Digital Switching System

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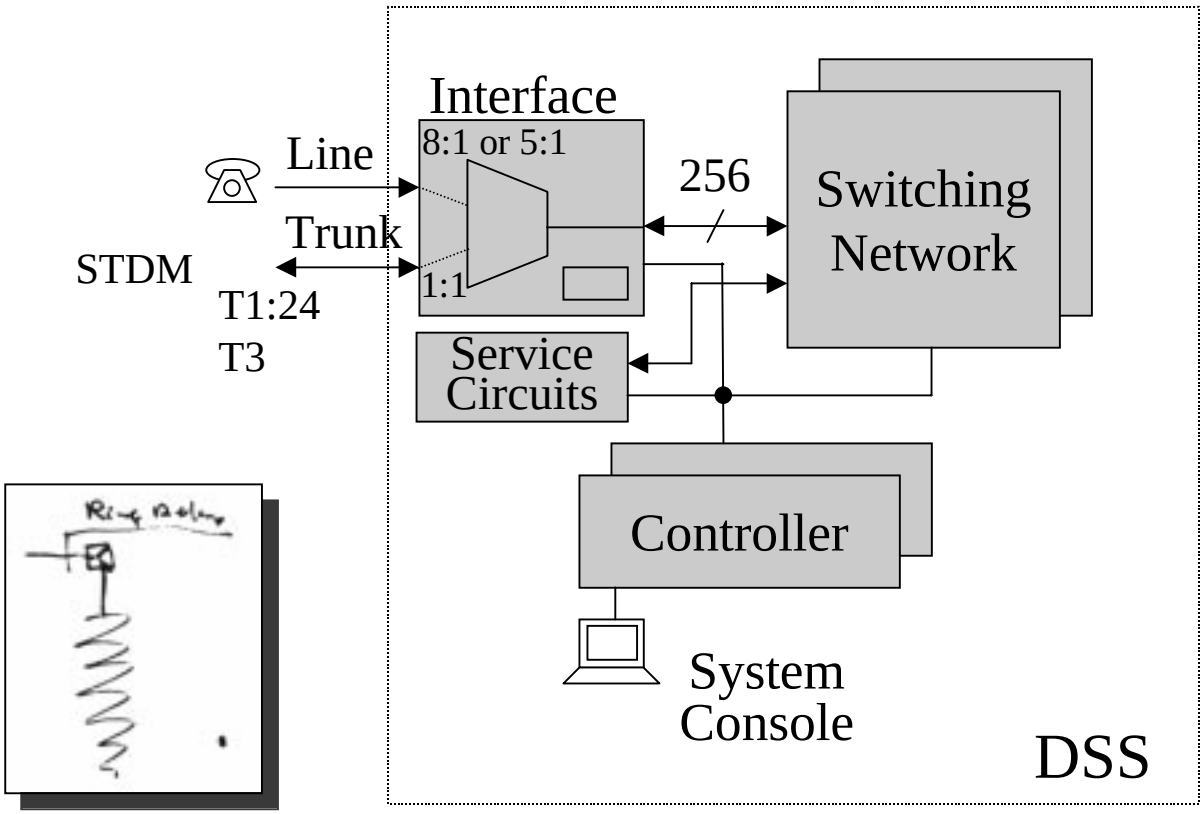
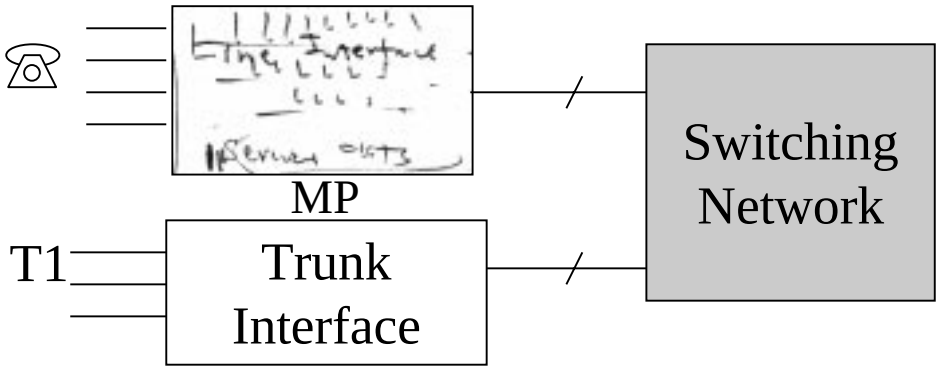
電信工程學系

Digital Switching System Architecture



Terminal Interface

BORSCHT functions for line circuit



1. Basic Switching System

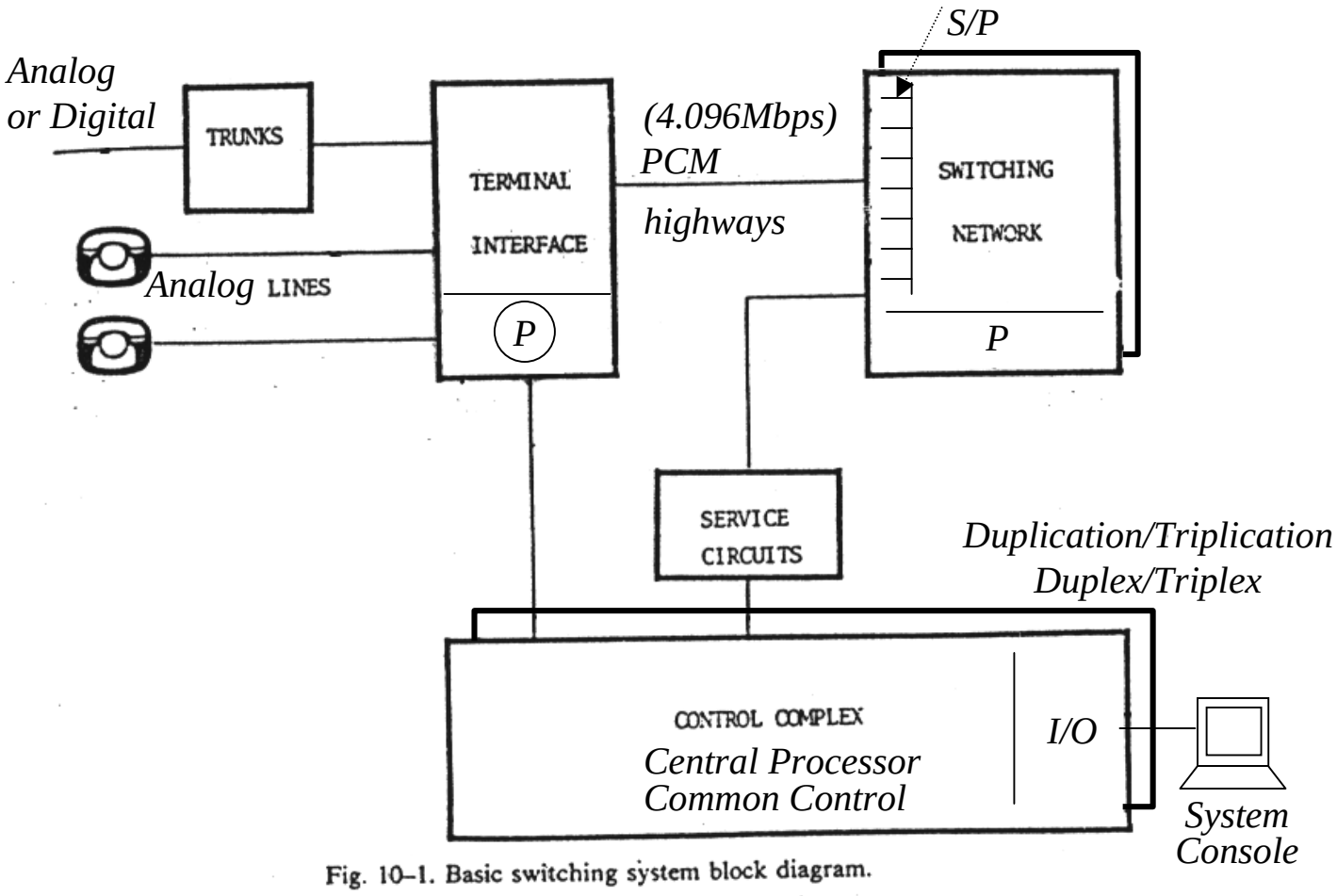
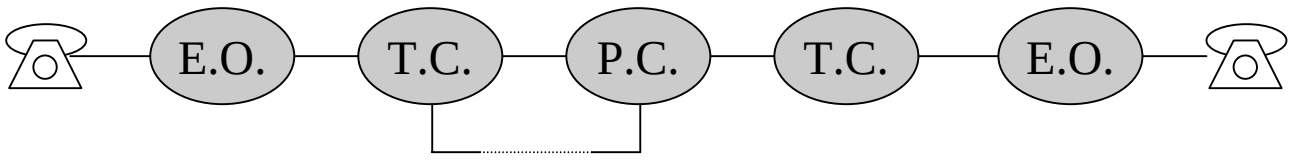


Fig. 10–1. Basic switching system block diagram.

P : Processor
BHCA : Busy Hour Call Attempt



2. Terminal Interface Techniques

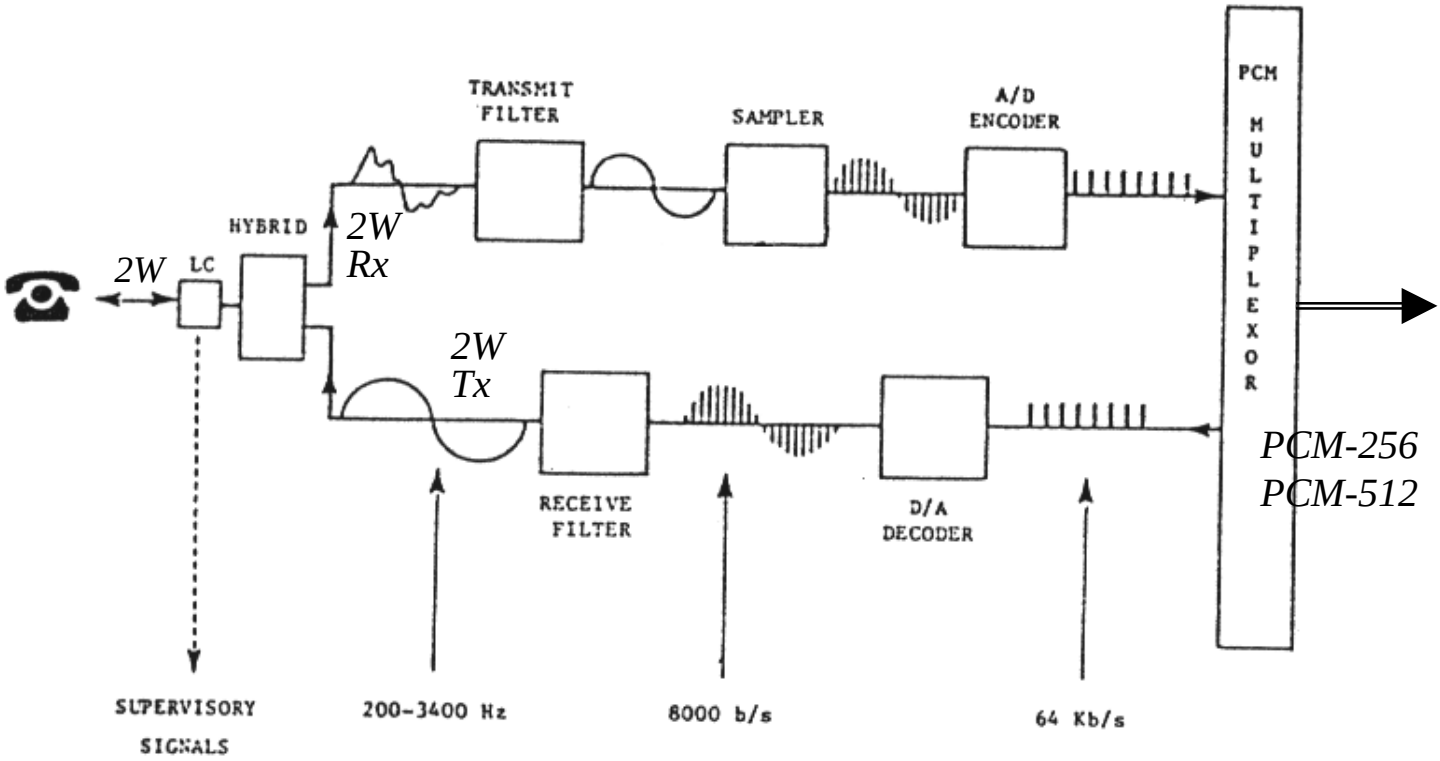


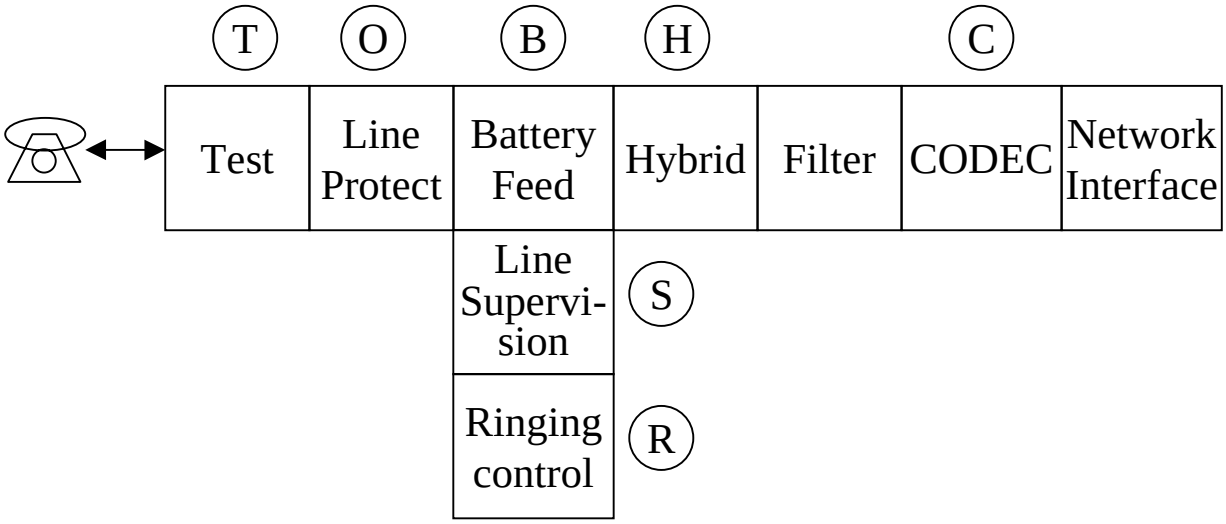
Fig. 11-1. Terminal interface functions.

BORSCHT

Line Scanning Program | Call Processing Program

BORSCHT Functions

- Line Circuit Functions are BORSCHT Functions.



B: Battery Feeding

O: Overvoltage Protection

R: Ringing (20Hz, 90 volt) 1 sec on, 2sec off

S: Supervision

C: Codec and channel Filtering

H: Hybrid

T: Testing

Example of Line Circuit

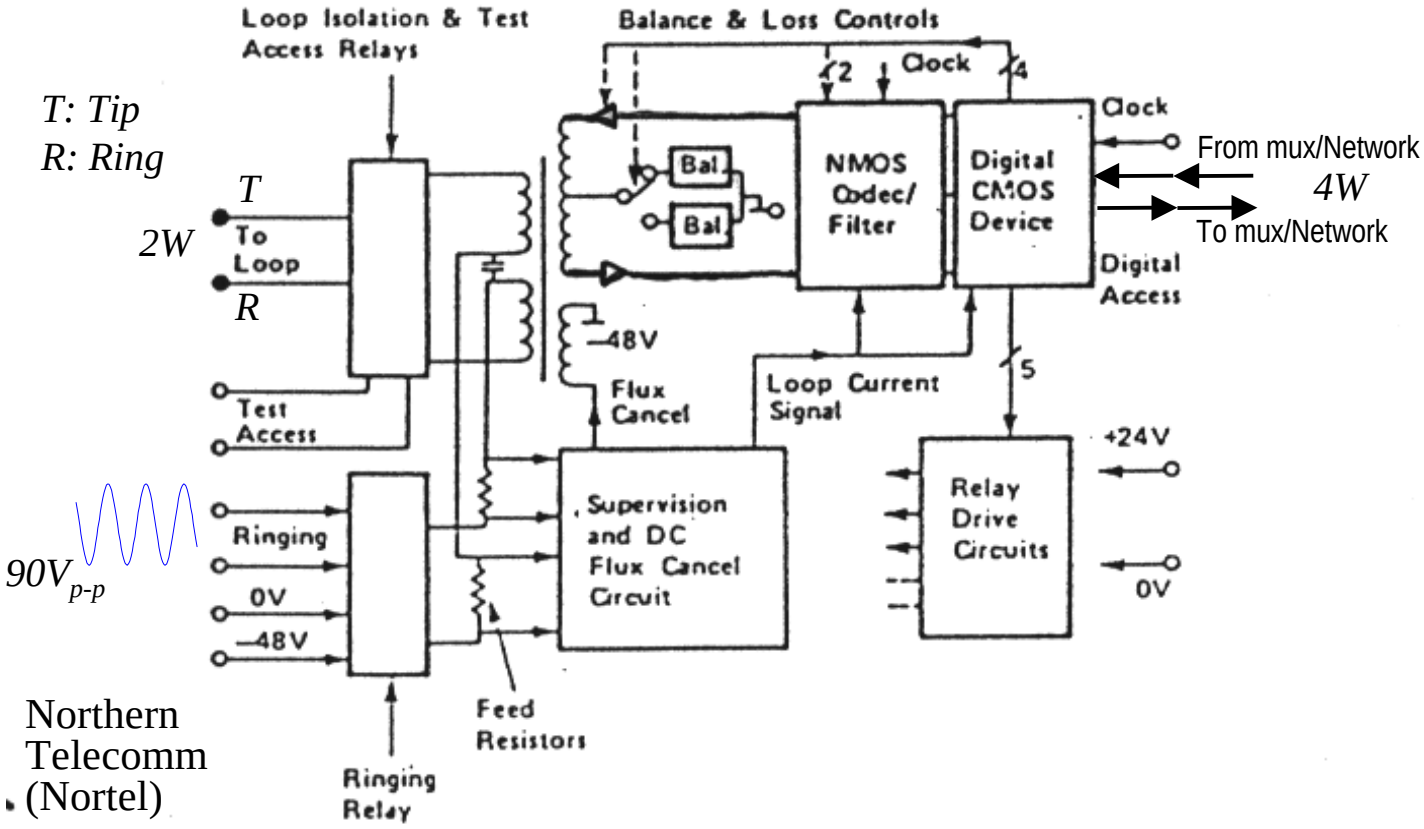


Fig. 11-2. DMS-100 line circuit block schematic. (From J. Terry, D. Younge, and R. Matsunaga, "A Subscriber Line Interface for the DMS-100 Digital Switch," *NTC '79*, © IEEE.)

Balance Network : Impedance match for decreasing echo.

Functional Block Diagram for a Line Module (LM)

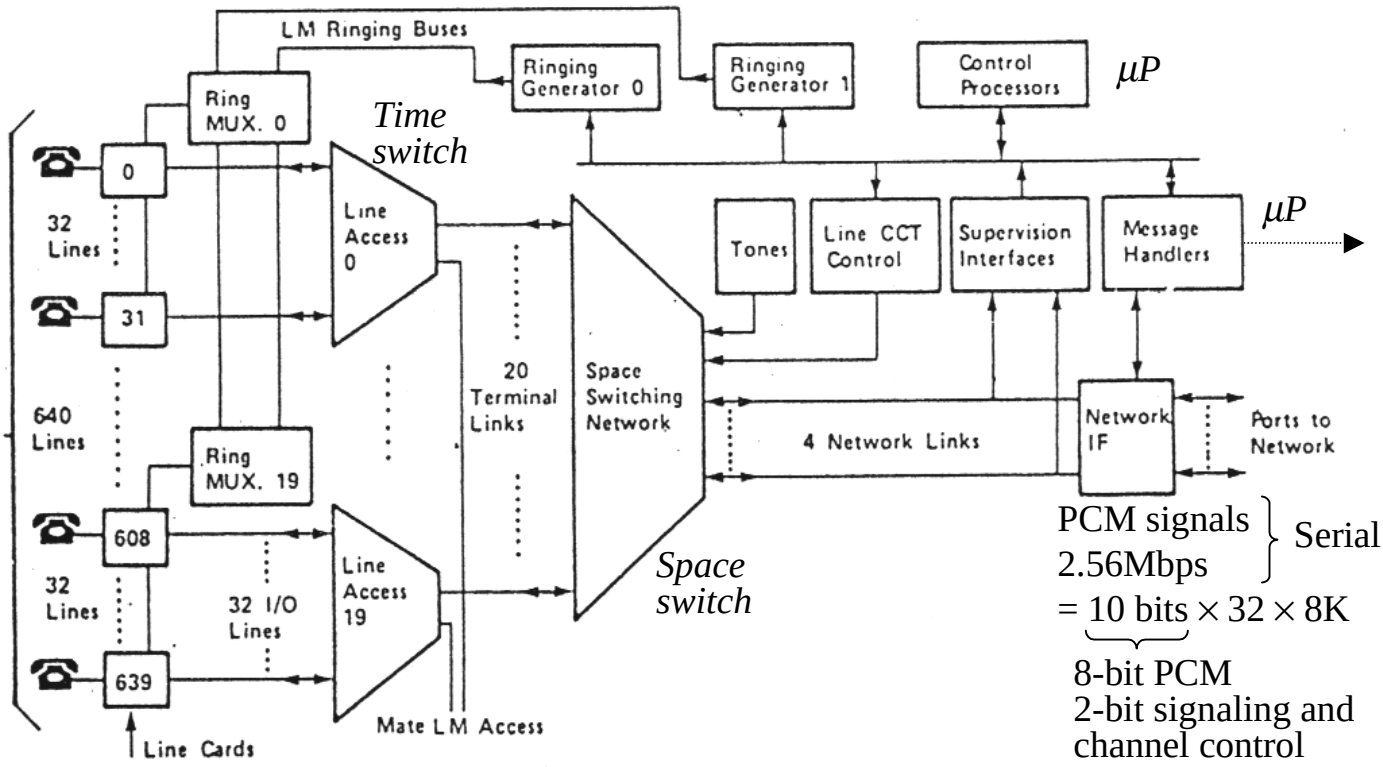


Fig. 11-3. DMS-100 line module functional diagram. (From J. Terry, D. Younge, and R. Matsunaga, "A Subscriber Line Interface for the DMS-100 Digital Switch," *NTC '79*, © IEEE.)

Northern Telecom (Nortel)

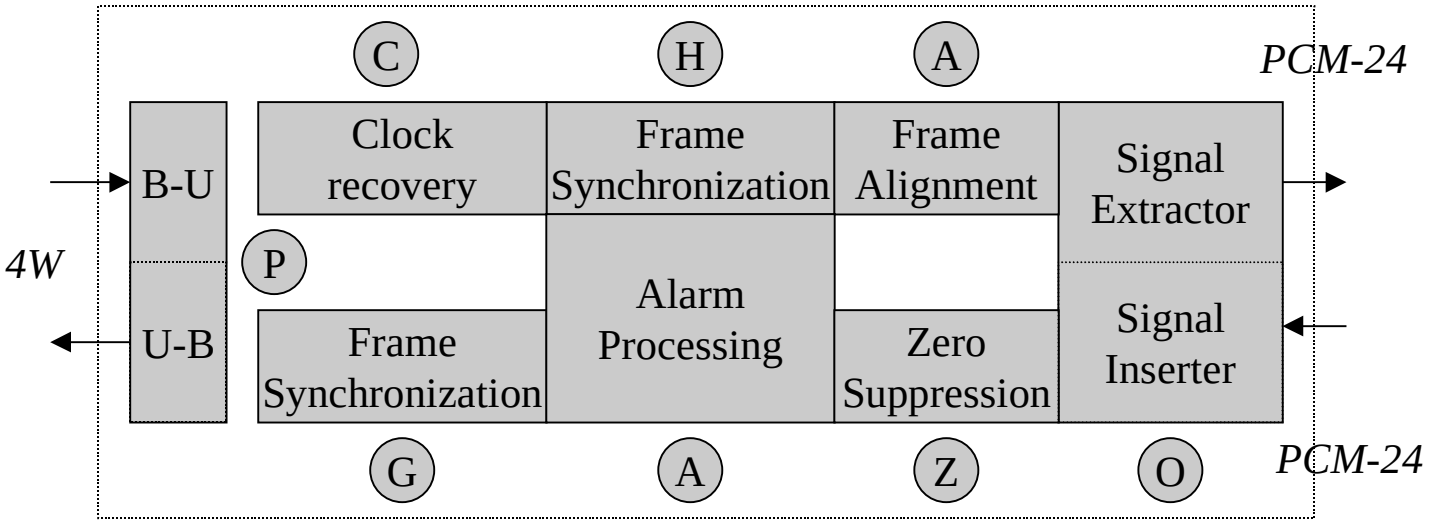
Analog Trunk Interface

- Similar to Subscribe Line
- Inband Signaling and Common-channel Signaling
- Per-channel CODEC
- Without Concentration

Digital Trunk Interface

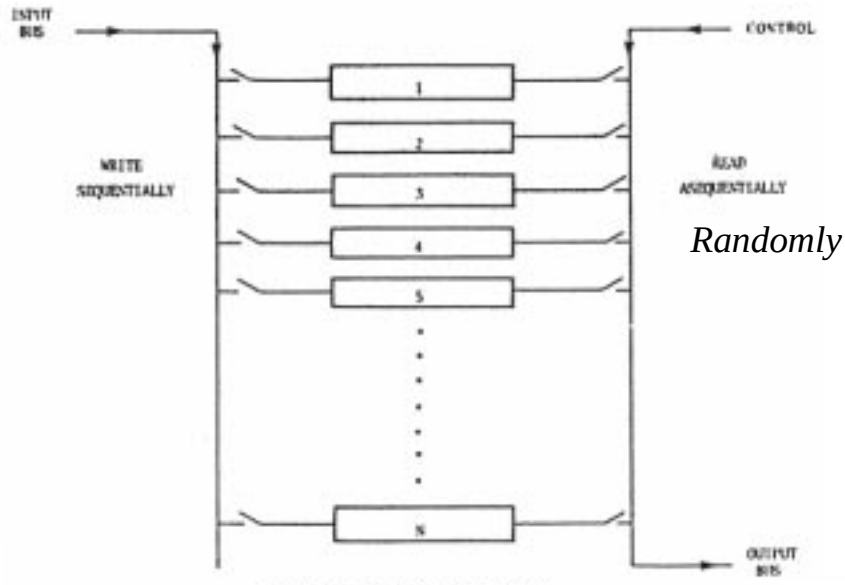
- GAZPACHO Functions
  - G: Generation of outgoing frame code
  - A: Alignment of incoming frame
  - Z: Zero string suppression
  - P: Polar conversion
  - A: Alarm processing
  - C: Clock recovery
  - H: Hunting during reframe
  - O: Office signal extraction and insertion

- Digital Terminal Function



3. Switching Network Considerations

- Time Division Switching
  - Time switching in memory



Randomly

Fig. 10–14. Switching in memory.

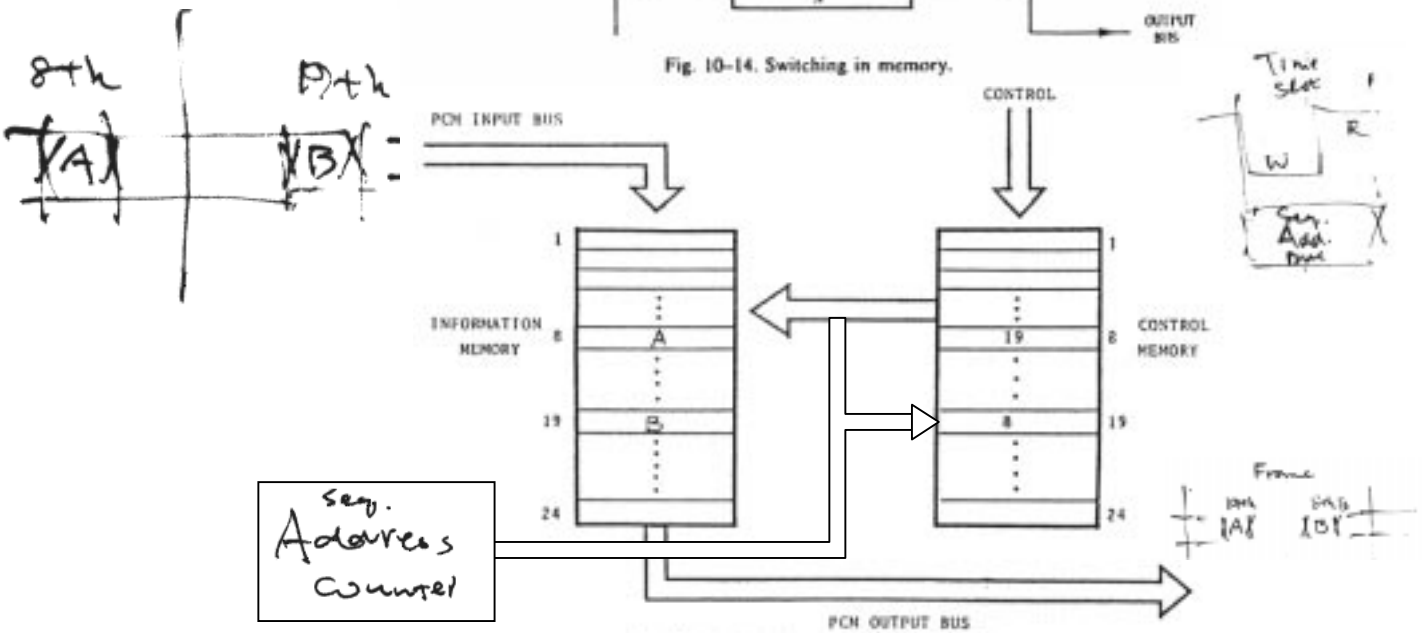
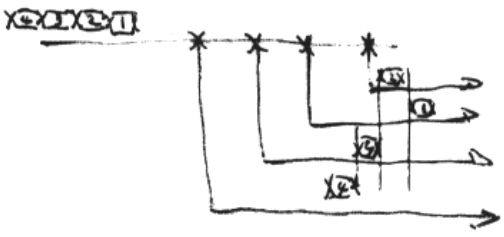


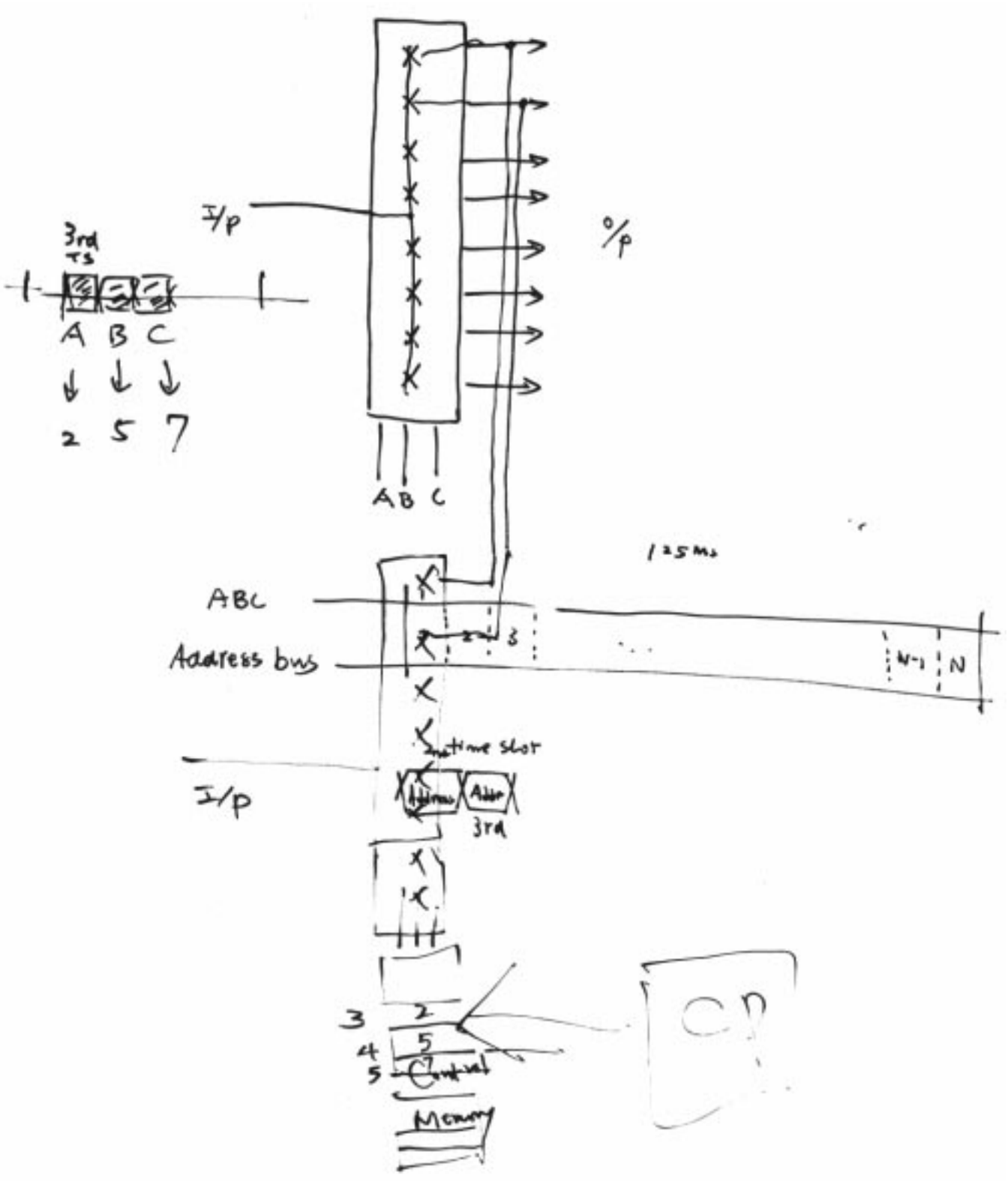
Fig. 10–15. PCM time slot interchange (TSI).

  - Time switching in space



3. Switching Network Considerations (cont.)

- Solid-state Xpt



3. Switching Network Considerations (cont.)

- Multistate Digital Switching
  - T-S-T Switching Network
    - ◆Sequential write-in
    - ◆Random write-in
    - ◆Random read-out
    - ◆Sequential read-out

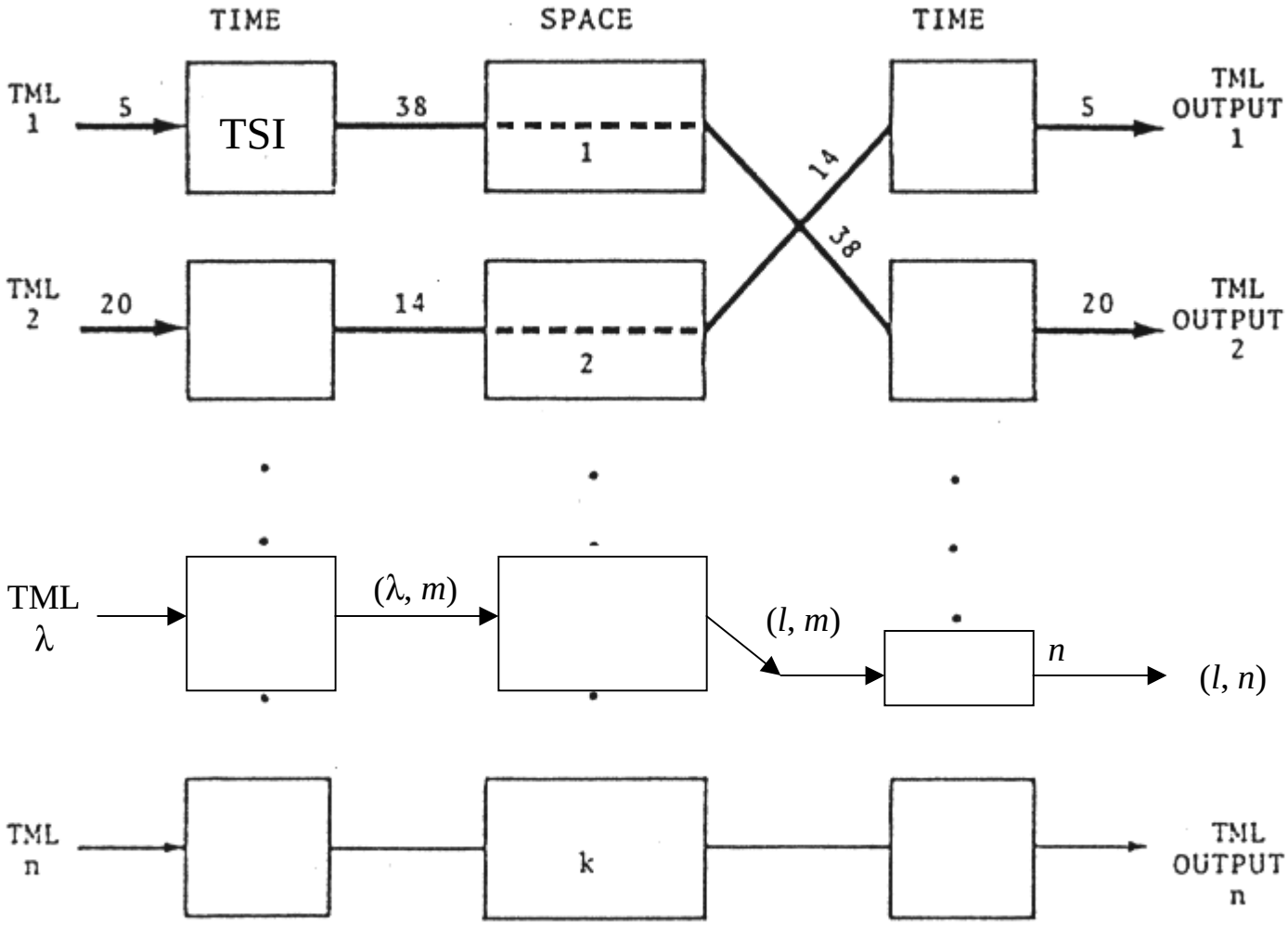


Fig. 11–4. Time-space-time (TST) switching network.

$$A: (\lambda, \nu) \xrightarrow{T} (\lambda, m) \xrightarrow{S} (l, m) \xrightarrow{T} (l, n)$$

$$B: (l, n) \xrightarrow{T} (l, m) \xrightarrow{S} (\lambda, m) \xrightarrow{T} (\lambda, \nu)$$

Link number

Time slot number

3. Switching Network Considerations (cont.)

- Multistate Digital Switching
  - S-T-S Switching Network

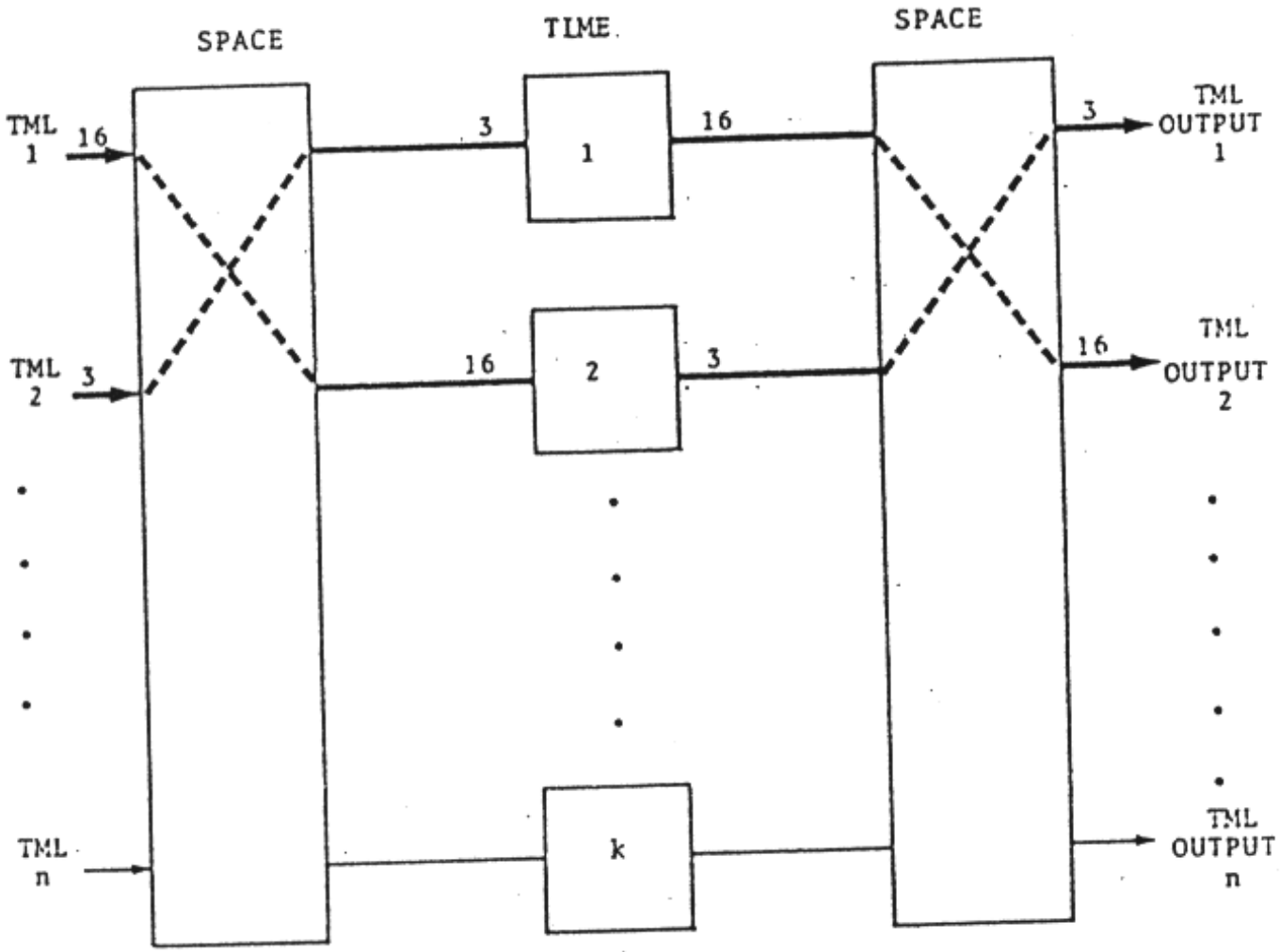


Fig. 11–5. Space-time-space (STS) switching network.

$$(\lambda,\nu) \overset{S}{\rightarrow} (k,\nu) \overset{T}{\rightarrow} (k,n) \overset{S}{\rightarrow} (l,n)$$

$$(l,n) \overset{S}{\rightarrow} (k,n) \overset{T}{\rightarrow} (k,\nu) \overset{S}{\rightarrow} (\lambda,\nu)$$

3. Switching Network Considerations (cont.)

Time-Multiplexed Switching

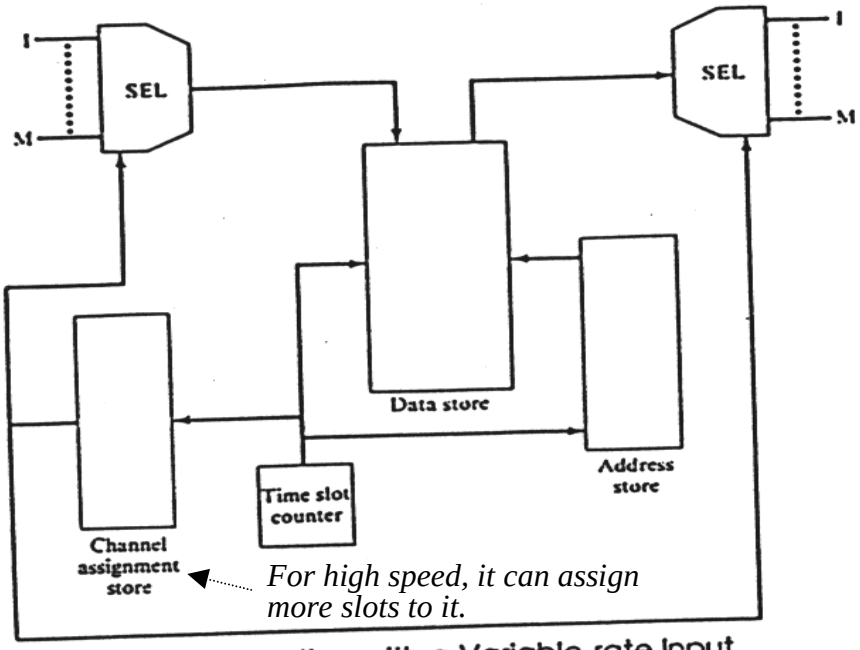
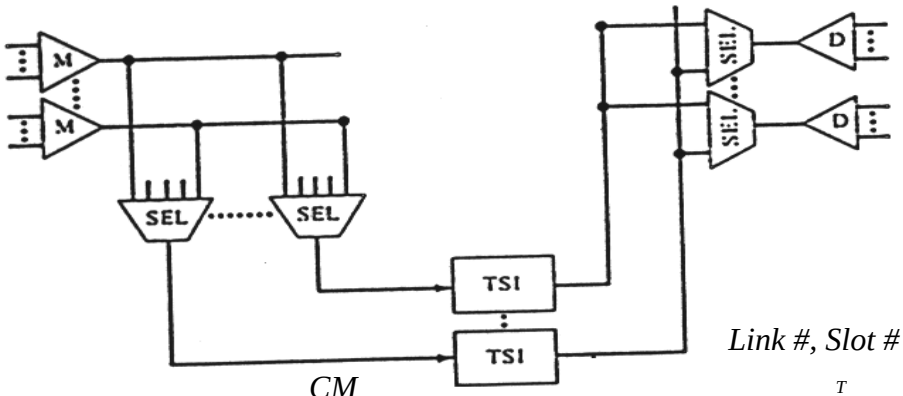


FIGURE 2-13 TSI Operation with a Variable-rate Input

Time Division space switch

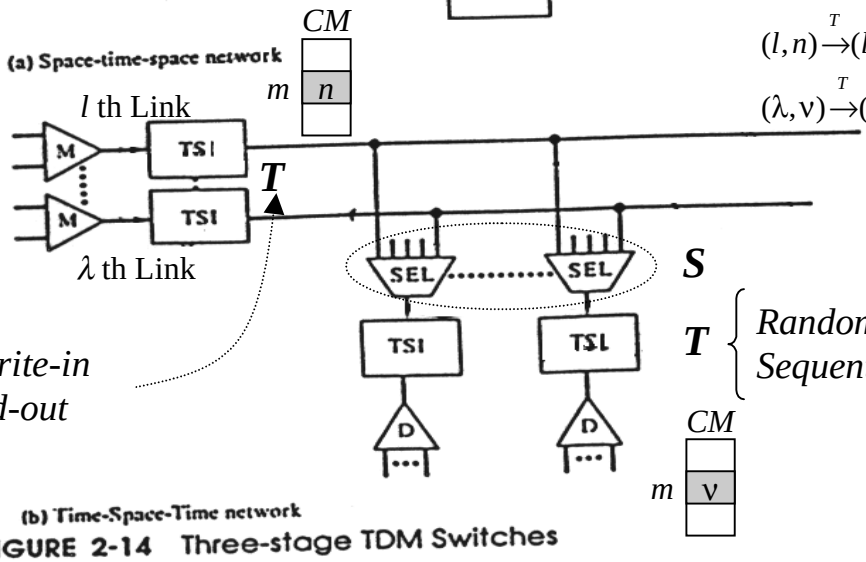
$l \rightarrow \lambda$



Link #, Slot #

$(l,n) \overset{T}{\rightarrow} (l,m) \overset{S}{\rightarrow} (\lambda,m) \overset{T}{\rightarrow} (\lambda,\nu)$

$(\lambda,\nu) \overset{T}{\rightarrow} (\lambda,m) \overset{S}{\rightarrow} (l,m) \overset{T}{\rightarrow} (l,n)$



Sequentially write-in
Randomly read-out

Randomly write-in
Sequentially read-out

FIGURE 2-14 Three-stage TDM Switches

4. Service Circuit Techniques

- Tone Generation : ROM Implemented
- Tone Reception : Digital Filters (DSP)
- Digital Conference :
  - Switching-type Conference
  - Summing -type Conference

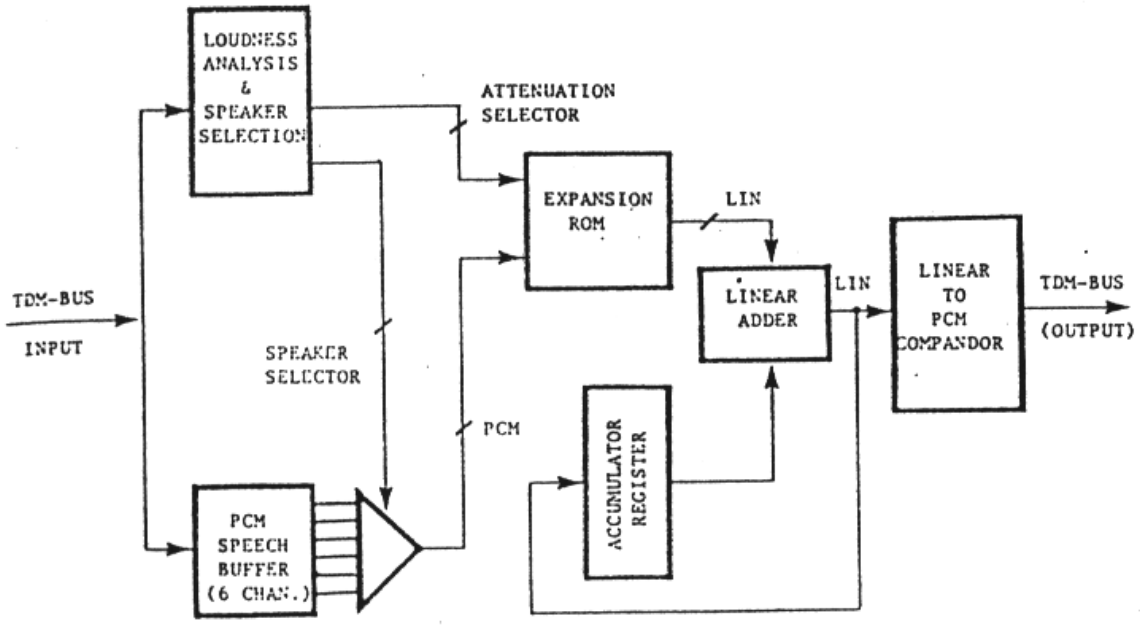


Fig. 11-6. Digital conference circuit. (From E. A. Munter, "Digital Switch Digitalks," *IEEE Communications Magazine*, Nov. 1982, © IEEE.)

- Hybrid method (Combination method)
  - Digital PAD : Implemented by ROM
  - Digital echo suppressor

5. Control Architectures

- Central Control Systems
  - small or medium-sized PABX
- Shared Control System (load-shared)
- Distributed Control Systems
  - by function
  - by block size

6. Maintenance Diagnostics and Administration

- System maintenance
  - fault detection, fault analysis, fault isolation, fault reporting, fault localization, fault clearance, and service restoration.
- Maintenance strategies
  - N+1 redundancy
  - periodic check (on-line maintenance)
  - notification, alarm
- Administration
  - Database management (recent change)
  - Generic program change (program patch/program retrofit)
  - Data collection (billing)

6. Maintenance Diagnostics and Administration (cont)

- Administration (Traffic)
  - Blocked call cleared assumption

$$B_{s,a} = \frac{a^s / s!}{\sum_{k=0}^{s} (a^k / k!)}$$

Erlang B formula
Erlang Loss formula

  - Blocked call held assumption

$$P_{s,a} = e^{-a} \sum_{j=s}^{\infty} \frac{a^j}{j!}$$

  - Blocked call delayed assumption

$$P(>0) = \frac{B_{s,a}}{1 - \frac{a}{s}(1 - B_{s,a})}$$

Erlang C formula

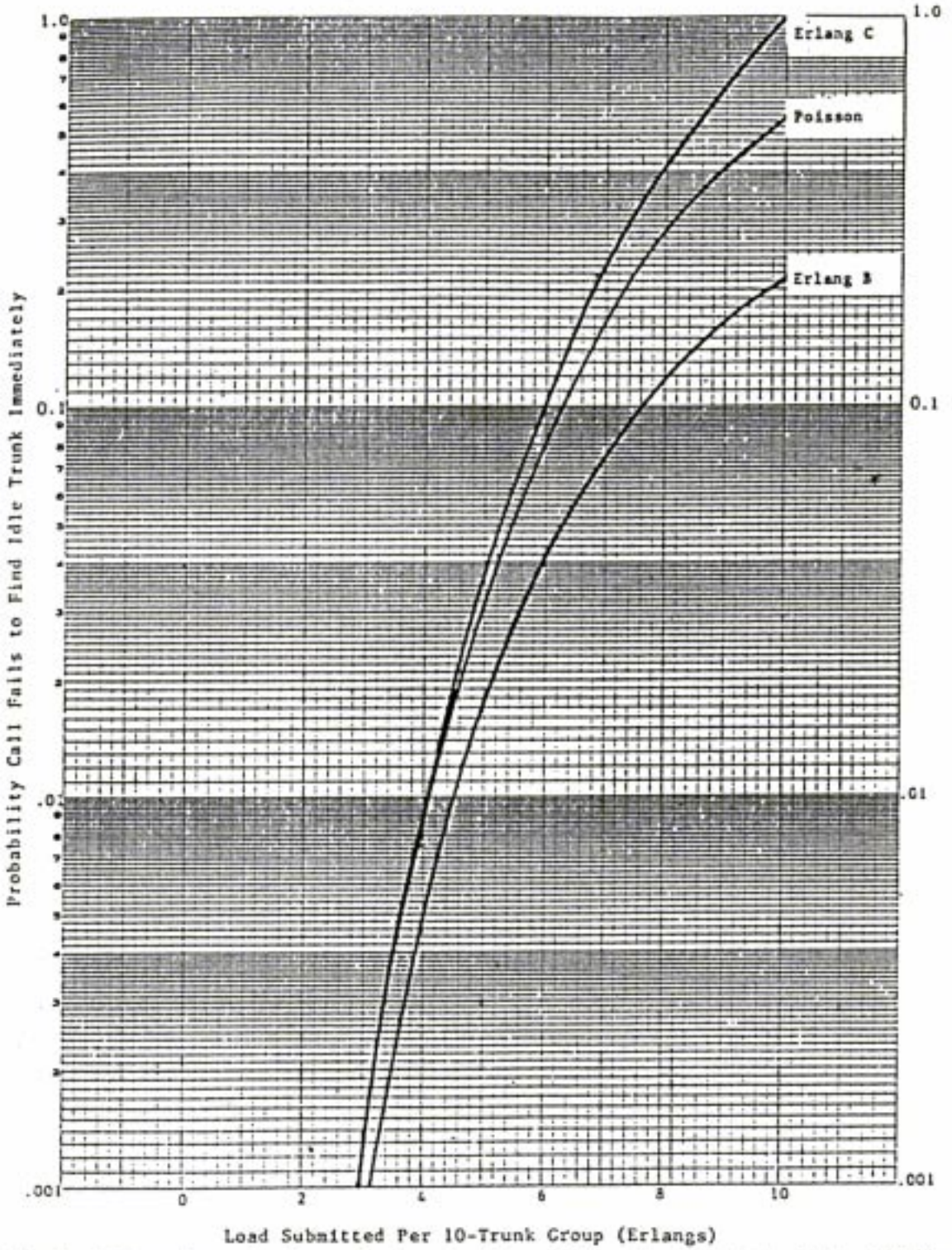


Fig. 11-8. Comparison of major traffic formulas. (From *Defense Communications System Traffic Engineering Practices*, Vol. XII.)

Call Control Procedure

Call Processing in Digital Circuit-Switching Systems

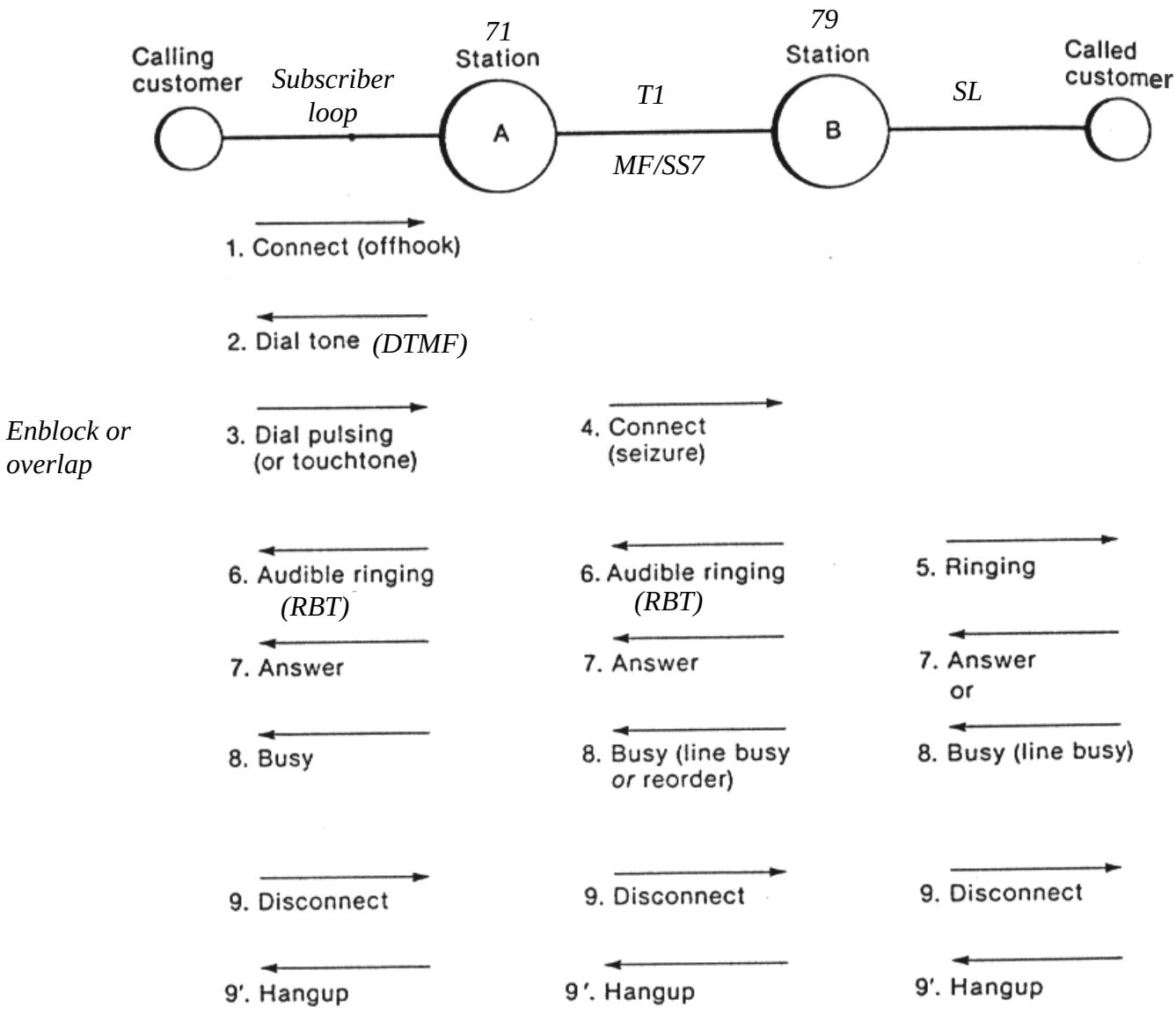


Figure 11–1 Sequence of signals transmitted, ordinary telephone call

- Common control functions:
  - A. Call processing
    - 1. The peripheral I/O scans the lines/trunks, and on detecting that a call is arriving, requests creation of a terminal-handling process (labeled A in Figure 11-4).
    - 2. Terminal process A applies dial tone via the peripheral I/O process and then waits for the digits.
    - 3. On receiving the first digit, terminal process A removes dial tone and collects the digits from the peripheral I/O process.
    - 4. Terminal process A sends a message to the routing and terminal-allocation process to locate the called party.
    - 5. The routing and terminal-allocation process, after locating the called party, notifies the switch-allocation process to set up the speech path through the time-multiplexed switch. The routing-terminal allocation process creates a terminal-handling process B in the called interface module, to handle the called line (telephone) or trunk.

- A. Call processing (cont)
  - 6. Terminal process B communications with terminal process A: It sends either a busy signal or a “setup complete” message, depending on conditions at the called interface. If the telephone at the called interface is on-hook, terminal process B applies a ringing tone.
  - 7. Terminal process A, on receiving the “setup complete” message from B, applies audible ringing to the calling terminal.
  - 8. When the called terminal goes off-hook, terminal process B removes the ringing and sends an answer message to A.
  - 9. Terminal process A suspends audible ringing.
    - At this point the calling and called parties can begin their two-way conversation. Note how the various steps in setting up the connection between the two parties correspond to the sequence of signals described in the earlier discussion, as portrayed in Fig. 11-1.

- A. Call processing (cont)
  - 10. When either terminal goes on-hook, the terminal process involved sends an appropriate release signal to the other side and notifies the switching-path-allocation process to release the speech path between the two interface modules.
- B. Maintenance
- C. Administration

- Switching software
  - Call Processing in Digital Circuit-Switching Systems

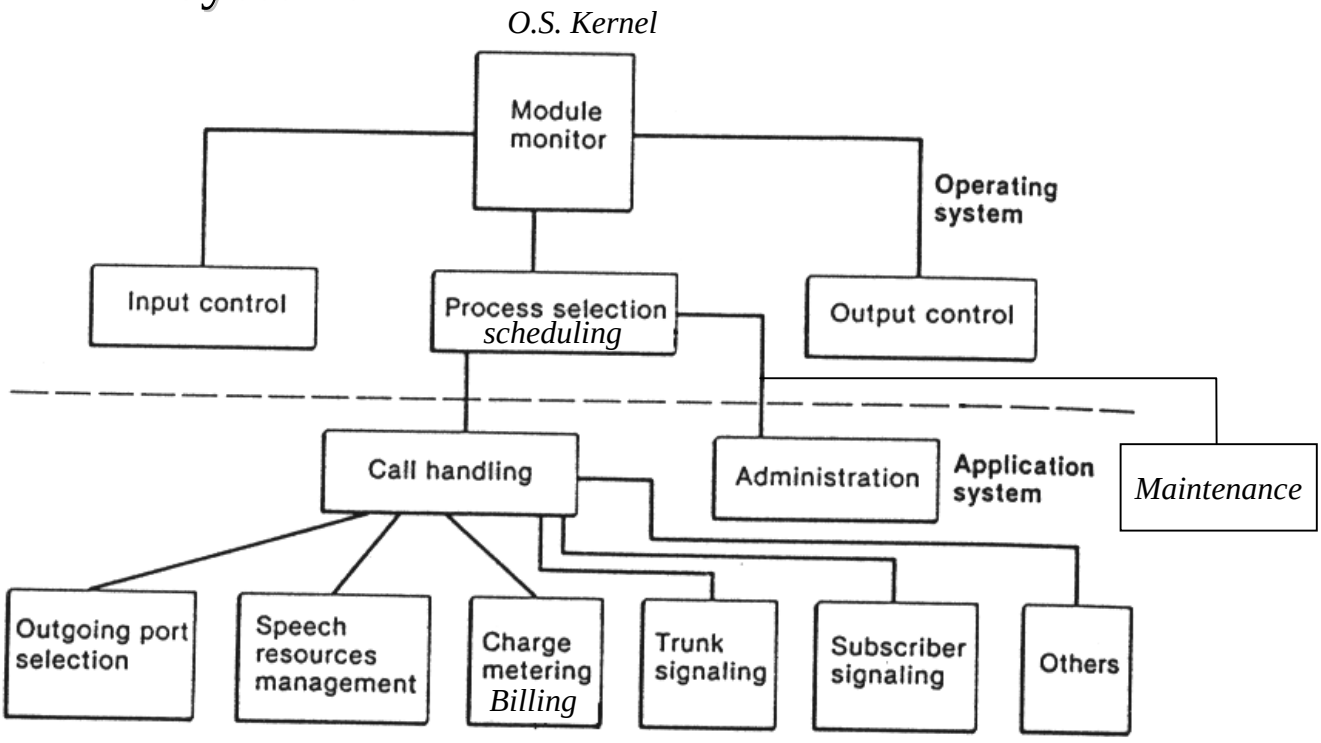
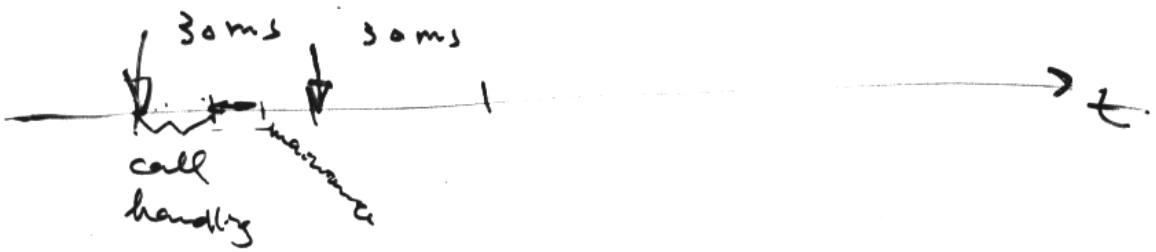


Figure 11–2 Italtel UT 10/3 module processor software structure: input/output management (from [PROT]. Reprinted by permission of Italtel. Proteo UT 10/3 is a product of the LINEA UT Family of Electronic Switching Systems)

OMAP



– Call Processing in Digital Circuit-Switching Systems

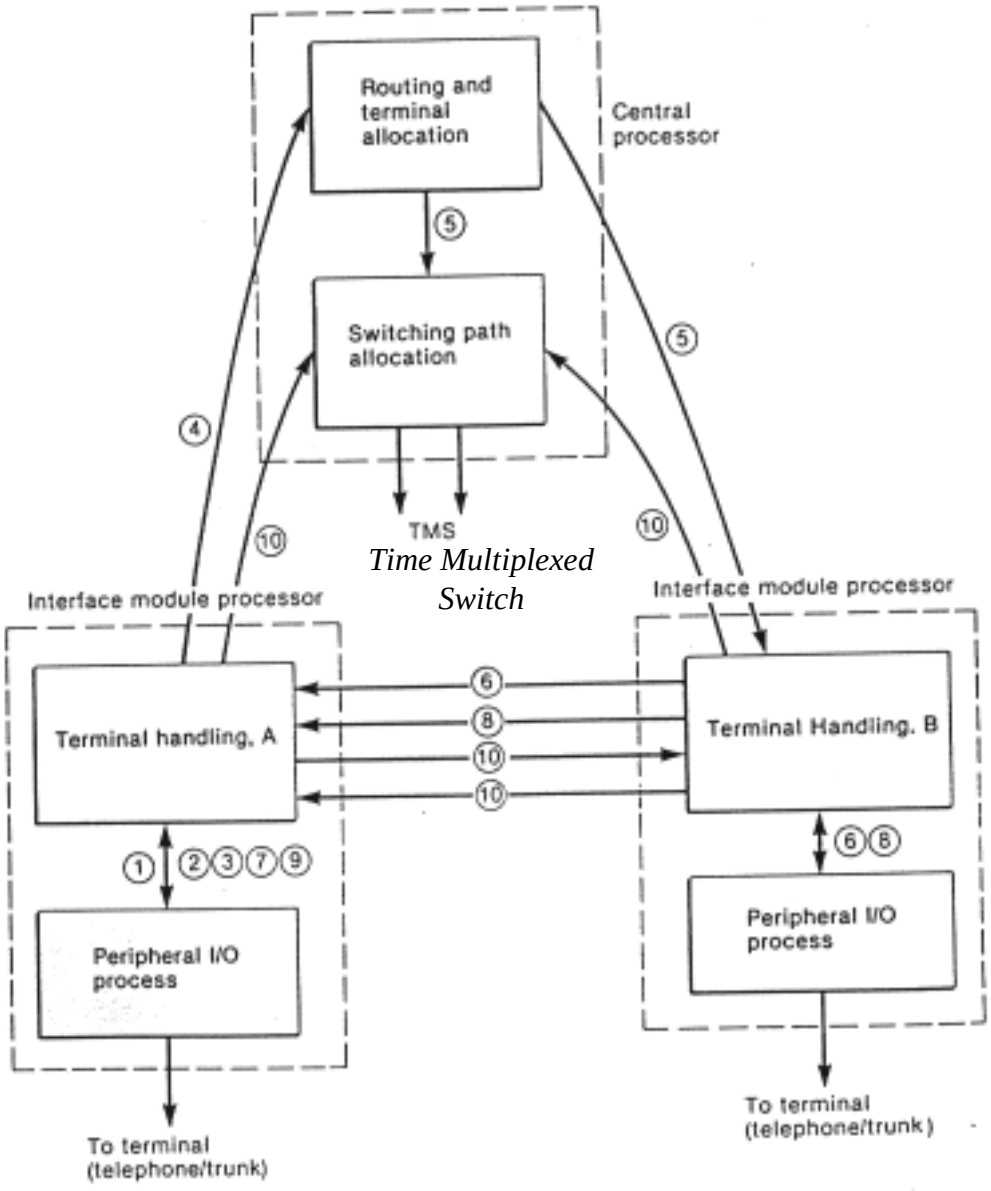


Figure 11–4 Call-processing software structure, AT&T No. 5 ESS (after [DUNC, Fig. 6], © 1982 IEEE, with permission)