

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

Relationship between density of fibroblasts and wound healing time:

- Increasing density of myofibroblasts increases stiffness - similar to a tumor/hypertrophic scarring
- Decreasing the stress on myofibroblasts induces apoptosis and less contractility
- There are age-related differences in fibroblast density and therefore wound healing

- As maturation occurs, there is a lower fibroblast density, but after injury, the proliferation of fibroblasts is higher than neonatal wounds
- May need to come up with our own model of density vs. healing time

Fairness Measure:

- A fairness index of 1 means the system is fair while an index of 0 means the system is unfair.
- See paper by Jain about fairness measure - has equations for determining fairness index in network systems

Notes

- Define how to model a tissue with an undirected graph (communication network)
- Nodes are processes, edges are for interprocess communication
- Define an injury
- Injury is a disruption of a part of a graph
- Could be a lost cluster, a disruption in communication, or one malfunctioning node
- Define a healing process
 - Initial Phase
 - * Monitoring system in phase to check for any "injury"
 - * Detect congestion through acknowledgment (3) or a time-out (TCP-IP); software-defined monitoring by counting number of packets (switches/routers) and making sure it hasn't gone over the threshold, AQM (nodes)
 - * Modeling number of acknowledgments with density
 - Steady-State
 - * After injecting alternative routes (scaffold)
 - * Options: Plain scaffold, scaffold with "cells", total alternative route. change priorities to traffic using GRE header (key)
 - End Phase
 - * After monitoring system decides the system is normal or too little
- Look at existing network models; resilience