



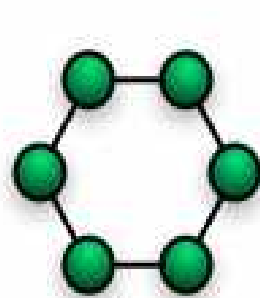
# Network Topology

# What is topology

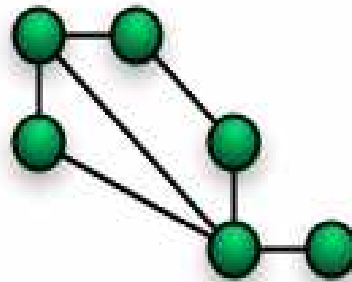
physical topology dari suatu network mengacu pada konfigurasi kabel-kabel, komputer-komputer, dan peripheral lainnya.

macamnya

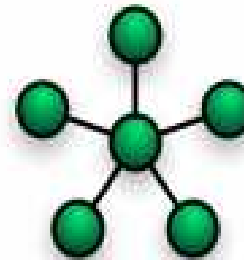
- Ring
- Mesh
- Bus
- Star
- Tree



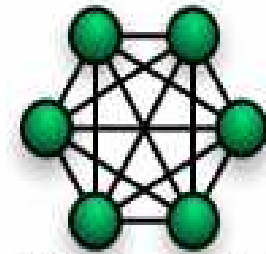
Ring



Mesh



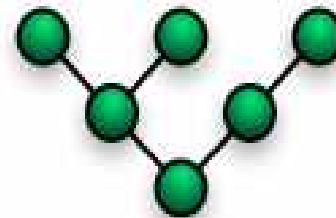
Star



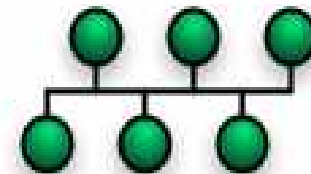
Fully Connected



Line

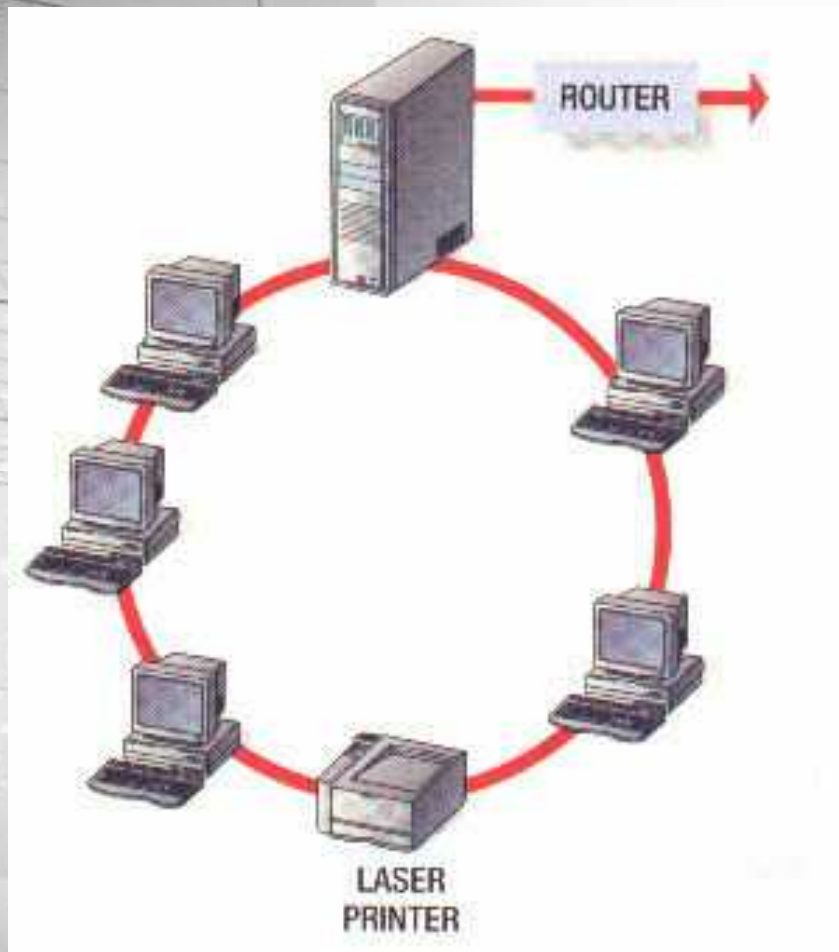


Tree



Bus

# Ring



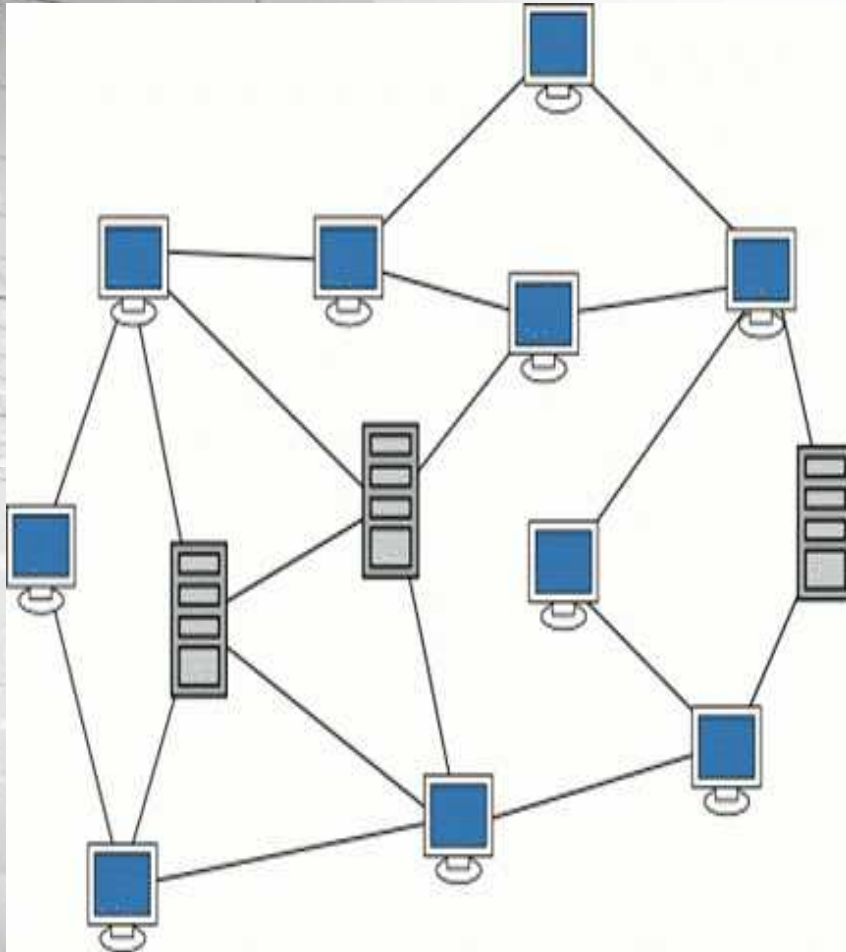
## Advantages

- Lebih bagus dibanding star pada jaringan yang padat

## Disadvantages

- Error di satu node dapat mempengaruhi yg lain
- Memindah, menambah, dan mengubah node dapat berpengaruh pada network
- Alat-alatnya lebih mahal

# Mesh



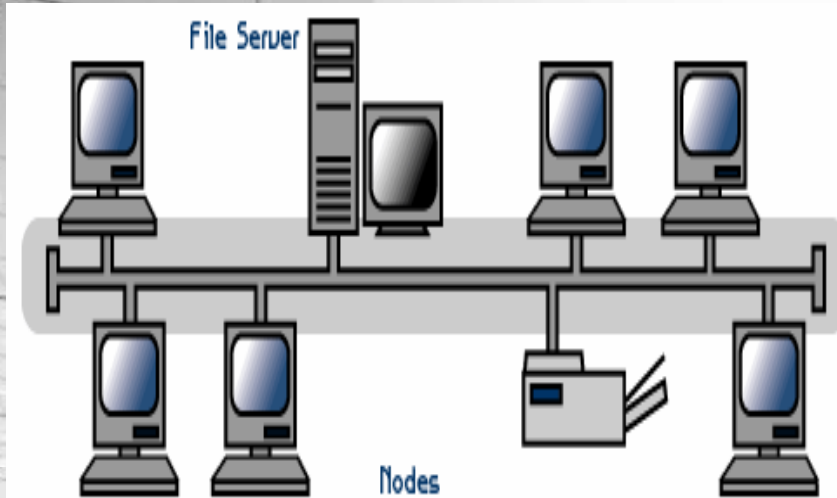
## Advantages:

- bersifat "self-healing"  
– jika ada node yang rusak, dapat mencari jalan sendiri
- Relatif tidak mahal untuk area yang luas

## Disadvantages:

- routing untuk traffic menjadi sulit
- Tidak ada central infrastructure

# Bus



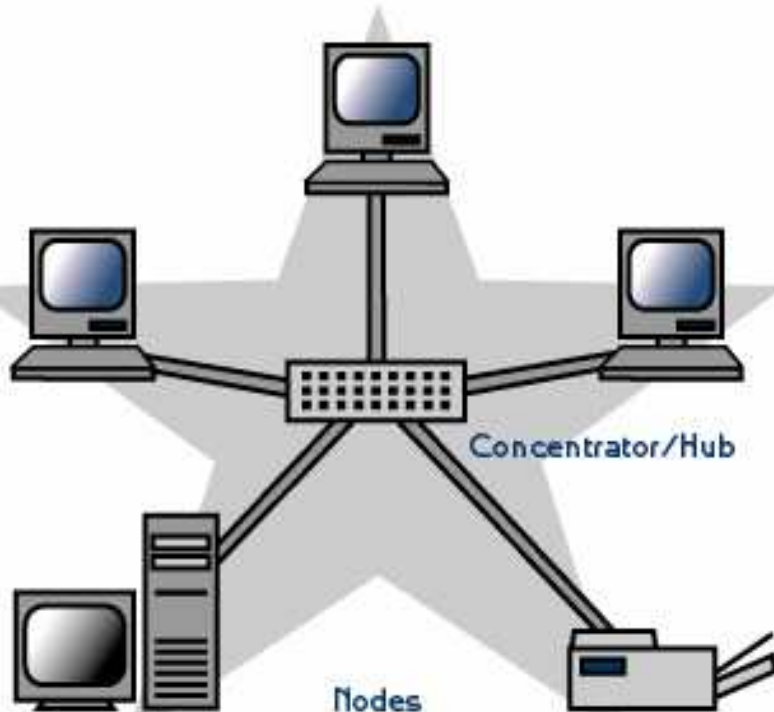
## Advantages:

- mudah mengkoneksi computer dan peripheral lain.
- Memerlukan lebih sedikit kabel dripada star

## Disadvantages:

- jika kabel utama rusak, seluruh network rusak
- Sulit untuk mendeteksi kerusakan apabila terjadi problem pada suatu node

# Bus



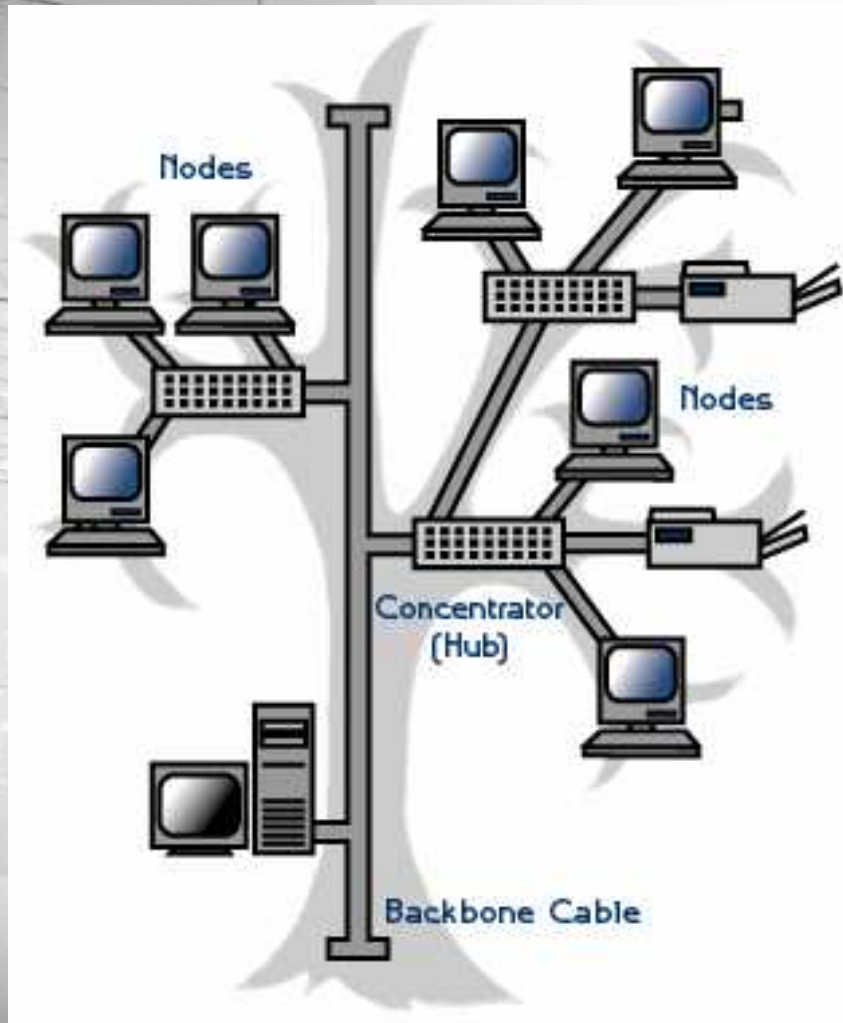
## Advantages:

- Mudah dalam instalasi dan Cabeling.
- Tidak ada gangguan untuk network saat ada tambahan/pengurangan node
- Mudah mendeteksi problem pada node

## Disadvantages:

- Lebih banyak membutuhkan kabel.
- Jika hub rusak, seluruh jaringan rusak
- Lebih mahal daripada bus, karena harus beli concentrator.

# Tree



## Advantages:

- Adanya segmentasi
- Support bagus dari banyak vendor software/hardware

## Disadvantages:

- Jika backbone line rusak, seluruh segment ikut down.
- paling sulit dalam konfigurasi dan cablingnya.

## Which one? Consider this

---

- **Money.**  
bus lebih murah karena tidak perlu beli concentrator.
- **Length of cable needed.**  
bus membutuhkan kabel yang lebih pendek
- **Future growth.**  
star lebih mudah untuk dikembangkan untuk kebutuhan penambahan node
- **Cable type.**  
tipe kabel yang paling umum adalah UTP yang digunakan pada star

## Ethernet and IEEE 802.3

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- Ethernet adalah LAN protocol yang dikembangkan oleh kerjasama Xerox, Intel , dan DEC, tahun 1970 an
- Sebelumnya Norman Abramson dari Universitas Hawaii 1960-1970 mengembangkan ALOHA untuk menghubungkan jaringan antar kampus di Hawaii. Bedanya ALOHA tanpa ada pengecekan node saat mengirim data apakah ada node lain yg mengirim data dan tidak ada prosedur pendeteksian collision yg menyebabkan seringnya retransmission.
- Pada awal 80an dikeluarkanlah vendor standar untuk ethernet : Ethernet Blue Book. Yang mendeskripsikan bagaimana ethernet di develop dan diimplementasikan. Dan tahun 1982 keluar Ethernet version 2.0

# Ethernet and IEEE 802.3

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- IEEE membuat juga standar yang hampir sama dengan Ethernet v2.0 dengan mengembangkan IEEE 802.3.
- Perbedaan mendasar antara keduanya : Ukuran kabel, Fungsi Transceiver, Frame Format, dan Topology
- Ukuran Kabel : Ethernet v20 : 0.395 inch, IEEE 802.3 0.405 inch.
- Fungsi transceiver: Pada IEEE 802.3 terdapat 'detak jantung' yang menandakan transceivernya 'hidup'.
- Frame Format : bagian frame 'tipe' pada Ethernet diganti fungsi menjadi panjang data dan tipe masuk ke MAC dan LLC. Kalau 2 perbedaan sebelumnya dapat diatasi agar jadi sama, perbedaan ini yang paling membuat Ethernet v.20 dan IEEE 802.3 tidak compatible.
- Topology : Ethernet hanya bisa bus, IEEE bus dan Star.

## Ethernet and IEEE 802.3

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- Pada akhirnya orang sering menyebut juga IEEE 802.3 sebagai ethernet. Dan antara IEEE 802.3 dan Ethernet menjadi bisa digabungkan dalam satu jaringan
- Alamat Ethernet/802.3 terdiri dari 48 bit yg direpresentasikan dalam 12 Hexsadesimal dan dibagi 2 bagian, 3 bytes pertama kode pabrik, sisanya adalah serial number. Contoh 08:00:20:01:D6:2A berarti diproduksi oleh 08:00:20 ( Sun Microsystem ) dengan nomor seri 01:D6:2A
- LAN berbasis IEEE ditulis dengan format :  
*Sig. Rate (Mbps)-Band (Base/Broad) - Length (M) /Cable Type*  
maka, 10-Mbps baseband LAN dengan kabel UTP ditulis sebagai 10BASE-T (T=twistedpairs)

# Ethernet/802.3 LANs

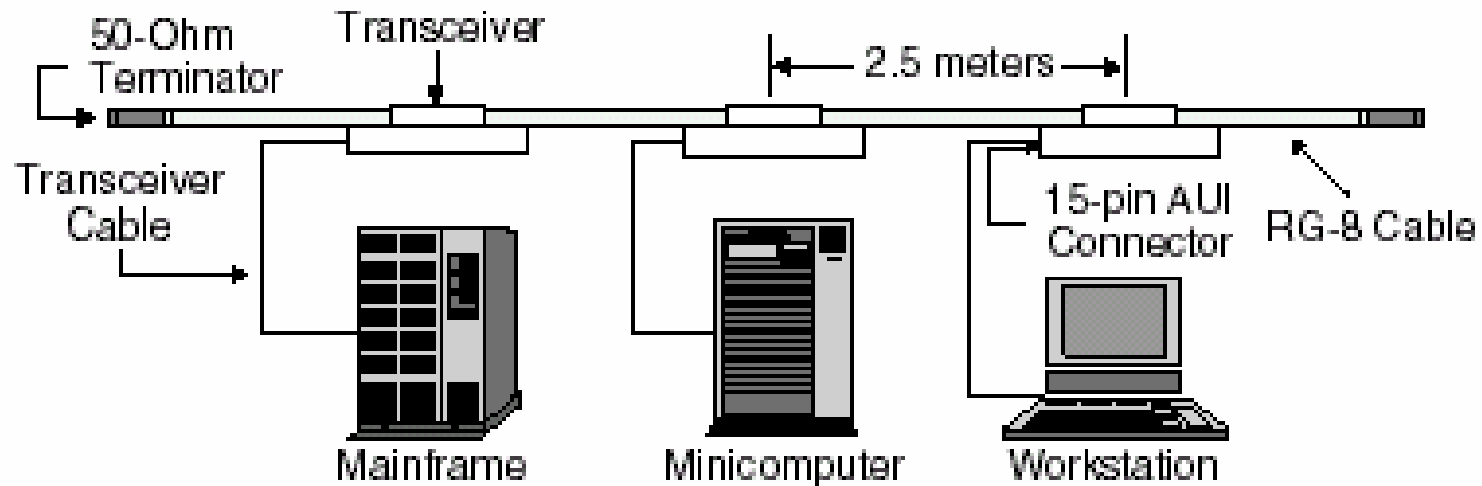


**FIGURE 9.1** IEEE 802.3 LANs are designated by bandwidth in Mbps, whether the LAN is baseband or broadband based, followed by either the type of cable it supports or its maximum length in meters.

**TABLE 9.1** Summary of IEEE 802.3 Specifications for 10 Mbps Ethernet

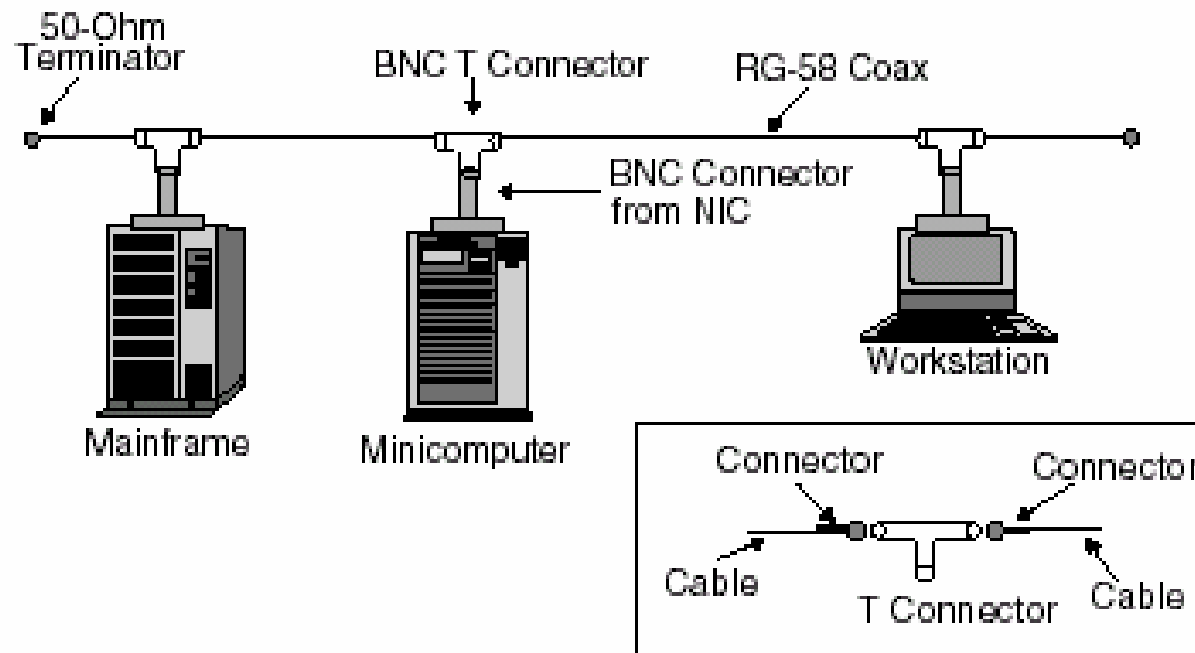
Type	Description
10BASE5 ThickWire	<b>Cable:</b> Thick Coax (RG-8); <b>Topology:</b> Bus; <b>Connectors:</b> Transceivers, transceiver cable, 15-pin AUI; uses “vampire” tap; <b>Maximum Segment Length:</b> 500m; <b>Maximum Nodes per Segment:</b> 100spaced in 2.5 m increments; <b>Maximum Diameter:</b> 2500 m; <b>Other:</b> 50-ohm termination at each end of cable; one end grounded to building ground
10BASE2 ThinWire	<b>Cable:</b> Thin Coax (RG-58); <b>Topology:</b> Bus; <b>Connectors:</b> BNC; <b>Maximum Segment Length:</b> 185 m; <b>Maximum Nodes per Segment:</b> 30minimum 0.5 m between nodes; <b>Maximum Diameter:</b> 925 m; <b>Other:</b> 50-ohm termination at each end of cable; one end grounded to building ground
10BASE-T UTP Ethernet	<b>Cable:</b> Category 3, 4,or 5 UTP; <b>Topology:</b> Star; <b>Connectors:</b> RJ-45, patch panels, repeaters; <b>Maximum Segment Length:</b> 100 m; <b>Maximum Nodes per Segment:</b> 2; <b>Maximum Diameter:</b> 500 m; <b>Other:</b> Each node is connected directly or indirectly to a hub; indirect connections are via wallplates or patch panels
10BASE-FBb Fiber Backbone	<b>Cable:</b> Fiber; <b>Topology:</b> Point-to-point; <b>Connectors:</b> Fiber-optic transceivers, ST; <b>Maximum Segment Length:</b> 2000 m; <b>Maximum Nodes per Segment:</b> 2; <b>Maximum Diameter:</b> 2500 m; <b>Other:</b> Backbone-only technology used to interconnect Ethernet repeaters; maximum of 15 repeaters permitted; uses synchronous signaling to retime the optical signals for data transmissions
10BASE-FLb Fiber Link	<b>Cable:</b> Fiber; <b>Topology:</b> Point-to-point or star; <b>Connectors:</b> Fiber-optic transceivers, ST; <b>Maximum Segment Length:</b> 2000 m; <b>Maximum Nodes per Segment:</b> 2; <b>Maximum Diameter:</b> 2500 m; <b>Other:</b> Can be used to interconnect workstations or repeaters; maximum of five repeaters permitted; replaces fiber optic inter-repeater link (FOIRL); if 10BASE-FL is mixed with FOIRL, max segment length is 1000 m
10BASE-FPb Fiber Passive	<b>Cable:</b> Fiber; <b>Topology:</b> Star; <b>Connectors:</b> Fiber-optic transceivers, ST; <b>Maximum Segment Length:</b> 500 m; <b>Maximum Nodes per Segment:</b> 33; <b>Maximum Diameter:</b> 2500 m; <b>Other:</b> Used for small installations such as workgroup LANs; specifies a passive hub, which means it uses no electronics (including power) and hence is immune to external noise

# Ethernet/802.3 LANs



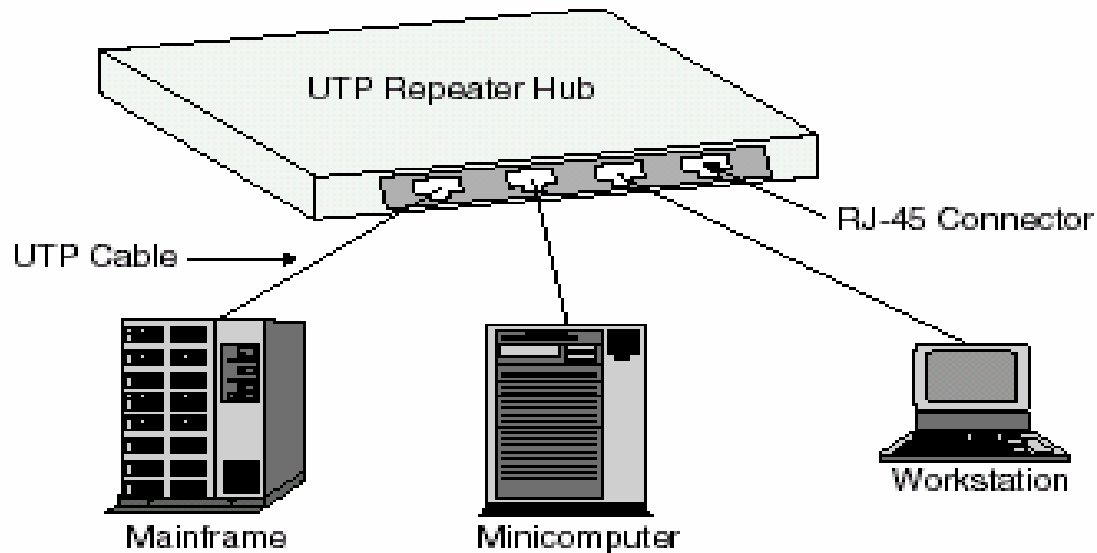
**FIGURE 9.2** Example of a **10BASE5** (ThickWire Ethernet) LAN. The topology is a bus configuration, the maximum length of a single segment is 500, and a single segment supports up to 100 nodes. Nodes are connected to the cable via transceivers and transceiver cable; transceivers are spaced 2.5 m apart to prevent signal interference. The actual physical connection of a transceiver involves drilling into the cable using a “vampire tap.” Each end of the cable is terminated with a 50-ohm resistor, and one end of the cable must be grounded.

# Ethernet/802.3 LANs



**FIGURE 9.3** Example of a **10BASE2** (ThinWire Ethernet) LAN. The topology is a bus configuration, the maximum length of a single segment is 185 m, and a single segment supports up to 30 nodes. Nodes are connected to the cable via BNC T connectors, which must be spaced at least 0.5 m apart to prevent signal interference. Each end of the cable is terminated with a 50-ohm resistor, and one end of the cable must be grounded. A segment is composed of several pieces of cable, with each piece being connected via a T connector (see inset).

# Ethernet/802.3 LANs



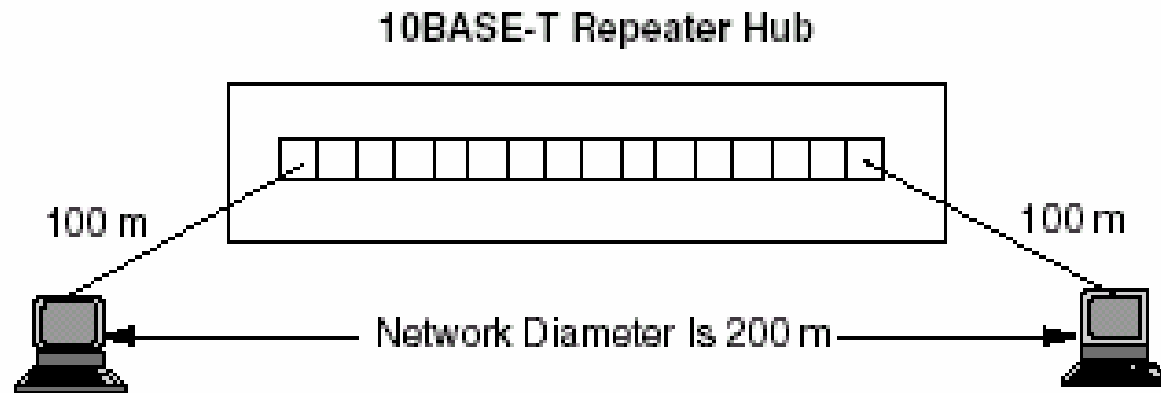
**FIGURE 9.4** Example of a typical **10BASE-T** (Twisted-Pair Ethernet) LAN. The topology is a star configuration, and the maximum length of a segment is 100 m. Note that only two nodes can be connected per segment—a workstation and a repeater. Both the hub and a device's network interface card (NIC) contain eight-pin modular (RJ-45) connectors. Cable can be Category 3, 4, or 5; higher grade cables provide better performance.

# Network Diameter dan Collision Domain

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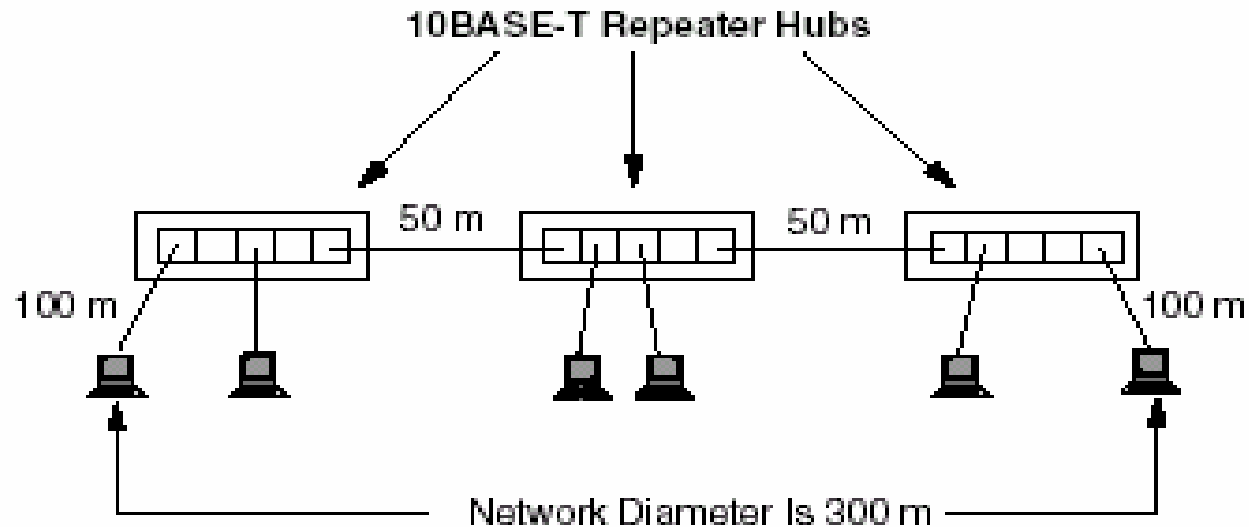
- Diameter di Ethernet/802.3 adalah panjang keseluruhan jaringan yang menghubungkan 2 node ter-ujung
- Diameter maximum dari Ethernet/802.3 adalah jarak maximum untuk sebuah Single Ethernet/802.3 LAN. Single berarti LAN yang terdiri dari satu segment atau banyak segment yang dihubungkan oleh repeater.
- Keterbatasan ini dapat diatasi dengan menambahkan devices : repeater, bridges, switch, dan router.

# Network Diameter dan Collision Domain



**FIGURE 9.6** A network diameter is the distance between the two remotest nodes of a network. In this illustration, we have a 10BASE-T LAN that can connect up to 16 nodes via a UTP repeater hub. If each node is connected to the hub with the maximum segment length permitted (100 m), then the network diameter is 200 m—100 m from sending node to repeater port plus 100 m from repeater port to receiving node

# Network Diameter dan Collision Domain



**FIGURE 9.6** A network diameter is the distance between the two remotest nodes of a network. In this illustration, we have a 10BASE-T LAN that can connect up to 16 nodes via a UTP repeater hub. If each node is connected to the hub with the maximum segment length permitted (100 m), then the network diameter is 200 m—100 m from sending node to repeater port plus 100 m from repeater port to receiving node

# Network Diameter dan Collision Domain

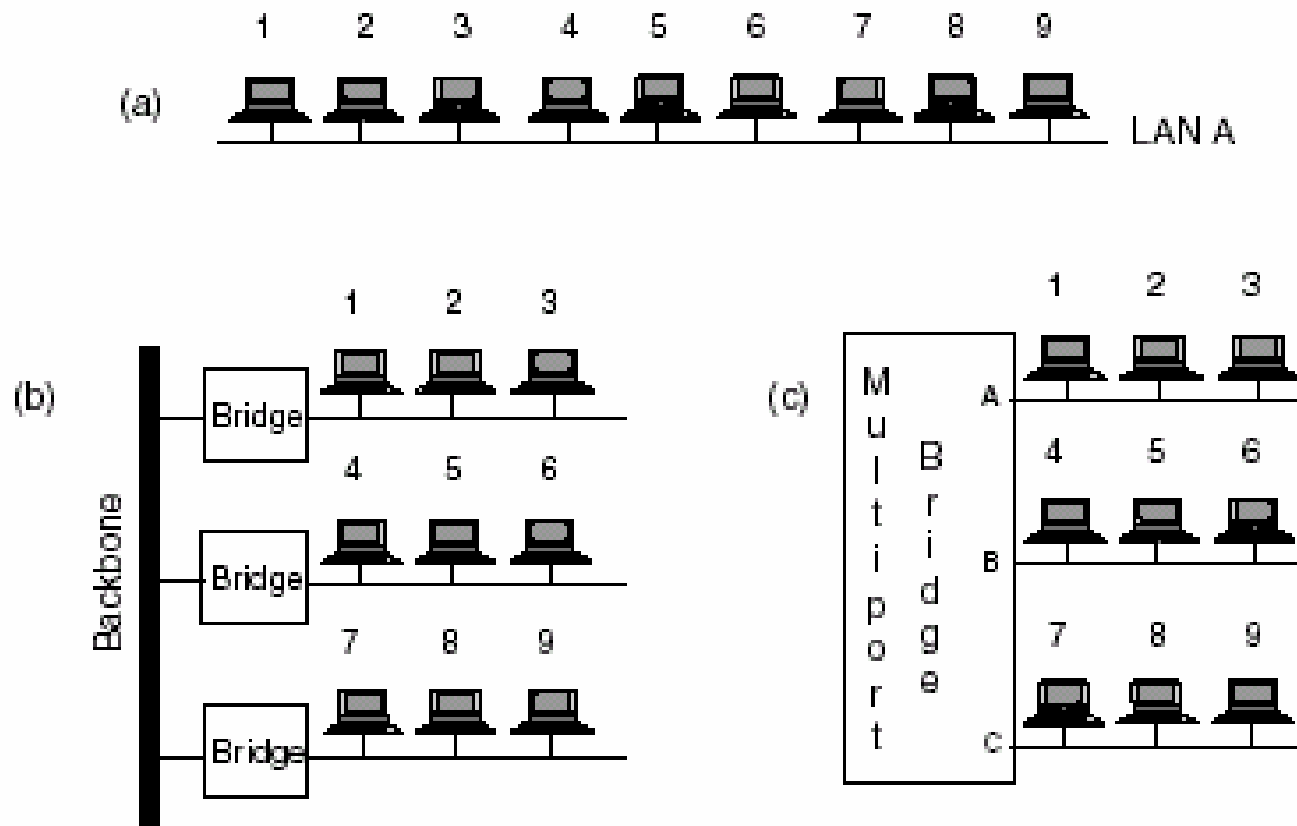
- Collision Domain tercipta karena adanya sebuah single network yang didalamnya terdapat 2 node yang dapat menyebabkan collision.
- Satu Collision Domain maksimal memiliki 1024 node dan diameter tidak lebih dari 2500 m.
- Dari beberapa device penghubung, Repeater yang perlu dicermati karena berada di layer 1 yang mentransfer seluruh signal, yg didalamnya termasuk collision-collision signal. Maka selama dihubungkan dengan repeater maka 2 buah segmen berada dalam satu collision domain.
- repeater dalam sebuah network harus dibatasi jumlahnya.
- Aturan 5-4-3
  - Cara sederhana untuk membatasi repeater.
  - Dalam satu jaringan tidak boleh lebih dari 5 segment ( masing2 s/d 500m) tidak boleh ada lebih dari 4 repeater, dan tidak boleh lebih dari 3 segmens yang punya end-node terkoneksi dengan repeater.

# Segmentation

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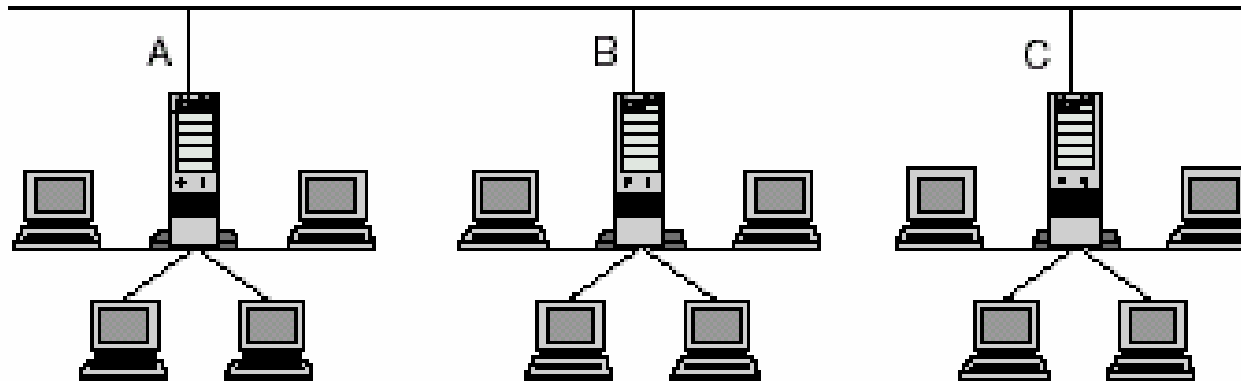
- Berkembangnya aplikasi client-server dan multimedia di awal 90an menyebabkan meningkatnya pengguna network. Hal ini menyebabkan performance network menjadi turun , biasanya dalam bentuk response time menjadi lambat, througput rendah, collision yang tinggi, dan banyak complain dari user. Semuanya berpangkal pada network congestion.
- berikut adalah strategi untuk mengurangi congestion dengan cara segmentation: **switched ethernet, Full Duplex Ethernet, dan Virtual LANs.**
- Segmentation (partitioning)=membagi network kedalam beberapa segmen terpisah tapi masih terhubung. Dapat meningkatkan performance keseluruhan network, meningkatkan security, dan reliability

# Segmentation



**FIGURE 9.8** In (a), an unsegmented Ethernet LAN is shown. In (b), this LAN is partitioned into three separate segments using individual bridges connected to a backbone, and alternatively, in (c), a multiport bridge is used in which the backbone of (b) is “collapsed” into the multiport bridge. In a properly segmented network, at least 80% of the network traffic generated by the nodes on a LAN remains local to that LAN. Keeping remote access to a minimum (no more than 20%) minimizes backbone congestion and increases network performance

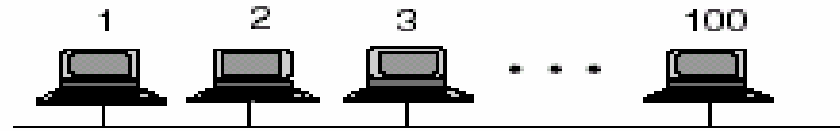
# Segmentation



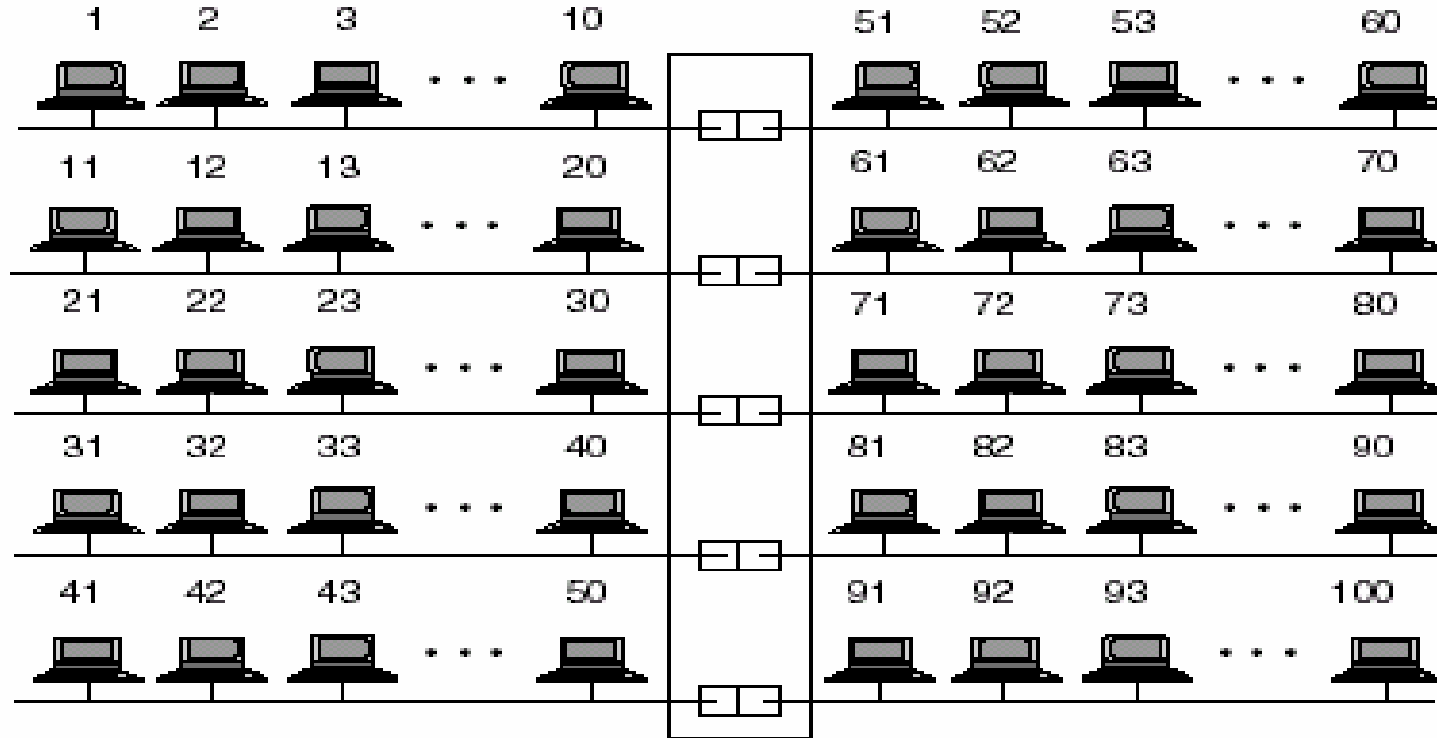
**FIGURE 9.9** Another way to partition a network is to physically connect all nodes with their server and to place all servers at partition boundaries. In this illustration, there are three separate partitions—A, B, and C. Note that network traffic is reduced since the majority of communication occurs within a separate segment. At the same time, by having the servers on the partition boundaries, nodes from one segment are not locked out from communicating with a server located on another segment.

- **Switched Ethernet**
  - Mengubah traditional ethernet/802.3 yang broadcast teknologi ke Point-to-Point technology. Meng-isolasi network traffic dari node pengirim dan node penerima dari keseluruhan node. Membuat signal mengunjungi node-node yang lebih sedikit daripada keseluruhan node yang ada di jaringan, jika dengan broadcast.
  - Ada 3 jenis : Workgroup Switch, Private Switch, dan Backbone Switch

(a) 100 Nodes Share One 10-Mbps Channel

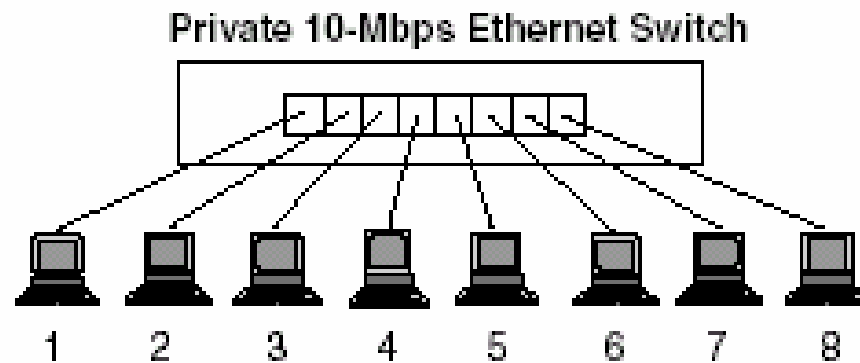


(b) Ten 10-Mbps Segments, Each with Ten Nodes



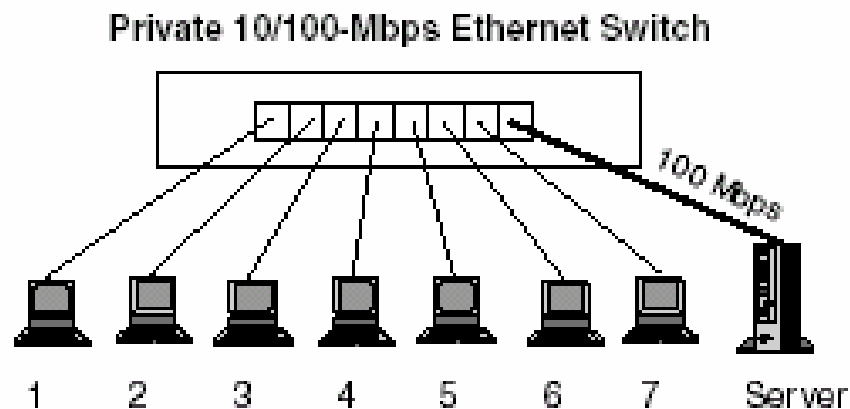
**FIGURE 9.10** The 100-node unsegmented 10-Mbps Ethernet network in (a) implies each node occupies one-hundredth of the shared medium. In (b), a workgroup Ethernet switch is used to partition this network into multiple LAN segments with ten nodes each. Each node now receives one-tenth of a 10-Mbps channel, and overall network performance for all nodes increases by a factor of 10.

## Switched Ethernet, Full Duplex Ethernet, dan Virtual LANs



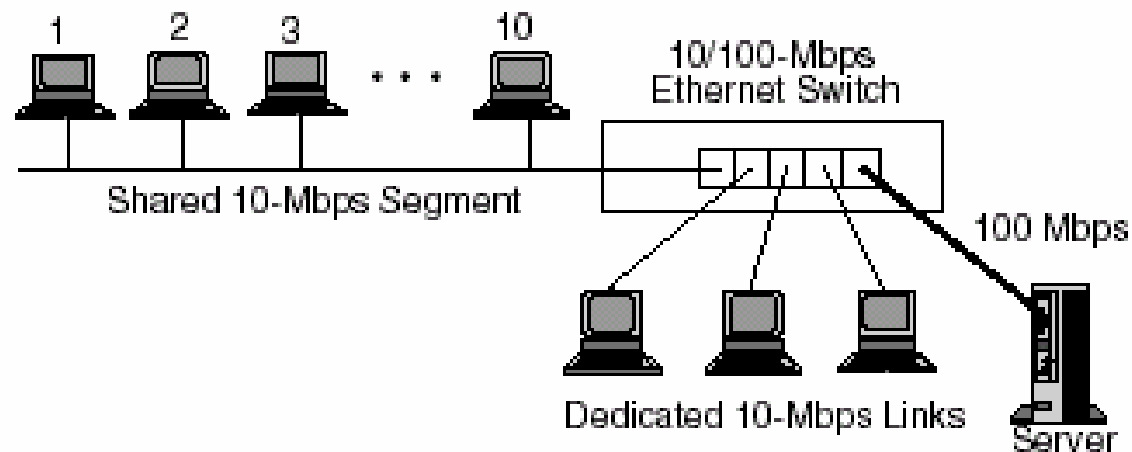
**FIGURE 9.11** A private 10-Mbps Ethernet switch resembles a UTP repeater hub. Unlike a repeater hub, a private switch dedicates a full 10-Mbps channel to each port, which supports only one node (i.e., one MAC address). Since each node has its own dedicated segment, there is no need for a node to perform collision detection.

## Switched Ethernet, Full Duplex Ethernet, dan Virtual LANs

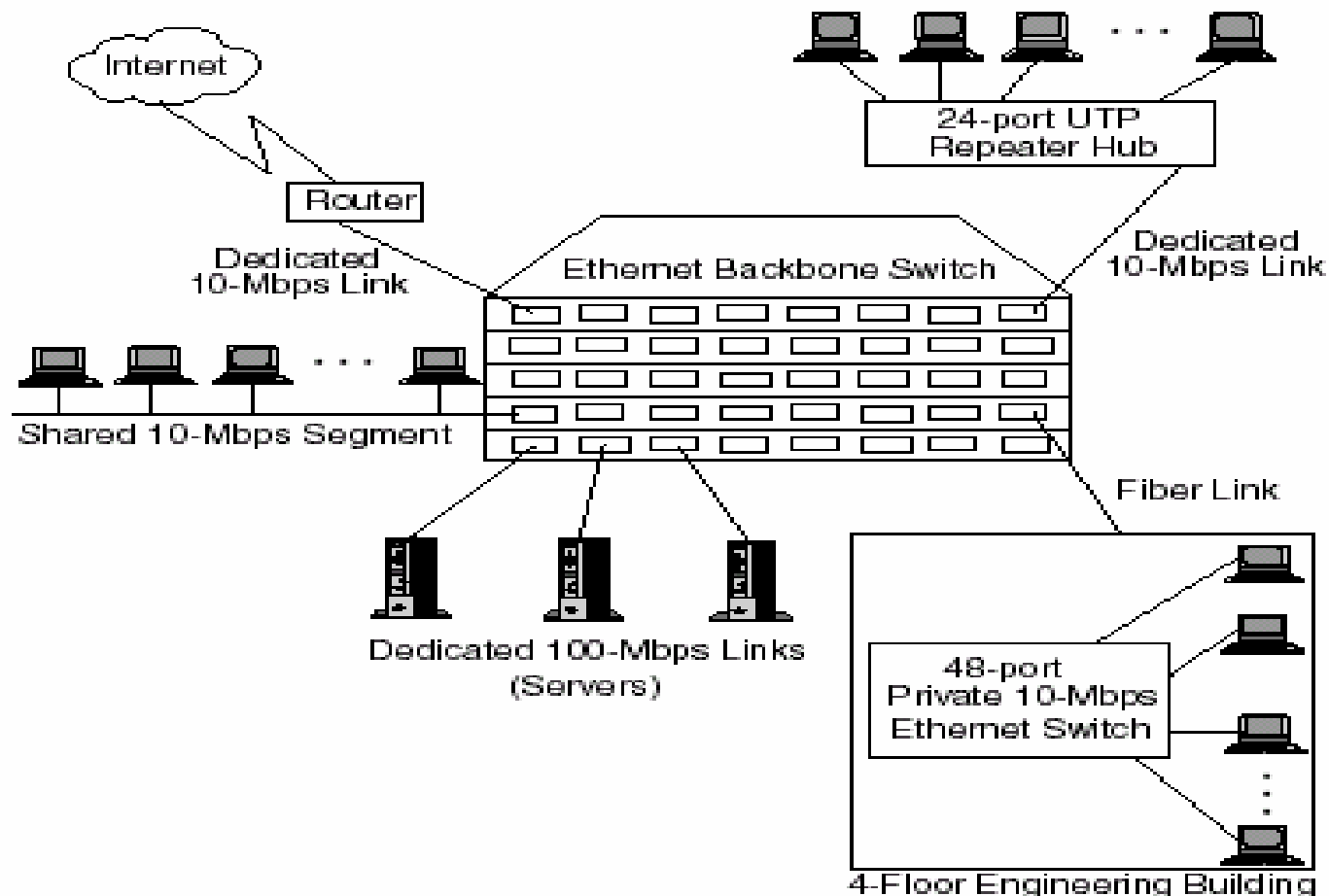


**FIGURE 9.12** A 10/100-Mbps private Ethernet switch can be used in a client/server environment to assign dedicated 10-Mbps channels to each client and a full, dedicated 100-Mbps channel to the server. Since all traffic is to and from the server, the higher-bandwidth segment reduces the possibility of a bottleneck existing at the server port.

## Switched Ethernet, Full Duplex Ethernet, dan Virtual LANs



**FIGURE 9.13** Some Ethernet switches are capable of supporting a mix of different segments. Here, ten nodes are connected to a shared 10-Mbps segment, three nodes have their own dedicated 10-Mbps segments, and a file server is connected to a dedicated 100-Mbps segment.



**FIGURE 9.14** A backbone Ethernet switch enables an organization's entire network to be collapsed into the switch. These switches are chassis-based and have gigabit per second backplanes. They also support multiple media types, shared or dedicated segments, and both 10-Mbps and 100-Mbps segments. To compensate for a single source of failure, backbone switches have provisions for fault tolerance and redundancy.

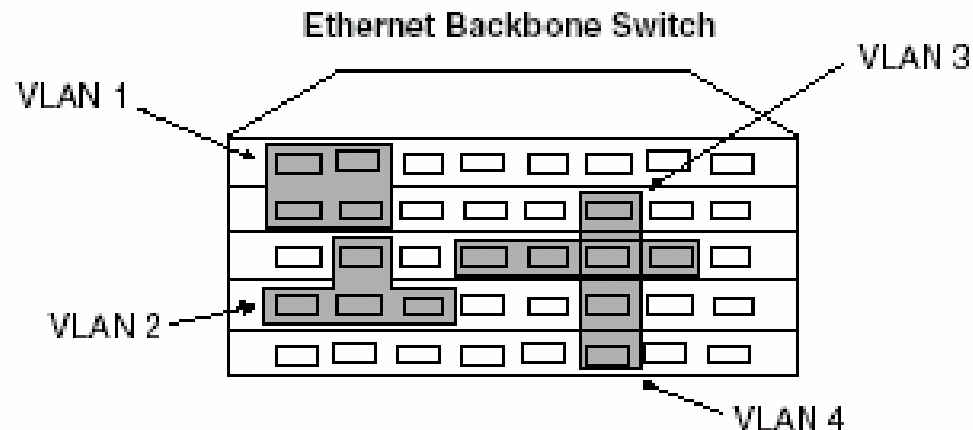
- Full Duplex Ethernet

- Mengubah traditional ethernet/802.3 yang hanya punya satu jalur secara bergantian untuk mengirim dan menerima data menjadi 2 jalur yang dapat mengirim dan menerima data sekaligus.
- Memerlukan full duplex port dan host harus punya full duplex NICs. Full Duplex card cocok untuk server karena di server sering terjadi aliran data masuk dan keluar bersamaan, dibanding dengan di client.
- Kelebihan ini hanya dapat bermanfaat bagi Sistem operasi yang multithreading seperti UniX atau Windows NT

- Virtual LANs

- Tidak seperti physical LAN, virtual LAN tidak benar2 tersambung pada media yang sama, tapi terkoneksi secara virtual lewat software khusus yang membuat beberapa port dalam switch menjadi sebuah workgroup.
- Cocok untuk lingkungan kerja yang dinamis.
  - Misal minggu ini 30 orang mengerjakan project di Server A, minggu depan 15 dari 30 orang ini mengerjakan project di Server B, dan sisanya ke Server C, dsb..

## Switched Ethernet, Full Duplex Ethernet, dan Virtual LANs



**FIGURE 9.15** Some Ethernet switches support virtual LANs, which group together selected ports to form independent subnets. Traffic between ports of a VLAN is restricted to only those members of a “port group.” Some switches also support routing protocols so that ports can belong to more than one VLAN, as is illustrated in VLANs 3 and 4.

## 100-MBps and 1000 MBps Ethernet LANs

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- Meskipun segmentation meningkatkan kinerja, tapi sebenarnya transmission ratenya belum bertambah. Maka itu dibuatlah standar baru yang meningkatkan transmission rate sampai 100 Mbps dan 1000 Mbps ( Jalan yang hanya 1 sudah dibuat jadi banyak, tapi kecepatan mobilnya masih sama. Maka dibuat mobil baru dengan kecepatan 10x dan 100x lebih cepat)
- 100 MBps : Fast Ethernet (IEEE 802.3u) dan 100VG AnyLAN (IEEE 802.12)
- 1000 Mbps : Gigabit Ethernet ( IEEE 802.3z untuk Fiber optic, IEEE 802.3ab untuk kabel)