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| Algorithm | Relevance | Layer | Parameters for  Congestion Detection and Avoidance | Congestion Avoidance Strategy | Drawbacks | Notes |
| Popularity aware congestion avoidance (PACA) |  |  | utilized frequency (Ui), i.e. number of paths using a particular node; characteristic ratio (CRi), i.e. value the ratio of downstream and upstream nodes for a particular node | A popularity cost is calculated for each node and for every potential path. Packets are forwarded to less popular nodes | Delay is increased due to the fact that less popular nodes belong to larger paths than nodes which have higher popularity |  |
| Congestion avoidance based on lightweight buffer management in sensor networks [6] | Journal 2006  Citation 31  Last citation 2012 | On MAC layer (It is tested with CSMA/CA and CSMA without ACK) | Utilized ratio buffer | Each node stamps its current state in the frame header. In such a way that nodes can be able to catch the current state of their neighbours. In this manner, nodes only send packets to nodes with sufficient buffer space | Increased energy consumption, since it protocol based on overhearing.  Increasing delay due to the available buffer space does not utilized | CODA and ESRT disadvantages  Event trigger |
| Congestion avoidance and fairness in wireless sensor networks [7] | Conference 2008  Citation 6  Last citation 2012 | In the network layer | Multipath  For each node considered: the ratio of the number of downstream and upstream (CR) and the queue size (Qa) | According to its CR value, each node decides: 1) implement fair queueing, 2) use a rate reduction technique to reduce sending, or 3) forward packets to downstream node, which the smallest Qa | It protocol is not suitable for critical mission applications due to it does not take in account the current traffic scenario in the network |  |
| Congestion avoidance control mechanism for multiple paths routing protocol (MR-CACM) [8] | Conference 2008  Citations 2  Last citation 2011 | In the network layer | Multipath  Transmitting capacity values of nodes and links | Source nodes finds paths by means of flooding network  Routing decisions are made, taking in account nodes and links with the best values of transmitting capacity | Overhead, since several packets are exchanged in the process of constructing paths. |  |
| Dynamic alternative path selection scheme (DAIPaS) [9] | Conference 2011  Citations 3  Last citation 2012 | In the network layer | Multipath  Remaining power and queue size of nodes; distance from sink; and channel interference | When a node: 1) receives packets from more than one flow; or 2) its buffer occupancy is reaching its upper limit; or 3) has low remaining power. Then, node chooses alternative paths, based on the neighbors’ availability and distance from sink | Increased energy consumption. The protocol based on overhearing. In hard congestion existence, a downstream node may not be able to inform its upstream neighbours about the congestion because of collisions. |  |
| XLP: Cross-layer protocol for WSNs [10] | Journal 2010  15 citations  Last citation 2012 | Cross Layer | Channel conditions, relay input rate, utilized ratio buffer, energy node | Rate of packet generation,  Control congestion based on current load of each node | The protocol is based on overhearing |  |
| Receiver-assisted congestion control mechanism (RACC) [11] | Journal 2010  2 citations  Last citation 2012 | Transport Layer | Packet inter arrival time | Congestion window adjustment | Measure of packet inter arrival time is not feasible due to it may be affected by collisions (It’s my point of view) |  |
| Decentralized Predictive Congestion Control (DPCC) [12] | Journal 2007  Citations 7  Last citation 2012 | MAC Layer | Buffer occupancy  Target outgoing rate | Back off interval selection scheme | X | CODA disadvantages |
| TARA [13] | Journal 2007  Citations 24  Last citation 2012 |  | Intermediate hotspot node detected congestion | As soon as hotspot node detects that its congestion  level is above watermark, it needs to quickly locate 2  important nodes :a) Distributor node a) Merger node. The  distributor node distributes the traffic between original path  and detour paths. | X |  |
| Priority based congestion control (PCCP) [14] | Journal 2007  Citation 41  Last Citation 2012 | Cross layer (Network) | Packet inter-arrival time  Packet service time | Multipath  (Rate adjustment )Priority based on node location |  | Priority based on node location  CODA disavantages  WSNM |
| CODA [15] |  | Transport layer | Channel utilization  Buffer occupancy | Transmission rate  Source rate |  |  |
| ESRT [16] |  | Transport layer | Buffer occupancy | Source rate |  |  |
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| Table 1. Congestion control algorithms for WSN | | | | |
| Algorithm | Layer | Parameters | Congestion Control Strategy | Drawbacks |
| Congestion avoidance based on lightweight buffer management in sensor networks [6] | On MAC layer (It is tested with CSMA/CA and CSMA without ACK) | Utilized ratio buffer | Each node stamps its current state in the frame header. In such a way that nodes can be able to catch the current state of their neighbours. In this manner, nodes only send packets to nodes with sufficient buffer space | Increased energy consumption, since it protocol based on overhearing.  Increasing delay due to the available buffer space does not utilized |  |
| Congestion avoidance and fairness in wireless sensor networks [4] | Cross Layer (2010, 6 citations, journal) | Ratio of the number of downstream and upstream  Utilized ratio buffer | Multipath and transmission rate reduction | It protocol does not take in account the current traffic scenario in the network |
| Cross-layer protocol for WSNs (XLP) [7] | Cross Layer  (2010, 15 citations, journal) | Channel conditions  Relay input rate  Utilized ratio buffer  Energy node | Control of generation packet rate  Local congestion control | It protocol is based on overhearing |
| Receiver-assisted congestion control mechanism (RACC) [8] | Transport Layer (2010, 2 citation, journal) | Packet inter arrival time | Congestion window adjustment | Measure of packet inter arrival time is not feasible due to it may be affected by collisions |

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| --- | --- | --- | --- | --- | --- | --- |
| Algorithm | Relevance | Layer | Parameters for  Congestion Detection and Avoidance | Congestion Avoidance Strategy | Drawbacks | Notes |
| Congestion avoidance based on lightweight buffer management in sensor networks [6] | Journal 2006  Citation 31  Last citation 2012 | On Link (It is tested with CSMA/CA and CSMA without ACK) | Utilized ratio buffer | Each node stamps its current state in the frame header. In such a way that nodes can be able to catch the current state of their neighbours. In this manner, nodes only send packets to nodes with sufficient buffer space | Increased energy consumption, since it protocol based on overhearing.  Increasing delay due to the available buffer space does not utilized |  |
| Dynamic alternative path selection scheme (DAIPaS) [9] | Conference 2011  Citations 3  Last citation 2012 | In the network layer | Multipath  Remaining power and queue size of nodes; distance from sink; and channel interference | When a node: 1) receives packets from more than one flow; or 2) its buffer occupancy is reaching its upper limit; or 3) has low remaining power. Then, node chooses alternative paths, based on the neighbors’ availability and distance from sink | Increased energy consumption. The protocol based on overhearing. In hard congestion existence, a downstream node may not be able to inform its upstream neighbours about the congestion because of collisions. |  |
| XLP: Cross-layer protocol for WSNs [10] | Journal 2010  15 citations  Last citation 2012 | Cross Layer | Channel conditions, relay input rate, utilized ratio buffer, energy node | Rate of packet generation,  Control congestion based on current load of each node | The protocol is based on overhearing |  |
| Receiver-assisted congestion control mechanism (RACC) [11] | Journal 2010  2 citations  Last citation 2012 | Transport Layer | Packet inter arrival time | Congestion window adjustment | Measure of packet inter arrival time is not feasible due to it may be affected by collisions (It’s my point of view) |  |
| CODA [15] |  | Transport layer | Channel utilization  Buffer occupancy | Transmission rate  Source rate |  |  |
| ESRT [16] |  | Transport layer | Buffer occupancy | Source rate |  |  |

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| Algorithm | Layer | Parameters | Strategy | Drawbacks |
| Dynamic alternative path selection scheme (DAIPaS) [9] | Network | Remaining node power  Buffer occupancy  Distance from sink  Channel conditions | Multipath based on the neighbors’ availability and distance from sink | It is based on overhearing  In hard congestion, it is not feasible because of collisions |
| Cross-layer protocol for WSNs (XLP) [10] | Cross Layer | Remaining node power  Buffer occupancy  Transmission rate  Channel conditions | Control packet generation rate | It is based on overhearing |
| Receiver-assisted congestion control mechanism (RACC) [11] | Transport | Packet inter arrival time | Congestion window adjustment | Measure of packet inter arrival time may be not feasible due to collisions |
| Congestion avoidance based on lightweight buffer management in sensor networks [6] | Link | Buffer occupancy | Multipath based on buffer occupancy | It is based on overhearing  Available buffer space does not utilized |
| Congestion detection and avoidance (CODA) [15] | Transport | Buffer occupancy | Control transmission rate  Control packet generation rate | It is not guaranteed to inform about onset congestion  It leads to packet losses |
| Event to sink reliable transport (ESRT) [16] | Transport | Buffer occupancy  Channel conditions | Control packet generation rate | Generation rate of noncongested sources nodes are constrained |