphs [002.], [003.], [005.]	6,12
X	----- IJ WIJNANDS ET AL: "Encapsulation for Bit Index Explicit Replication in MPLS Networks; draft-wijnands-mpls-bier-encapsulation-01.txt", ENCAPSULATION FOR BIT INDEX EXPLICIT REPLICATION IN MPLS NETWORKS; DRAFT-WIJNANDS-MPLS-BIER-ENCAPSULATION-01.TXT, INTERNET ENGINEERING TASK FORCE, IETF; STANDARDWORKINGDRAFT, INTERNET SOCIETY (ISOC) 4, RUE DES FALAISES CH-1205 GENEVA, SWITZERLAND, 16 October 2014 (2014-10-16), pages 1-11, XP015102220, [retrieved on 2014-10-16] abstract paragraphs [001.], [003.], [004.]	32,33, 36,39,40
X	----- APOSTOLOPOULOS J G: "RELIABLE VIDEO COMMUNICATION OVER LOSSY PACKET NETWORKS USING MULTIPLE STATE ENCODING AND PATH DIVERSITY", OPTOMECHATRONIC MICRO/NANO DEVICES AND COMPONENTS III : 8 - 10 OCTOBER 2007, LAUSANNE, SWITZERLAND; [PROCEEDINGS OF SPIE , ISSN 0277-786X], SPIE, BELLINGHAM, WASH, vol. 4310, 24 January 2001 (2001-01-24), pages 392-409, XP008007254, DOI: 10.1117/12.411817 ISBN: 978-1-62841-730-2 paragraphs [5.2.2.] - [5.3.]; figures 4,5	32,34-38
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/035839

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>SINGH T KARKKAINEN J OTT S AHSAN AALTO UNIVERSITY L EGGERT NETAPP V: "Multipath RTP (MPRTP); draft-ietf-avtcore-mprtp-00.txt", MULTIPATH RTP (MPRTP); DRAFT-IETF-AVTCORE-MPRTP-00.TXT, INTERNET ENGINEERING TASK FORCE, IETF; STANDARDWORKINGDRAFT, INTERNET SOCIETY (ISOC) 4, RUE DES FALAISES CH- 1205 GENEVA, SWITZERLAND, 20 December 2014 (2014-12-20), pages 1-40, XP015103675, [retrieved on 2014-12-20] abstract paragraphs [001.], [8.1.5], [9.1.], [9.1.1]</p> <p style="text-align: center;">-----</p>	32-40

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-12

A controller and a method for modifying a routing table and sending this table to a router upstream

2. claims: 13-26

A controller and a method for causing an information bit to be set in a reverse flow

3. claims: 27-31

A method for detecting queuing delays

4. claims: 32-40

A router configured to determine a routing path based on a sub-flow-ID
