SRP Rules When a Node Receives a Packet/Timer Expires

During the initialization of the network, all nodes in the network determine their hop count to a destination node. There could be a number of destinations nodes. A hop count is saved for each one. Once the network begins sending data, each node maintains a list, per destination, that contains packet IDs and the state of that packet ID. In a number of instances a timer is set, if the timer expires then depending on that packet IDs state it will execute certain rules. When a data packet is received at a node or the timer expires the list of rules below are followed to determine the nodes actions. If a node does not have an entry for a packet ID, it treats it as a new packet.

Before going through the rules there are two variables that are used for calculating timers. The first is λ. It is the upper limit of the back-up delay prior to sending a packet. It name in the code is ForwardDelay. The second variable is RetryMultiplier, which allows for the adjustment of the timers effecting the Owner, Father, and Resend states without affecting λ. RetryMultiplier of 1.5 is used in our simulations. The Rand(x) function get a random number between 0 and x and is used in calculating timers.

New Packet. When a node receives a packet for the first time, it compares the packets expected hop count to the destination with its known hop count to the destination as determined in the network initialization. At that point one of three things happens.

1. If the nodes hop count to the destination is farther away than the expected hop count in the packet, the node does nothing. It does not even log it as seeing the packet. That way if it sees the packet later with a higher hop count to destination it treats it as new. This is important in route repair.

2. If the nodes hop count to the destination is less than or equal to the expected hop count in the packet, the nodes does the following steps.

a. Compares the known number of hops to the destination saved at the node and the expected hop count to the destination in the packet header and sets a timer to a random delay to forward the packet according the following rule. If the node is on a reliable path (RP), the delay is λ/625 with a minimum value set as the transition time the radio needs to change from receive to broadcast mode. If the node is one hop closer to the destination, the delay is a random number between 0 and λ/4. If the node is closer than one hop to the destination, the delay is a random number between λ/4 and λ/2. If the node has an equal hop count to the destination, the delay is a random number between λ/2 and λ. This creates an order of precedent for which node forwards a packet to nodes with PP, nodes one hop closer, nodes closer, nodes at the same distance.

b. Enters the packet ID into the list and changes the state in the list for that packet ID to Possible.

3. If the node is the destination node, the node starts a timer for 10 * λ and adds the packet ID into the list with the state SendAck.

Possible State. There is a timer running when a packet ID is in the list at this state. So one of two things happen, the timer expires or a data packet or acknowledgement packet with that ID is received by the node.

1. Timer Expires. The node had the shortest delay so it does the following.

a. Send the packet after reducing the expected hop count to the destination in the packet header to one less than its known hop count to destination.

b. Starts a timer for Rand(0.5 * λ) + (RetryMultiplier - .25) * λ (1.25 λ to 1.75 λ), and changes the state for that packet ID in its table to Owner.

c. Changes the flag at the node to become part of the reliable path.

2. Packet received with the same ID.

a. If it is an ACK packet from a node with a lower hop count to destination, the node cancels the timer and changes the state for the packet ID to Ignore and removes itself from the reliable path for the flow.

b. If it is a DATA packet being sent from a node that is equal distance or closer to the destination, then the node cancels the timer and changes the state for that packet ID to Ignore and removes itself from the reliable path for the flow.

Owner State. There is a timer running when a packet ID is in the list at this state. So one of two things happen, the timer expires or a packet with the same ID is received by the node.

1. Timer Expires. Send the packet again, set a timer for Rand(0.5 * λ) + (RetryMultiplier - .25) * λ (1.25 λ to 1.75 λ), and change the state in the table for that ID to Resend.

2. Packet received with the same ID.

a. If it is an ACK packet from a node closer to the destination, then the timer is canceled and the state in the table is changed to Ignore for that ID.

b. If it is a data packet from a node closer to the destination, then the state in the table it changed to Father for that ID.

Father State. The timer that is running with a packet ID in the list at this state is the same one set when the state was changed to the Owner state. Again there are only two things that can happen. The timer expires or a packet with the ID is received by the node.

1. Timer Expires. Change the state in the table for that ID to Ignore.

2. Packet received with the same ID.

a. If it is a DATA packet from a node one hop closer to the destination, an ACK packet is sent to stop all other packets at that level from broadcasting, the timer is canceled, and the state for that ID is changed to Ignore.

b. If it is an ACK packet for a node close, the timer is canceled and the state for that ID is changed to Ignore.

Resend State. A timer is running with a packet ID in this state. There are two possibilities as described below.

1. Timer Expires.

a. Increase the expected hop count in the packet header by two. This allows nodes that could not respond earlier to do so.

b. Send the packet.

c. Change the state for that packet ID to Ignore.

2. Packet received with the same ID. If it is an ACK or DATA packet from a node that is closer to the destination, the timer it canceled and the state for that packet ID is set to Ignore.

SendAck State. There is a timer running.

1. Timer Expires. Change the state in the table for the ID to Ignore.

2. Packet received with the same ID. If it is a DATA packet, then send out an ACK packet to try and stop any other nodes from forwarding that packet.

Ingore State. Once a packet ID changes to this state, it does nothing when it receives a packet with this ID.