CISC 7332X T6

LAN Switching: Spanning Tree Algorithm

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Acknowledgements

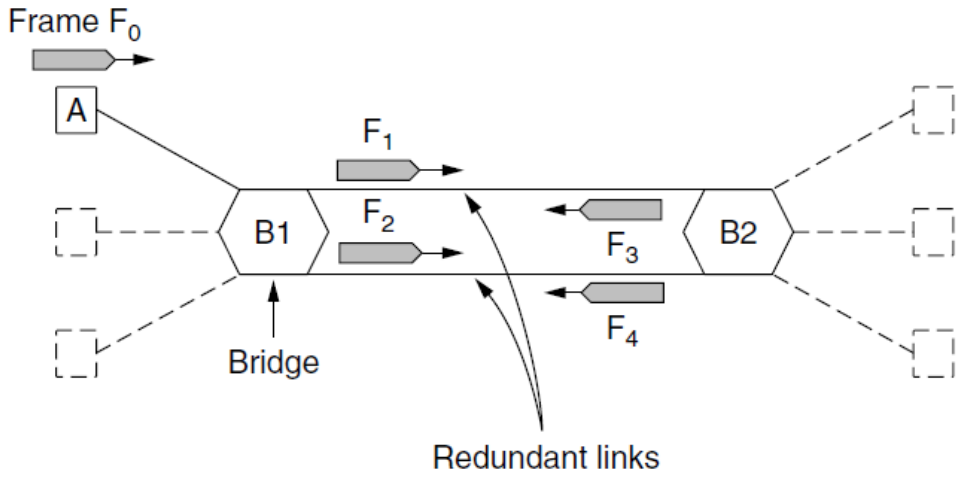
- Some pictures used in this presentation were obtained from the Internet
- The instructor used the following references
  - Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, 5th Edition, Elsevier, 2011
  - Andrew S. Tanenbaum, Computer Networks, 5th Edition, Prentice-Hall, 2010

Loops in Extended LAN

- Bridge topologies can have with loops
- Created unintentionally
  - No one knows the entire topology of the network …
  - Not everyone has knowledge of what is NOT supposed to be done
- Created intentionally
  - To provide redundancy in case of failure

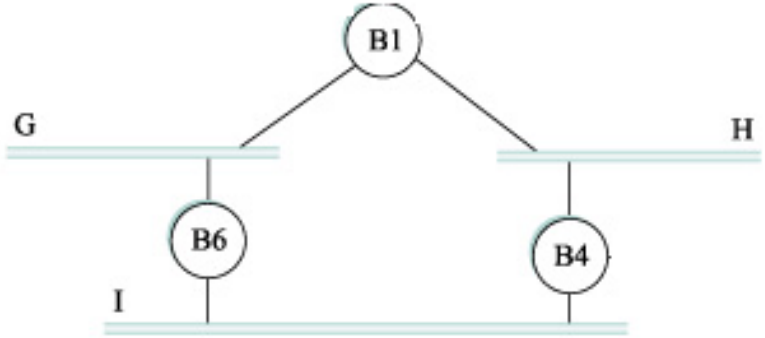
Problem in Extended LAN

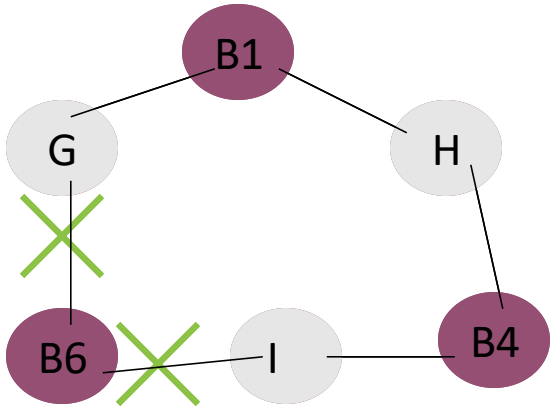
- Frames may circulate forever in bridge topologies with loops



An Extended LAN with Loops

- 3 bridges: B1, B4, and B6
- 3 LANs: G, H, and I
- Q: Can you draw its corresponding graph? (bridges/LANs as nodes, links as edges)?



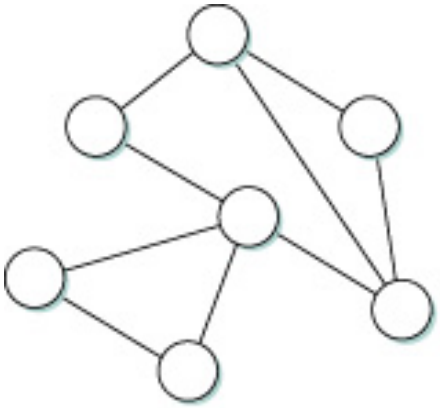


Q: How to break up the loops? → find "spanning tree"
Q: What bridges should do then? → stop forwarding to corresponding ports

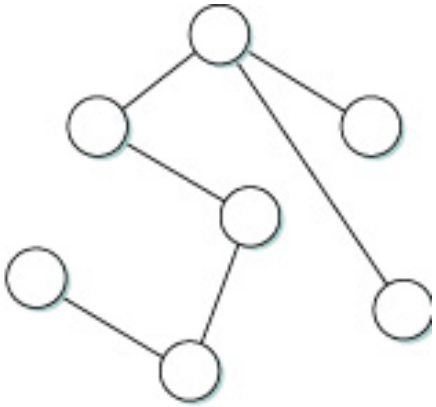
Spanning Tree

- Spanning tree: A spanning tree of an undirected graph of *n* nodes is a subgraph of a set of $n - 1$ edges that connects all nodes.
  - A tree is a simple, undirected, connected, acyclic graph
  - A connected graph with n nodes and n-1 edges is a tree.
  - A graph is connected if there is a path from any point to any other point in the graph.
  - A graph G is a pair (V,E), where V is a set of vertices, and E is a set of edges between the vertices $E \subseteq \{\{u,v\} \mid u, v \in V\}$

Spanning Tree: Example



A Graph

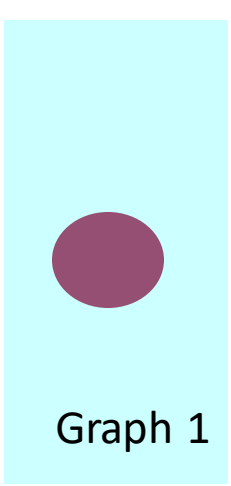


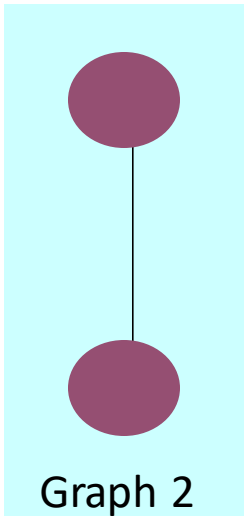
A spanning tree of the Graph

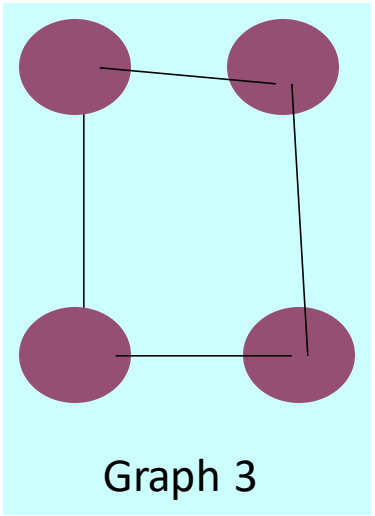
Exercise 1

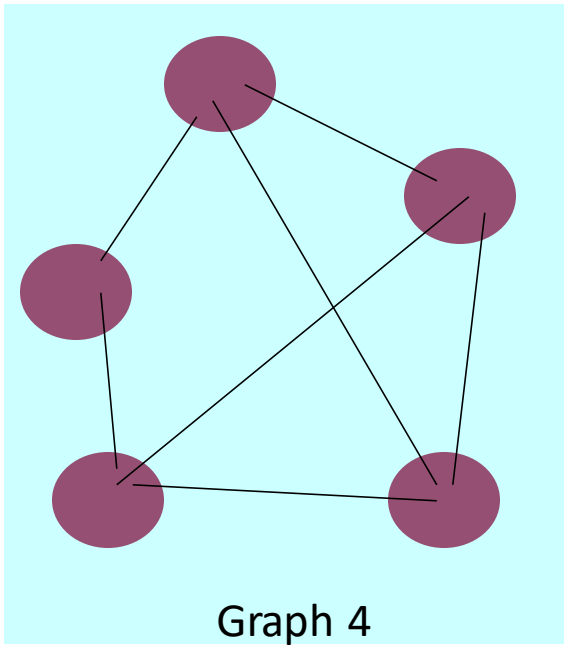
- Question
  - Indicate whether a spanning tree exists for each graph in next slide
  - Depict a spanning tree for each of the following graphs if it exists

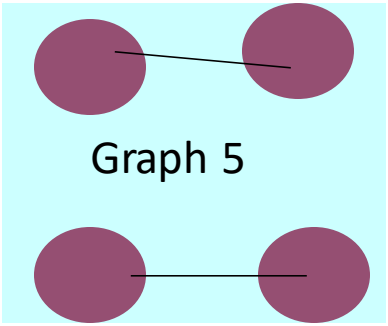
Exercise 2











Spanning Tree Algorithm for Extended LAN

- A distributed algorithm selects a subset of forwarding ports for forwarding frames to avoid loops
  - A spanning tree consists of selected ports (graph edges) and bridges & networks (graph vertices)
- Developed by Radia Perlman, 1985

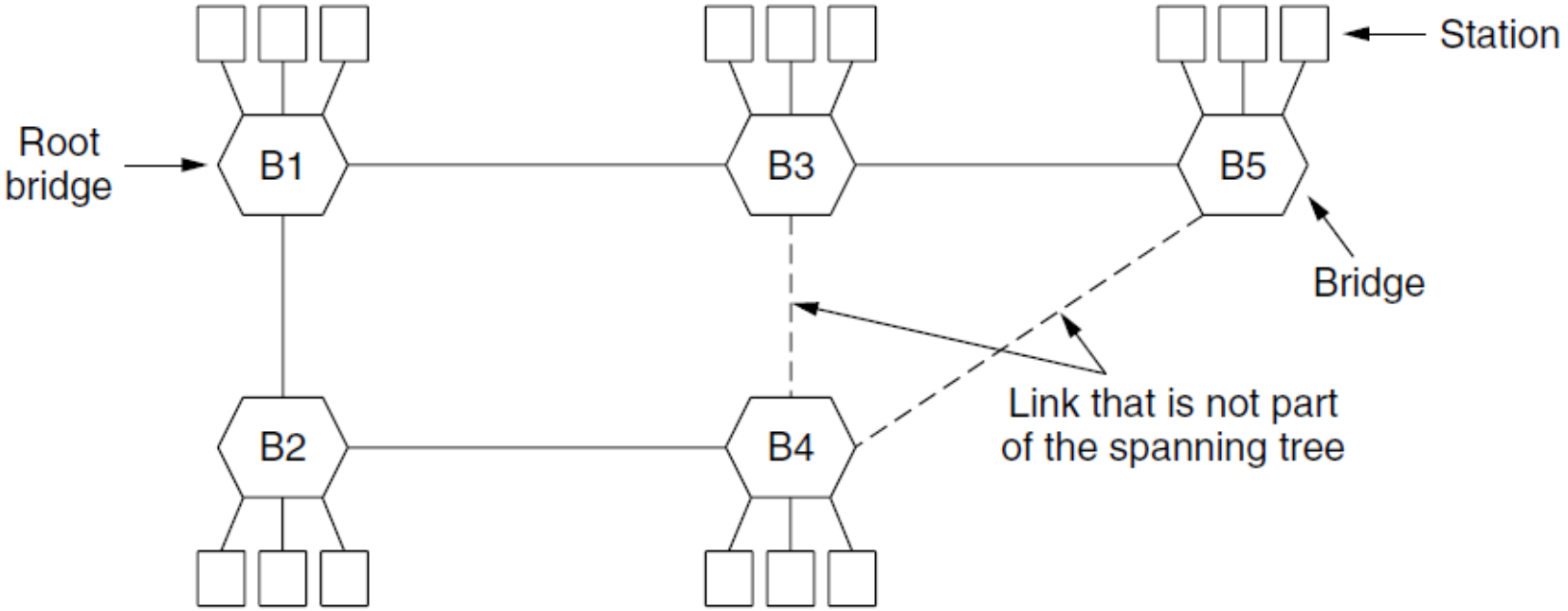
In Her Own Words

I think that I shall never see
A graph more lovely than a tree.
A tree whose crucial property
Is loop-free connectivity.
A tree which must be sure to span.
So packets can reach every LAN.
First the Root must be selected
By ID it is elected.
Least cost paths from Root are traced
In the tree these paths are placed.
A mesh is made by folks like me
Then bridges find a spanning tree.

– Radia Perlman, 1985.

Spanning Tree Algorithm: Example

- Starting from an extended LAN as follows,



Questions

- Extended LANs can have loops (intentionally or unintentionally)
- What problem do the loops cause in extended LANs?
- What is the solution? What is it based on?