Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed Computing

HS 2014 Prof. R. Wattenhofer

Distributed Systems Part II

Exercise Sheet 9

1 Clock Synchronization: Spanning Tree

Common clock synchronization algorithms (e.g. TPSN, FTSP) rely on a spanning tree to perform clock synchronization. In the TPSN protocol sender-receiver synchronization is performed along the edges of the tree while FTSP is flooding synchronization messages along a tree rooted at the reference node. Finding a good spanning tree for clock synchronization is not trivial. Nodes which are neighbors in the network graph should also be close-by in the resulting tree. Show that in a grid of $n = m \times m$ nodes the stretch of the spanning tree is at least m. The stretch is defined as the hop distance in the tree divided by the distance in the grid.

2 Network Updates

Assume you have a network with n nodes and an extra node d as a destination.You want to migrate the network from an old set of forwarding rules to a new set of forwarding rules – without introducing loops in the process!

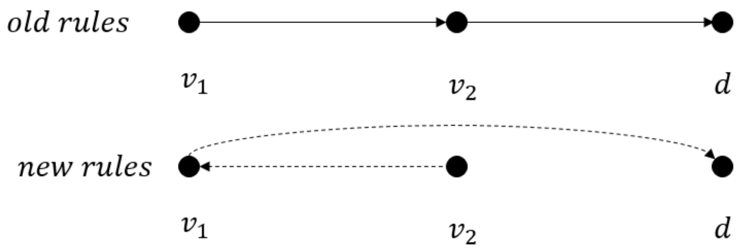

Figure 1: Simple example: In the old rules, v_1 forwards to d via v_2, and v_2 is directly connected to d. In the new rules, v_2 forwards to d via v_1, and v_1 is directly connected to d. v_2 may not migrate in a first update step, because that would induce a potential loop between v_1 and v_2!

a) Construct an example graph with old and new rules that needs at least three update steps.

b) You know from the lecture that you can always migrate at least one rule per step. When comparing the set of current rules to the next step, what property does this rule have?

c) Give a class of graphs with n nodes and a single destination with old and new rules that needs exactly n update steps to migrate without loops.

d) Give two different ways to migrate the network in Figure 2 without introducing loops.

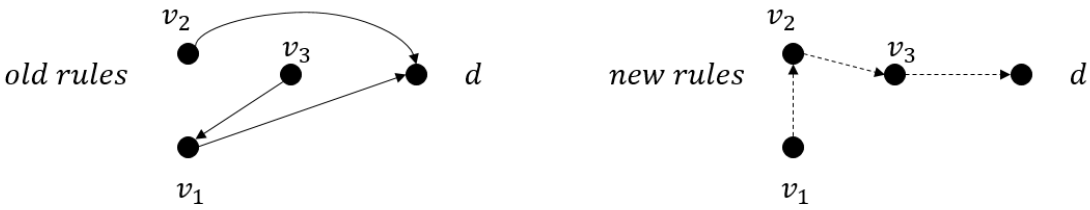

Figure 2: Another example for a set of old and new rules.