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(54) Title: NODE OUTAGE DETERMINATION AND REPORTING IN A MESH NETWORK

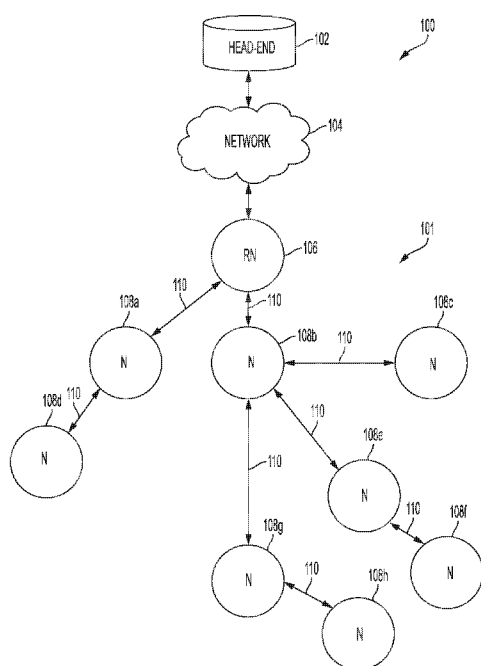


FIG. 1

(57) Abstract: A method includes receiving beacons originating from end-points. The beacons are received during a single beacon interval and are sent using a power strength to reach nodes within physical proximity of the end-points. The method also includes establishing a list including multiple end-points from which a node receives the beacons at more than a threshold percentage of the beacon intervals. The method includes detecting that a threshold number of the beacon intervals have passed since receiving a most recent beacon from an endpoint. The method includes outputting a ping at full power strength to the endpoint requesting a response. When the response is not received from the endpoint, the method includes transmitting an outage alarm to a next topologically higher layer of a mesh network. The outage alarm includes an identification of the endpoint and a timestamp indicating when the first node received the most recent beacon from the endpoint.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/064127

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.:

1-15

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
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A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W24/04 H04W84/18
ADD. H04W24/08 H04W40/14

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)
H04W

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)

EP0-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.
A	WO 2008/033514 A2 (ITRON INC [US]; PICARD GILLES [FR] ET AL.) 20 March 2008 (2008-03-20) paragraph [0177] - paragraph [0181]; figure 2A paragraph [0606] - paragraph [0611] -----	1-15
A	UCHIYAMA A ET AL: "Neighbor Selection Algorithm for Ad Hoc Networks with Highly Dynamic Urban Mobility", WIRELESS COMMUNICATIONS AND MOBILE COMPUTING CONFERENCE, 2008. IWCMC '08. INTERNATIONAL, IEEE, PISCATAWAY, NJ, USA, 6 August 2008 (2008-08-06), pages 165-170, XP031306920, ISBN: 978-1-4244-2201-2 Whole section II ----- -/--	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 application or patent but published on or after the international filing date

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

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"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

10 March 2020

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23/06/2020

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/064127

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LI LI ET AL: "Robust Networking for Bandwidth Constrained Mobile Tactical Radios", 2012 IEEE 75TH VEHICULAR TECHNOLOGY CONFERENCE (VTC SPRING 2012) : YOKOHAMA, JAPAN, 6 - 9 MAY 2012, IEEE, PISCATAWAY, NJ, 6 May 2012 (2012-05-06), pages 1-5, XP032202442, DOI: 10.1109/VETECS.2012.6240025 ISBN: 978-1-4673-0989-9 Whole section III	1-15
A	MCCARTHY P ET AL: "An efficient broadcast query forwarding technique for wireless multipath routing", PERFORMANCE, COMPUTING, AND COMMUNICATIONS CONFERENCE, 2005. IPCCC 2005. 24TH IEEE INTERNATIONAL PHOENIX, AZ, USA APRIL 7-9, 2005, PISCATAWAY, NJ, USA, IEEE, 7 April 2005 (2005-04-07), pages 337-346, XP010812798, DOI: 10.1109/PCCC.2005.1460584 ISBN: 978-0-7803-8991-5 Whole sections II and III	1-15
A	US 2010/172258 A1 (YANG JUN-MO [KR] ET AL) 8 July 2010 (2010-07-08) paragraph [0021] - paragraph [0030]; figure 2	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2019/064127

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-15

The claimed node

- receives a set of beacons originating from a set of endpoints, wherein the set of beacons are received during a time period that corresponds to at least a single beacon interval;
- establishes a list comprising one or more endpoints of the set of endpoints from which the first node receives the set of beacons at more than a threshold percentage of the beacon intervals;
- detects that a threshold number of the beacon intervals have passed since receiving a first most recent beacon from a first endpoint of the list;
- outputs a ping at full power strength to the first endpoint requesting a response to the ping; and
- transmits, when the response to the ping is not received from the first endpoint, an outage alarm message to a next topologically higher layer of a mesh network, the outage alarm message comprising a timestamp indicating when the first node received the first most recent beacon from the first endpoint.

2. claims: 16-20

The claimed node:

- receives an alarm packet from a second node;
- parses the alarm packet into endpoint identifications;
- analyzes the endpoint identifications for repeat alarm indications;
- stores non-repeat alarm indications of the endpoint identifications;
- generates an updated alarm packet comprising the non-repeat alarm indications; and
- transmits the updated alarm packet to a next topologically higher layer of a mesh network comprising the node and the second node.
