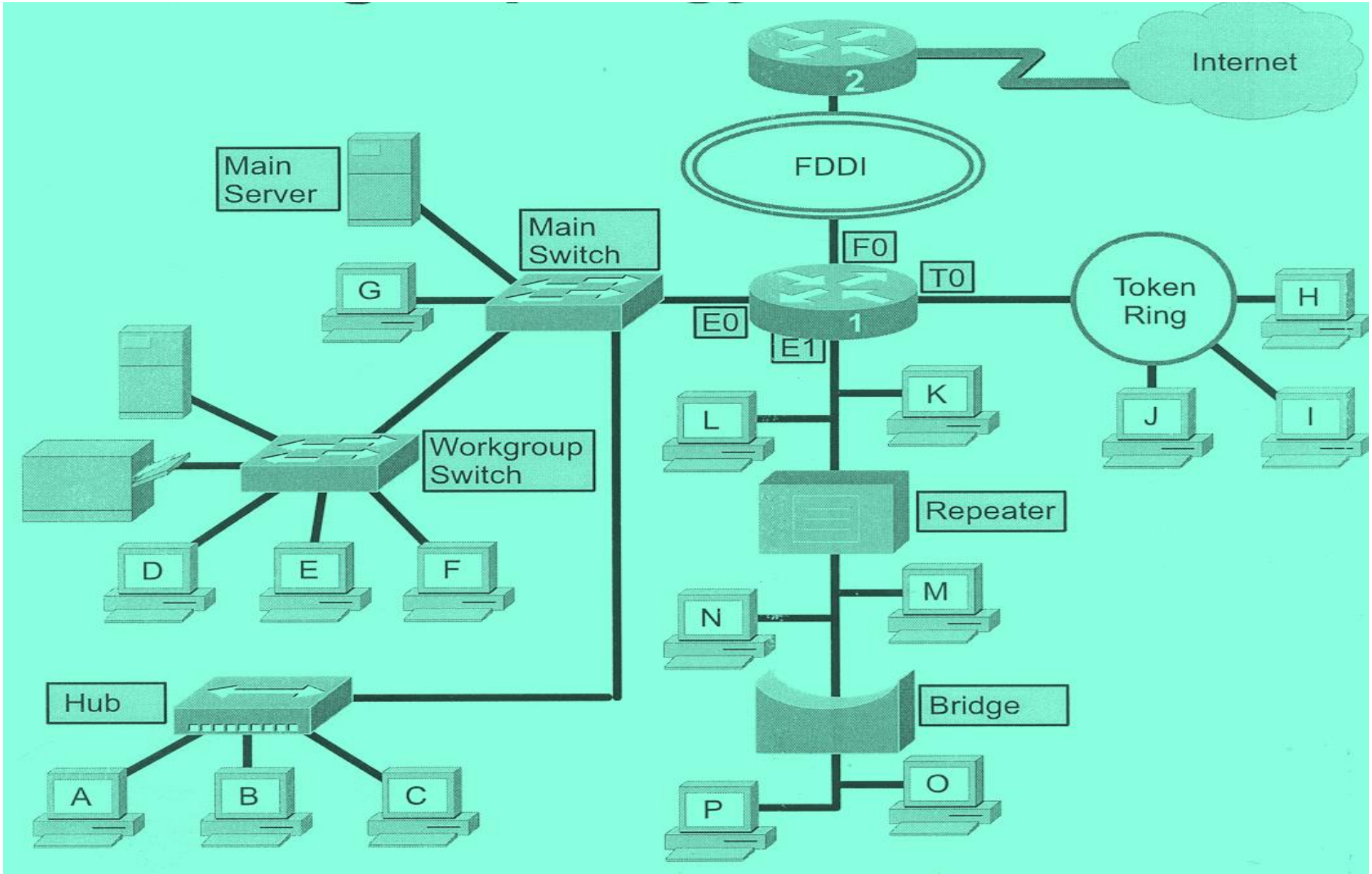
LAN Interconnection

– different interconnecting devices, many approaches



Need for ability to expand beyond single LAN; appears concept of **Extended LAN**, extending the number of attached stations and maximum allowed distance between them

Provide interconnection to other LANs/WANs

Remember:

Repeater: regenerate and retime network signals at the bit level to allow them to travel a longer distance on the media

Hub: regenerate and retime network signals; process known as concentration; known as a multi-port repeater; use of a central connection point for the wiring media will increase the reliability of the network.

Bridge - a Layer 2 device designed to connect two LAN segments; filter traffic on a LAN, keep local traffic local, allow connectivity to other parts (segments) of the LAN for traffic that has been directed there

Switch - a Layer 2 device just as a bridge is; called a multi-port bridge

Router - work with that is at the OSI network layer; make decisions based on groups of network addresses (Classes), as opposed to individual Layer 2 MAC addresses

Hub

Bridge

Switch

Routers

Bridges

Use Bridge or Router, but bridge is simpler (operates at Data Link level)

- Connects similar LANs
- Identical protocols for physical and data link layers
- Minimal processing

Router more general purpose: interconnect various LANs and WANs, level 3 device

Why Bridge?

Reliability – not an unique big LAN for that enterprise, but a set of small. Self contained units

Performance – avoid performance problem given by an increased number of stations

Security – may keep separately different kinds of traffic

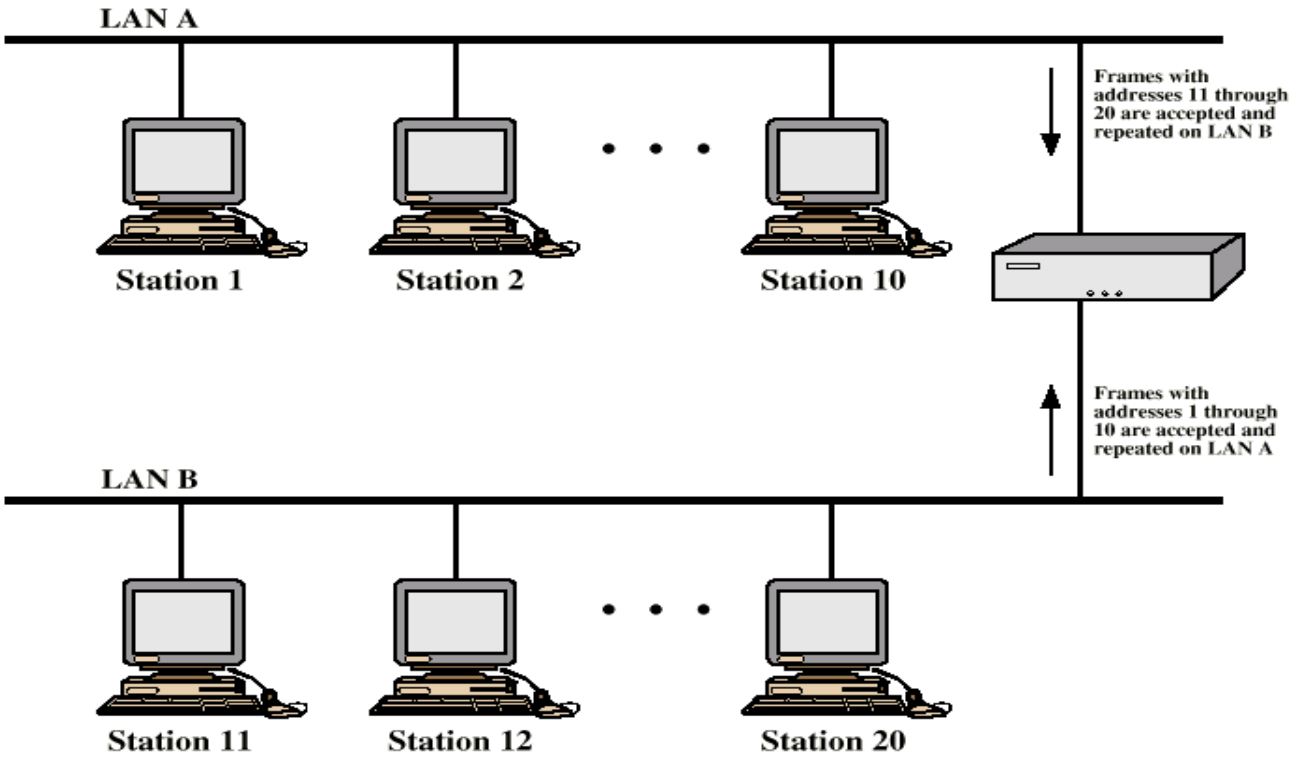
Geography – may interconnect geographically separated LANs

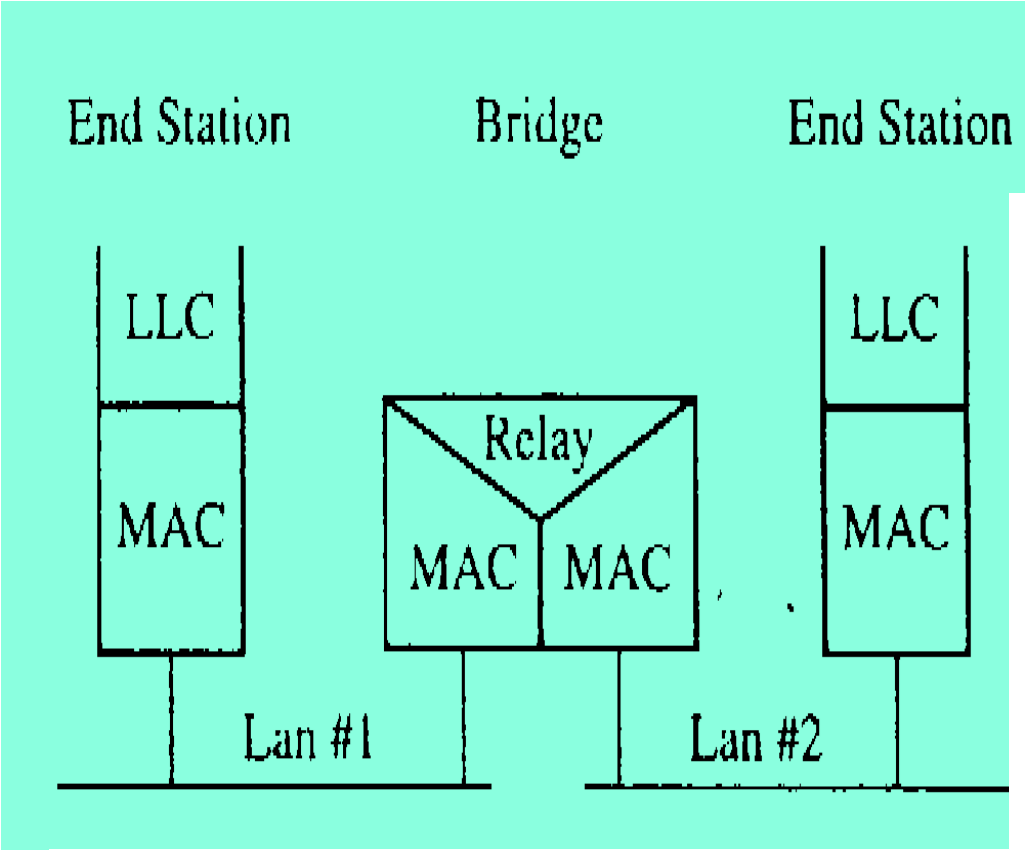
Two types of bridges:

transparent bridge – IEEE standard; operates in promiscuous mode, use of addressing tables

source-routing bridge – proposed by IBM's Token Ring, follows the route imposed by the source station

Bridge Operation





Bridge as protocol converter

Characteristics of a Transparent Bridge

Read all frames transmitted on one LAN, and accept those address to any station on the other LAN

Using MAC protocol for second LAN, retransmit each frame; acts as a **protocol relay**

Do the same the other way round

No modification to content or format of frame, no more encapsulation

Exact bitwise copy of frame

Minimal buffering to meet peak demand

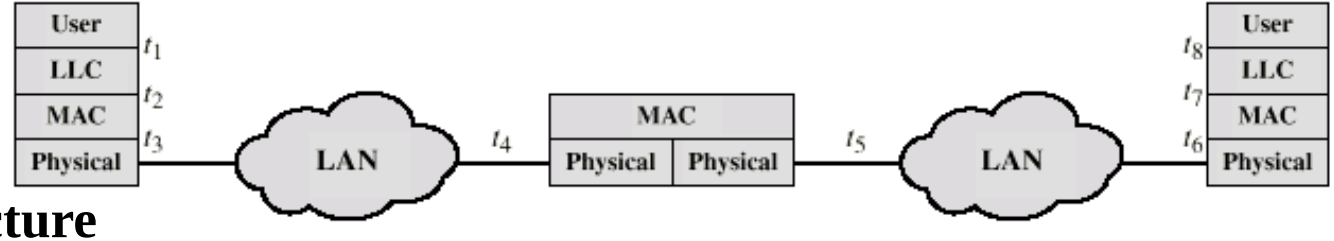
Contains routing and address intelligence

- Must be able to tell which frames to pass
- May be more than one bridge to cross

May connect more than two LANs

Bridging is **transparent** to stations

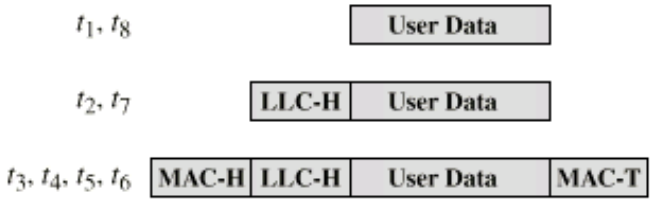
- Appears to all stations on multiple LANs as if they are on one single LAN



(a) Architecture

Bridge Protocol Architecture

IEEE 802.1D standard



(b) Operation

MAC level

Station address is at this level

Bridge does not need LLC layer

It is relaying MAC frames

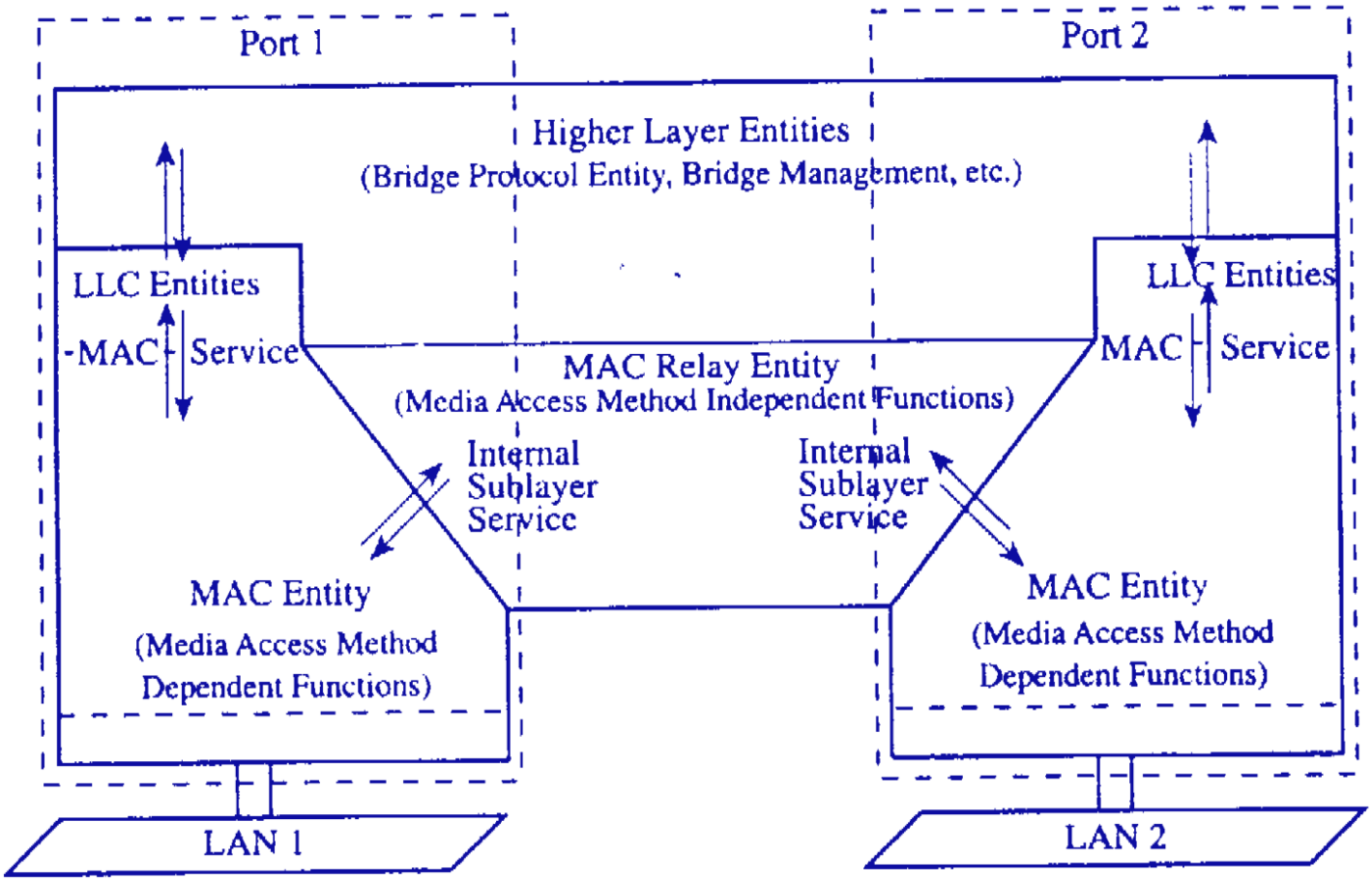
Can pass frame over external comms system (WAN link)

Capture frame

Encapsulate it

Forward it across link

Remove encapsulation and forward over LAN link



Bridge Architectural Structure

Fixed Routing

Complex large LANs need alternative routes

- Load balancing
- Fault tolerance

Bridge must decide whether to forward frame

Bridge must decide which LAN to forward frame on

Routing selected for each source-destination pair of LANs

- Done in configuration
- Usually least hop route
- Only changed when topology changes

Spanning Tree

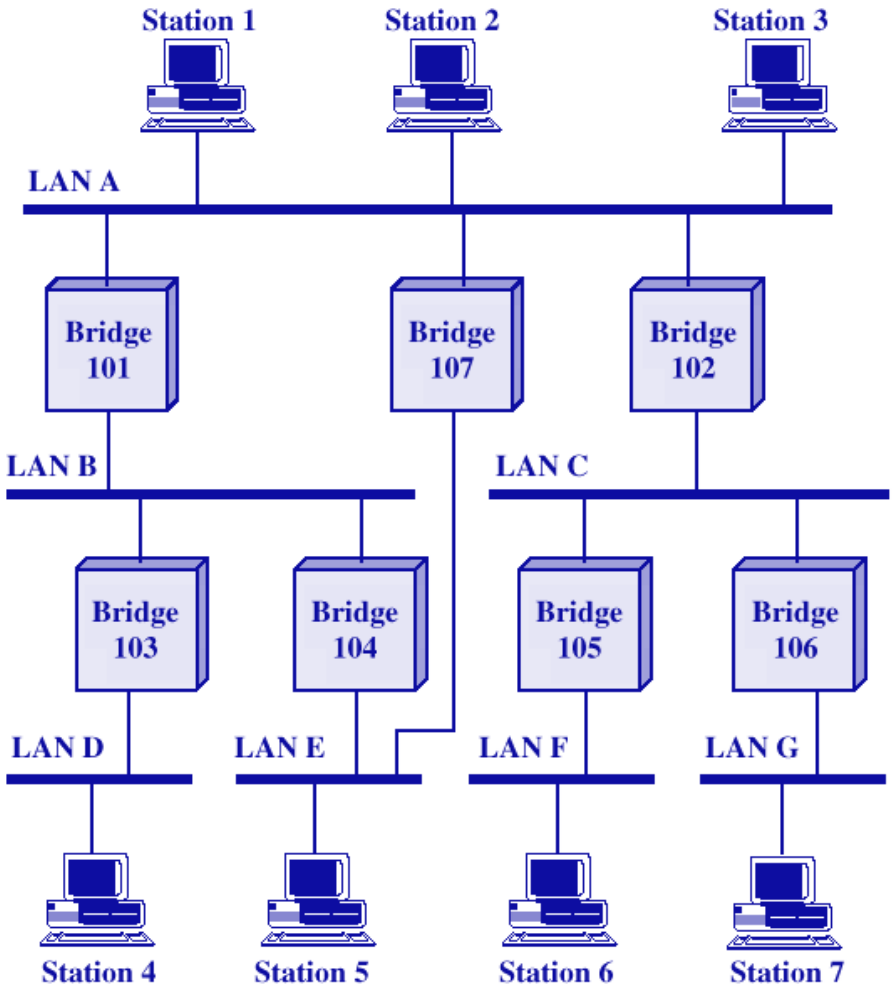
Algorithm used for:

Automatically develop **routing table**

Automatically update in response to changes

Bridge Operations:

- Frame forwarding
- Address learning
- Loop resolution



Frame forwarding

Maintain forwarding database for each port

List station addresses reached through each port

For a frame arriving on port X:

Search forwarding database to see if MAC address is listed for any port except X

If address not found, forward to all ports except X

If address listed for port Y, check port Y for blocking or forwarding state

Blocking prevents port from receiving or transmitting

If not blocked, transmit frame through port Y

Address Learning

Can preload forwarding database

Can be learnt

When frame arrives at port X, it has come form the LAN attached to port X

Use the source address to update forwarding database for port X to include that address

Timer on each entry in database

Each time frame arrives, source address checked against forwarding database

Loop Resolution

Use of **Spanning Tree Algorithm**

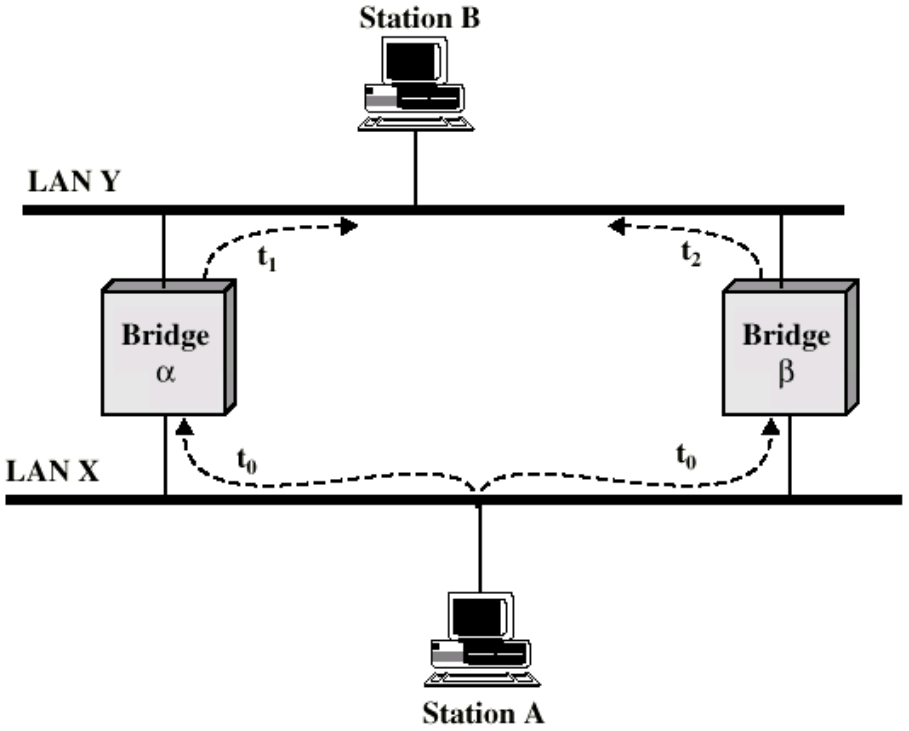
Address learning works for tree layout

i.e. no closed loops

THEORY: For any connected graph there is a spanning tree that maintains connectivity but contains no closed loops

Each bridge assigned unique identifier

Exchange between bridges of Configuration Bridge PDUs, to establish spanning tree (every 2 seconds).



IEEE 802.1d Spanning-Tree Protocol

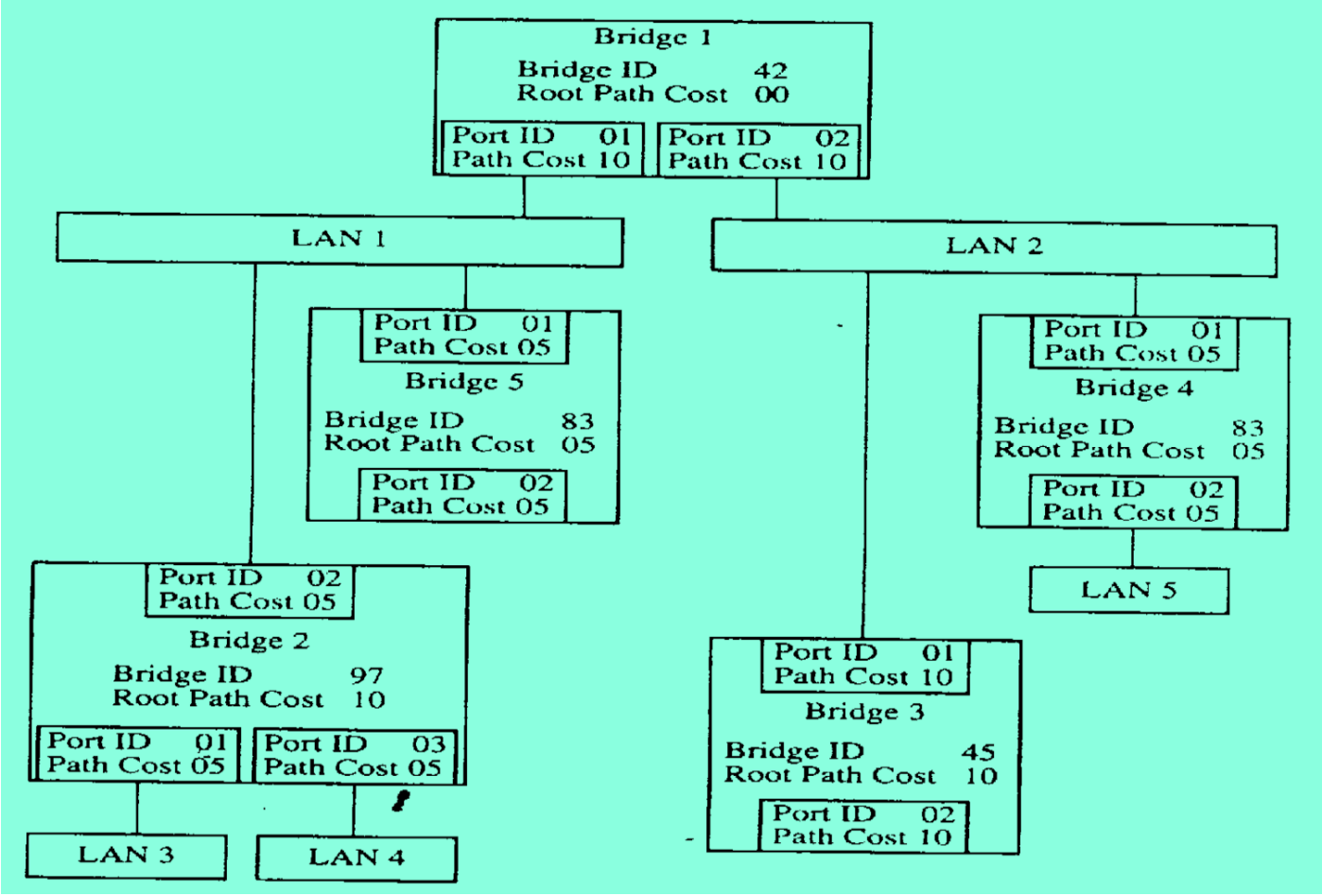
Root BID	Root Path Cost	Sender BID	Port ID

BPDU message structure

7	6	5	4	3	2	1	0
Bridge Priority		MAC address					

BID structure

Spanning-tree algorithm used to configure the extended-LAN: sample of bridge IDs and associated costs



Link Speed	Cost
10Mbps	2000000
100Mbps	200000
1Gbps	20000
10Gbps	2000
1Tbps	20
10Tbps	2