CHAPTER CONTENTS

3.0 DMS Family

3.1 DMS

3.2 DMS–100

3.3 DMS SuperNode

3.4 S/DMS

3.5 Sprint

3.6 #5 ESS

Review Questions

For Further Research

3.0 DMS Family

Objectives

This section will:

- Describe the evolution of Nortel's DMS-100
- Examine DMS-100 block diagram
- Examine DMS SuperNode architecture
- Examine S/DMS and its network fabrics
- Review the deployment options of the AccessNode

The PSTN is the largest communications system in the world. In many respects, it is extremely advanced but in some ways, it has been hindered by its own success. Starting towards the end of the 19th century, telephones became relatively commonplace. Today one can hardly find any location too remote or isolated to be connected by phone. However, as the system grew, it became locked in to certain technologies such as wire transmission, which now acts as a sort of straightjacket. The millions of miles of wire strung on poles and buried underground has become somewhat of a liability as the bandwidth and service demands of modern society gradually began to exceed its capabilities.

A study of the development of the telephone network and its impact on society could fill volumes, and yet its presence is taken for granted and largely ignored until it fails.

Several companies design and manufacture telecom switches. Each offers a variety of sizes and capabilities to meet the diverse needs of Telcos. Unfortunately, most vendors release very little design or architectural information. Consequently, this section will deal primarily with the Nortel product line.

All telecommunication equipment eventually becomes obsolete, as will these notes, which attempt to describe them. However, it can be quite instructive to see how a device as complex as a class 5 office has evolved over the years.

Some North American Switching Systems[1]

System	Manufacturer	Year	Application	Line Size [K]
#4 ESS	AT&T	1976	Toll	107
#5 ESS	AT&T	1983	Local	100
E 10-five	CIT-Alcatel	1983	Local	100
3 EAX	GTE	1978	Toll/Tandem	60
5 EAX	GTE	1982	Local	145
AXE10	LM Ericsson	1978	Local/Toll	200
NEAX-61	NEC	1979	Local/Toll	80
System 1210	ITT	1978	Local/Toll	26
DMS-10	NT	1977	Local	7
DMS-100	NT	1979	Local	100
DMS-200	NT	1978	Toll	60
EWSD	Siemens	1981	Local	200
DC0	Stromberg Carson	1977	Local	32
ITS4	Vidar	1977	Toll/Tandem	7
ITS4/5	Vidar	1978	Local/Toll	12.7

3.1 DMS

Minimum Reading

www.nortelnetworks.com
DMS-100 Wireless System
AccessNode
Packet Telephony Solutions

For the advanced student

S/DMS AccessNode FST
AccessNode Data Direct
S/DMS Transport Overview
S/DMS TransportNode OC-12
S/DMS TransportNode OC-192
DMS-100/200 Portfolio Evolution 1Q99
DMS-100/200 Feature Planning
DMS-300 Hardware Portfolio
DMS-300 Feature Planning Guide
DMS-500 SuperNode Data Manager
DMS-500 Advantage

[1] *Digital Telephony* (2nd ed.), John Bellamy, Table 1.13

DMS-500 Hardware Portfolio
DMS-500 Feature Planning Guide NCS07&08
DMS-500 Planning NCS09&10
8000 Access Switch
Baystack Ethernet Solutions
Broadband Access Cable Modem
Next Generation Campus Networking
High-Performance Campus Networking
Cornerstone Voice – HFC
Global Voice Modules
Passport EBM
Succession Background
Closing the Next Generation Gap

The DMS† family of telecommunications switches, designed and manufactured by Nortel, are sold all over the world. Nortel is the only company in Canada that makes central offices switches. Mitel and a host of others produce PBXs, which operate very much like COs, except that the wiring is generally inside plant. This small subtle difference has a significant impact on the BORSHT interface design.

DMS Milestones	
1976	SL–10 Packet Switch - 1st 4 nodes went into trial service, used in DATAPAC network of the Trans Canada Telephone System
	DMS–100 introduced
1979	DMS–10 - at year end, 25 in service, 150 on order
	DMS– 200 Toll Switch introduced
	DMS–100 class 5 office in operation
1982	DMS–100 gets new network modules
	DMS–300 International Gateway introduced
1984	DMS–100 new peripherals introduced
1986	1047 DMS–100s in service
	ISDN field trials in Phoenix Arizona
1987	DMS SuperNode
	S/DMS
1993	S/DMS AccessNode
2000	XA-Core Multiprocessor

3.2 DMS–100

The largest switch in the DMS family is the DMS–100 class 5 office. It was introduced in 1976, and within a decade, there were 1047 in service. Its unique architecture pioneered many technological innovations such as the integrated access CODEC and single subscriber line card.

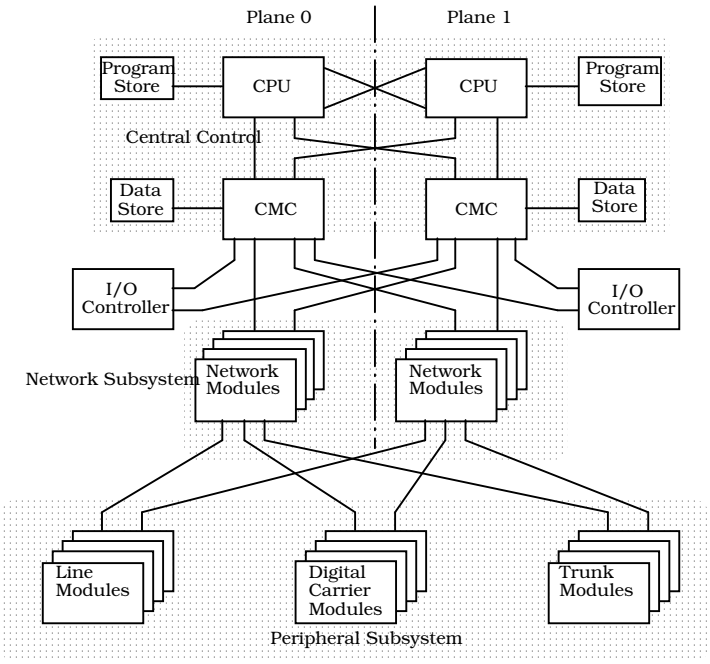
† Digital Multiplexing System

The commitment to a completely digital system was quite a step into the future since no other manufacturer was prepared to take this initiative. The chief US competitor to the DMS–100 is the #5ESS, which used analog crosspoints to provide concentration at the line equipment bay.

Over the years, DMS has continued to evolve and expand its formidable capabilities. It is justifiably considered by many to be the best all round telecommunications switch in the world.

Designation	Application
DMS–10	Small Switch
Meridian–100	PBX
DMS–100	Class 5 End Office
DMS–200	Toll Office
DMS–250	OCC Switch [US Common Carrier]
DMS–300	International Gateway
DMS–500	Local/Long Distance Switch

DMS-100 Block Diagram



The DMS-100 is comprised of:

- Central Control Module
- Switching Network
- Peripheral Modules
- Input-Output Controllers

The central control is responsible for overall system management and sanity monitoring, and is comprised of:

- CPU - Central Processing Unit
- CMC - Central Message Controller
- Data Store
- Program Store

The CPU contains two identical processors running in hot standby mode. Each receives the same input and performs identical functions. However, at any given time only one of them is in control. Every 24 hours, the processor in charge hands over responsibility to the other.

The CC uses processor matching and a trap system to detect faults or performance differences between the two CPUs. If a mismatch is detected, an interrupt is generated and a software maze sequence invoked to locate the fault. The idea is that a CPU in error will not be able to exit from the maze program, and the sane processor will take over.

The CMC consists of a pair of message processors running in a load-sharing mode. They share in making and executing decisions. In the event of a failure, each CMC is capable of carrying the full load.

3.2.1 Switching Network

The networking subsystem contains a maximum of 64 network modules [NM] divided into two planes [0 and 1], both of which are connected to the two CMCs. Normally CMC0 controls network plane 0 and CMC1 controls plane 1. In the event of a CMC failure, the sane CMC takes control of all NMs.

The network is fully digital and consists of a 4-stage time switch in the voice/data path. It also routes control messages between the CC and PMs. The serial ports connecting each network module together are based on the European digital plan and consist of 30 voice and 2 control channels.

The network modules are continually checked for faults by both the CC and peripheral modules.

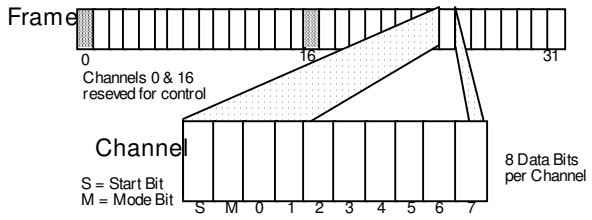
3.2.2 Peripheral Modules

Peripheral modules are the most prolific part of any communications system. Although they have control redundancy built into them, it is impractical to make redundant line interfaces. Therefore, the reliability of the line interface card must be extremely high.

Some common PMs are:

- TM - Trunk Module
- DCM - Digital Carrier Module
- LCM- Line Card Module
- RLCM - Remote Line Card Module

DS-30



The DS-30 format is a multiplexed link used to communicate between various DMS-100 modules.

The bit rate for this scheme is:

$$\frac{10 \text{ bits}}{\text{channel}} \times \frac{32 \text{ channels}}{\text{frame}} \times \frac{8 \text{ K frames}}{\text{second}} = 2.56 \text{ Mbps}$$

The S or start bit is used to indicate that the channel is in use.

The M or mode bit indicates whether the information to follow in a voice, data, or an internal control transaction.

Within the DMS, this format is implemented as a biphase ac coupled signal between the LGC and network, and as a balanced TTL signal between the LGC and LCM. The mux/demux occurs within the LCM. The individual channel to the line card is implemented as a ping-pong signal.

XPMs

Later versions of peripheral modules connect to the network via XPM†s.

This represents a subtle redistribution of control and intelligence away from the central core.

Some XPMs are:

- LGC - Line Group Controller
- DTC - Digital Trunk Controller
- LTC - Line Trunk Controller
- MSB - Message Switch and Buffer
- CSC - Cell Site Controller
- RCC - Remote Cluster Controller

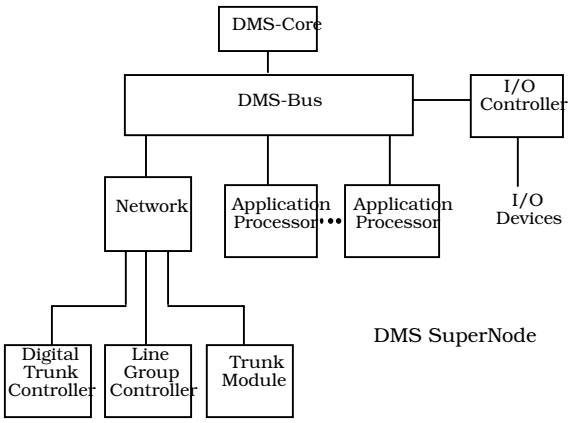
3.3 DMS SuperNode

The SuperNode is the second generation of the DMS–100. It involved the redesign of the central control and network modules, and the creation of

† eXtended Peripheral Modules

applications processors. It incorporates circuit and packet switching techniques, is backward compatible with DMS–100.

With the advent of the DMS-Bus, it was possible to directly attach applications processors that could provide new features.



The DMS SuperNode consists of three principle components:

- DMS Core
- DMS Bus
- DMS Link

The DMS Core performs all call management and system control functions.

XA-Core

Minimum Reading

XA-Core Multiprocessing

For the advanced student

XA-Core Architecture

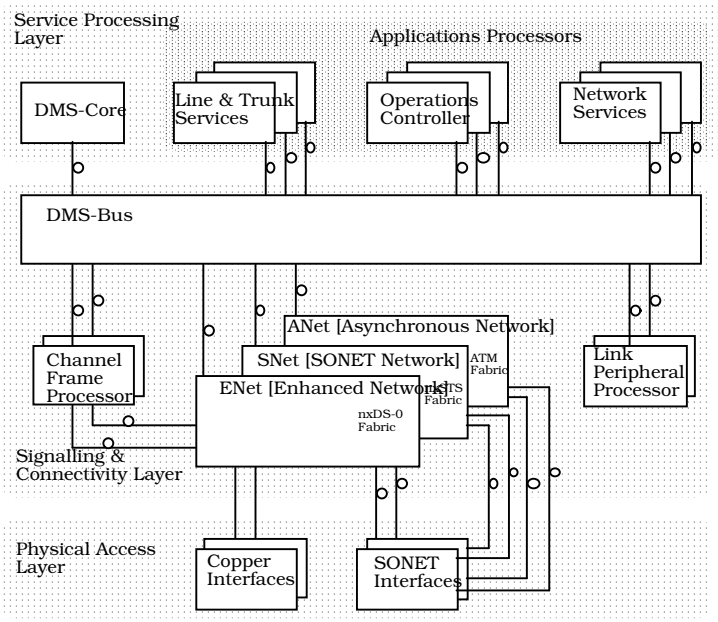
The DMS-Bus is a transactional pathway, which connects various applications processors to the DMS-Core and network.

3.4 S/DMS

S/DMS supports fiber optics and SONET technology.

To take full advantage of developments such as ISDN, ATM, and SONET, the network was redesigned into three different switching fabrics: the ENet, ANet, and SNet.

S/DMS Block Diagram



With the advent of fiber and SONET, the traditional routing support mechanisms [DS–0 switching, bridging, etc.] become inadequate. Therefor it becomes necessary to develop new switching, routing, and networking structures.

The ENet† supports narrow band and wide band circuit-switched services. It is a non-blocking nxDS–0 time switch that supports everything from a single 64 Kbps channel to the 1.544 Mbps DS–1 rate.

The ANet† utilizes the ATM† cell structure to support large-scale data networks and broadband ISDN services. There is a great deal of international interest in developing this type of network.

The SNet† allows the S/DMS SuperNode to provide nxSTS services, for broadband customers with synchronous channel requirements.

3.4.2 S/DMS AccessNode

For the advanced student

AccessNode Application and Feature Overview

† Enhanced Network

† Asynchronous Network

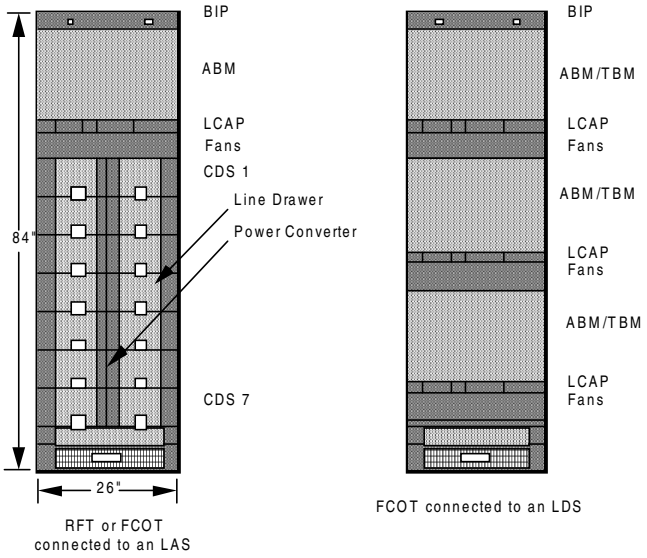
† Asynchronous Transfer Mode

† Synchronous Network

S/DMS AccessNode is an OC–12 digital loop carrier module that can be connected to a compatible digital and/or analog office.

http://www.nortel.com/broadband/images/accessnode.gif

AccessNode Frame Layouts

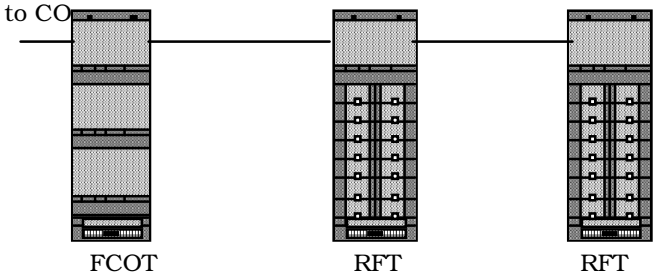


Minimum Reading

FST – Full (or Fiber) Services Terminal

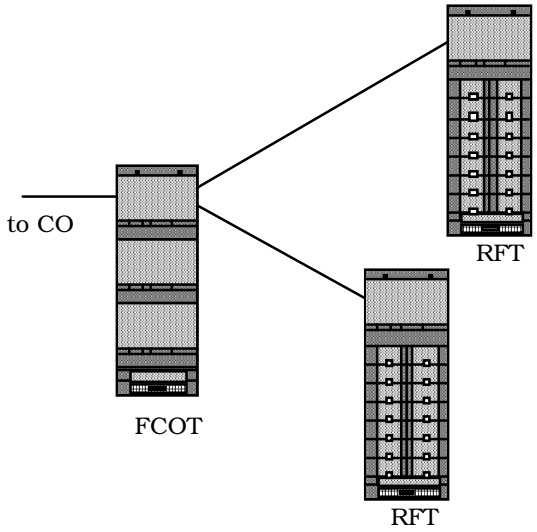
Add Drop

In the add-drop configuration, the link leaving the CO has an enormous bandwidth. As RFTs are added to the network, some bandwidth is dropped off to each unit and excess is passed on to the next RFT.

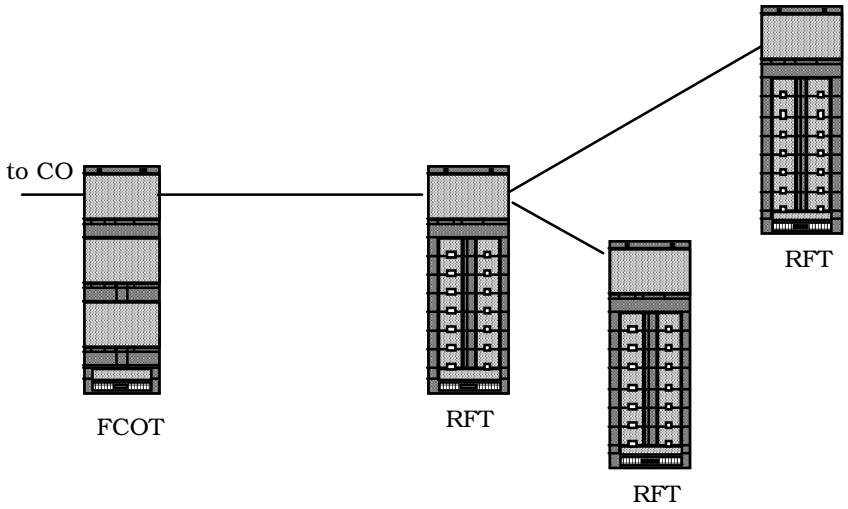


CO Hub

In the hub arrangement, the CFOT fans out the bandwidth to each RFT on a separate link. In this configuration, each RFT has access to the entire incoming bandwidth.

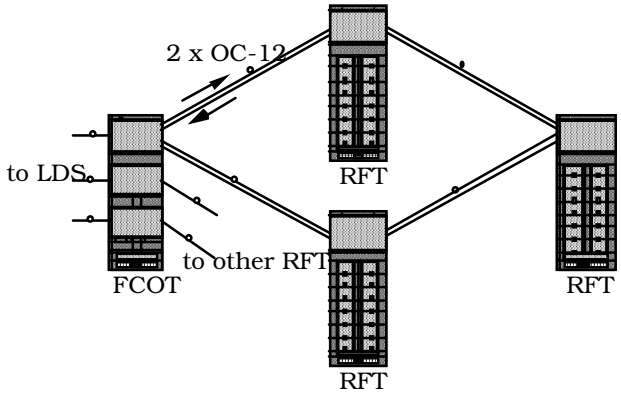


Remote Hub



AccessNode Rings

AccessNode uses a shared protection ring [SPRING]. Although an OC–12 or OC–48 fiber link pair connects all of the components, only the lower half of the total STS payload capacity is actually assigned in each direction. This allows either fiber to take over the load if one is cut.



Service Adaptive Access [SAA] BORSCHT

Traditionally, each service offering required a specialized line interface. This becomes impractical as more and more services are offered. The result is semi-intelligent programmable line cards. The predominant cards are known by the Greek letters Epsilon [E], and Omega [Ω].

SAA Line Card Service Set[2]

Service	Line Card Type						
	E Source	E Sink	Ω Source	Ω Sink	Ω 4 Wire	Ω 6/8W	T1 DS-1
POTS	√	√	√	√			
Coin			√	√			
FSR			√	√			
TP/ANI, 2 party			√	√			
SIR, multi-party			√	√			
FXS			√		√		
FXO				√	√		
DPO			√				
DPT				√			
TO			√	√	√		
ETO			√	√	√		
ISDN U			√				
MBS, P phone			√				
Datapath			√				
DAML			√				
PLAR			√				
DDS, OCUDP					√		
DDS, DS-0 DP					√		
ISDN T					√		
DX					√		
E&M I, II, III						√	
PLR I, II						√	
Tandem I, II						√	
DS-1							√
T1							√
ISDN PRA							√

World Line Card[3]

This interface is compliant with all relevant telecommunications specifications published by Bellcore, ITU, and REA. It therefore allows the same card to be used at any location in the world. The feature set is simply downloaded to the card.

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2 *Telesis,* 1990 one/two

3 Telesis, issue 100, October 1995

The DSP chip allows the following 8 parameters to be programmed:

- Input impedance
- Balance impedance
- Frequency response
- Tx & Rx gain
- Current limit
- A-law and µ-law coding
- Signaling of over voltage conditions
- Ground fault protection

It can interface to both twisted pair and coax systems, and has a predicted MTBF of 3000 years.

For the advanced student

S/DMS TransportNode Overview

S-DMS TransportNode OC-192

3.4.5 DMS-500

The DMS-500 is both a local and long distance switch, combining the local services of the DMS-100, the toll and operator services of the DMS-100/200 and long distance services of the DMS-250. It supports DMS-250 trunk connections, and DMS-100 residential and business line types.

3.4.6 Succession

Minimum Reading

Succession Backgrounder

Succession White Paper 99

For the advanced student

Succession Network Product Briefing

The succession network builds on the multi-fabric switching network in the S/DMS SuperNode.

The product portfolio includes:

IPConnect – Supports standard telephony functions over an IP network.

Centrex IP – Provides centrex services over an IP network.

MultiMedia Carrier Switch – A switching platform with an integrated IP gateway.

MultiService Connect – An access device supporting voice, video and data.

Sucession supports telephony services over packet-based networks. The network consists of four parts: a call server, a multiservice gateway, a network manager and a Passport 15000 ATM switch.

For the advanced student

Rapport

Passport Enterprise Bandwidth Manager

3.4.7 Intelligent Networks

Nortel Networks IN services are based on the DMS-100 platform.

Powered by the DMS SuperNode family of DMS-Core processors, the DMS-100 SSP (Service Switching Point) can be scaled to match the capacity needs. It also incorporates the E-Net call switching module and peripheral modules for line and trunk interfaces.

It supports 800 service, Line Information Database (LIDB) access, and virtual private networking (VPN).

The DMS-100 International SSP includes all DMS-100 capabilities, such as scalable architecture, broad service portfolio, extensive network interface support, billing capabilities, and OAM support. It also supports a wealth of international IN standards, including ITU's CS-1, CS-1R, and CS-2 and ETSI INAP.

The DMS-STP is considered the most reliable large-capacity STP on the market. More than 400 DMS-STP nodes are positioned through the world. Utilizing DMS SuperNode switching architecture, the DMS-STP's field-proven technology provides robust, economical, and high-capacity message transfer among the nodes of a SS7 network. Capable of interfacing up to 432 links, each DMS-STP can process over 348 million SS7 messages per hour.

3.4.8 Other Nortel Products

For the advanced student

8000 Access Switch

Baystack Ethernet Solutions

Cable Modem 100

Cornerstone Voice – Hybrid Fiber Coax

DMS 100 Wireless
Global Voice Modules
Packet Telephony

3.5 Sprint

Minimum Reading

Sprint Network Overview
Sprint Network Architecture

For the advanced student

Sprint Services & Features

Sprint is one of the largest IXC carriers in the US. Its network consists of 46 DMS-250 switches. Each switch is directly connected to every other switch by means of IMT† links. Circuit switching is used for customer calls and CCS7 is used for the signaling network.

Nearly 40,000 Km of single mode fiber is used to interconnect the network nodes. Depending on the local traffic requirements, the fiber operates at anywhere from 565 Mbps to 1.7 Gbps. It is thought that WDM† can expand this capacity in the future to 10 Gbps.

The fiber network actually carries a number of services and network overlays.

- Private networks can be created by leasing excess capacity on the system
- It supports SprintNet, the worlds largest X. 25 and frame relay network
- It supports Sprint's ISDN
- It carries the Meeting Channel, the world's largest videoconferencing network with nearly 1000 conference rooms

3.6 #5 ESS

For the advanced student

The 5ESS Switch
AnyMedia Access Interface Units
R7/E Now

† Inter-Machine Trunk

† Wave Division Multiplexing

http://www.lucent.com/minds/techjournal/

The #5 ESS† is the AT&T equivalent to the Nortel DMS–100.

One of the major differences between the #5 ESS and DMS–100, is the use of analog crosspoints. These high voltage semiconductor switches allow certain BORSCHT functions to be provided on a group bases rather than on a line bases. Essentially, the #5 ESS is mid-way between a crossbar switch and an all digital one.

This reduces the hardware cost per line, but increases the software control overhead since the first and last switching stages are space switches.

3.7 AXE

Minimum Reading

AXE Hardware Evolution

For the advanced student

AXE Central Processor
AXE SDH Interface

AXE is perhaps the most widely deployed switching system in the world. It can be configured to support all types of telephony applications including: local, transit, international and combined networks.

AXE also supports all major analog and digital mobile standards.

3.8 Alcatel

Minimum Reading

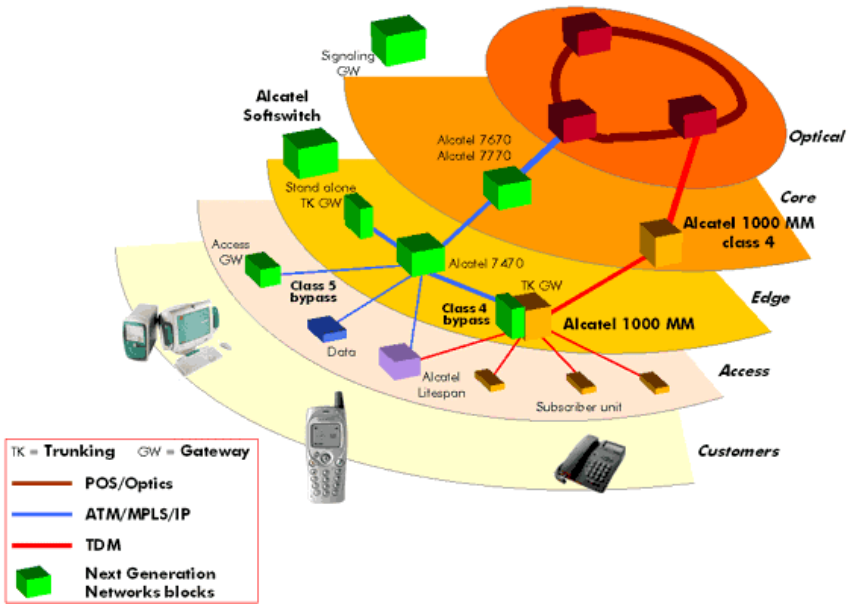
1000 Soft Switch

For the advanced student

Voice Network Evolution
Photo

† 5th Electronic Switching System

_____ Notes _____


Signaling GW
Alcatel Softswitch
Alcatel 7670
Alcatel 7770
Optical
Stand alone TK GW
Core
Alcatel 1000 MM class 4
Access GW
Alcatel 7470
TK GW
Class 5 bypass
Class 4 bypass
Alcatel 1000 MM
Edge
Data
Alcatel Litespan
Subscriber unit
Access
Customers
TK = Trunking
GW = Gateway
POS/Optics
ATM/MPLS/IP
TDM
Next Generation Networks blocks

Review Questions

Quick Quiz

1. The DMS-100 network modules operate in the [hot standby, load sharing] mode.
2. The DMS-100 is a [2, 4, 6, 8] stage time switch.
3. Borscht interfaces are found in the [XPM, LCM].
4. In the DMS SuperNode, call processing functions are performed in the DMS-[Bus, Core].
5. The [SuperNode, S/DMS] has multiple switching fabrics.
6. AccessNode [can, cannot] be connected to an analog exchange.
7. The XA-Core processor can handle up to [1, 7, 10] million BHCA.
8. The XA-Core processor can handle switched circuit connections but not packet switched connections. [True, False]
9. FST can be used to port S/DMS broadband services to small business. [True, False]
10. FST does not support CLASS or ISDN functions. [True, False]
11. Sprint [deploys, does not deploy] SONET rings.
12. Sprint WDM system supports an aggregate bit rate of 100 Gbps per fiber. [True, False]
13. Sprint [uses, does not use] ATM over SONET.
14. Sprint's SONET architecture is based on a [2, 4, 8] line bi -directional ring.
15. Sprint [uses, does not use] add drop multiplexing.
16. Six nines reliability is equal to 10 seconds of downtime per year. [True, False]
17. The present #5ESS [supports, does not support] convergence.
18. The AXE communications switch does not uses any space switching. [True, False]
19. A Softswitch gateway converts voice traffic between circuit and packet switching formats. [True, False]

Composition Questions

1. Discuss the evolution of the DMS-100, highlighting the characteristics of its three principle versions:

    a) DMS-100 [NT-40]

    b) DMS SuperNode

    c) S/DMS

2. Make a sketch of the DS-30 format used in the DMS-100.

3. Discuss the relative merits of operating equipment in the hot standby and load sharing modes.

4. How does the SAA line card differ from the traditional borscht circuit?

For Further Research

http://china.si.umich.edu/telecom/telecom-operating.html

http://www.nortel.com

http://www.lucent.com/

http://www.ssc.siemens.com/