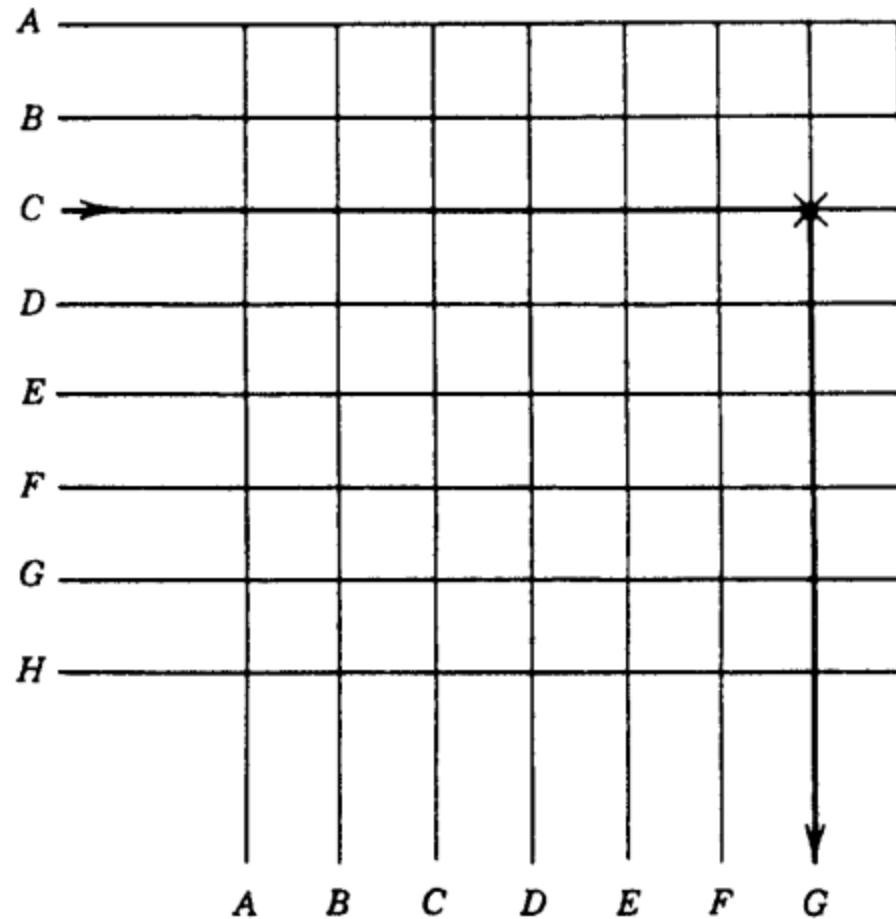# Time division Switching

Digital Switching

- **Switch** is the key device in **PSTN** .
- **PSTN** is an example of **Circuit Switched Network**.
- A **Digital Switch** in **PSTN** is divided into two parts:
1. **Space-Division Switch.**
2. **Time-Division Switch.**
- Combination of **Space-Division Switch** and **Time-Division Switch** construct the **Digital Switch**.

- **Crossbar Switch** is also known as **Space-Division Switch**.

- **Space Division** refers to the fact that **speech paths are physically separated in space**.

- In **Space-Division Switching**, a metallic path is set up between calling and called subscriber.

A space-division switch showing connectivity from user C to user G

- **Time-Division Switch** is also known as **Time-Slot Interchanger** (**TSI**).
- It permits a **single common metallic path** to be used by many **calls separated** one from the other in the **time domain**.
- With **Time-Division Switching**, the speech to be switched is **digital in nature** (**PCM**).

- Where, samples of each telephone call are assigned **time-slots**, and **PCM switching** involves the distribution of these slots in sequence to the desired destination port(s) of the switch.

- Internal functional connectivities in the switch are carried out by **digital highways**.

- A **highway** consists of sequential speech path **time-slots**.
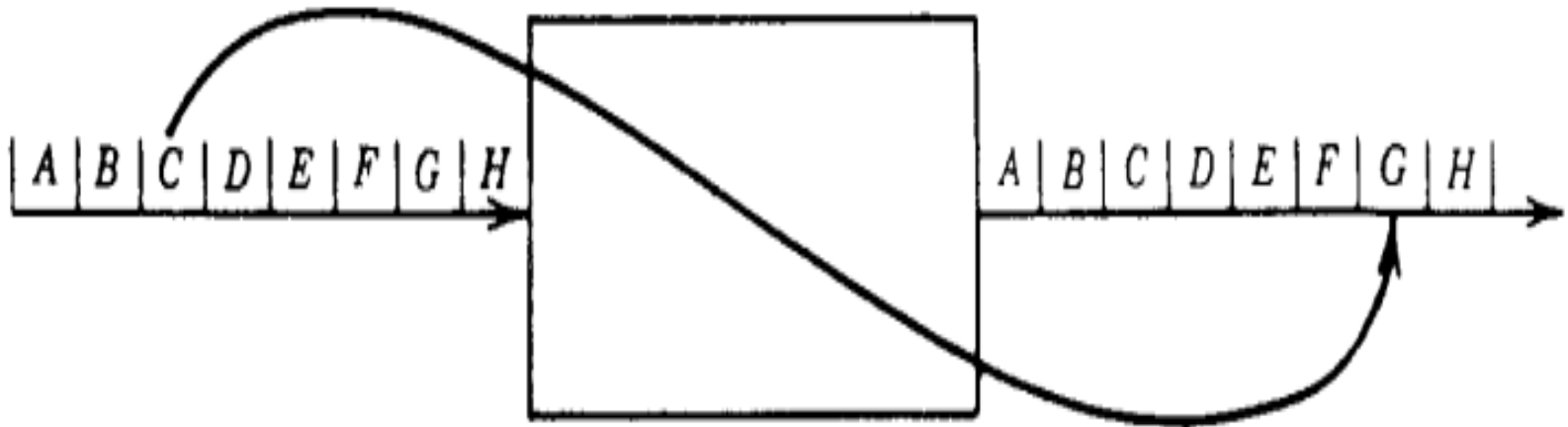
A time-division switch which is a time-slot interchanger (TSI). Connectivity is from user C (in incoming times slot C) to user G (in outgoing time slot G)

- A classical **Digital Switch** is made up of two functional elements:

1. **A Time Switch called "T".**
2. **A Space-Switch called "S".**

- The architecture of a digital switch is described in sequences of **T**s and **S**s.

- For example, the **4ESS** is a **TSSSST switch**.

- Where, the **input stage is a time switch**, followed by **four space switches** in sequence and the **last stage is a time stage**.

- Another example, the **Northern Telecom DMS-100** is a **TSTS** switch that is folded back on itself.

- Many of the **new switches** or enhanced versions of the switches just mentioned have **very large capacities** (e.g.,**100,000 lines**) and are simply **TST** or **STS switches**.
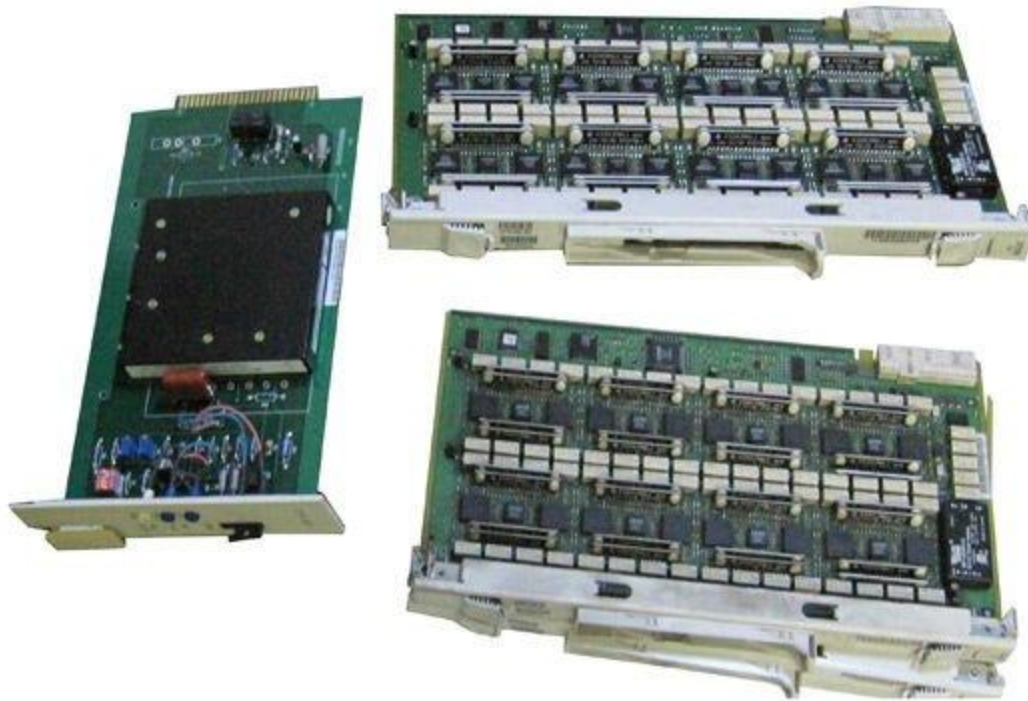
Lucent 5ESS TSSSST Switch

**Northern Telecom DMS-100 Line Card Drawer showing line cards**

Time Switch

- **Time-Division Switch** or simply, **Time-Switch** is a **Time-Slot Interchanger** (**TSI**).

- We know that **E1** consists of **32 time-slots** in **125 μs**, with time slot duration of **3.906 μs**, and each **time-slot** contain **8-bits**.

- **TSI** involves moving the data contained in each **time-slot** from the incoming bit stream at the **switch inlet ports**, to an outgoing bit stream at the **switch outlet ports**, but with a different **time-slot** arrangement in accordance with the destination of each **time-slot**.

- To accomplish this, at least one **time-slot** must be stored in **memory** (**Write**) and then called out of memory in a changed position (**Read**).

- The operations must be **controlled** in some manner, and some of these **control actions** must be kept in **memory** together with the **software managing** such actions.

- Typical **control functions** are **time-slot** "**idle**" or "**busy**".

- The three basic functional blocks of a **time switch** are:

1. **Memory for speech.**
2. **Memory for control.**
3. **Time-slot counter or processor.**

- There are two choices in handling the **time switch**:

1. **Sequential write, random read**
2. **Random write, sequential read.**
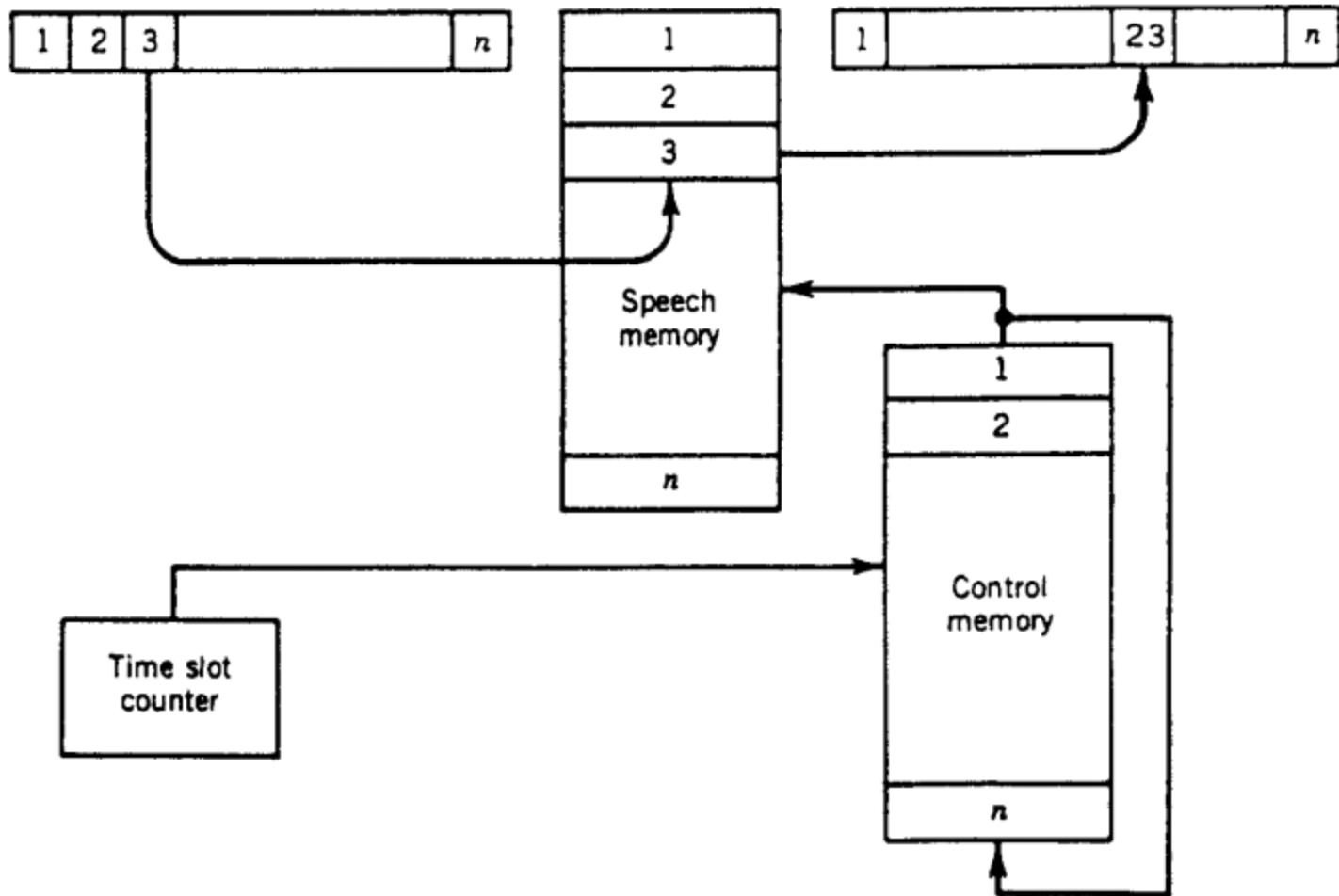
**Time-slot interchange: time switch (T). Sequential write, random read.**

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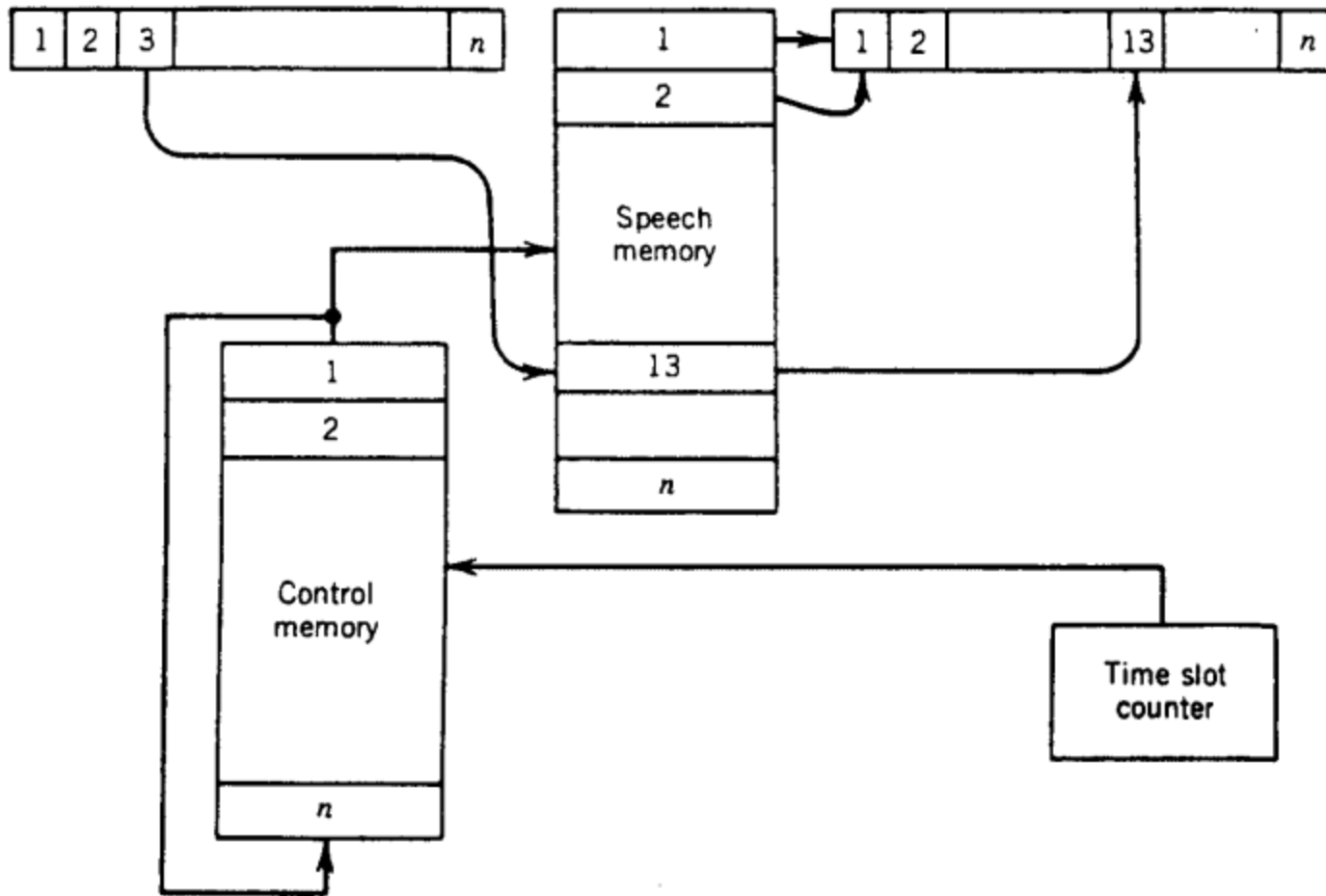
Time-switch, time-slot interchange (T). Random write, sequential read.

- **With sequential write**, the **time-slots** are written into the speech memory as they appear in the incoming bit stream.
- **With random write**, the incoming **time-slots** are written into memory in the order of appearance in the outgoing bit stream (the desired output order).
- The writing of incoming **time-slots** into the speech memory can be controlled by a simple **time-slot** counter and can be sequential (e.g., in the order in which they appear in the incoming bit stream).

- If the **readout** of the speech memory is controlled by the **control memory**,

- In this case the **readout is random** where the **time-slots** are read out in the desired output order.

- If the **write** is of the speech memory is controlled by the **control memory**,

- In this case, the **writing process is random**.

- The memory has as many cells as there are **time-slots** (e.g. **E1 = 32 time-slots**, **DS1 = 24 time-slots**).

- This time switch, works well for a **single multiplexed inlet – outlet switch**, which we denote by **single inlet – outlet trunk** .

- How can we increase a switch's **capacity**?
- Enter the **space switch** (**S**). (**see the figure in the next slide**)
- For example, **time-slot B_1** on the **B** trunk is moved to the **Z** trunk into **time-slot Z_1**, and **time-slot C_n** is moved to trunk **W** into **time-slot W_n**.
- However, we see that there is no change in **time-slot position**.
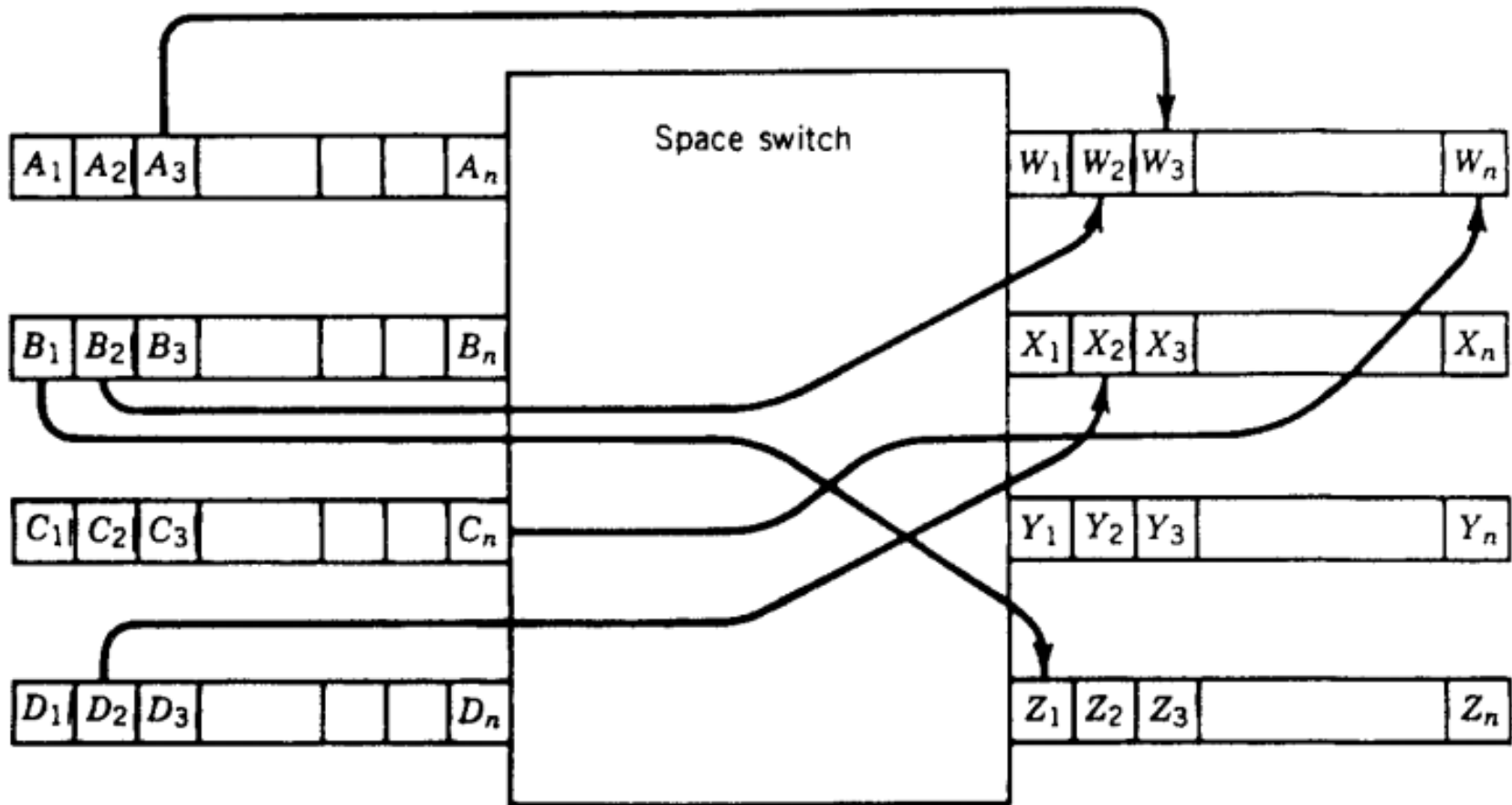
Space switch connects time slots in a spatial configuration.

Space Switch

- Figure in the next slide illustrates a typical **time-division space switch**.

- It consists of a **Cross-Point Matrix** made up of **Logic Gates** that allow the switching of **time-slots** in the **spatial domain**.

- These **PCM time-slot bit streams** are organized by the switch into a pattern determined by the required network connectivity.
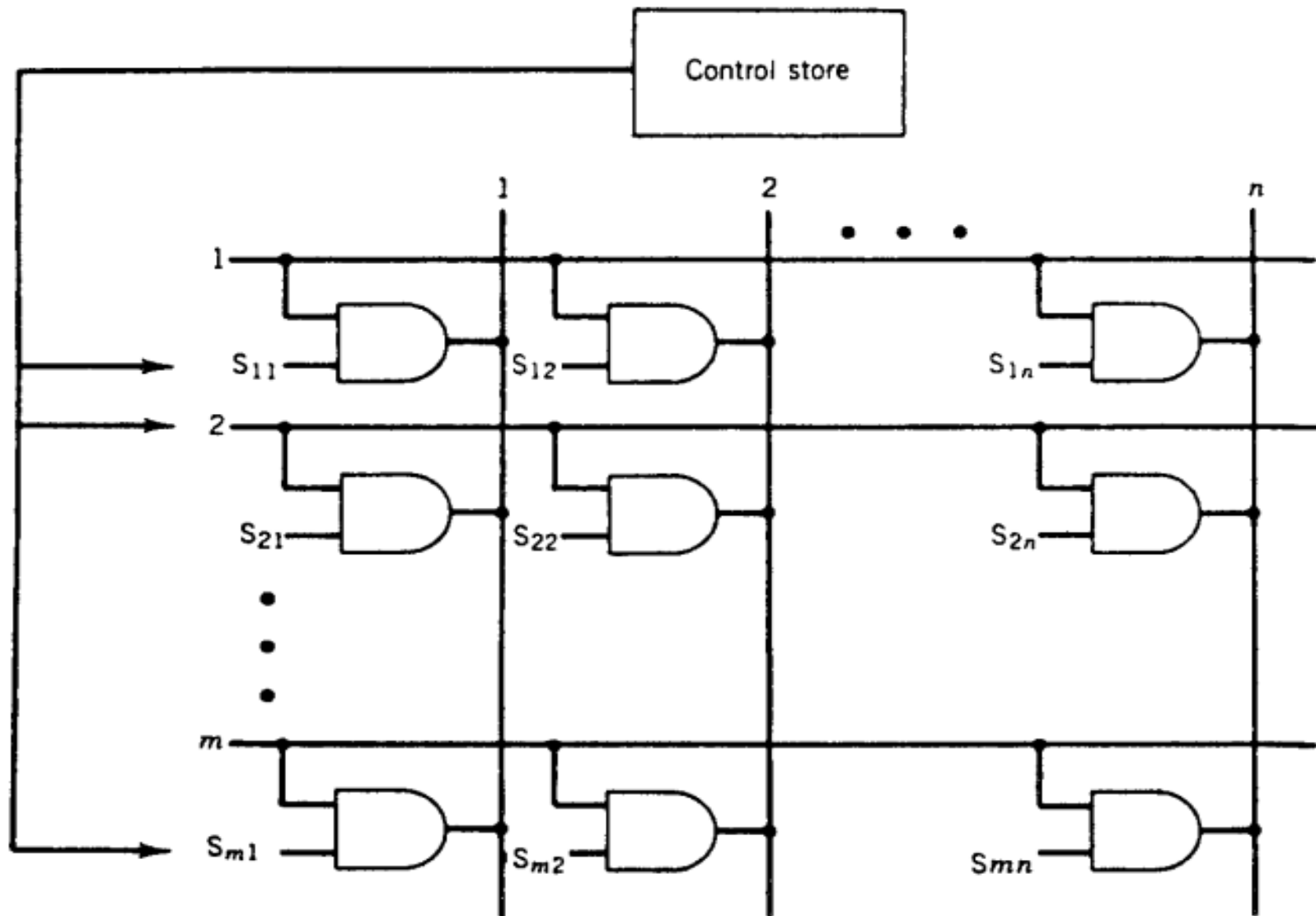
Time-division space switch cross-point array showing enabling gates.

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- The matrix consists of a number of **input horizontals** and a number of **output verticals** with a **Logic Gate** at each **cross-point**.

- The array, as shown in the figure, has *M* **input horizontals** and *N* **output verticals**, and we call it an *M × N* array.

- If $M = N$, **the switch is Non-blocking**.
- If $M > N$, **the switch Concentrates**;
- If $N > M$, **the switch Expands**.
- For a given **time-slot**, the appropriate **Logic Gate** is enabled and the **time-slot** passes from the **input horizontal** to the desired **output vertical**.