

# TSN: Lecture 11

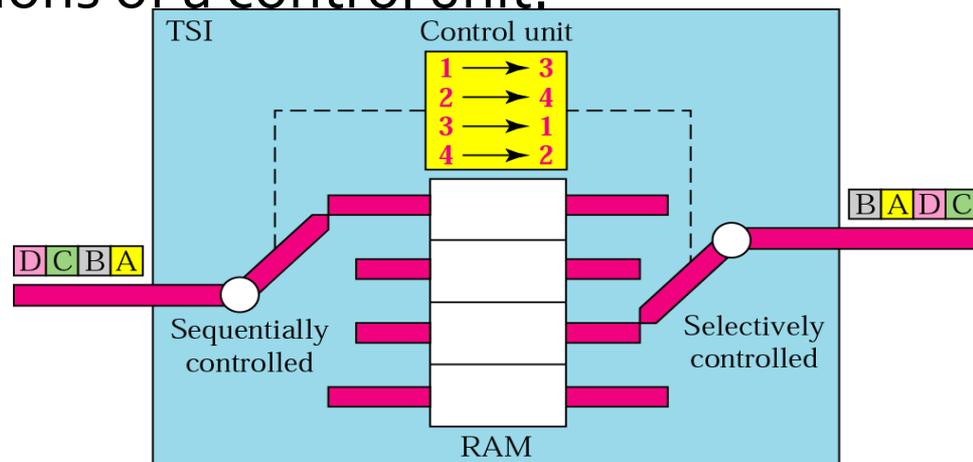
## Switching Network II

# Topics Covered

- Time-slot interchange
- Comparison of SDM and TDM
- TDM bus
- TST switch
- POPs

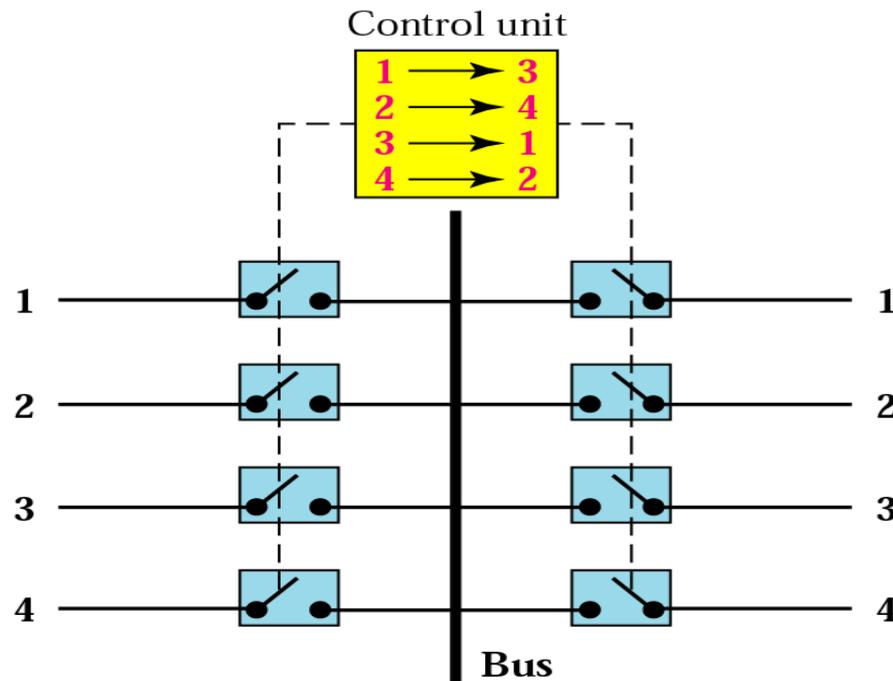
# Time-slot interchange

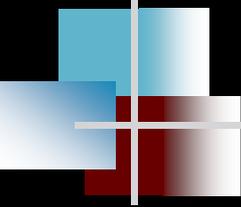
- TSI consists of random access memory (RAM) with several memory locations. The size of each location is the same as the size of a single time slot.
- The number of locations is the same as the number of inputs.
- The RAM fills up with incoming data from time slots in the order received. Slots are then sent out in an order based on the decisions of a control unit.



# TDM bus

- Input and output lines are connected to a high-speed bus through input and output gates (microswitches)
- Each input gate is closed during one of the four slots.
- During the same time slot, only one output gate is also closed. This pair of gates allows a burst of data to be transferred from one specific input line to one specific output line using the bus.
- The control unit opens and closes the gates according to switching need.





# Comparison of SDM and TDM

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- SDM
  - Advantage:
    - Instantaneous.
  - Disadvantage:
    - Number of cross points required.
- TDM
  - Advantage:
    - No cross points.
  - Disadvantage:
    - Processing delay.

# TST switch

- Combine Space division and time division switching.
- This results in switches that are optimized both physically (the number of crosspoints) and temporally (the amount of delay).
- Various types are: time-space-time (TST), time-space-space-time (TSST), space-time-time-space (STTS), etc.

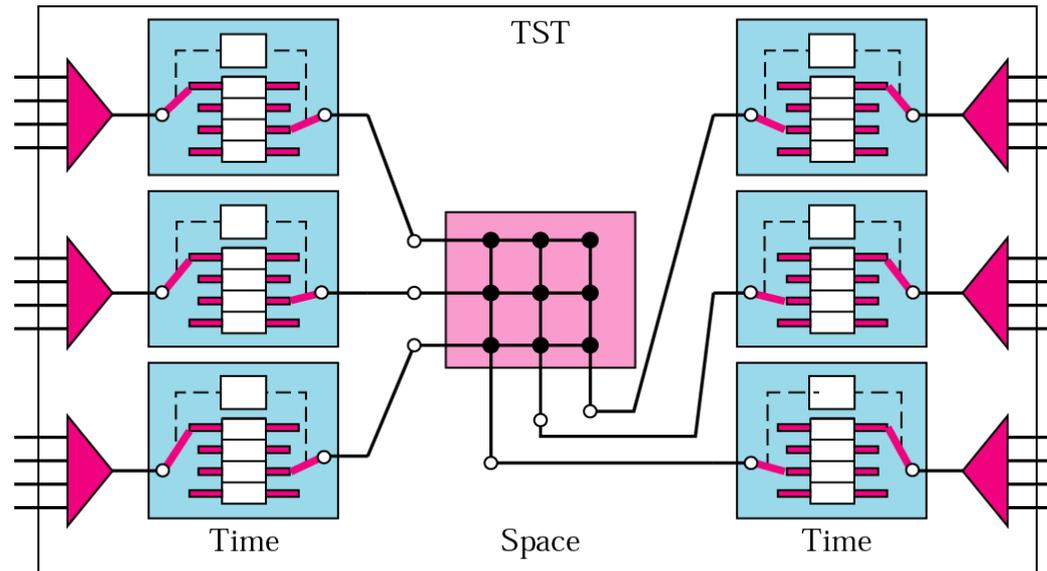


Figure 8.11

- Telephone networks use circuit switching.
- In 1800s, Plain old telephone system (POTS) was an analog system using analog signals to transmit voice.
- In 1980s, POTS started carrying data along with voice and also has become digital instead of analog.
- Major components of Telephone network: Local loops, trunk, and switching office.
- Different levels of switching offices: End offices, tandem offices, and regional offices.
- Local loop: Twisted pair cable that connects the subscriber telephone to the nearest end office or local central office. It has a bandwidth of 4000 Hz for voice. The first three digits of local telephone number define the office, and the next four digits define the local loop number.
- Trunks: Transmission media that handle communication between offices. It handles hundreds or thousands of connections through multiplexing. Transmission is usually through optical fibers or satellite links.

■ Switching office: To avoid having a permanent physical link between any two subscribers, switches are located here. Switch connects several local loops or trunks and allows different subscribers to connect.

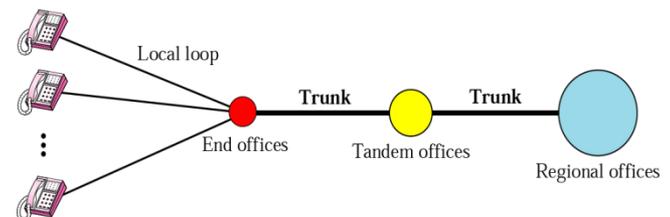


Figure 8.12 *Switching offices in a LATA*

- LATA (Local access transport areas)
- Services offered by the common carriers (telephone companies) inside a LATA are called intra-LATA services. The carrier that handles these services is called a local exchange carrier (LEC).
- Intra-LATA services are provided by local exchange carriers. Since 1996, there are two types of LECs: incumbent local exchange carriers (ILEC) and competitive local exchange carriers (CLEC)
- ILEC would provide main services and owns the local loop. CLEC would provide other services such as mobile telephone service, toll calls inside a LATA, ...
- Communication inside a LATA is handled by end switches and tandem switches. A call that can be completed by using only end offices is called toll-free. A call that has to go through a tandem office (intra-LATA toll office) is charged.

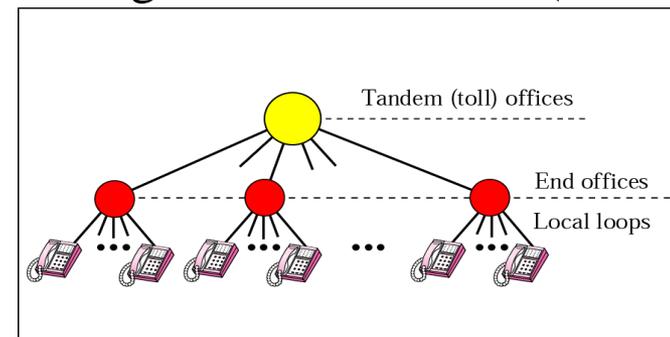
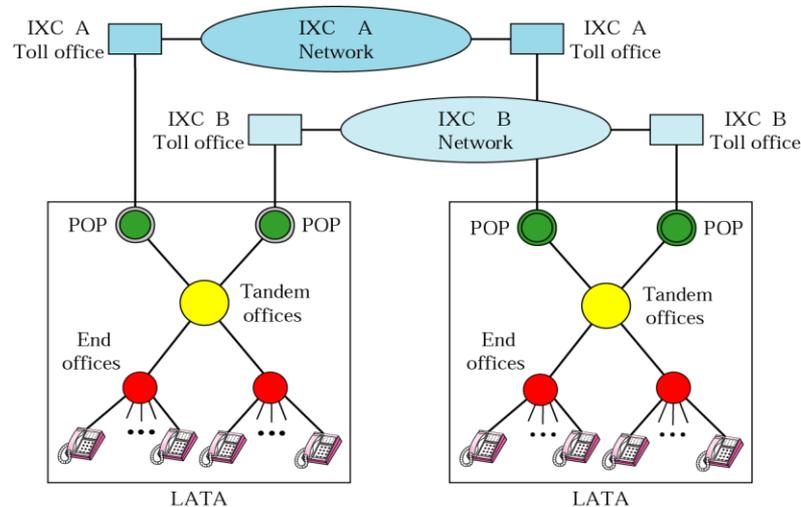


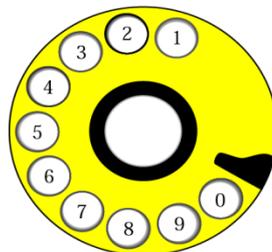
Figure 8.13 *POPs*

- Interexchange carriers (IXCs) or long-distance companies handle services between LATAs.
- Carriers that provide inter-LATAs include AT&t, MCI, WorldCom,...
- A telephone call going through an IXC is normally digitized, with the carriers using several types of networks to provide service.
- Intra-LATA services can be provided by several LECs (one ILEC and possibly more than one CLEC).
- Point of Presence (POP) is a switching office.
- Each IXC that wants to provide inter-LATA services in a LATA must have a POP in that LATA.

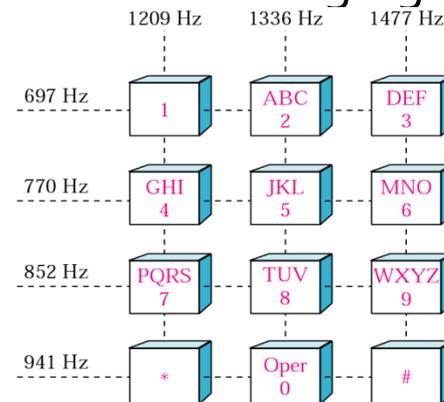


# Making a Connection

- Accessing the switching station at the end offices is accomplished through dialing.
- In the past, telephones featured rotary or pulse dialing, in which a digital signal was sent to the end office for each number dialed. This type of dialing was prone to errors due to the inconsistency of humans during the dialing process.
- Today, dialing is accomplished through the touch-tone technique. In this method, instead of sending a digital signal, the user sends two small bursts of analog signals, called dual tone. The frequency of the signals sent depends on the row and column of the pressed pad.
- Pressing number 8 will generate two bursts of analog signals with frequencies 852 and 1336



Rotary



Touch-Tone

- Local loop is analog, bandwidth is usually between 0 and 4000 Hz.
- With switched lines, when the caller dials a number, the call is conveyed to a switch, or series of switches, at the exchange. The appropriate switches are then activated to link the caller's line to that of the person being called. The switch connects the two lines for the duration of the call.
- Local Call services: Flat monthly rate OR rate for each call or a set of calls.
- Toll Call services:
  - Toll call can be intra-LATA or inter-LATA.
  - Inter-LATA calls are long distance calls [that pass via a tandem office (toll office)] and are charged for.
- 800 Services:
  - If a subscriber (normally an organization) needs to provide free connections for other subscribers (normally customers), it can request an 800 service [also 888, 877, 866]. Call is free for caller but it is paid by the callee. Rate is less expensive than a normal long distance call.
- WATS: Wide-Area Telephone Service
  - It is the opposite of 800/888 service. Charged for outbound calls.
  - Service is a less expensive alternative to regular toll calls; charges are based on number of calls.
  - Service can be specified as outbound calls to the same state, to several states, or to the whole country, with rates charged accordingly.
- 900 Services:
  - Call is paid by the caller and is normally much more expensive than a normal long-distance call. The reason is that the carrier charges two fees; the first is the long-distance toll, and the second is the fee paid to the callee for each call.
  - This service is used by organization that needs to charge customers for its services.

## ■ Analog Leased Services

- Offers customers the opportunity to lease a line, sometimes called a dedicated line, that is permanently connected to another customer.
- Although the connection still passes through the switches in the telephone network, subscribers experience it as a single line because the switch is always closed, no dialing is needed.

## ■ Digital Services

- Digital Services are less sensitive than analog services to noise and other forms of interference.
- Common digital services are switched/56 and digital data service (DDS).
- Switched/56 Service
  - Digital version of an analog switched line. It is a switched digital service that allows data rates of up to 56 Kbps. To communicate through this service, both parties must subscribe. A caller with normal telephone service cannot connect to a telephone or computer with switched/56 even if using a modem.
  - On the whole, digital and analog services represent two completely different domains for the telephone companies.
  - Switched/56 service is digital and so subscribers do not need modems to transmit digital data. However, they do need another device called a digital service unit (DSU). This device provides 56 Kbps and encodes the digital data in the format used by service provider.
  - Supports bandwidth on demand, video conferencing, fast facsimile, multimedia, fast data transfer, etc. Also allows subscribers to obtain higher speeds by using more than one line (inverse multiplexing).

## ■ Digital Data Service

- Digital version of an analog leased line; it is a digital leased line with a maximum data rate of 64 Kbps.

## ■ Telephone history

### ■ Before 1984

- Local and long-distance services were provided by AT&T Bell System.
- By law, this monopoly company was broken into AT&T Long lines, 23 Bell Operating Companies (BOCs) and others.
- Telephone rates became lower after this law.

### ■ Between 1984 and 1996

- LATAs and IXCs were formed.
- No LEC provide long-distance services and no IXC provide local services.

### ■ After 1996

- A common carrier company provides both inside the LATA and between LATA services.
- To avoid recabling of residents, the carrier that was given intra-LATA services (ILEC) continues to provide the main services; the new competitors (CLEC) provide other services.