**A Survey on Congestion Control Techniques in Wireless Sensor Networks**

* **Causes of congestion**: buffer overflow, channel contention, interference, packet collisions and bottleneck around sink.
* **Congestion control** is a method used for monitoring the process of regulating the total amount of data entering the network to keep traffic levels at an acceptable value.

**Techniques for Control Congestion**

1. ***Local Cross Layer Congestion Control [1]***

* This method [1] is based on buffer occupancy. Input to buffer is of two types: a) Generated packets and b) Relay packets.
* A sensor node has 2 duties a) Source duty and b) Router duty.
* It technique realizes two activities: a) (In a source node) it controls the rate of generated packet; b) (In a router node) it regulates the congestion based on current load on node.
* Receiver-based contention: each nodes decided participate in communication based on receiver parameters
* Cross Layer. Functionalities medium access, routing and congestion control. Considered channel effects
* Based in over hearing
* Receiver parameters: Channel conditions (SNR), relay input rate, utilized ratio buffer, energy node

1. ***Adaptive Duty Cycle based Congestion Control (ADCC)***

* It is an energy efficient and lightweight congestion control scheme.
* It periodically calculates the required service time using incoming packet information of child nodes and infers there is congestion or not based on calculated service time.
* If the congestion degree is below a certain threshold, this scheme adjusts its own duty cycle to reduce congestion.
* On the other hand if the congestion degree is above threshold, it notifies child nodes of congestion so that transmission rates of child nodes can be adjusted.

1. ***Receiver Assisted Congestion Control* (RACC) [3]**

* It realizes two kinds of control: sender performs loss and receiver performs delay
* Receiver maintains 2 timers, one for recording the packet inter arrival time and other for measuring RTT.
* Sender uses this information from receiver to adjust the congestion window.
* The receiver can estimate the rate bandwidth based on packet inter arrival timer
* The sender should adapt to make best use of measured bandwidth based on packet inter arrival timer (receiver sent this information to the sender).
* The RTT timer at receiver times the arrival of the next packet and detect packet drop if timeout occurs.
* Since receiver detects packet drop earlier than sender, it can send ACK to inform sender thereby reducing the waiting time of sender to retransmit a lost packet.

1. ***Learning Automata based Congestion Avoidance Scheme*** (LACAS) [4]

* It deals with congestion problem for many-to-one traffic patterns.
* A simple autonomous learning machine called automata is stationed at each intermediate node of network.
* It intelligently learns from the past and controls the rate of flow of data at intermediate nodes based on probabilistically how many packets are likely to get dropped if a particular flow is maintained.

1. ***Decentralized Predictive Congestion Control* (DPCC) [5]**

* It is a methodology that utilizes both rate control and back-off interval selection schemes along with distributed power control scheme.
* The rate selection scheme implemented at each node takes into account the buffer occupancy and target outgoing rate and acts as a backpressure signal to minimize the effects of congestion on a hop-by-hop basis by estimating the outgoing traffic flow.
* The target rate at next hop node indicates what the incoming rate should be.
* The back off interval selection scheme for a node plays a critical role in deciding which node gains access to channel since multiple nodes compete to access the shared channel.

*F. Topology-Aware Resource Adaptation Scheme*

Topology-Aware Resource Adaptation (TARA) scheme [6]

activates appropriate sensor nodes whose radio is off to form a

new topology that has enough capacity to handle increased

traffic. 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. The detour paths are formed by backup

nodes around hotspot node that are woken up. The merger

node merges these two flows. Thus TARA serves the dual

purpose of alleviating congestion during crisis state and

conserving energy during dormant states.

*G. Priority based Congestion Control*

Priority based Congestion Control (PCCP) [7] is an

upstream congestion control protocol that is used in case of

many-to-one communication. It introduces the concept of node

priority index. PCCP consists of 3 components: a) Intelligent

Congestion Detection (ICD) b) Implicit Congestion

Notification and c) Priority based Rate Adjustment (PRA).

ICD detects congestion based on joint participation of packet

inter-arrival time and service time that reflects the current

congestion level and provide rich congestion information. In

ICN, congestion information is piggybacked in header of data

packets to avoid transmission of additional control messages

and help improve energy efficiency. In PRA, each sensor node

is given a priority index. It is designed to guarantee that the

node with higher priority index gets more bandwidth, the nodes

with same priority index gets equal bandwidth and node with

sufficient traffic gets more bandwidth than the one that

generates less traffic. Thus PCCP achieves efficient congestion

control and flexible weighted fairness for both single path and