Module 9

Digital Switching

Lesson

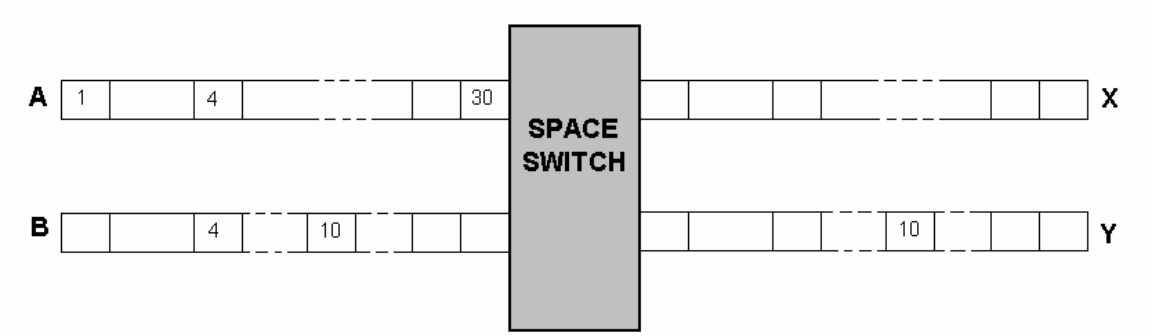
32

Time and Space Switches

Version 1 ECE , IIT Kharagpur

9.4.1 COMBINATION OF TIME AND SPACE SWITCHES

The time switch has a capacity limit as even with a memory cycle at 833 MHz (approx 1 ns) only 125000 users can be served by a single switch. Advantage is however obtained in terms of flexibility. To increase the capacity we use a combination of space and time switches as shown below. Say user 4 on incoming line A wants to connect to user 10 on outgoing line Y then the switching may be performed as A4 to B4 using a Space switch and then from B4 to Y10 using a Time switch. Alternately we may perform the TS Interchanging first i.e. from A4 to A 10 and then perform a space switching from A10 to Y10.



The space switch has a computer for control and is generally multiplexed. To optimize the cost of this combination switch we should have T as large as possible and augment many such T switches using the S switches. In spite of this the combination is not Non-Blocking.

2-stage combination switches

Time multiplexed time division space switches do not provide full availability as they are not capable of performing time slot interchange. Time slot interchange switches are not capable of switching sample values across the trunks without the help of some space switching matrices. Therefore, a combination of the time and space switches leads to configurations that achieve both time slot interchange and sample switching across trunks. These structures also permit a large number of

simultaneous connections to be supported for a given technology. A combination switch can be built by using a number of stages of time and space switches. A two-stage combination switch may be organized with time switch as the first stage and the space switch as the second stage or vice versa. Accordingly, the two switch configurations are known by the nomenclature time-space (TS) or space-time (ST) switches respectively.

Each time multiplexed inlet/outlet stream carries *M* channels. A subscriber on the input side is assigned to one of the inlets and a time slot in that inlet. An input subscriber assigned to line *i* at time slot *j* is identified by the label I_{ij}. Similarly, a subscriber connected to the outlet *m* and time slot *n* is identified by 0_{mn}.The corresponding time slots are identified as IS_{ij} and OS_{mn}.

Theoretically, the TS switch can be made nonblocking by using an expanding time switch and a concentrating space switch. In the worst case, all the subscribers in one line may want to establish connection to the same output time slot. In order that they can be accommodated without blocking, we need *(M* - 1) additional slots for each time slot. The space switch must be able to establish *M* connections for each input time slot. This implies *M2* time slots on the output side of TSI. A time switch providing expansion from *M* inlet time slots to *M2* outlet time slots is very expensive. Moreover, the space switch at the second stage has to concentrate the time slots on the output side. Design of such a space switch is complex. Instead, the space switch may be symmetric with regard to time slots and a concentrating TSI switch may be added as another stage in the network.

Similar to a TS switch, the Space-Time switch is also blocking. This happens when the input samples originate from two different inlets during the same time slot and are destined to the same outlet though to different time slots.

3-stage combination switches

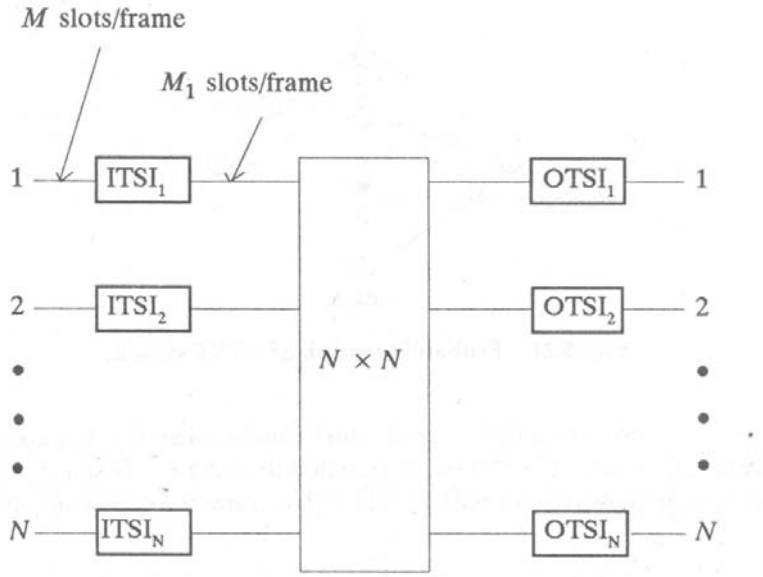
Three-stage time and space combination switches are more flexible than their two-stage counterparts. The most common three-stage configurations are:

Those which place time stages on either side of a space stage giving rise to TST configuration

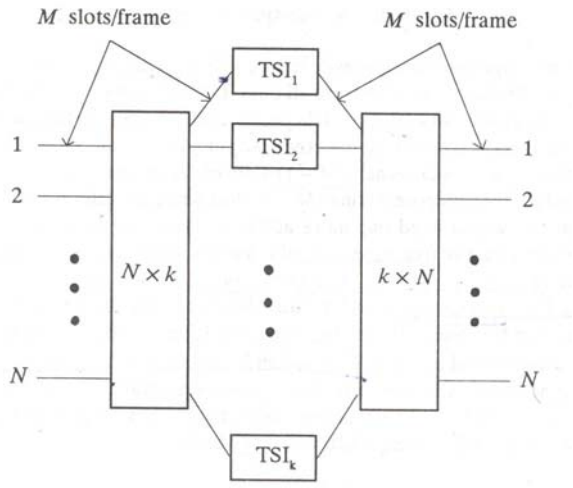
Those which place space stages on either side of a time stage giving rise to STS configuration.

A TST network is shown in the figure below. The two time stage exchange information between external channels and the internal space array

channels. The first flexibility that becomes obvious in this arrangement is that there is no need to have a fixed space stage time slot for a given input or output time slot. There are many alternative paths between a prescribed input and output unlike a two stage network which has only one fixed path. This factor reduces the value of the blocking probability of a three-stage combination switch.



Three-stage combination switches are still blocking. Consider a situation when *(M* -1) slots in an inlet I_j are all busy. Let traffic arrive in the Mth slot destined to a time slot outlet O_k. It is possible that during the time slot *M,* the outlet O_k is busy receiving some other output. As a result, blocking occurs. The worst case happens when *(M* -1) slots of O_k are busy and the outlet is occupied for this purpose during *(M* - 1) slots when the inlet I_j is free. If this happens, we would need one more additional time slot to establish a connection between the free time slots of I_j and O_k. This means that we need a total of *(M-1)* + *(M-1)* + *1* time slots, i.e. *2M*- 1 time slots in the intermediate space stage.



A space-time-space (STS) architecture consists of an *N* x *k* space matrix at the input, an array of *k* TSI switches in middle and a *k* x *N* space matrix at the output as shown in the figure above. In this architecture, the choice of input and output time slots is fixed for a given connection. But the flexibility is provided by the ability to utilise any free TSI switch by space switching on the input and the output side. There are as many alternative paths for a given connection as there are TSI switches.

The expansion and the concentration take place at the space switch level and not at the time slot level. The time slots are symmetrical throughout the switch. Based on a reasoning similar to the one used for TST switch, a STS switch is non-blocking if *k=2N-1*.

Switches are designed to be concentrating when the utilisation of the input links is low. As the input traffic intensity increases, less and less concentration is acceptable. When the input loading becomes sufficiently high, space expansion in the STS switch and time expansion in the TST switch are required to maintain low blocking probabilities. Time expansion is cheaper than space expansion. Hence, TST architecture is more cost effective than STS architecture for higher loads. There are, of course, other factors like modularity, testability and maintainability which must also be taken into account before deciding on a particular architecture.

☞*ESS 4 USES 4 S STAGES AND 2 T STAGES.*

INTEGRATION OF SWITCHING AND TRANSMISSION

The switch is not analog, but the exchange is as it handles analog signals. The media between Trunk exchanges (telecom districts) may be coaxial cable, microwave, satellite or Optical fiber cable.

Analog signal has a bandwidth of 300 Hz to 3400 Hz. 12 such FDM channels can be multiplexed, then 5 such groups are multiplexed, and so on. We have the European E series of multiplexing and the American T series of multiplexing.

Objective Questions

32.01

Subjective Questions

32.11

Level 2 Questions

32.21

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