Extending the reach of LANs

- Where there is a need to *extend* or *interconnect* LANs three devices can be used:
  - *Repeaters:*
    - Used to interconnect *identical* LANs i.e. LANs using the same MAC protocols (e.g. conforming to IEEE 802.3 **or** 802.5 etc.).
    - Repeaters do not process frames.
  - *Bridges*:
    - Used to interconnect LANs that use similar or different MAC protocols (e.g. IEEE 802.3 **and/or** 802.5 etc.).
    - Bridges do process frames.

Extending LANs - contd.

- *Routers*: Similar to bridges but with extra functionality i.e. used to interconnect *different* LAN technologies. To be examined later under the topic *Internetworking*

Bridges

- Bridges facilitate the interconnection of **small** LANs to create **one** large LAN:
  - This is preferable to creating a single large LAN.
- Advantages of using small *interconnected* LANs:
  - *Reliability*: The effects of a fault can be contained and restricted to only a few stations.
  - *Performance*: Smaller LANs provide better performance to locally attached devices. This ties in with the *Principal of Locality of Reference*:
    - The *majority* of traffic is often between locally connected stations.

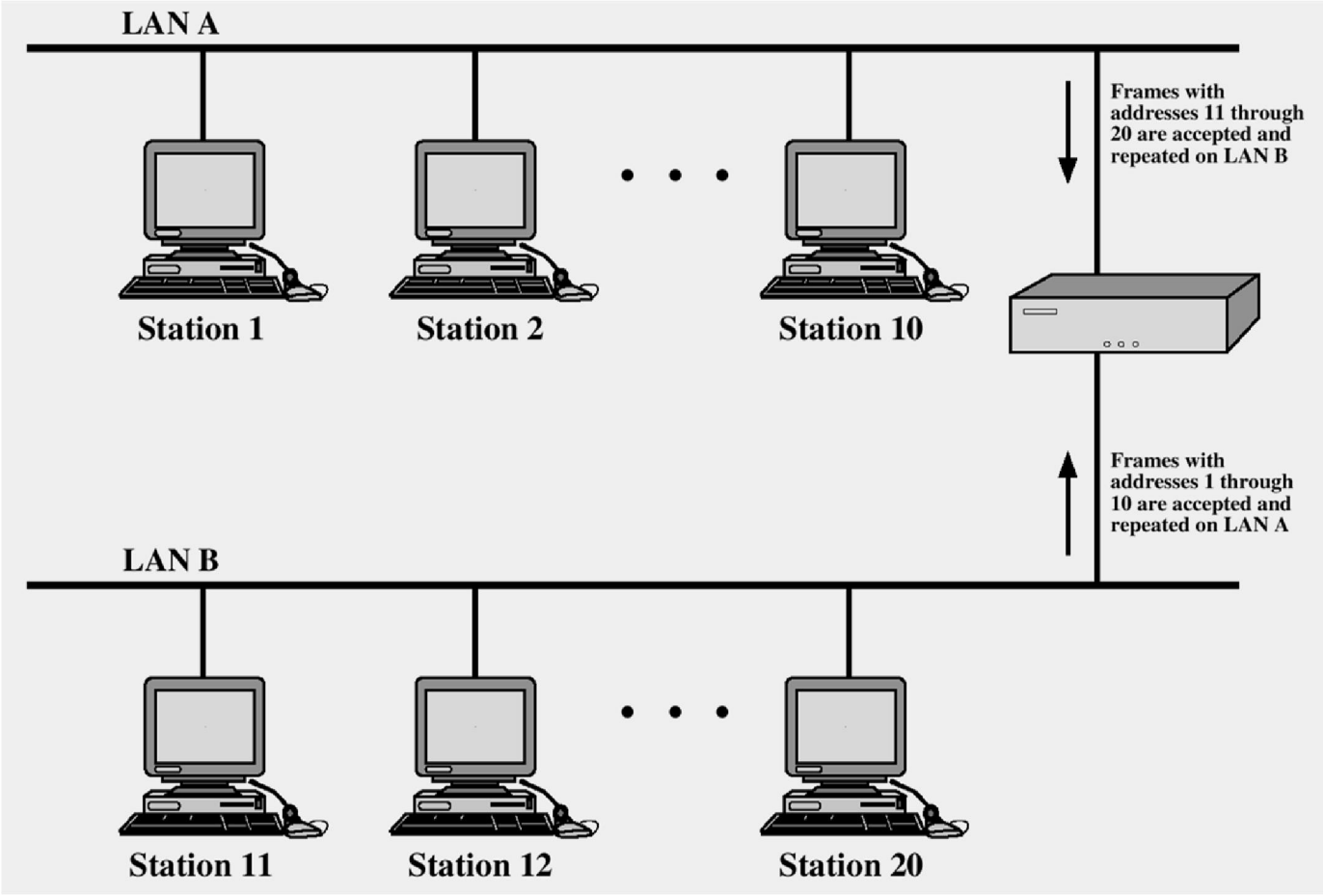
Bridges – contd.

- *Security*: With some LAN topologies such as Bus and Wireless LANs all stations can potentially see all frames. The use of a Bridge facilitates the *physical* isolation of high security traffic and users with special security access.
- *Geography*: It facilitates extending a LAN to isolated clusters of stations using long distance communications links e.g. microwave links, satellite links etc.

◆ The following slide shows a typical implementation of a Bridge connecting two LANs:

- However, Bridges can interconnect more LANs.

Bridge Implementation



Functions of a Bridge

- Bridges that understand only one frame format are sometimes called *MAC Relay Bridges.* These provide the following functionality:
  - *Store and Forward*:
    - Operating in *promiscuous mode* a Bridge reads all frames transmitted on one LAN.
    - It retransmits frames to an outgoing port to which another LAN is connected only if the destination station is on that LAN.
    - The retransmission is done without modification to the frame i.e. *bit-by-bit.*
    - This function is performed in both directions.
  - *Routing and Addressing*:
    - Not all frames are copied. Only those relevant to a particular LAN segment are copied. This implies a **routing** capability.

Functions of a Bridge

- The use of a bridge does not affect how stations communicate with each other:
  - *MAC addresses* are used for routing frames between stations connnected to the same bridged network.
- The routing decision that a Bridge uses to decide if a frame should be forwarded onto another LAN depends on the *routing strategy* employed.
- There are two *routing strategies* to consider:
  - *Fixed routing.*
  - *Address Learning.*

Fixed Routing Strategy

- Fixed routing:
  - For each pair of *source-destination* station a route is created in a *routing table* stored on the bridge.
  - Based on the destination address in a received MAC frame the bridge performs a lookup of the routing table to determine if the frame is to be forwarded.
- Advantages/Disadvantages of *fixed routing*:
  - *Simplicity.* Requires minimal processing overhead. However, this can become very complicated if multiple bridges are used.
  - Requires a lot of manual intervention when more stations/bridges are added or removed.

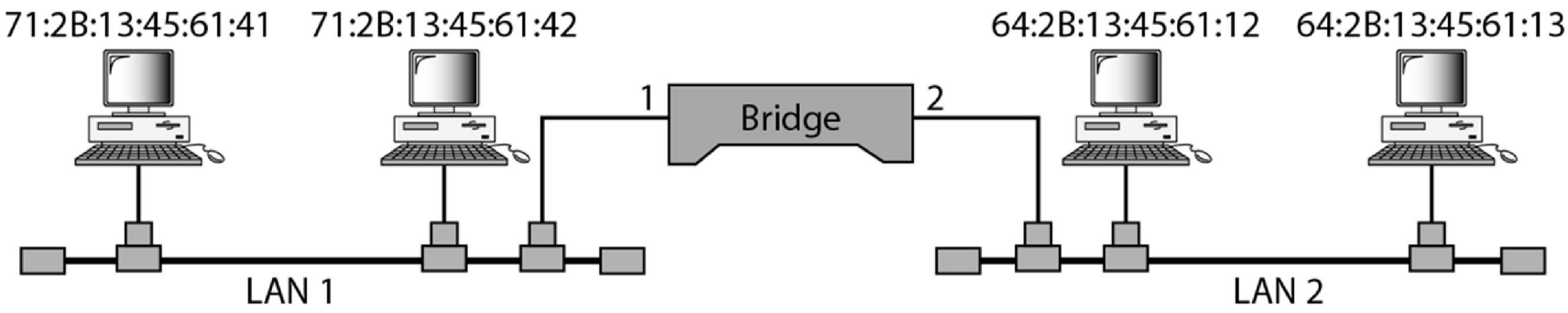
Address Learning Routing Strategy

- *Address Learning* is an alternative approach to routing.
- Here the Bridge can *learn* the location of each station automatically because:
  - Each incoming MAC frame contains a *source address* field.
  - Each LAN attaches to one *port* only.
- Using both of these pieces of information (*source address* and *port number*) the bridge constructs a *routing table* by itself i.e. without manual intervention.

Example Bridge Routing Table

Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	1
64:2B:13:45:61:12	2
64:2B:13:45:61:13	2

Bridge Table



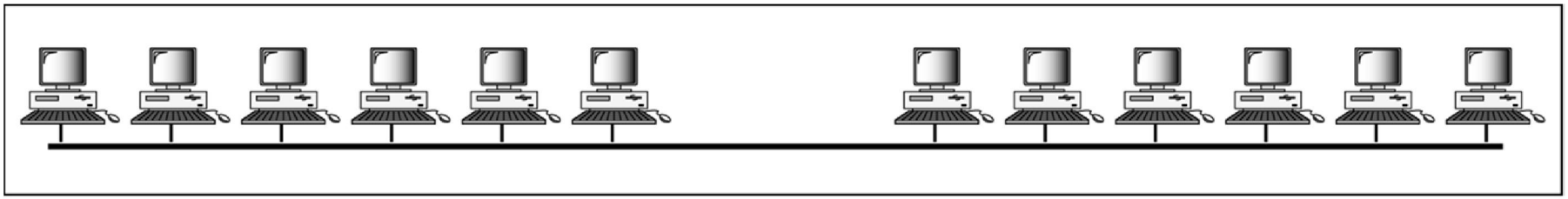
Address Learning Routing Strategy

- Address learning starts at boot-up time :
  - Initially the routing table is empty.
  - As MAC frames arrive on any of the incoming ports the Bridge constructs the routing table using the source MAC address/source port information.
- After a period of time known as the ***steady-state*** period the table is complete:
  - ***Frame filtering*** can commence in earnest.

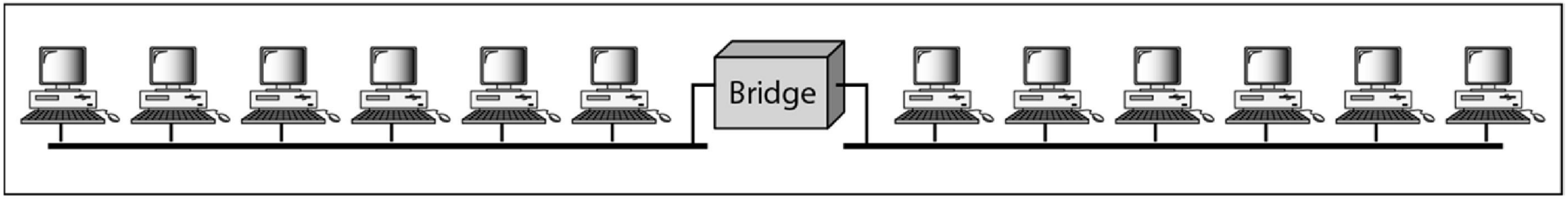
Advantages of using Bridges

- Advantages of using bridges are as follows:
  - *Parallelism*: Not every frame arriving at the bridge is copied to another LAN:
    - This allows for two pairs of stations to communicate simultaneously provided each pair is on a separate LAN and separated by a bridge.
  - *Optimized performance*:
    - Stations that are likely to communicate with each other frequently can be moved to the same LAN to ensure adherence to the *Prinicipal of Locality of Reference.*
    - *Collision Domains* are smaller reducing the likelihood of collisions occurring.

Optimized performance and *Parallelism*



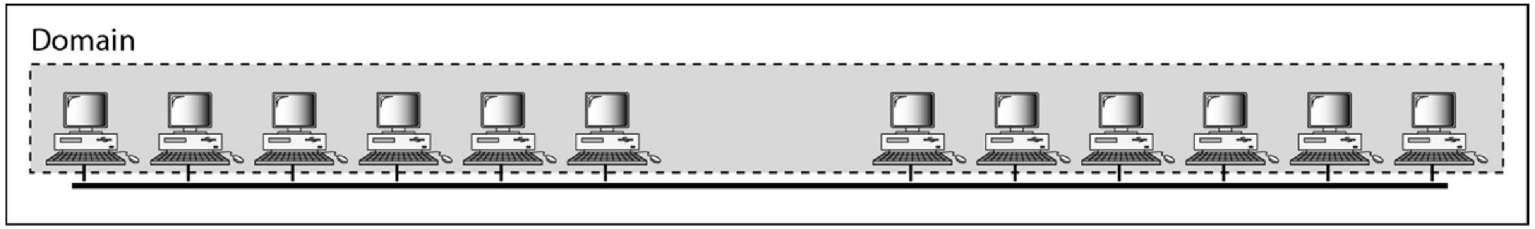
a. Without bridging



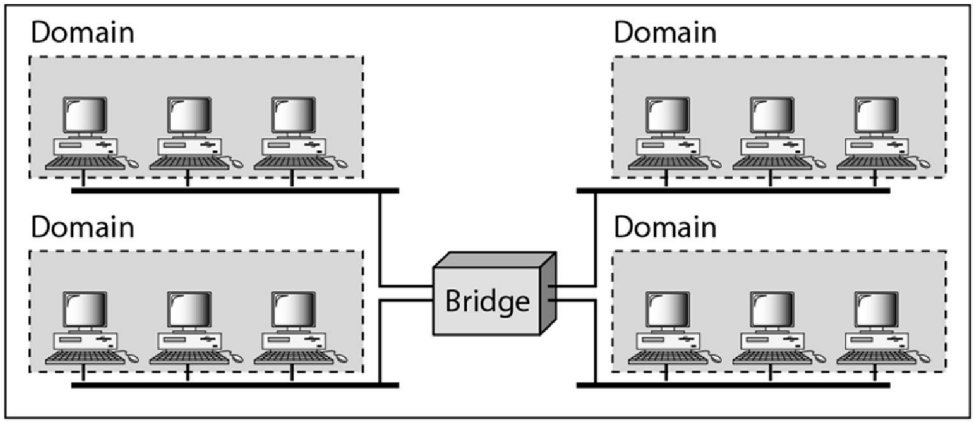
b. With bridging

- Without bridging each station perceives the speed of the LAN as:
  - (LAN Data Rate) / (number of stations).
- This is significantly improved with bridging.

Collision Domains are reduced in size



a. Without bridging



b. With bridging

- With bridging the size of the collision domain is reduced and contention is therefore reduced.

Summary of Bridges

- Used to extend LANs:
  - Facilitates the implementation of small *interconnected* LANs rather than one single large LAN.
- Can connect LANs using same or different MAC protocols.

Summary of Bridges - contd.

- Contains *Routing* functionality to *filter* frames:
  - This facilitates *parallelism* which in turn improves *performance* of each connected LAN
  - Also, collisions are not copied between LANs which reduces the Collision Domain and improves contention ratio.
- Contains *Store and Forward* functionality:
  - Facilitates connecting fast, busy LANs to slow LANs.