



NPTEL ONLINE CERTIFICATION COURSES

COMMUNICATIONS NETWORK

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Module 02: Circuit Switched Networks

Lecture-05: Space switch Architecture

Concepts Covered

- Space and Time Switching
- Synchronization
- Multiplexing

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Space Switching

Local Loop: Two wire switching matrix (a) square (b) Triangular (folded)

Trunk: (a) Rectangular crosspoint array, (b) Graded rectangular switching matrix

Limitations:

High number of cross points – most of them are not utilized (no sharing)

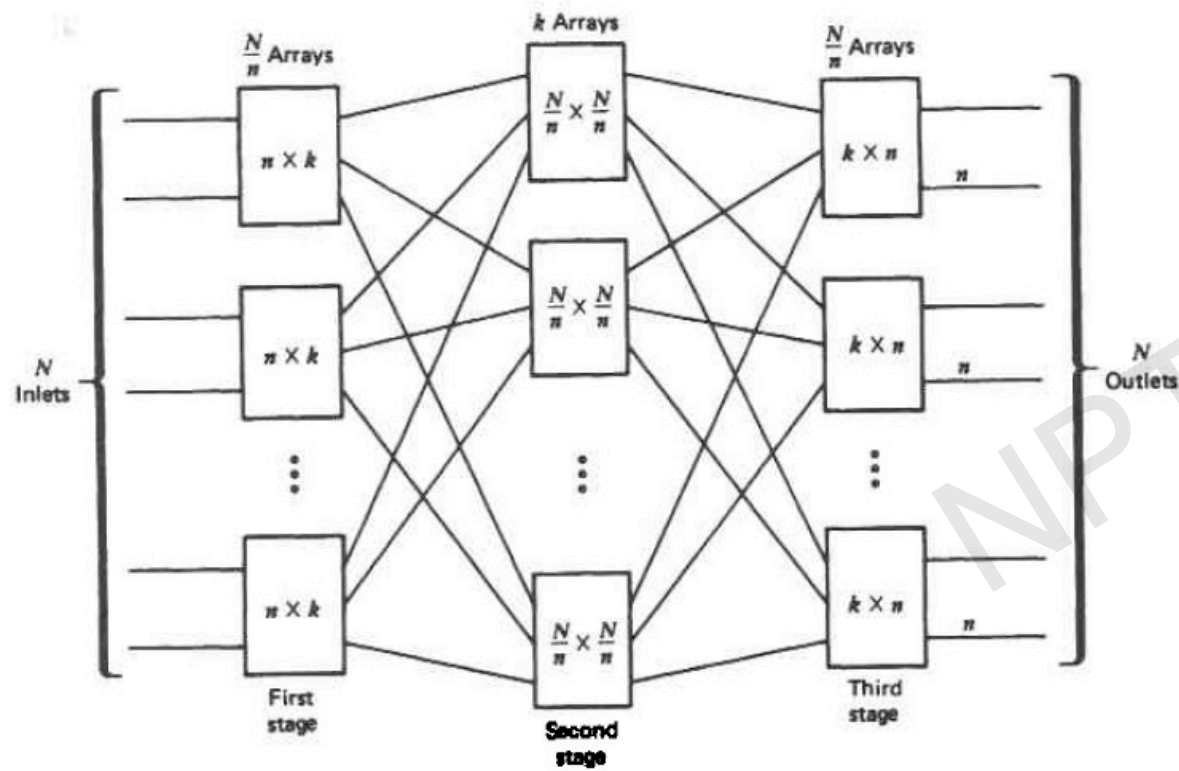
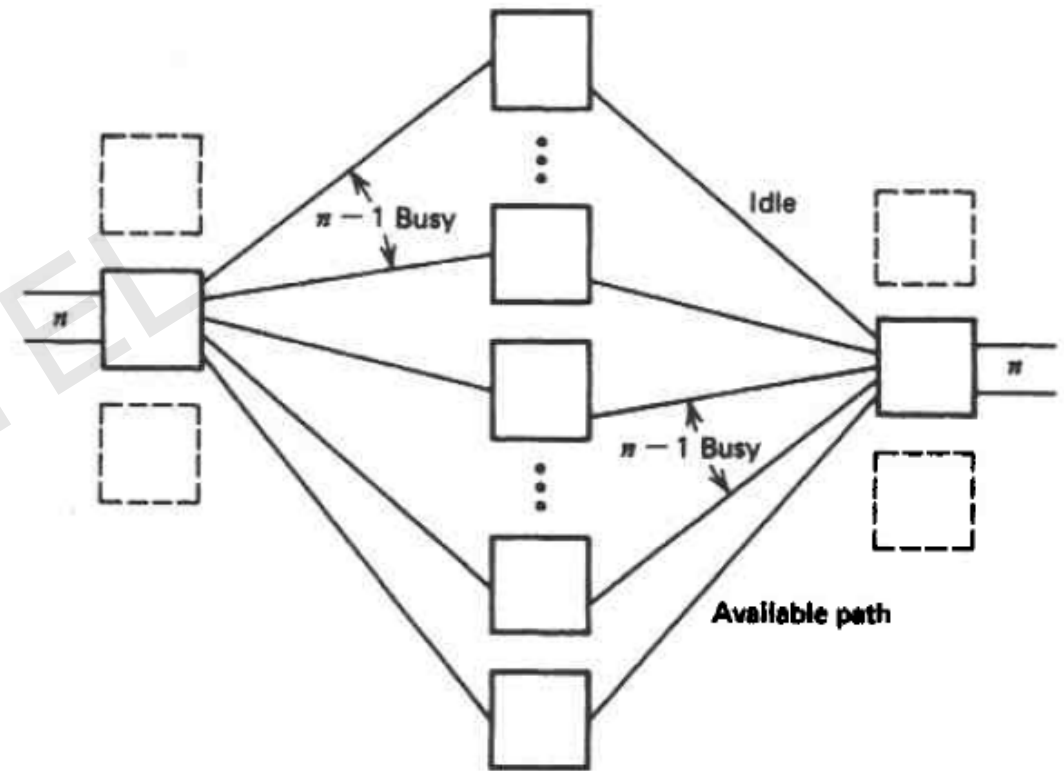
Capacitive load effect

Design Challenges:

Sharing – availability issue – how to make it non blocking

Solution:

Multi stage switching – Clos switch



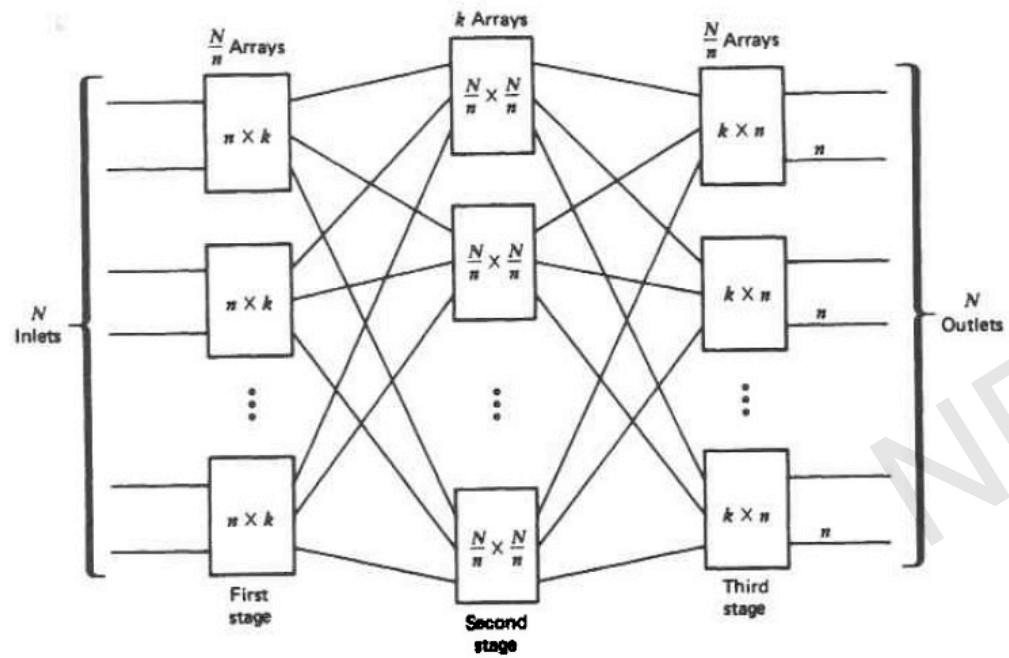
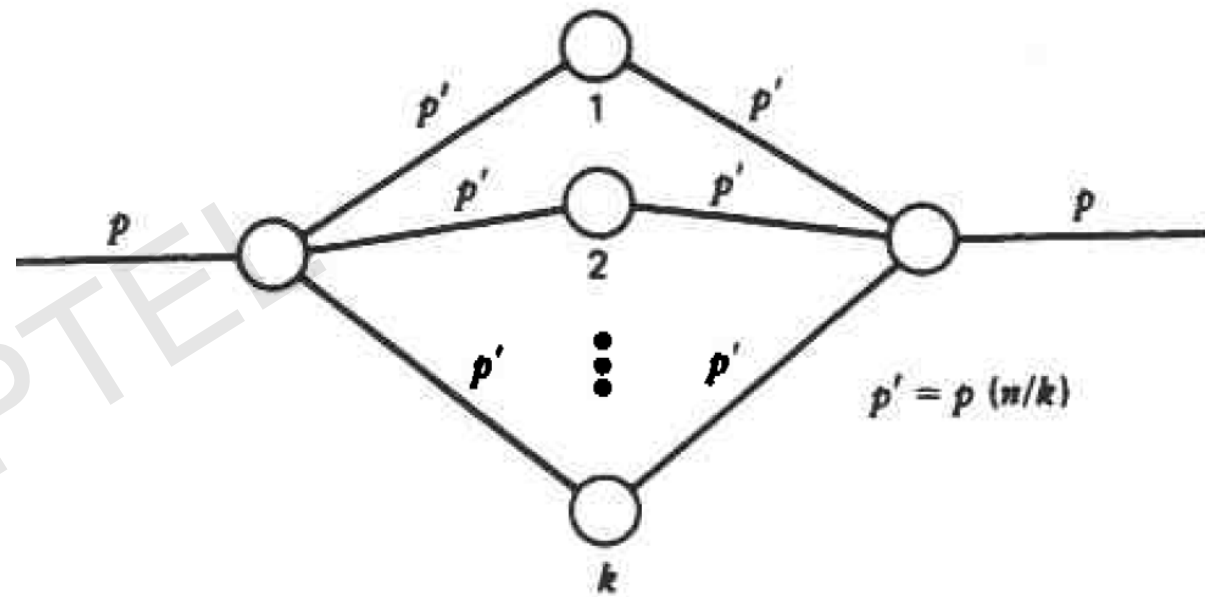
$$K=2(n-1)+1=2n-1$$

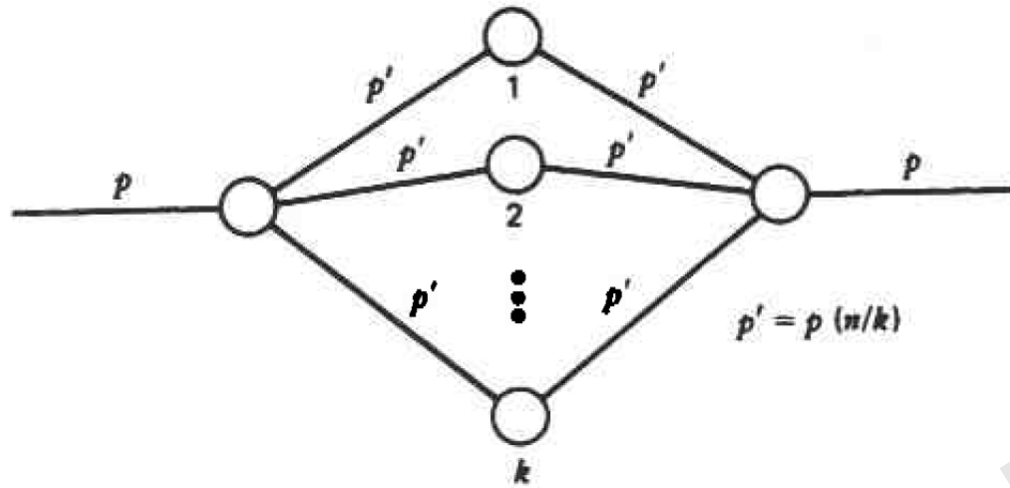
Number of Lines	Number of Crosspoints for Three-Stage Switch	Number of Crosspoints for Single-Stage Switch
128	7,680	16,256
512	63,488	261,632
2,048	516,096	4.2 million
8,192	4.2 million	67 million
32,768	33 million	1 billion
131,072	268 million	17 billion

Space Switch Classification

- Strictly Non Blocking
- Rearrangeably Non Blocking

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p – Probability that the link is busy (Occupancy)

$q = 1-p$ - Probability the link is available

$$p' = \frac{p}{\beta} \quad (p < \beta) \quad \beta = k/n$$

q' = a centre-stage link is idle = $1-p'$

B = Probability that all paths are busy

= (probability that an arbitrary path is busy) ^{k}

= (probability that at least one link in an arbitrary path is busy) ^{k}

= $(1 - q'^2)^k$

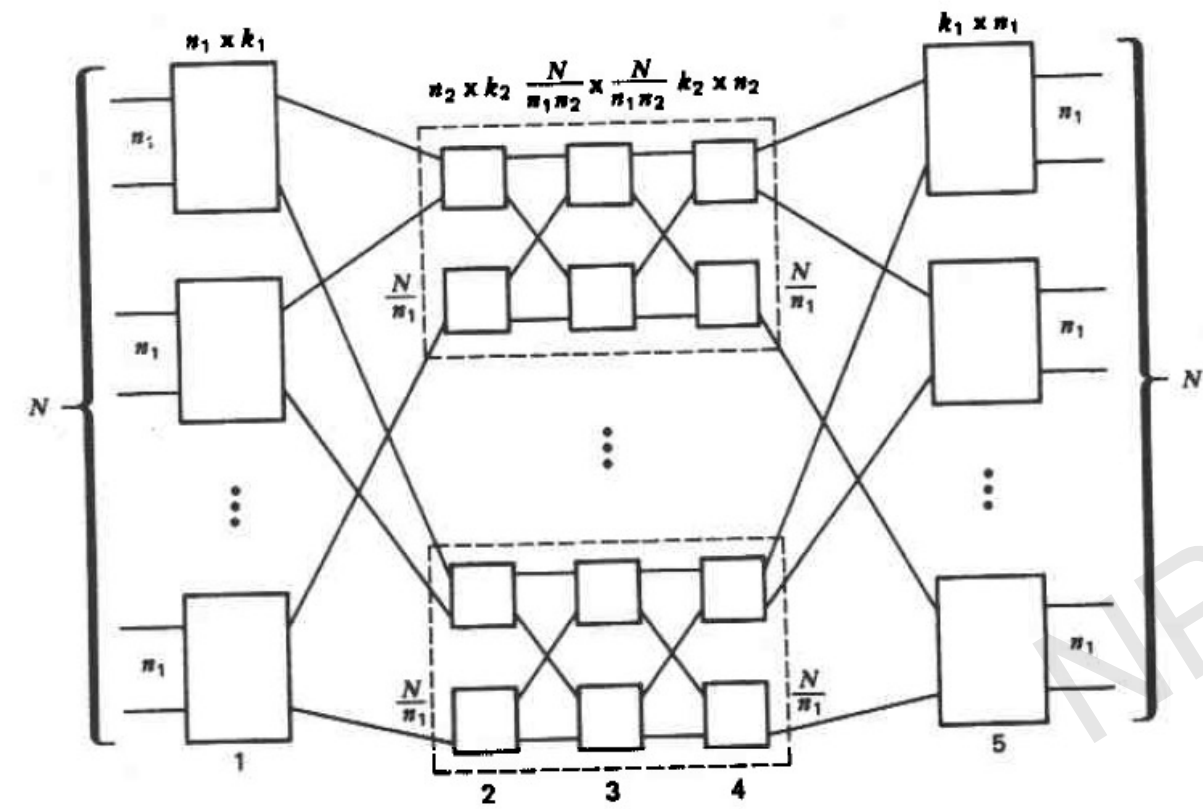
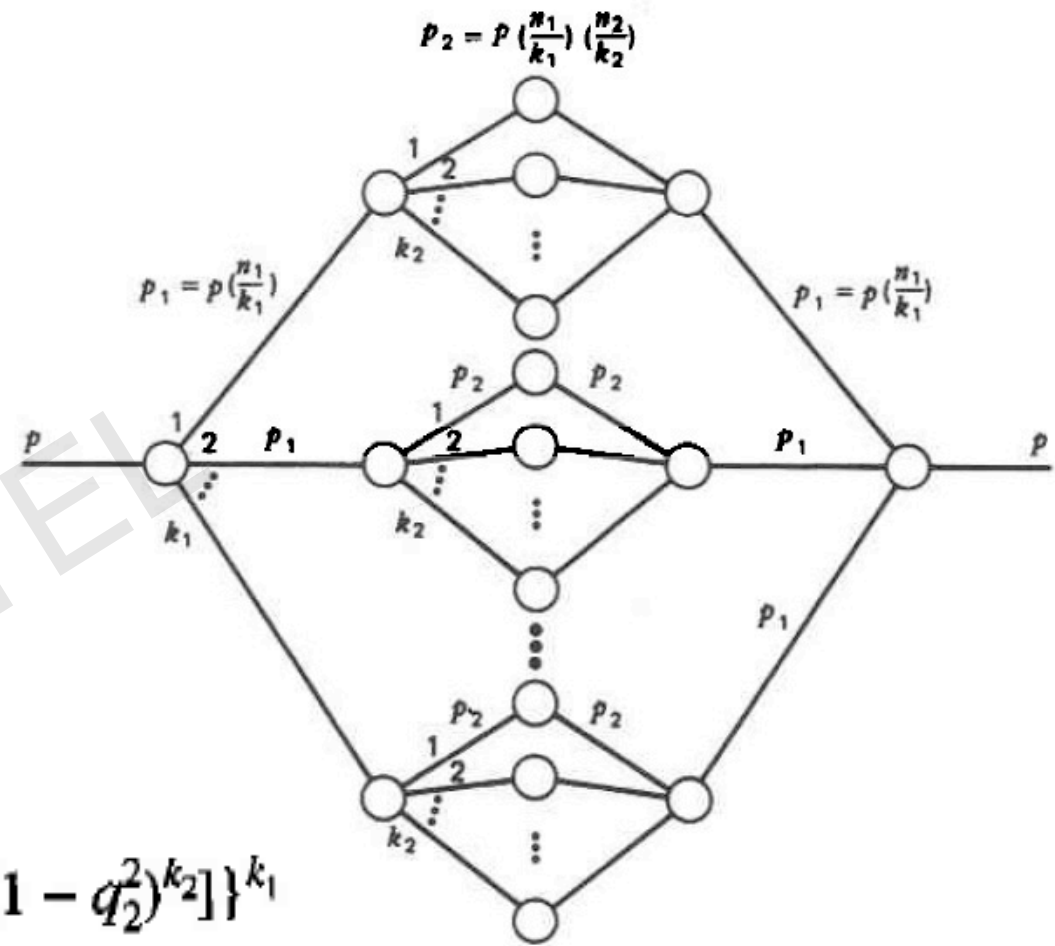
$$B = \left[1 - \left(1 - \frac{p}{\beta} \right)^2 \right]^k$$

Switch Size, N	n	k	β	Number of Crosspoints	Number of Crosspoints in Nonblocking Design	
128	8	5	0.625	2,560	7,680	($k = 15$)
512	16	7	0.438	14,336	63,488	($k = 31$)
2,048	32	10	0.313	81,920	516,096	($k = 63$)
8,192	64	15	0.234	491,520	4.2 million	($k = 127$)
32,768	128	24	0.188	3.1 million	33 million	($k = 255$)
131,072	256	41	0.160	21.5 million	268 million	($k = 511$)

$B = 0.002, p = 0.1$

Switch Size N	n	k	β	Number of Crosspoints	Number of Crosspoints in Nonblocking Design	
128	8	14	1.75	7,168	7,680	($k = 15$)
512	16	22	1.38	45,056	63,488	($k = 31$)
2,048	32	37	1.16	303,104	516,096	($k = 63$)
8,192	64	64	1.0	2.1 million	4.2 million	($k = 127$)
32,768	128	116	0.91	15.2 million	33 million	($k = 255$)
131,072	256	215	0.84	113 million	268 million	($k = 511$)

$B = 0.002, p = 0.7$

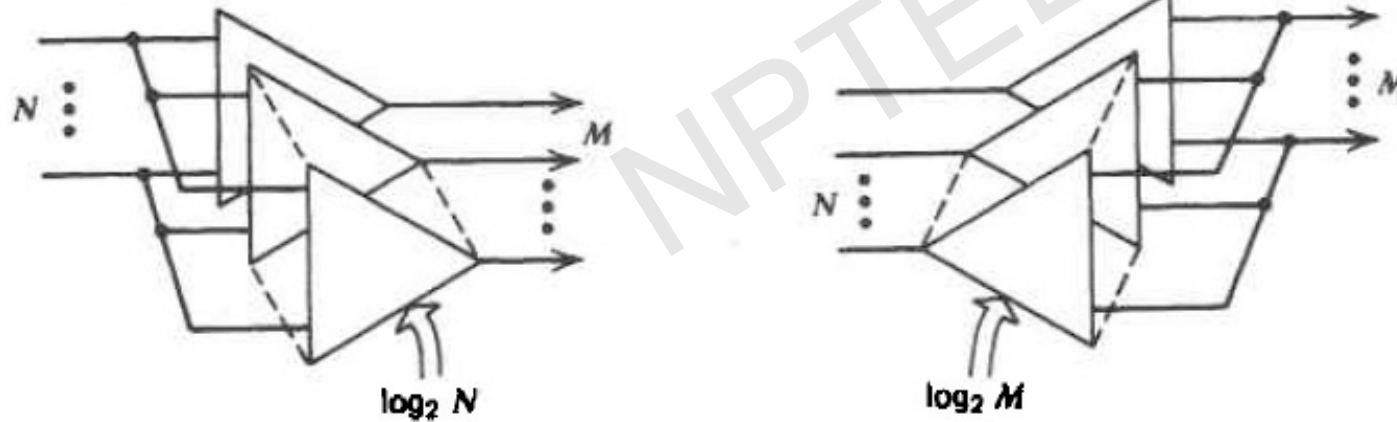


$$B = \{1 - (q_1)^2 [1 - (1 - q_2^2)^{k_2}]\}^{k_1}$$

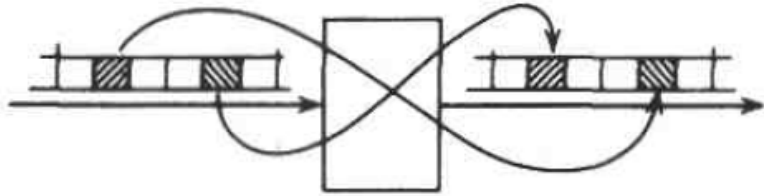
$$q_1 = 1 - p_1 \quad q_2 = 1 - p_2$$

Space Switch Control

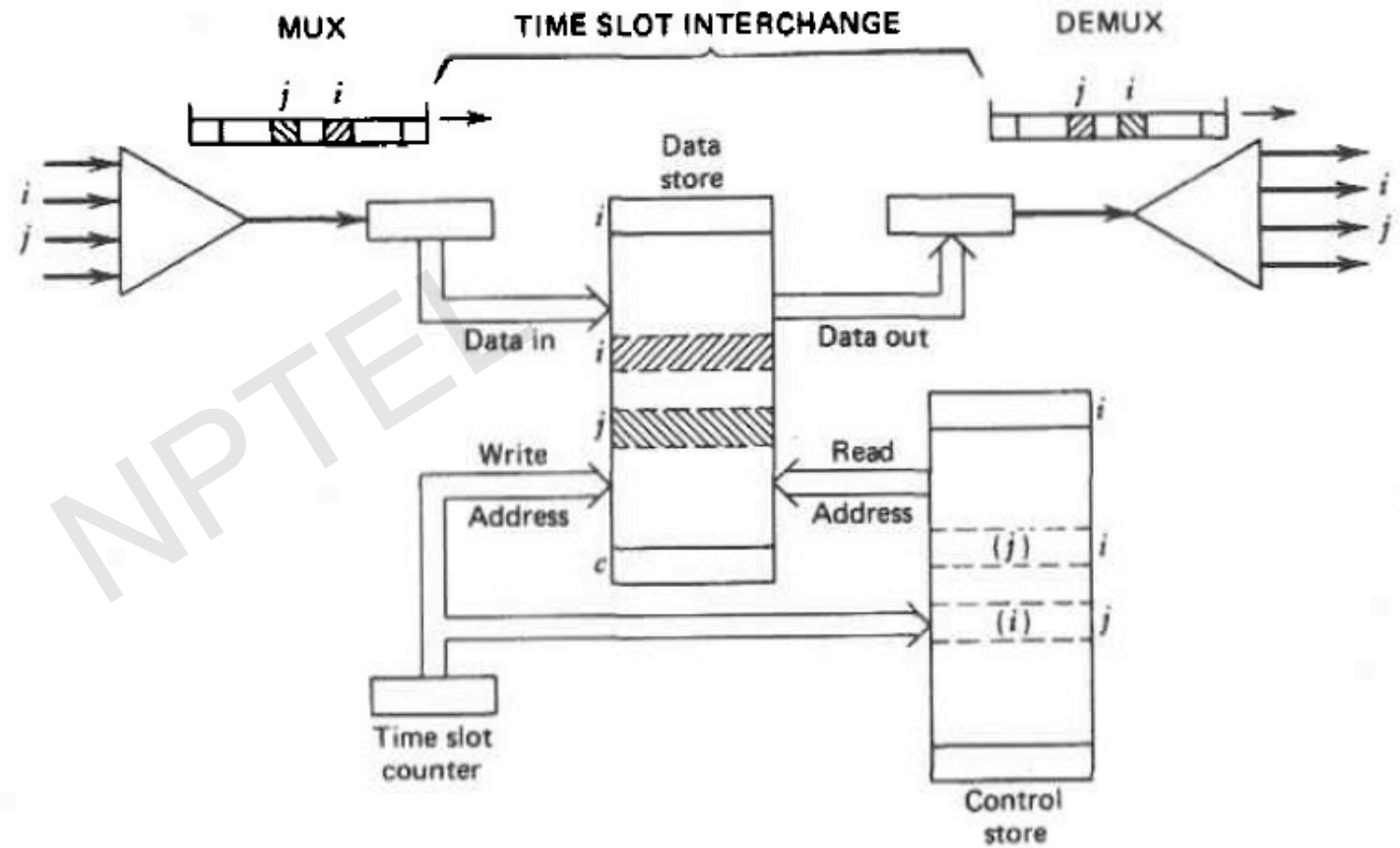
1. Output Associated Control
2. Input Associated Control



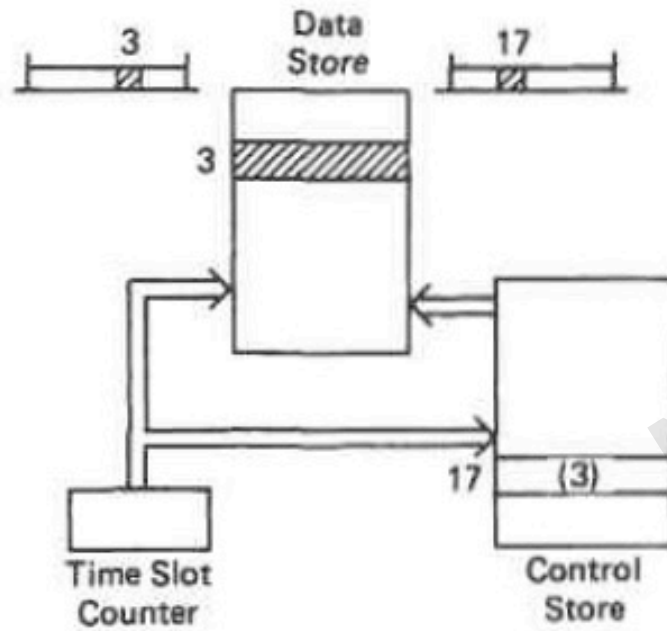
Time Switch



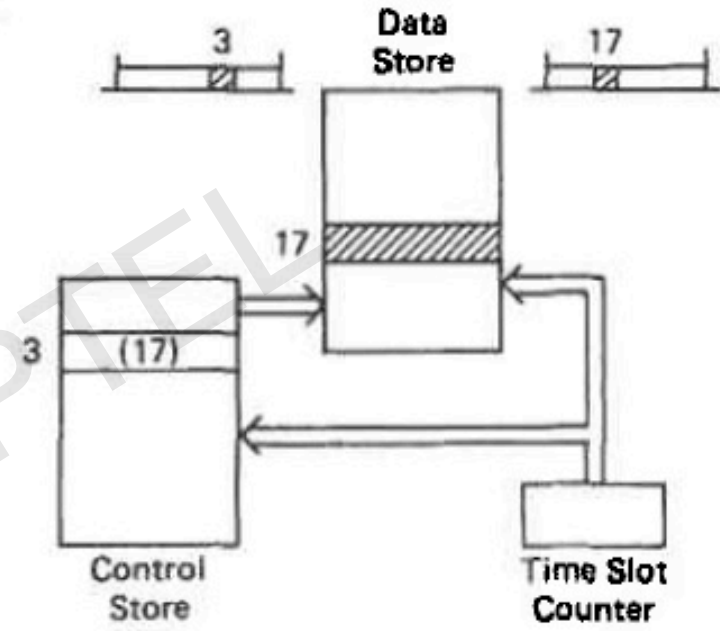
Time Slot Interchange



Time Switch Realization



Sequential Write Random Read



Random Write Sequential Read

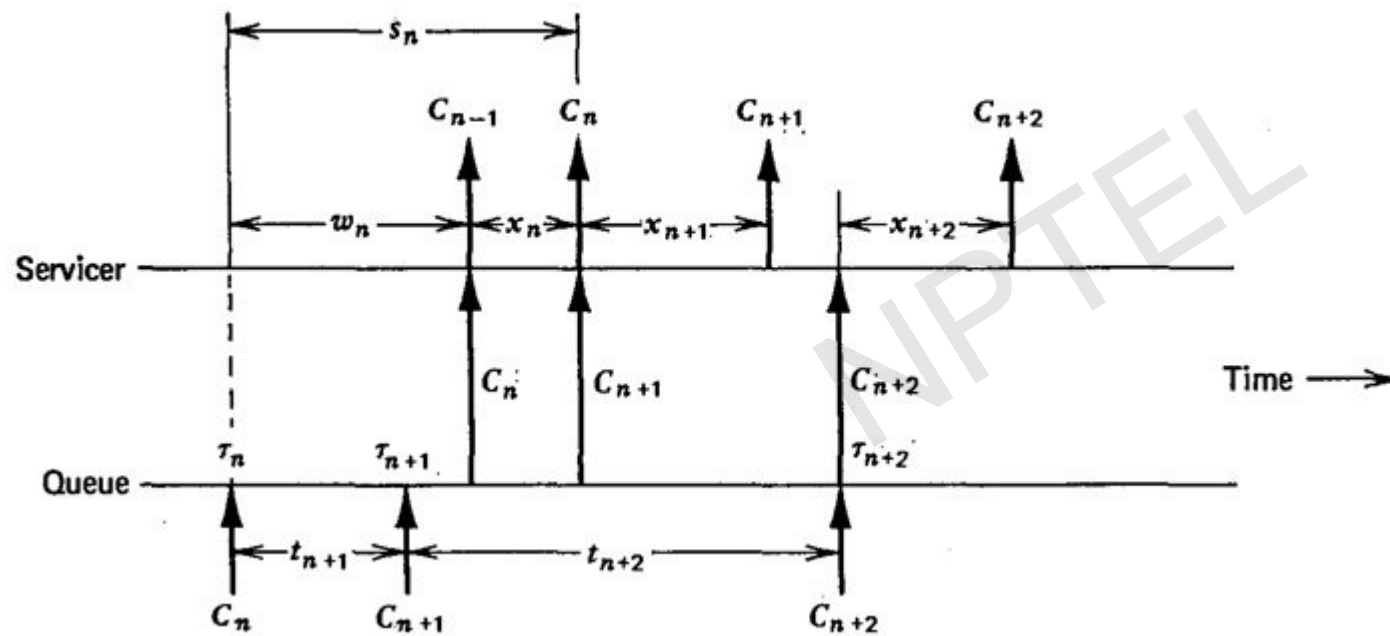
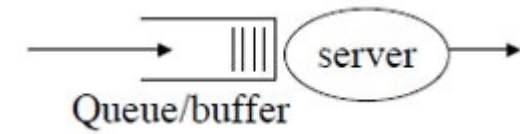
Trunk Switch Blocking

Queuing Theory

Markovian queues with Multiple servers

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Typical Arrival Departure – time bookkeeping



Conclusion

Space Switch Design – cross point and multistage
Blocking Probability
Space Switch control

References

Book:

Digital Telephony – J. Bellamy

Queuing Systems Vol. 1 – L. Kleinrock

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