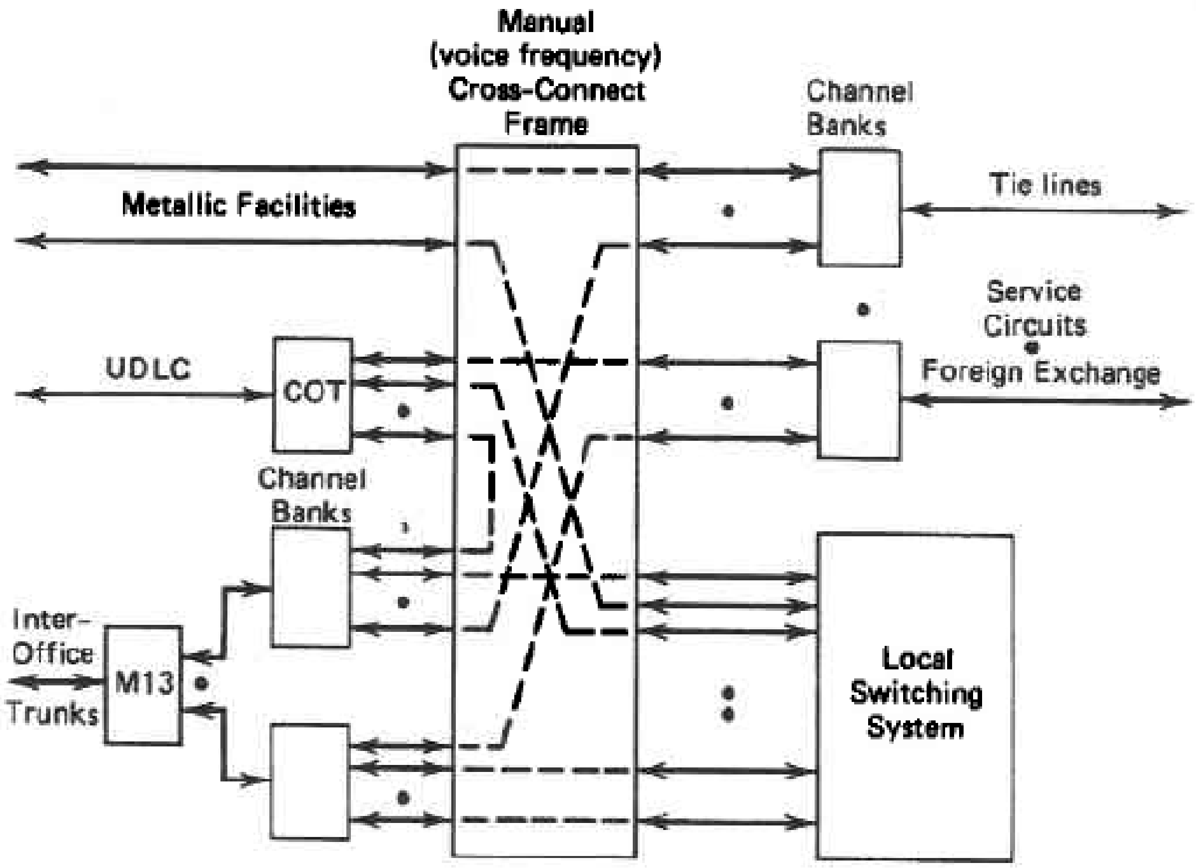
Digital Cross Connect Systems & Digital switching in analog environment

Lecture 3

Digital Cross Connect System

- A digital Switching matrix with an operations interface for setting up relatively static connections between input and output signals or channels.
- DCS connections are established in response to network configuration needs.
- Most basic function of DCS is to act as an electronic patch panel in lieu of a manual cross connect facility.

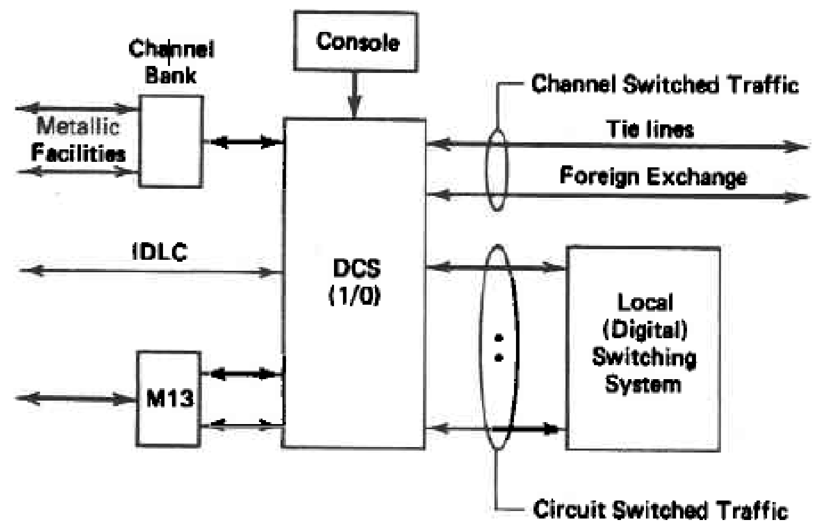
Manual Cross connect system diagram



Manual cross-connect system.

Additional advantages of cross connect system

- Automatic record keeping: Because the cross connects are under processor control, circuit connection reports are readily available through the management interface. In contrast , records in manual systems were inherently error prone and often out of date.



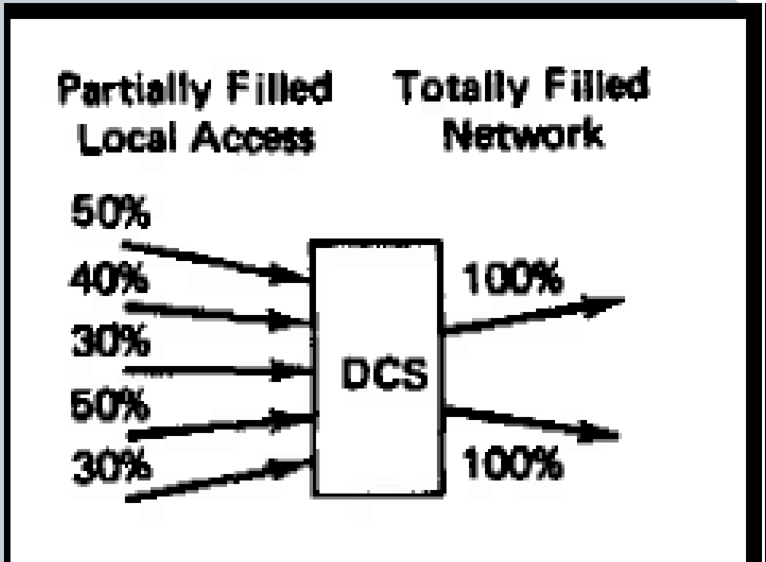
Electronic digital cross-connect system.

(continued)

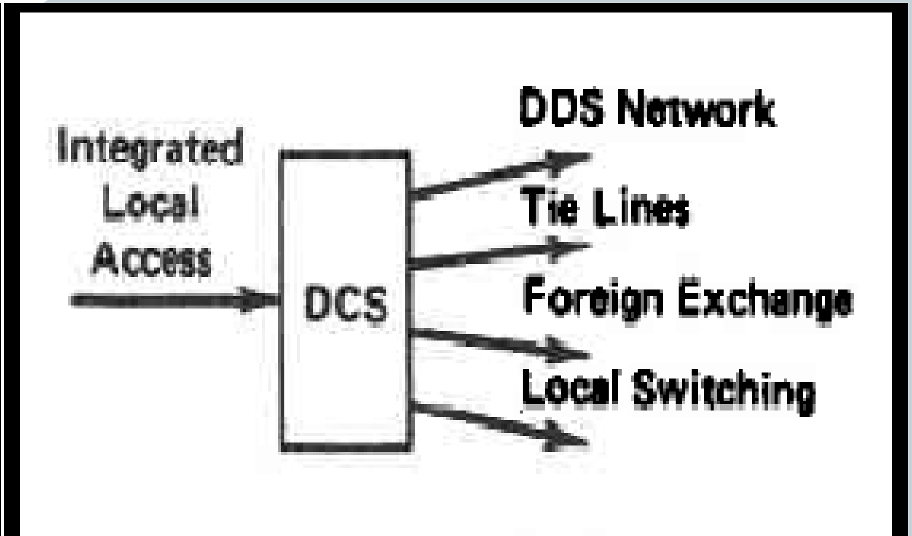
2. Remote and Rapid Provisioning: Provisioning is the basic process of providing (or discontinuing) service to a particular customer. The basic operations involved are outside-plant cross connections, inside-plant cross connections, configuration changes in switching system data base, and customer record updates in business(billing) Systems.

- 3. Automated Test Access: Testing analog circuits at a manual cross-connect frame involves physically breaking the connection (by removing bridging clips) and attaching the test equipment to the side of the circuit to be tested. All manual operations are eliminated with an electronic patch panel by entering commands at the management console to connect the desired test tone$ and (DSP) measurement channels to the circuit under test.

Consolidation and Segregation



Consolidation.

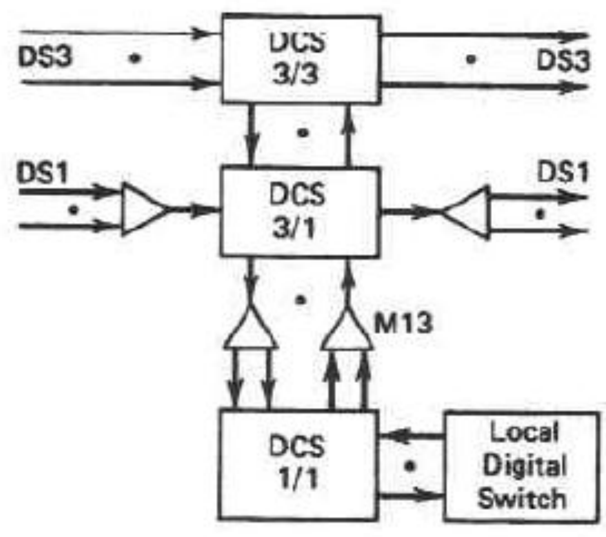


Distribution.

Two basically different DCS grooming functions are depicted in Figures are consolidation and segregation. When multiple-access lines carrying traffic destined to a common distant node are partially filled, the per-channel costs of transport to the remote node can be reduced by consolidating the traffic. Conversely, when different types of traffic originate at a single location, it is desirable to allow a single facility to carry all types of traffic and segregate it at the DCS.

DCS Hierarchy

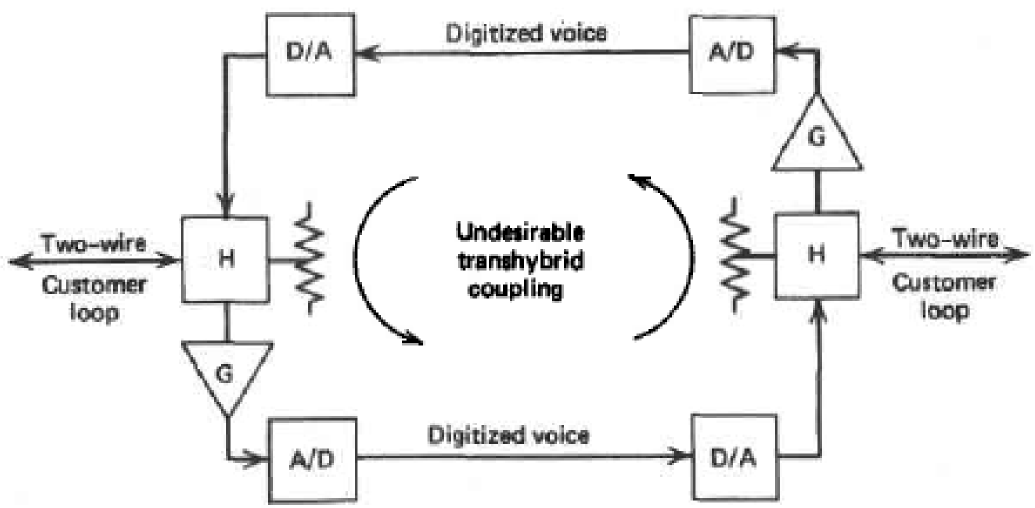
The cross-connect System depicted terminates DSI signals and interchanges DSO signals, which leads to the designation DCS l/O. Similarly, a digital cross-connect System that terminates DS3 signals and rearrange DSl signals within the DS3s is referred to a DCS3 /1. If a DCS, such as DCS3 /0, provides rearrangement of lower level signals, such as DSOs, it does not necessarily mean that it also provides cross-connect services for intermediate-level signals, such as DS1s.



DCS hierarchy.

DIGITAL SWITCHING IN AN ANALOG ENVIRONMENT

When digital end office switches (or PBXs) are installed in an analog environment, the analog interfaces are necessarily unchanged. Although the digital switch may interface with digital subscriber carrier or digital fiber feeder systems, these systems merely extend the analog interface point closer to the subscriber. This section describes the basic considerations of using digital switching in such an analog environment. Chapter 11 describes digital end office switching with digital subscriber loops in relation to the integrated services digital network.



Four-wire digital switch with two-wire analog interfaces.

BORSCHT

In Chapter 1 the basic functional requirements of the subscriber loop interface are described. These requirements are repeated here with two additional requirements for a digital switch interface: coding and hybrid. The complete list of interface requirements is unaffectionately known as BORSCHT [18]:

B: Battery feed
O: Overvoltage protection
R: Ringing
S: Supervision
C: Coding
H: Hybrid
T: Test

As mentioned in Chapter 1, the high-voltage, low-resistance, and current requirements of many of these functions are particularly burdensome to integrated circuit implementations. First-generation digital end office switches reduced the termination costs by using analog switching (concentrators) to common codecs. The DMS-100 [19] of Northern Telecom and the No. 5 ESS of AT&T [20] use analog concentration at the periphery. Integrated circuit manufacturers have worked diligently to implement the BORSCHT functions in what is called a subscriber loop interface circuit (SLIC). Per-line SLICs allow implementation of per-line BORSCHT functions. SLICs can be used in PBX applications with a minimum of other external components. In central office applications, where lightning protection and test access are more demanding, SLICs typically need other components for a complete interface.

TSSST Switches

When the space stage of a TST switch is large enough to justify additional control complexity, multiple space stages can be used to reduce the total crosspoint count. Figure 5.25 depicts a TST architecture with a three-stage space switch. Because the three middle stages are all space stages, this structure is sometimes referred to as a TSSST switch. The EWSD switch of Siemens [9] uses a TSSST structure.

The implementation complexity of a TSSST switch can be determined as*

$$\text{Complexity} = N_X + \frac{N_{BX} + N_{BT} + N_{BTC}}{100}$$

where N_X = number of crosspoints, $= 2Nk + k\,(N/n)^2$

N_{BX} = number of space stage control store bits, $= 2k(N/n)l\,\log_2(n) + k(N/n)l\,\log_2(N/n)$

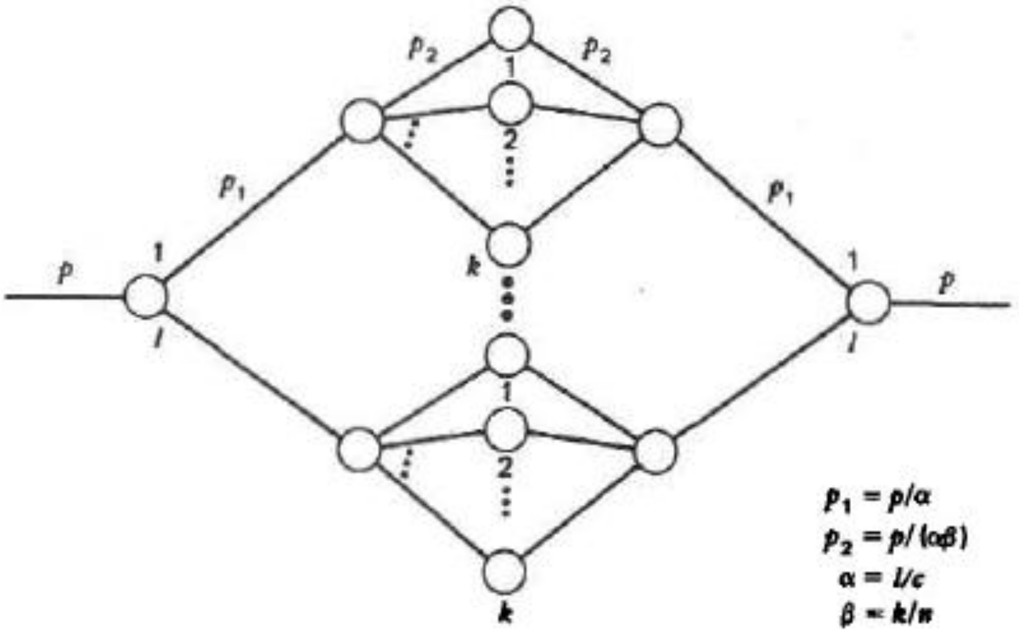
N_{BT} = number of bits in time stages, $= 2Nc\,(8)$

N_{BTC} = number of time stage control store bits, $= 2Nl\,\log_2(c)$

The probability graph of a TSSST switch is shown in Figure 5.26. Notice that this diagram is functionally identical to the probability graph of a five-stage space switch shown in Figure 5.10. Using the probability graph of Figure 5.26, we can determine the blocking probability of a TSSST switch as

$$B = \{1 - (q_1)^2[1 - (1 - q_2^2)^k]\}^l$$

Probability of TSSST switch



Probability graph of TSSST switch.

where $q_1 = 1 - p_1 = 1 - p/\alpha$

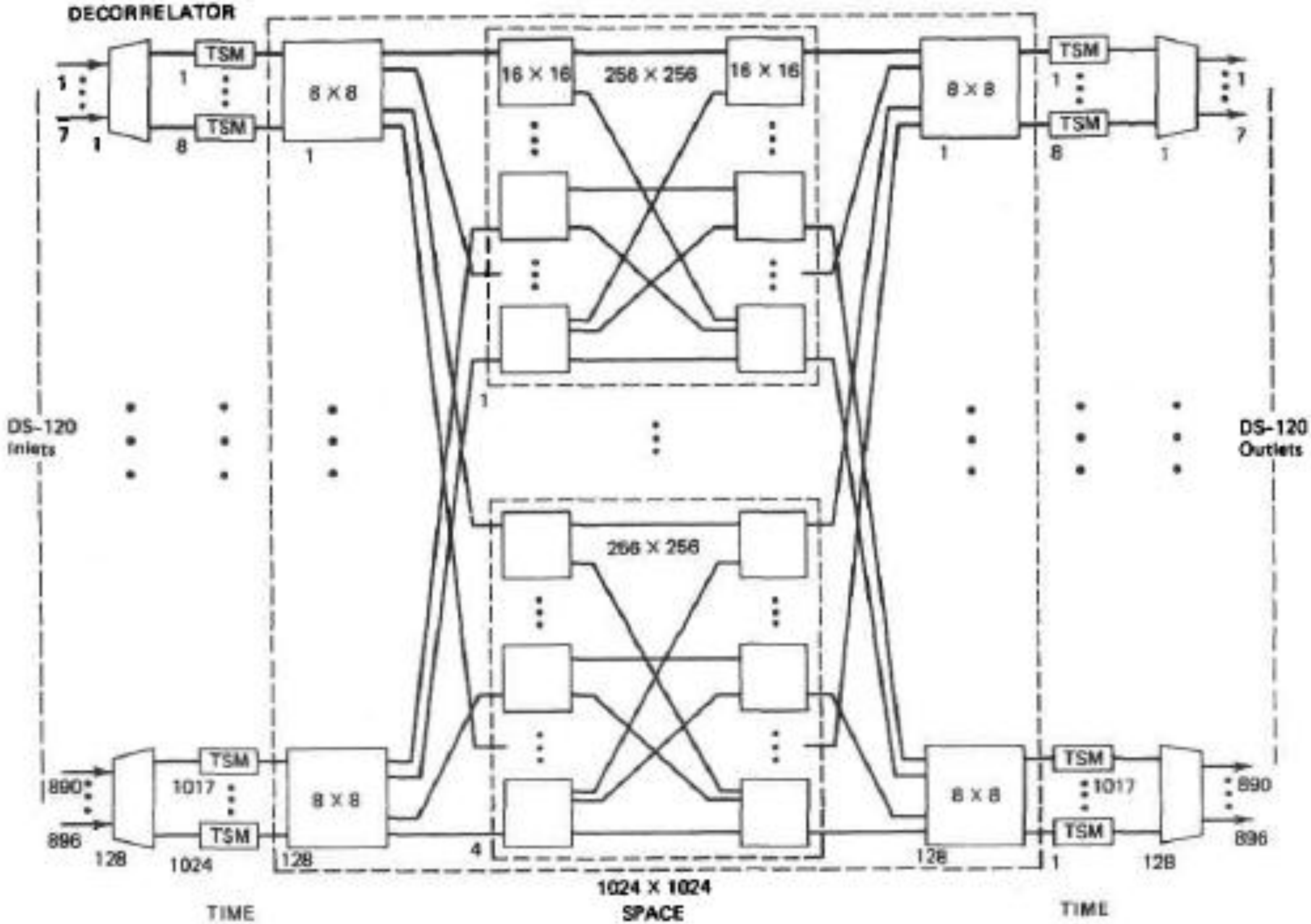
$q_2 = 1 - p_2 = 1 - p/\alpha\beta$

No. 4 ESS Toll Switch

As shown in Figure 5.27, the basic structure of a No. 4 ESS matrix is time–space–time with four stages in the space switch (i.e., a TSSSST) [10, 11]. The inputs to the matrix are 120-channel TDM links formed by multiplexing five DS1 signals together. Before these inputs are interfaced to the matrix, they are passed through a decorrelator to distribute the channels of incoming TDM trunk groups across multiple TDM links into the matrix. Decorrelation is used because the No. 4 ESS is a toll switch in which the incoming TDM links represent trunk groups from other switching machines. In contrast to TDM links of an end office switch formed by multiplexing independent subscriber channels, the channels of a TDM trunk group are not independently busy. In fact, the act of concentrating multiple, independent sources onto a trunk group causes high levels of correlation between the activity on the individual channels. If the channels of a trunk group were not decorrelated, they would experience much higher blocking probabilities because they would all be vying for the same paths through the matrix. Decorrelation shuffles the trunk groups so the alternate paths available for any particular connection are more likely to be statistically independent. Notice that, besides shuffling channels, the decorrelator provides space expansion (7 to 8) and time expansion (120 to 128).

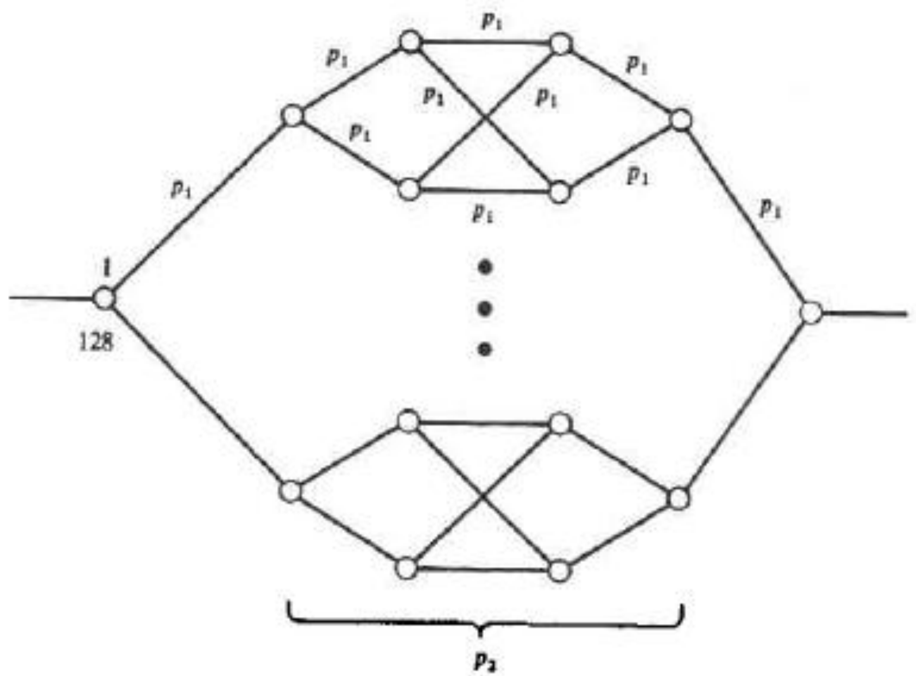
The maximum size of the No. 4 ESS uses 128 decorrelators with seven 120-channel inputs each. Thus the maximum channel capacity is (128)(7)(120) = 107,520 channels. The space stage is a 1024×1024 matrix with four possible paths provided during each of the 128 space stage time slots. The probability graph of the No. 4 ESS switch is shown in Figure 5.28, from which the following blocking probability is derived:

$$B = [1 - (1 - p_1)(1 - p_2)(1 - p_1)]^{128} \qquad (5.20)$$



No. 4 ESS matrix architecture.

Probability of No. 4 ESS switch



Probability graph of No. 4 ESS matrix.