Using tissue-healing inspired strategies to repair congested network nodes

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Introduction

- Want to use tissue-healing inspired repair strategies to repair network nodes that are overcongested with traffic.
- Use the idea that when a tissue is injured, the body will begin to form new cells that will replace the damaged tissue.
  - After an injury, the immune system will send out white blood cells that phagocytize damaged cells. New fibroblasts begin to contract the wound and new blood vessels form.
- As packets flood a node, the queue becomes more congested, causing traffic delays and other problems.

Hypothesis:

- Use models of tissue formation during wound healing to create more nodes to redirect traffic from a congested node.
- To check if the queue for a node gets too congested, the controller should compare the queues for all nodes to determine which is congested, using the fairness measure
- Maybe create enough nodes and redirect traffic to those nodes to ensure that the fairness index is close to 1 in the network system

Research

Defining a tissue as an undirected graph::

- Each cell is a node
- Links between the cells are the intercellular junctions that send information between cells - gap junctions, axons/dendrites
- Tissues are undirected because signals between cells can be sent in any direction

- Literature also defines various tissue systems as such. Which connections between cells count depends on the situation.
- Define the edges between cells to only be ways to send information

Defining an injury

- An injury is a disruption of part of the graph
- Relation to tissue: In a wound, cells are infected, which causes apoptosis. Similarly, in this model, nodes are injured when the number of packets sent to the node exceeds the threshold, causing a disruption or when a node is malfunctioning.

Defining a healing process

1. Initial Phase
    - Monitoring system to check for injuries: Acknowledgment (density), time-out, SDN monitoring (number of packets), AQM
    - Counting number of packets and ensuring that no node has received more than the threshold
    - Active monitoring of anything faulty
2. Healing Phase
    - Insert alternative routes
    - "Plain scaffold" reroute traffic to avoid damaged nodes
    - "Plain scaffold with cells" - create new edges with new nodes to redirect traffic
    - This can be done by changing priorities for the traffic
    - Eliminate the faulty nodes
    - The choice between plain scaffold and with cells can be analyzed by testing by determining amount of time it takes for the system to normalize
3. End Phase
    - Continue to monitor system until traffic is returned to normal operation

To-Do - 03/26/2018

- Modeling density using three equations
- Be more descriptive - flesh out
- Try to test it
- Look at PID Controller and Model Predictive Control
- Email Dr. Ahn