SYSTEM ENGINEERING BULLETIN

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SUBJECT: SuperNode Data Manager / Fault Tolerant (SDM/FT)

DESCRIPTION: This document is intended for use by engineering personnel to plan and engineer CM and SDM resources for SDM based applications. It covers the SDM/FT at the SDM08 release of the SDM product for NA008/CSP08 DMS systems and NA007 DMS systems that have received the appropriate patch or initial software. The resource algorithms in this SEB may be used to drive manual calculations. Alternatively, one may use an Excel 5 capacity sizing mechanism spreadsheet that implements these algorithms.

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Issue History

Issue	Date	Author	Reason for Issue
03.01	1997 August 29	Dave Wilhelm	For SDM08, update information on the SDM platform and applications from SDM07; add information on the new SDM08 application, SBA

Table of Contents

1. Introduction

1.1 SDM Executive Summary

The capacity information in this document focuses on
- SDM real time and memory resources,
- CM real time and scheduler classes,
- CM-SDM communication link resources and
- SDM-LAN communication link resources.

Maintaining and provisioning sophisticated telephony services requires advanced OAM&P tools that use significant real time and memory resources on their host platform. Running these applications on the CM would cause them to compete with call processing activities, reducing the amount of real time available for call processing and adversely affecting capacity and performance. The SDM uses a high throughput, dedicated processing engine to provide OAM&P capacity without competing with call processing activities and with the possibility of offloading some processing or communication intensive tasks from the CM to the SDM.

SDM is part of an overall Nortel OAM&P evolution strategy. This strategy consolidates today's multiple file systems and I/O (Input/Output) facilities into a single unified cost reduced architecture. The SDM is optimized for data manipulation and analysis and is used by OAM&P applications requiring either a high degree of processing power, data throughput or an industry standard interfaces and operating system. The SDM replaces many of the communication capabilities of the Input/Output Controller (IOC).

SDM is fully supported as a standard Nortel product. TAS (Technical Assistance Service), repair and return, warranty, field service, installation, and service contracts are all handled through Nortel.

1.2 System Engineering Bulletins Process

System Engineering Bulletins (SEBs) contain information necessary for engineering the DMS family of switches. They are written for NORTEL customers and employees and present capacity engineering rules in a simplified, end-user-oriented format. The information in these documents is product specific and/or related to a specific software release. These documents are produced by engineers in a variety of Systems Engineering departments in support of new product introductions or existing product support.

The SEB process is under the direction of System Capacity Engineering, Department 3178, at the 200 Perimeter Park building, Research Triangle Park, North Carolina. A dedicated volume SYSENG on the file server MACHD 3470 K4 LIBRARY1 has been set up on Appletalk zone RTP.200PP. This file server is the repository for the SEA and SEB libraries, indexes and templates. The system capacity engineers and regional performance engineers in the U.S. have direct access to this server. SEA/SEB authors and reviewers that cannot directly access MACHD 3470 K4 LIBRARY1 should use HyperFTP or Fetch to transfer files via the NTFTP.nash.nt.com file server. If none of these methods are effective, contact your regional performance engineer or one of the persons in the System Capacity Engineering Group for assistance.

1.3 Trademark Acknowledgment

AIX is a trademark of IBM.

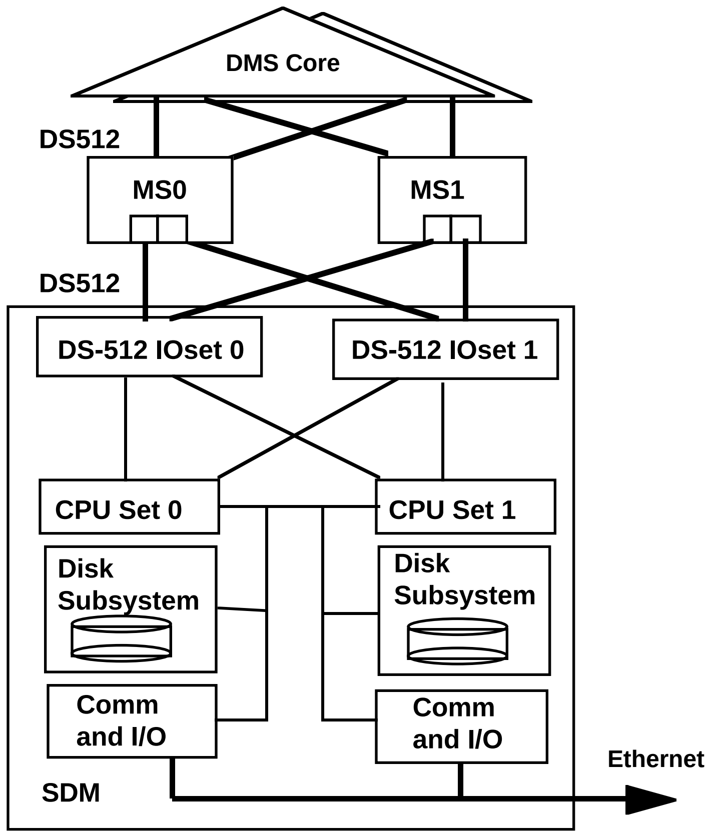
PowerPC is a pending trademark of IBM.

UNIX is a trademark of UNIX System Laboratories.

2. SDM/FT System Description

The SDM/FT is based on a high-performance UNIX computing platform for multiple OAM&P applications packages. It is a fully CO compliant fault tolerant platform that supports stringent reliability and availability requirements.

The figure immediately below shows the duplex SDM/FT platform block diagram.



Fault Tolerant SDM/FT Block Diagram

The SDM/FT consists of two sides with dedicated I/O and memory for each processor. Each side is configured with:

- a PowerPC 604/100 MHz processor
- 128, 256, or 512 Mbytes of DRAM
- a 2 Gbyte DAT
- up to 20 Gbytes of mirrored disk storage
- an Ethernet port
- a DS512 port for connection to the message switch
- a console port capable to 38.4 Kbps

One of the 2 Gbyte DATs is reserved for the use of the SuperNode Billing Application. The other 2 Gbyte DAT is for the use of the operating system and the other applications.

The operating system volume group disk storage consists of a single mirrored disk of either 2 Gbyte or 4 Gbyte capacity. A data volume group may consist of up to 4 mirrored disks, each disk of either 2 Gbyte or 4 Gbyte capacity, for a total of up to 16 Gbytes.

There is always an operating system volume group. It is not necessary to have a separate data volume group. The data volume group may be stored on the operating system volume group disks, in which case the maximum total disk capacity is 4 Gbytes.

SDM/FT connectivity to the CM is achieved using four DS512 links that connect the SDM/FT directly to the DMS message switch (MS). Both SDM/FT input/output domains on the SDM are cross connected via DS512 links to both MS planes, providing four way redundancy.

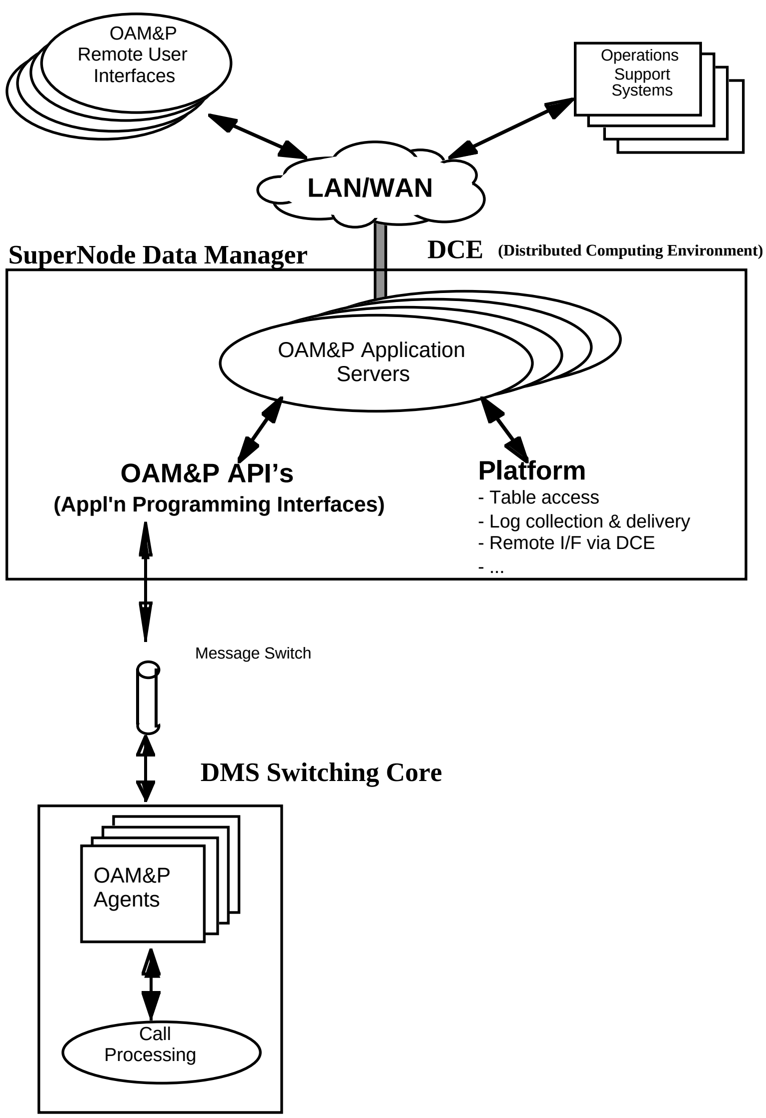
Due to limitations of hardware interfaces, throttling and protocol effects, the available data throughput is less than the base 32.768 megabits/second of the DS512 links. The CM-to-SDM effective data rate is 10 megabits/second or 1.25 megabytes/second. The SDM-to-CM effective data rate is 800 kilobits/second or 100 kilobytes/second.

3. SDM Software Architecture

The SDM software architecture is composed of platform, application and product/market specific layers. This structure permits the independent development of application software and base software, reducing time to market for both. The figure below shows the software structure and main communication links.

All SDM services are accessible by SDM applications via a set of internal application program interfaces (APIs) at the platform layer boundary. These APIs provide a consistent interface to the applications for these services, while ensuring that the services themselves are used in the proper fashion by the applications.

Standard, non-proprietary protocols are used at the platform layer allowing third-party software packages to be used in SDM resident applications.



SDM Software Structure and Communication Links

4. CM System

The CM uses memory and real time resources to support SDM resident applications

4.1 CM Memory

The CM provides program and data store memory to support the SDM platform and the SDM resident applications.

Program Store	345	Kbytes
Data Store	173	Kbytes
Total CM Memory Requirement	518	Kbytes

4.2 CM Real Time

There is not a large direct real time effect on the CM from the SDM platform or from SDM resident applications.

There is an insignificant real time usage increase related to infrastructure integrity checking and maintenance messaging between the CM and SDM.

Some CM real time savings are possible in the areas of log and OM transmission to multiple downstream sources. These savings are of moderate size, dependent on office parameters and have not been characterized.

The CM real time advantage coming from the SDM and SDM applications, results not from reductions in existing real time usage, but in the avoidance of CM real time use for applications that would have run on the CM but are running on the SDM or will run on the SDM in future releases, for example,

increasingly complex log screening,
exception analysis and reporting,
AMA record sorting, searching and formatting,
Q.3 interfaces,
FTP capability,
software delivery ,
GUI based applications and
databases.

4.3 CM Scheduler Classes for SDM

This discussion is a simplification of information provided in the BRISC Engineering Philosophy SEB 91-11-003 version 01.04 issued October 12, 1995.

For any DMS100/200 CM, the calculation to determine the proportion of processor time available for the CP scheduler class (call processing) is determined by beginning with the entire 100% of processor real time, and deducting recommended proportions reserved for other activities. These scheduler class limits are not enforced so long as the CM has real time available to meet all requests.

Complete Processor	100%
Maintenance Class	- 8%
OM, Background and Audit Classes	- 6%
Scheduler, System and System Tools	- 4%
Buffer	- 4%
Guaranteed Terminal Share	- 2%
AuxCP Share	- 1%
Network Maintenance	- 0%
NOSFT Class	- 0%
SNIP Class	- 1%

Processor Available for Call Processing	74%

To support the SDM, additional CPU real time proportions are reserved for the SNIP (SuperNode Internet Protocol) and NOSFT (Network Operations System File Transfer) classes. Each class is allocated 3%. The NOSFT class has existed previously and has been used by BNM (Business Network Management) processes. The SNIP class has been created for processes using SuperNode Internet Protocol, of which SDM resident applications will be one of the early users.

Continuing with our scheduler class example for SDM,

NOSFT Class	- 3%
SNIP Class	- 2%

Processor Available for Call Processing	69%

From the example above, the SDM reduces the guaranteed CPU call processing class allocation by a maximum of 5% over previous allocations for the NOSFT and SNIP classes. For a discussion of actual expected usage and limits on the SDM use of CM, see the discussion below in section 4.4.

The scheduler classes that are used by SDM infrastructure and applications are

CM Scheduler Class	Total Allocation	SDM Related Use
Maintenance	8%	CM-to-SDM maintenance traffic
SNIP	3%	SDM-to-CM traffic and some CM-to-SDM throttled IP traffic
NOSFT	3%	CM-to-SDM high priority traffic
Background	2.7%	CM-to-SDM default traffic

The SNIP scheduler class is used by CM application processes using Internet Protocol, of which processes communicating with SDM resident applications are expected to be significant users. Other EIU and SNMP (Simple Network Management Protocol) related processes may also use the SNIP class. The NOSFT class may be used by other activities such as BNM, though initially is expected to be used mostly by SDM related activities for NA100 switches. The maintenance and background classes are shared among many processes and activities.

The scheduler class occupancy reservations are only enforced at times when there are more demands for CM processor time that there is processor time available. In other cases, the scheduler class occupancy reservations are not enforced. In cases where some scheduler classes are not using all their reserved CM processor time, their time is given to the other scheduler classes in the same proportion as their occupancy reservations. To the extent that the provisioning and data dictionary downloads occur during non peak call processing times, the impact is smaller than the scheduler class reservations would indicate.

It is possible to assign values other than 3% to the NOSFT and SNIP classes. This would require a high level of knowledge regarding the relationship of the scheduler class usage and the response times of the CM processes involved.

Increasing the amount of CM processor occupancy assigned to the NOSFT and SNIP scheduler classes would improve the performance of processes in those scheduler classes, while decreasing the time available to processes in other scheduler classes.

Decreasing the amount of CM processor occupancy assigned to the NOSFT and SNIP scheduler classes would worsen the performance of processes in those scheduler classes, while reserving additional time for processes in the other scheduler classes.

4.4 Expected Scheduler Class Usage for SDM

While a maximum of 6.0% is allocated between the NOSFT and SNIP classes for SDM related activities, the expected maximum usage of the two is 3.4%, not 6.0

The SDM utilization of NOSFT class and SNIP class is almost mutually exclusive. Full utilization of both classes can not occur simultaneously. The worst case SDM real time impact on the CM is when the CM is fully loaded and the NOSFT class 3% is fully utilized. When this occurs, the maximum simultaneous usage of the SNIP class for TCP/IP acknowledgments is 0.4%. This brings the actual worst case impact of the SDM to CM real time to 3.4% rather than the theoretical 6% maximum.

The maximum SDM usage of CM real time falls into two scenarios: SNIP maximum case and NOSFT maximum case.

For the maximum SNIP case, CM real time usage by the SDM under full load conditions during typical run time operations is 4.5%. Out of this 4.5%, the majority of the 3% SNIP utilization is due to SDM provisioning via table access. The 1.5% Background usage is for logs and Telnet traffic. Other processes will be sharing the Background class real time allotment. This scenario includes logs and Telnet, provisioning (DMS table updates), no data dictionary download.

BKG	SNIP	MAINT	NOSFT	TOTAL
1.5%	3%	≈0%	0%	4.5%

For the maximum NOSFT case, peak CM real time usage by the SDM under full load conditions during data dictionary downloads is 4.9%. Of this 4.9%, 1.5% usage is in Background class for logs and Telnet traffic. The remaining 3.4% is the actual NOSFT and SNIP real time impact. This scenario includes logs and Telnet, provisioning (DMS table updates) and data dictionary download.

BKG	SNIP	MAINT	NOSFT	TOTAL
1.5%	0.4%	≈0%	3%	4.9%

The probability of doing data dictionary downloads in high day busy hour is low. During normal operation, data dictionary downloads occur during BCS upgrades or restart reloads. This activity is of 10 to 30 minutes duration depending on the size of the dictionary, the availability of unused CPU and link utilization. The full 3% of SNIP is not utilized at this time as provisioning can not occur until the download completes.

5. SDM Platform Software

This section provides information on SDM resource usage by the SDM platform software packages. The resource categories covered are

SDM memory,
SDM paging space,
SDM disk,
SDM real time,
SDM/CM transmission and
SDM/LAN transmission.

Characterization of the SDM platform and the SDM resident applications has provided the information to determine the resource usage under various platform and application activity rates.

The SDM memory, paging and disk characterization are straightforward.

The SDM real time characterization is based on long term average real time usage of the SDM platform and the SDM resident applications. The characterization information is determined from either long term real time average measurements or from burst real time measurements averaged out to long term values.

The data link utilizations are calculated based on known unit sizes and repetition rates.

The SDM08 platform software package consists of

the AIX operating system,
base software,
table access,
OM API,
network protocols and
device drivers.

The SDM platform software requires the following resources:

memory	45.3 megabytes
paging space	48.6 megabytes
disk storage allocation	630.7 megabytes
average SDM CPU real time occupancy	6.45 %
SDM/CM data rate	≈ 0
SDM/LAN data rate	≈ 0

6. SDM Application Software

This section provides information on the SDM resource usage on SDM resident application scenarios supported by the SDM08 software packages. The resource categories covered are

SDM memory,
SDM paging space,
SDM disk,
SDM real time,
SDM/CM data transmission and
SDM/LAN data transmission.

The SDM08 software application packages covered in this SEB are

enhanced terminal access,
log delivery,
exception reporting and
SuperNode billing application.

The SDM09 SEB will cover these applications plus DDMS, DMS Data Management System. The DDMS application supports a number of value added applications to provide enhanced data management, operations support systems and user interfaces on the DMS system.

Key objectives of DDMS are to maintain a real time synchronized view of the current DMS SuperNode switch data, provide a machine-to-machine interface with standard operations for updating and querying the database, and deliver a graphical user interface for basic table editing and browsing.

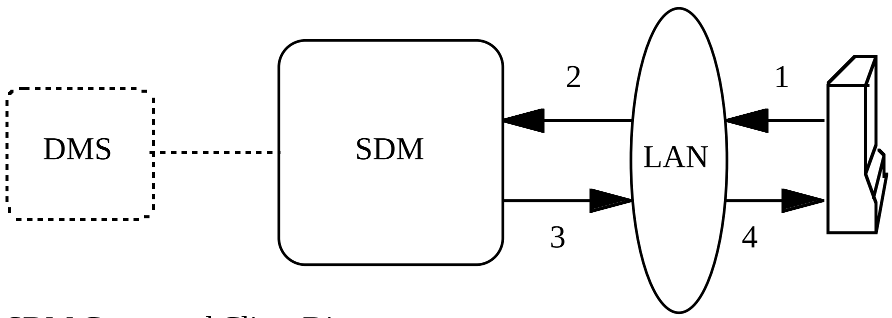
No DDMS preview information is available for including in this SDM08 SEB.

6.1 Enhanced Terminal Access

The enhanced terminal access application provides secure access to the SDM and CM from workstations on the network provider's TCP/IP LAN or WAN using state of the art authentication procedures and authorization mechanisms through the DCE (distributed computing environment). It provides multiple MAP sessions to reduce the total number of terminals required, streamline maintenance tasks, and allow the network provider to designate certain maintenance tasks to one of its technical groups in a centralized location.

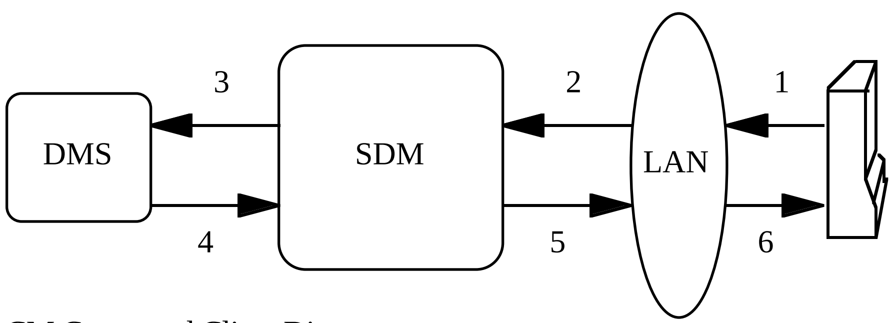
There are two configurations for the enhanced terminal access. Each is shown in one of the diagrams below.

The configuration in which a client terminal is connected to the SDM for the purpose of communicating with the SDM is shown in the figure immediately below. In this case the client terminal is termed an SDM connected ETA client.



SDM Connected Client Diagram

The configuration in which a client terminal is connected through the SDM for the purpose of communicating with the CM is shown in the figure immediately below. In this case the client terminal is termed a CM connected ETA client.



CM Connected Client Diagram

The information below is based on measurements of a scenario where each client terminal is executing a simple request of 150 bytes every 15 seconds and the CM or SDM is returning 4.5 kilobytes of information in response to the request. This reflects a very active manually operated terminal. The actual real time usage was observed as being bursty and using a larger amount of real time for a brief period. The real time information below has been averaged over the 15 second period between one request and the next that captures all the activities for a single request and response.

The resource usage for memory, paging space, real time and data links are categorized according to whether the client is an “SDM connected ETA client” or a “CM connected ETA client.” An SDM connected client is one that is connected to the SDM from the operating company LAN and that does operations only on the SDM itself, with no CM involvement. A CM connected client is one that is connected to the SDM for connecting through it to the CM.

An ETA client only uses the resources for its client type, either SDM connected or CM connected. That is if a CM connected client is “charged” 0.6% SDM real time as a CM connected ETA client, it does not additionally incur the 0.6% real time for being connected to the SDM.

The SDM enhanced terminal access application requires

ETA base memory	1.9 megabytes
ETA memory for first SDM connected client	0.4 megabytes
ETA memory for each additional SDM conn'd client	0.2 megabytes
ETA memory for first CM connected client	0.4 megabytes
ETA memory for each additional CM conn'd client	0.3 megabytes
ETA base paging space	1.3 megabytes
ETA paging space for first SDM connected client	0.5 megabyte
ETA paging space for each additional SDM client	0.4 megabyte
ETA paging space for first CM connected client	0.5 megabyte
ETA paging space for each additional CM client	0.4 megabyte
disk storage usage/allocation	0.4 megabyte
average SDM real time per SDM connected client	0.6%
average SDM real time per CM connected client	0.6%

For each SDM connected client

LAN-to-SDM data transmission rate	.01 kilobytes/second
SDM-to-LAN data transmission rate	0.3 kilobytes/second

For each CM connected client

LAN-to-SDM data transmission rate	.01 kilobytes/second
SDM-to-LAN data transmission rate	0.3 kilobytes/second
CM-to-SDM data transmission rate	0.3 kilobytes/second
SDM-to-CM data transmission rate	.01 kilobytes/second

Conversion of the terminal activity level to the bytes per second figures in the table is performed as shown in the calculations below.

Terminal requests to the SDM or CM,

150 bytes / 15 seconds = 10 bytes / second = .010 Kbytes / second

SDM or CM responses to the terminals,

4.5 Kbytes / 15 seconds = 300 bytes / second = 0.3 Kbytes / second

6.1.1 ETA Terminal Capacity

The ETA application uses variable amounts of memory, paging space, real time and data link resources based on the number of active client terminals and the total activity level of the terminals.

The ETA memory usage requirement is proportional to the number of active client terminals as shown in the table above. The incremental memory usage is small compared to the total amount of the resource available. The memory usage is 0.2 to 0.3 Mbytes for each active client terminal. The amount of available memory is 128 megabytes and can be easily expanded to 512 megabytes. Memory is not a capacity constraint for the ETA application.

The ETA paging space requirement is also proportional to the number of active client terminals. The incremental paging space requirement is also small compared to the amount of the available paging space resource. The ETA paging space usage is 0.4 to 0.5 Mbytes per active client terminal. The amount of paging space is 384 Mbytes minimum, it increases with increasing memory size, and can be easily expanded further if required. Paging space is not a capacity constraint for the ETA application.

The ETA real time requirement varies with the total activity level of the active client terminals. Continuing our ETA activity model defined above, each terminal needs 0.6% of the SDM CPU real time occupancy. The total available SDM CPU occupancy is 100%. The only way to increase the available real time is to use a different processor with increased processing capacity. This is possible, but not as easy as increasing the memory, paging space or disk capacities.

The preferred SDM CPU real time occupancy engineering limit is 50%, though SDM CPU occupancy to 70% is possible in many systems and even 90% in some special cases. The SDM platform uses 6.45% of the SDM CPU real time. This leaves sufficient SDM CPU real time to support 72 active ETA client terminals operating at the defined activity level provided no other application processes are running.

Quantity of supported ETA Client Terminals

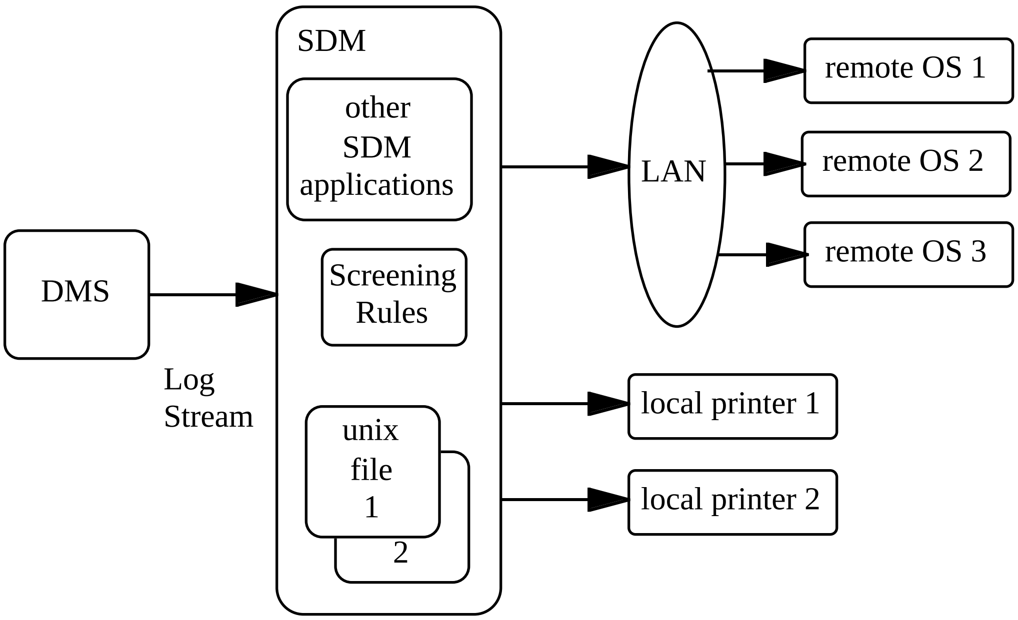
$$= \frac{\text{SDM CPU Real Time Engineering Limit} - \text{SDM Platform CPU Real Time}}{\text{SDM CPU Real Time per Client Terminal}}$$

$$= (50\% - 6.45\%) / 0.6\%$$

$$= 72.6 \text{ ETA client terminals}$$

6.2 High Speed Logs

The log delivery application is illustrated in the figure below. It receives the log stream from the DMS CM, plus SDM originated logs, screens these and forwards the requested set of logs to each client. It can provide a set of screened logs to three remote operating systems, two local printers, two UNIX files and other SDM applications.



The actual real time usage for high speed logs is bursty and occurs upon the receipt of each log from the CM. The SDM CPU real time usage was measured at a rate of 1 log per second coming from the CM to the SDM and then averaged to reflect a uniform long term SDM real time usage. All the values given below are based data collected with the log delivery application running at 1 log per second.

The SDM high speed logs application requires the resources as indicated.

memory	2.0 megabytes
paging space	2.0 megabytes
disk storage allocation	8.5 megabytes
average SDM real time	0.3% (for 1 log/second rate)
CM-to-SDM data transmission rate	average log size * CM-to-SDM log delivery rate
SDM-to-LAN data transmission rate	average log size * CM-to-SDM log delivery rate * average number of destinations

For an average log delivery rate of 1 log/second, the average SDM real time used is 0.3%.

For an average log size of 600 bytes, sent from CM to SDM every second, the CM-to-SDM data rate would be

(600 bytes / 1000) * (1 log / second) = 0.60 kilobytes per second.

The SDM-to-LAN log traffic is based on the CM-to-SDM log traffic, multiplied by the average number of destinations per incoming log. This could result in fewer logs due to screening and exclusion, or more logs due to multiple destinations per log. For one 600 byte log per second from the CM to the SDM, with an average 2 destinations per incoming log, the SDM-to-LAN data transmission rate is

(600 bytes / 1000) * (1 log / second) * 2

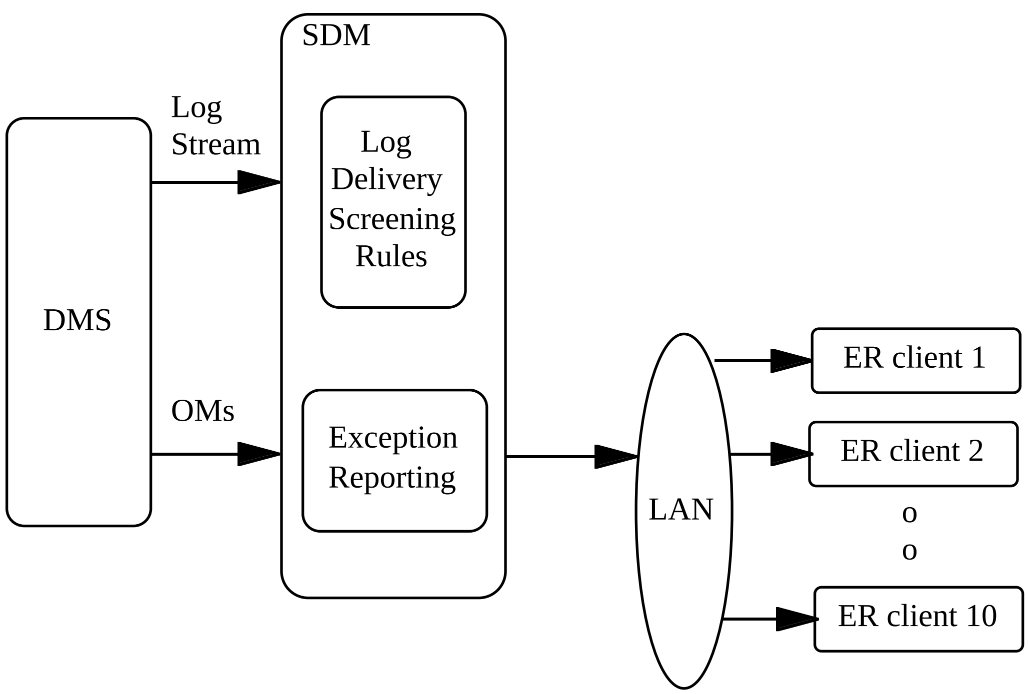
= 1.20 kilobytes / second.

= 9.60 kilobits / second

6.3 Exception Reporting

The SDM exception reporting application provides filtering of log and OM information, that can result in the generation of alarms and additional logs. Logs generated in the CM are processed by an SDM resident expert system that uses a knowledge base to identify rules that point to exceptions. The exception rules are defined by the telephone operating company on the exception reporting template, and are based on types and volumes of logs and call traffic information.

The exception reporting application is illustrated in the figure below.



The real time usage for the exception reporting application is bursty and occurs upon the receipt of each log from the SDM as well as time triggered processing activity. The value given below is an average value for a 1 log/second delivery rate from the CM.

Other effects on the exception reporting real time may occur with variations in the quantity and complexity of the exception criteria.

The SDM exception reporting application requires

memory	3.3 megabytes
paging space	13.3 megabytes
disk storage allocation	34.7 megabytes
average SDM real time	3.5% (for 1 log/second rate)
CM-to-SDM data transmission rate	0.43 kilobits/second
SDM-to-LAN data transmission rate	negligible

The exception reporting application contribution to the CM-to-SDM data rate covers the transmission of OMs used by the exception reporting application to determine items such as number of calls. These are used when the exception criteria is based on the quantity of a certain log type per 100,000 calls or similarly.

The 0.43 kilobits/second estimate for the exception reporting CM-to-SDM data rate is based on 80 OMs of 200 bytes each, delivered every five minutes.

Average exception reporting CM-to-SDM data rate

$$= \frac{80 \text{ OMs} * 200 \text{ bytes / OM}}{5 \text{ minutes} * 60 \text{ seconds / minute}}$$

$$= 53.3 \text{ bytes / second}$$

$$= 427 \text{ bits / second}$$

$$= 0.43 \text{ kilobits/second}$$

The exception reporting application contribution to the SDM-to-LAN data rate is negligible. It covers the transmission of exception logs to downstream telco offices. Generation and transmission of exception report logs is expected to occur only occasionally.

The log data traffic from the CM to the SDM is attributed to the log delivery application, not to the exception reporting application, and so is not included here.

6.4 SuperNode Billing Application

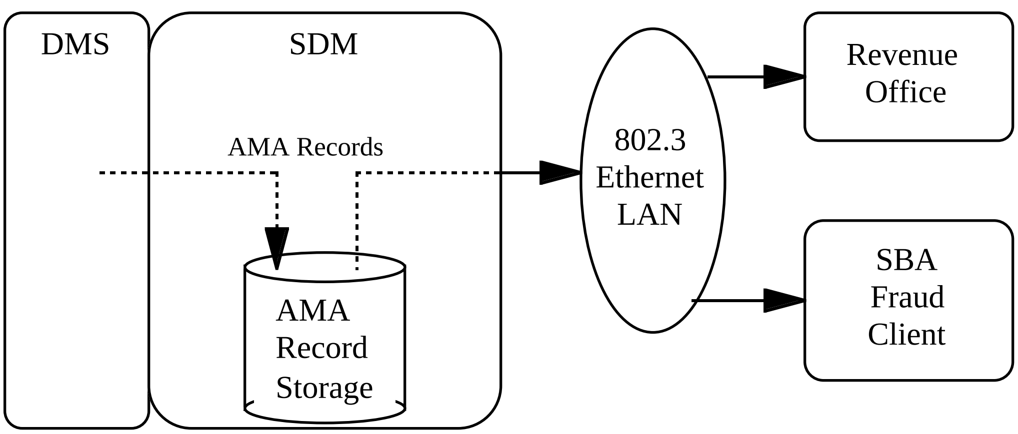
The SBA (SuperNode Billing Application) is the new application in SDM08.

The SuperNode Billing Application has been developed to provide the data server functionality of the Bellcore AMADNS specification GR-1343-Core. This capability allows the improvement of the billing / AMA network in the following ways:

> higher data transmission rates to support large volumes of data, increased AMA record throughput up to 1.2 million AMA records per hour,
>
> enhanced data retrieval, near real time data transfer within five minutes of call completion and on demand data access via remote data polling,
>
> specialized processing application support, record segregation and multiple output streams, multiple AMA record formats, MDR, SMDR, BAF and
>
> lowered system maintenance costs from network based data transfer, eliminating dedicated or dial up polling links, and from the integration into the DMS system itself, eliminating the requirement for external units.

SBA supports three operations. The most basic operation is the receipt of AMA records from the DMS CM and storing them on mirrored disks. FTP (file transfer protocol) provides the ability to receive requests from a telco office to send the stored AMA records to the telco downstream AMA record processing office. AMADUMP provides the ability to search and retrieve AMA records based on search criteria.

The SBA application on the SDM is illustrated in the figure below.



The SBA on SDMNA008 has a throughput capacity limit based on a maximum data rate of 26.7 kilobytes/second or 96.12 megabytes/hour. This capacity limit will increase in SDMNA009 and again in SDMNA011.

The SDMNA008 SBA throughput capacity limits for various size AMA records are provided in the table immediately below.

AMA Record Size (Bytes)	AMA Record Throughput (Records / Hour)
75	1.28 million
80	1.20 million
85	1.13 million
90	1.07 million
95	1.01 million
100	961,200
105	915,400
110	873,800
115	835,800
120	801,000
125	768,900
130	739,400
135	712,000

The SDM SBA application requires

SBA basic memory	9.3 megabytes
SBA memory, each FTP instance	0.50 megabyte
SBA memory, each AMADUMP instance	1.8 megabytes
SBA basic paging space	5.3 megabytes
SBA paging space, first FTP instance	0.5 megabyte
SBA paging space, each additional FTP instance	0.4 megabyte
SBA paging space, first AMADUMP instance	2.2 megabyte
SBA paging space, each add'l AMADUMP instance	1.8 megabyte
disk storage allocation (code storage)	46.9 megabytes
disk storage allocation (data)	12.1 gigabytes (see discussion below)
average SDM CPU real time occupancy	2.5% per 100,000 AMA records / hour (see discussion below)
LAN-to-SDM data transmission rate	≈ 0
SDM-to-LAN data transmission rate	up to 360 kilobits/second (see discussion below)
CM-to-SDM data transmission rate	up to 360 kilobits/second (see discussion below)
SDM-to-CM data transmission rate	≈ 0

The average SBA application SDM CPU real time occupancy was measured at 30%, at 1.2 million AMA records per hour. The activity during the measurement period included the receipt of the AMA records from the CM, storage to SDM mirrored disk, retrieval from disk and transmission via FTP sessions to a downstream telco office.

The SBA data rate depends on the AMA record size and AMA record rate. The SBA disk storage requirement depends on the AMA record size and rate, plus the retention period.

Consider an intense AMA example where the DMS CM generates 1.2 million AMA records per hour during the busy hour, of average size 80 bytes, and each record will be retained at the SDM disk for seven days after it is initially collected. One day is added to the retention period as retention period is interpreted as the number of days after collection, not including the day of collection itself.

Use 10.0 as the conversion factor from busy hour AMA rate to daily AMA rate.

The calculation for the disk storage requirement for this case is shown below.

SBA AMA Disk Storage Requirement

= 1,200,000 records/hour * 80 bytes/record * 10 (busy hour to daily)
* 8 (1 + 7 retention days) * 1 / 1024^3 (units to giga conversion)

= 7.15 gigabytes

The actual disk storage requirement varies with all the elements combined to determine it. To meet the 7.15 gigabyte SBA AMA record disk storage requirement of this example, the SDM would supply two 4 gigabyte data volume disks on each side.

Because the same AMA records are being transferred from the CM to the SDM and from the SDM to the telephone operating company LAN, the average CM-to-SDM and SDM-to-LAN data rates are the same.

CM-to-SDM & SDM-to-LAN

= 1,200,000 records/hour * 80 bytes/record / 3600 seconds/hour * 8 bits/byte

= 213.3 kilobits/second

This is 2.1% of the 10 megabit/second CM-to-SDM data link capacity. It is also 2.1% of the 10 megabit/second Ethernet LAN capacity.

6.4.1 Telco Processing Office AMA Record Polling

Though the average CM-to-SDM and SDM-to-LAN data rates are the same, there may be a difference in actual practice due to non-continuous polling strategies by the telco to transfer the AMA records from the SDM to their AMA office. The CM-to-SDM AMA record transmission occurs at a continuous, slowly varying rate. The SDM-to-LAN data rate most likely will be intermittent as the downstream telco office requests the records to be transmitted via FTP sessions.

There is a tradeoff between the SDM-to-LAN data rate and the amount of time required to transmit the data. For the example above, if the telco wished to poll for the accumulated AMA records every four hours, and for the transmission time to be thirty minutes or less, the necessary data transmission rate would be the average CM-to-SDM data rate from above, divided by the polling utilization, the fraction of time during which the actual transmission takes place.

In this case,

polling utilization = polling time / time between polls

= 30 minutes / 4 hours = 0.125

data transmission requirement = average data rate / polling utilization

= 213.3 kilobits/second / 0.125

= 1,707 kilobits/second

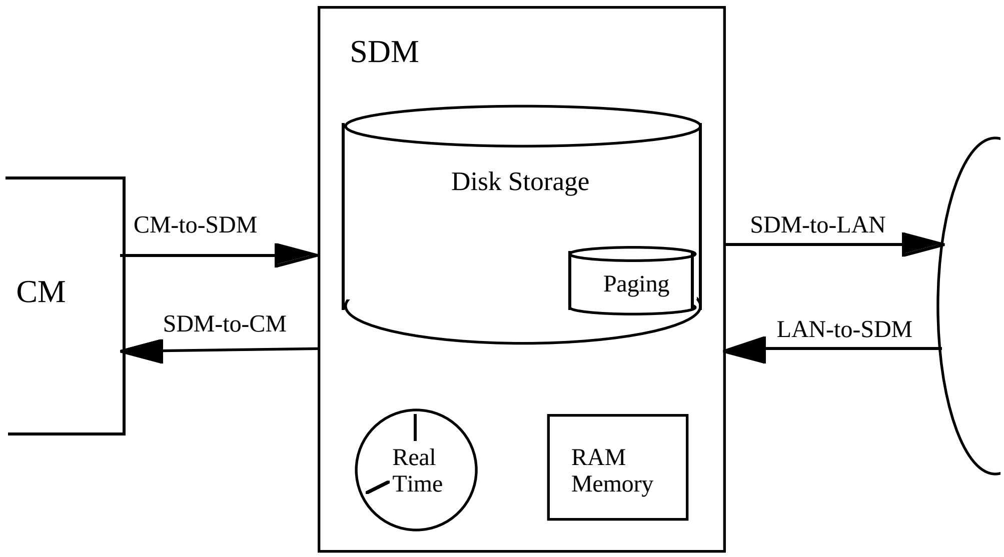
= 1.7 megabits/second

While comfortably less than the maximum data rate of the 10 megabit/second LAN, it is a significant portion of a 10 megabit/second LAN's capacity.

7. SDM Resource Usage Algorithms

The resource algorithms include all four applications that are covered in this SEB: ETA, log delivery, exception reporting and SuperNode billing application. The activity level of each application whose resource usage varies with activity level must be specified for the calculations.

The model for SDM resources is shown in the figure immediately below.



SDM Resource Model

The resource categories considered are

SDM RAM memory,
SDM disk paging area,
SDM disk storage area,
SDM real time,
CM-to-SDM and SDM-to-CM DS512 links,
SDM-to-LAN and LAN-to-SDM links.

Conversion among memory units of bytes, kilobytes, megabytes and gigabytes are done in multiples of 1,024. Conversion among data rate units of bits/second, bytes/second, kilobits/second, kilobytes/second and so forth are done in multiples of 1,000.

7.1 SDM Memory Algorithm

The SDM total memory requirement consists of fixed platform memory, fixed application memory and variable application memory for the ETA and SBA applications.

SDM Memory Requirement

= fixed platform memory
\+ variable platform memory (= 0)
\+ fixed application memory
\+ variable application memory

SDM Memory Requirement

= 45.3 megabyte
\+ 0
\+ 16.5 megabytes
\+ variable application memory (details below)

SDM Memory Requirement

= 61.8 megabytes

\+ 0.4 megabytes for first SDM connected ETA client
\+ 0.2 megabytes for each additional SDM connected ETA client
\+ 0.4 megabytes for first CM connected ETA client
\+ 0.3 megabytes for each additional CM connected ETA client

\+ 0.5 megabytes for each FTP instance
\+ 1.8 megabytes for each AMADUMP instance

The recommended maximum ratio of SDM memory used to available is 80%.

7.2 SDM Paging Space Algorithm

The SDM paging space requirement consists of fixed platform paging space, fixed application paging space and variable application paging space for the ETA and SBA applications.

SDM Paging Space Requirement

= fixed platform paging space
\+ variable platform paging space (= 0)
\+ fixed application paging space
\+ variable application paging space

SDM Paging Space Requirement

= 48.6 megabytes
+ 0
+ 21.9 megabytes
+ variable application paging space (details below)

SDM Paging Space Requirement

= 70.4 megabytes

+ 0.5 megabytes for first SDM connected ETA client
+ 0.4 megabytes for each additional SDM connected ETA client
+ 0.5 megabytes for first CM connected ETA client
+ 0.4 megabytes for each additional CM connected ETA client

+ 0.5 megabytes for first FTP instance
+ 0.4 megabytes for each additional FTP instance
+ 2.2 megabytes for first AMADUMP instance
+ 1.8 megabytes for each additional AMADUMP instance

The amount of paging space allocated is set at three times the amount of total available memory in the SDM system. For a system with 128 megabytes of memory, this is 384 megabytes of paging space.

The alarm threshold for paging space usage is usually set at 70%. Systems run with no apparent degradation up to 80%.

7.3 SDM Disk Storage Allocation

The SDM disk storage space requirement consists of fixed platform disk space, fixed application disk space and variable application disk space for SBA application.

SDM Disk Storage Space Requirement

= fixed platform paging space (including paging space)
+ variable platform paging space (= 0)
+ fixed application paging space
+ variable application paging space

To determine the SDM disk storage space requirement, first consider the fixed platform disk space and fixed application disk space together, without the variable disk space for the SBA application.

SDM Fixed Disk Storage Space Requirement

= 630.7 megabytes
+ 0
+ 90.4 megabytes
+ variable application paging space (covered later)

= 721.1 megabytes

The SDM08 platform minimum disk storage space in the root volume group is 2 gigabytes or 2,048 megabytes.

The disk storage space configured is 1,312 megabytes.

Configured Disk Space / Root Volume Group Disk Space

= 1,312 megabytes / 2,048 megabytes

= 64%

The SDM fixed disk storage space requirement, used or allocated, is 721.1 megabytes.

Used Disk Space / Configured Disk Space

= 721.1 megabytes / 1,312 megabytes

= 55%

The recommended maximum ratio of SDM disk space used to disk space configured is 90%. As the recommended ratio of used to configured space is approached, additional disk space would be reconfigured in the areas that were approaching the limit. This method is effective until the configured disk space approaches the total disk space, at which time the total disk space must be increased by adding physical disks.

In SDM08 the only application that requires variable disk storage space is SBA. Refer to the discussion in section 6.4 on how to derive the equations and for an example.

Variable SDM Disk Storage Space Requirement

= SBA Variable Disk Storage Space Requirement

= AMA records / hour
* bytes / record
* busy hour to daily conversion factor
* (number of days retention + 1)

The SBA variable disk storage space requirement may be met by sharing the root volume group disks with the operating system and the fixed application requirements. Alternatively a separate data volume group may be established with its own physical disks. The decision whether to share the root volume group disks or dedicate data volume group disks for SBA depends on the amount of storage required and whether read/write contention for the disks would introduce excessive inefficiencies for the platform or SBA.

7.4 SDM Average Real Time Algorithm

The SDM real time organization is quite different from the CM. The CM uses a fair share scheduling mechanism which is well suited for call processing activities. These constitute a large number of short processing time requests.

The SDM runs on a computing platform with a scheduler designed to ensure that all active processes receive some portion of real time until they are completed. It is based on an operating system that always allows all tasks to complete. Based on the amount of work to be done for itself and the other active processes, the total elapsed time of a job varies.

The real time values reported in this SEB are the long term average SDM CPU real time usage by an application. The measured real time values over a short period of activity have been converted to average long term values.

The actual real time activity for a particular application occurs in a bursty mode. That is, for servicing of logs, terminals or other service requesters, the SDM system devotes a portion of its time to servicing that particular request for a brief period of time. It then shares its time among other activities until a subsequent request occurs and that new request is added to the processes that each receive a portion of the processor real time.

An activity that uses 20% of the SDM processor for 10 seconds every 5 minutes converts to an average real time usage value of 0.67%. The arithmetic is shown below.

Average Real Time Occupancy

$$= \frac{20\% \ * \ 10 \text{ seconds}}{5 \text{ minutes} \ * \ 60 \text{ seconds / minute}}$$

$$= 2.0 \text{ seconds} \ / \ 300 \text{ seconds}$$

$$= 0.67\%$$

Average real time occupancy engineering is valuable in that it provides the average CPU utilization. Both the probability of delay and the amount of expected delay time for a process to finish vary with the average CPU utilization. However, it does not account for the arrival pattern of process requests for CPU time nor the scheduler algorithm itself.

The SDM CPU real time requirement consists of fixed platform real time, fixed application real time and variable application real time for the ETA and SBA applications.

Average SDM CPU Real Time Requirement

= fixed platform real time
+ variable platform real time (= 0)
+ fixed application real time
+ variable application real time

Average SDM CPU Real Time Requirement

= 6.45%
+ 0
+ 3.8%
+ variable application real time (details below)

Average SDM CPU Real Time Requirement

= 10.25%

+ 0.6% * SDM connected ETA clients
+ 0.6% * CM connected ETA clients

+ 2.5% * AMA records/hour / 100,000 AMA records/hour

If the total average SDM CU real time utilization is less than or equal to 50%, the SDM can support the SDM platform and the set of applications at the designated activity levels.

If the total average SDM CPU real time utilization is greater than 50% and less than or equal to 70%, the SDM can probably support the applications at the activity levels. The arrival rates and patterns of real time demands and the elapsed time requirements for critical applications may also need to be considered.

If the total average SDM CPU real time utilization is greater than 70% and less than or equal to 90%, the SDM can probably not support the applications unless the arrival rates and patterns are well behaved and close to uniform, and the application scenario elapsed time requirements are not critical.

If the average SDM CPU real time utilization is greater than 90%, the SDM almost certainly cannot support the applications and activity levels, and either some of the applications need to be discontinued or run at a lower activity level, or a more powerful processor used.

This information is summarized in the table below.

SDM CPU Utilization	SDM CPU Capability to Support Platform and Applications
Utilization ≤ 50%	Okay
50% < Utilization ≤ 70%	Probably okay; check for applications with critical response times
70% < Utilization ≤ 90%	Probably not okay, unless all application response times are not critical
90% < Utilization	Cannot handle; reduce applications or convert to more powerful SDM processor

7.5 SDM Data Traffic Algorithms

The SDM data traffic requirement consists of fixed platform traffic, fixed application traffic and variable application traffic for the ETA and SBA applications. There are four separate paths that the data may traverse, either direction between the CM and SDM, and either direction between the SDM and the telco LAN.

The fixed platform data traffic consists of sanity checking messages between the CM and the SDM to ensure individual integrity as well as communications path integrity. The amount of this traffic in each direction is negligible and is disregarded in the rest of this section There is no variable platform data traffic.

The fixed data link traffic consists of the OMs from the CM to the SDM delivered every five minutes to support the exception reporting application. The variable data link traffic consists of the logs themselves from the CM to the SDM, logs from the SDM to the LAN and the ETA traffic. Not included in the traffic is the delivery of the exception logs themselves. This exception log traffic is expected to be very close to zero.

For additional information on the source of the data transfer rate among the CM, SDM and the telephone operating company LAN, refer to the description of the data rates of the individual applications in sections 6.1 through 6.4.

The bi-directional data links between the CM and SDM are independent. That is, CM-to-SDM data traffic is on a different physical link from SDM-to-CM traffic. The data links between the SDM and the network provider's LAN are considered separately, but are combined together on the LAN itself.

The calculations are shown below for kilobytes/second. The easy conversion to kilobits/second by multiplying by 8 has not been shown.

CM-to-SDM data rate (kilobytes/second)

= fixed application data rate (OMs for exception reporting)
+ variable ETA data rate
+ variable log delivery data rate
+ variable SBA data rate

CM-to-SDM data rate (kilobytes/second)

= 0.053 kilobytes / second

+ 0.30 kilobytes/second * quantity of CM connected ETA clients

+ average log size (bytes) / 1,000 * log delivery rate (logs / second)

+ AMA record size (bytes) / 1,000
    * AMA record rate (records / hour) / 3,600

Conversion constants are used to convert log size and AMA record sizes from bytes to kilobytes (1,000), and to convert AMA records / hour to AMA records / second (3,600).

SDM-to-CM data rate (kilobytes/Second)

= variable ETA data rate

= .01 kilobytes/second * quantity of CM connected ETA clients

SDM-to-LAN data rate (kilobytes/second)

= variable ETA data rate
+ variable log delivery data rate
+ variable exception reporting data rate (≈ 0)
+ variable SBA data rate

= 0.3 kilobytes/second * quantity of CM connected ETA clients

+ 0.3 kilobytes/second * quantity of SDM connected ETA clients

+ average log size (bytes) / 1,000 * log delivery rate (logs / second)
    * log retransmit proportion

+ AMA record size (bytes) / 1,000
    * AMA record rate (records / hour) / 3,600

Conversion constants are used to convert log size and AMA record sizes from bytes to kilobytes (1,000), and to convert AMA records / hour to AMA records / second (3,600).

LAN-to-SDM data rate (kilobytes/second)

= variable ETA data rate

= .01 kilobytes/second * quantity of CM connected ETA clients

+ .01 kilobytes/second * quantity of SDM connected ETA clients

8. SDM Resource Calculations Examples

This section considers a sample office activity level and shows the calculations to determine memory, paging space, disk storage, SDM real time and data link requirements.

The following parameters must be specified to determine if the SDM system has sufficient resources to support the applications at the desired activity levels. The first 11 parameters relate to the activity levels of the applications resident on the SDM. The last 2 parameters provide details of the SDM platform to support the applications.

Quantity of ETA client terminals connected to SDM	6
Quantity of ETA client terminals connected through SDM to CM	22
Average log size in bytes	760
Expected number of log reports per second	1
Average number of destinations logs are forwarded to	1.5
Busy hour AMA records	300,000
Busy hour to daily conversion factor	10
Average AMA record size	79
AMA record retention period	5
ftp instances	1
AMADUMP instances	1
SDM System Memory (megabytes)	128
SDM System Disk Storage (gigabytes)	2

8.1 SDM Example Memory Manual Calculations

The SDM memory algorithm from section 7.1 is repeated below as the starting point for the calculations.

SDM Memory Requirement

= 61.8 megabytes

\+ 0.4 megabytes for first SDM connected ETA client
\+ 0.2 megabytes for each additional SDM connected ETA client
\+ 0.4 megabytes for first CM connected ETA client
\+ 0.3 megabytes for each additional CM connected ETA client

\+ 0.5 megabytes for each FTP instance
\+ 1.8 megabytes for each AMADUMP instance

SDM Memory Requirement

= 61.8 MB

+ 0.4 * (1) + 0.2 * (6 - 1) + 0.4 * (1) + 0.3 * (22 - 1)

+ 0.5 * (1) + 1.8 * (1)

= 72.2 megabytes

SDM Memory Required (megabytes) =72.2

SDM Memory Available = 128 megabytes

Ratio Required Memory / Available Memory = 72.2 MB / 128 MB = 0.56

Ratio Used/Available < Ratio Upper Limit (0.80) ==> Okay

8.2 SDM Example Paging Space Manual Calculations

The SDM paging space algorithm from section 7.2 is repeated below as the starting point for the calculations.

SDM Paging Space Requirement

= 70.4 megabytes

+ 0.5 megabytes for first SDM connected ETA client
+ 0.4 megabytes for each additional SDM connected ETA client
+ 0.5 megabytes for first CM connected ETA client
+ 0.4 megabytes for each additional CM connected ETA client

+ 0.5 megabytes for first FTP instance
+ 0.4 megabytes for each additional FTP instance
+ 2.2 megabytes for first AMADUMP instance
+ 1.8 megabytes for each additional AMADUMP instance

SDM Paging Space Requirement

= 70.4 megabytes
+ 0.5 * (1) + 0.4 * (6 - 1) + 0.5 * (1) + 0.4 * (22 - 1)
+ 0.5 * (1) + 2.2 * (1)

= 84.5 megabytes

SDM Paging Space Required (megabytes) = 84.5 megabytes

SDM Paging Space Available (megabytes) = 3 * 128 = 384 megabytes

Ratio Required Paging Space to Available = 84.5 MB / 384 MB = 0.22

This is well below the 70% alarm threshold.

8.3 SDM Example Disk Storage Manual Calculations

In section 7.3, the SDM disk storage algorithm is developed in two pieces, one piece for the fixed platform and application storage requited for code and paging space. The variable disk storage space requirement is only for the SBA application.

SDM Fixed Disk Storage Space Requirement

= 721.1 megabytes (from section 7.3)

Used Disk Space / Configured Disk Space

= 721.1 megabytes / 1,312 megabytes

= 55%

Ratio Used/Configured < Ratio Upper Limit (90%) ==> Okay

Configured Disk Space / Root Volume Group Disk Space

= 1,312 megabytes / 2,048 megabytes

= 64%

Variable SDM Disk Storage Space Requirement (megabytes)

= SBA Variable Disk Storage Space Requirement

= AMA records / hour
* bytes / record
* busy hour to daily conversion factor
* (number of days retention + 1)
* 1 / 1,024^2

= 300,000 records / hour * 79 bytes / record * 10 hours / day * (5 + 1) days
* 1 / 1,024^2

= 1,356.1 megabytes AMA record storage

Total SDM Disk Storage Space Requirement

= SDM Fixed Disk Storage Requirement
+ SDM Variable Disk Storage Requirement

= 721.1 megabytes + 1,356.1 megabytes

= 2,077 megabytes

The requirement for 2,077 megabytes of SDM disk storage space puts it just beyond the 2 gigabyte disk capacity of 2,048 megabytes. Two alternatives are possible. Either the root volume group disks may be increased to 4 gigabyte disks, providing enough additional room for the AMA records to be stored there, or separate physical disks may be used for a data volume group that would store just the AMA records. To minimize potential interference from read and write operations from the platform and various applications, the best choice is a separate data volume group.

8.4 SDM Example Real Time Manual Calculations

The SDM CPU real time usage algorithm from section 7.4 is repeated below as the starting point for the calculations.

Average SDM CPU Real Time Requirement

= 10.25%

+ 0.6% * SDM connected ETA clients
+ 0.6% * CM connected ETA clients

+ 2.5% * AMA records/hour / 100,000 AMA records/hour

Average SDM CPU Real Time Requirement

= 10.25%
+ 0.6% * (6) + 0.6% * (22)
+ 2.5% * (300,000 / 100,000)

= 34.55%

SDM CPU Real Time Required < Real Time Upper Limit (50%) ==> Okay

8.5 SDM Example Communication Link Manual Calculations

The SDM communication link algorithms from section 7.5 are repeated below as the starting points for the calculations.

CM-to-SDM data rate (kilobytes/second)

= 0.053 kilobytes / second

+ 0.30 kilobytes/second * quantity of CM connected ETA clients

+ average log size (bytes) / 1,000 * log delivery rate (logs / second)

+ AMA record size (bytes) / 1,000
  * AMA record rate (records / hour) / 3,600

= .053
+ 0.30 * (22)
+ 760 / 1,000 * 1
+ 79 / 1,000 * 300,000 / 3,600

= 14.0 kilobytes / second

= 112.0 kilobits / second

SDM-to-CM data rate (kilobytes/Second)

= .01 kilobytes/second * quantity of CM connected ETA clients

= .01 * (22)

= 0.22 kilobytes / second

= 1.8 kilobits/ second

SDM-to-LAN data rate (kilobytes/second)

= 0.3 kilobytes/second * quantity of CM connected ETA clients

+ 0.3 kilobytes/second * quantity of SDM connected ETA clients

+ average log size (bytes) / 1,000
  * log delivery rate (logs / second)
  * log retransmit proportion

+ AMA record size (bytes) / 1,000
  * AMA record rate (records / hour) / 3,600

= 0.3 * (22)
+ 0.3 * (6)
+ 760 / 1,000 * 1 * 1.5
+ 79 / 1,000 * 300,000 / 3,600

= 16.12 kilobytes / second

= 129.0 kilobits / second

LAN-to-SDM data rate (kilobytes/second)

= .01 kilobytes/second * quantity of CM connected ETA clients

+ .01 kilobytes/second * quantity of SDM connected ETA clients

= .01 * (22)
+ .01 * (6)

= .028 kilobytes / second

= 0.22 kilobits / second

9. SDM Model Examples

The examples shown in sections 9.1 and 9.2 show the memory, disk, real time and transmission link activities as examples of two SDM configurations and application activity levels. The example in 9.1 is a lightly loaded one. The example in 9.2 has a high level of activity. Each of the examples was calculated using the Capacity Sizing Mechanism described in section 10.

9.1 SDM Lightly Loaded Example

This lightly loaded SDM example has just one terminal connected to the SDM, and 3 terminals connected through the SDM to the CM.

There is one log sent from the CM to the SDM every second, thus a rate of 1 log per second. These logs average 760 bytes in length. On average, they are forwarded to 1.1 destinations. With the screening capability of the log delivery application, each incoming log from the CM to the SDM may be forwarded to none, one or multiple destinations, subject to the flexible screening and routing rules of the application. This could be all of them forwarded to one destination, with 10% of them forwarded to another destination as well. All sorts of other combinations are possible.

Each side of the SDM has 128 megabytes of memory and 2 gigabytes of disk storage

During the busy hour 50,000 AMA records of average size 79 bytes are sent to the SDM. The conversion factor for busy hour to daily is 10. The retention period is 5 days. There is one FTP process active and no AMADUMP processes.

This information is entered into the EngrInfo sheet of the SDM08 CSM spreadsheet as shown below.

128	SDM System Memory (megaBytes)
2	SDM System Disk Storage (gigaBytes)

1	Quantity of ETA client terminals connected to SDM
3	Quantity of ETA client terminals connected through SDM to CM

760	Average log size in Bytes
1	Expected number of log reports per second (must = 1 in SDM08)
1.1	Average number of destinations logs are forwarded to

50,000	Busy Hour AMA records
10	Busy Hour to Daily Conversion Factor
79	Average AMA record size
5	AMA record retention period (days, +1 used in calculations)
1	ftp instances
0	amadump instances

The results of processing the input configuration according to our resource algorithms are presented in the SmryInfo sheet of the SDM08 CSM spreadsheet as shown below.

As expected, all the resource demands for this lightly loaded system are well within the limits of the system can handle.

	Memory
61.8	Fixed Memory Required (megaBytes)
1.9	Variable Memory Required (megaBytes)
63.7	Total Memory Required (megaBytes)
128	SDM Memory Available (megaBytes)
49.7%	% SDM Memory Used
80.0%	% Memory Used Limit
Okay	Memory Resource Status

	Disk Swap and Storage Space
70.4	Fixed Swap/Paging Space Required (megaBytes)
2.2	Variable Swap/Paging Space Required (megaBytes)
72.7	Total Swap/Paging Space Required (megaBytes)
384.0	SDM Swap/Paging Space Available (megaBytes)
18.9%	% Swap/Paging Space Used
2,048.0	Total Disk Space (megaBytes)
1,312	SDM Disk Storage Configured (megaBytes)
953	Disk Storage Used (megaBytes)
64.1%	% Disk Space Configured/Available
72.6%	% Disk Space Used/Configured
90.0%	% Disk Space Used/Configured Limit
Okay	Disk Resource Status

	Real Time
10.3%	Fixed Real Time Required
3.7%	Variable Real Time Required
13.90%	Total Real Time Required
50.0%	% Real Time Limit
Okay	Real Time Resource Status

	Communication Links
0.32	LAN-to-SDM (Kilobits/Second)
25.07	SDM-to-LAN (Kilobits/Second)
25.39	Σ LAN Activity
0.25%	% LAN Capacity Used
22.48	CM-to-SDM (Kilobits/Second)
0.22%	% CM-to-SDM Capacity Used
0.24	SDM-to-CM (Kilobits/Second)
0.03%	% SDM-to-CM Used

9.2 SDM Heavily Loaded Example

This heavily loaded SDM example has 5 ETA client terminals connected directly to the SDM, and another 50 connected through the SDM to the CM.

This example has 1 log per second delivered from the CM to the SDM, averaging 1000 bytes, and on the average being delivered to 2 destinations.

The system is configured with 256 megabytes of memory and a total of 8 gigabytes of disk storage space
.

256	SDM System Memory (megaBytes)
8	SDM System Disk Storage (gigaBytes)

5	Quantity of ETA client terminals connected to SDM
50	Quantity of ETA client terminals connected through SDM to CM

1000	Average log size in Bytes
1	Expected number of log reports per second (must = 1 in SDM08)
2	Average number of destinations logs are forwarded to

400,000	Busy Hour AMA records
10	Busy Hour to Daily Conversion Factor
115	Average AMA record size
10	AMA record retention period (days, +1 used in calculations)
1	ftp instances
0	amadump instances

The results as calculated by the SDM capacity sizing mechanism are shown below.

The total memory required is 77.8 megabytes, not much more than the lightly loaded system. In a real sizing exercise, we would probably reduce the memory size to see if any other constraints were violated with the smaller size memory. It also shows that 30.4% of the memory is actually used.

The disk paging space is somewhat over provisioned at 12.19% of the swap/paging space used.

The total disk space is approaching saturation. The ratio of configured to total available disk space is 87.9%. The ratio of disk space used or allocated to configured disk space is 84%. If any growth at all is foreseen, the disk space should be expanded to 10 or 12 gigabytes to start and avoid a hardware upgrade later.

Real time has increased significantly compared to the lightly loaded system. The total real time required is 53.25% of the SDM CPU. This is above the 50% value, but toward the low end of the 50% to 70% range. This higher SDM CPU usage is due to the larger number of terminals active at the CM and SDM and the higher AMA record rate. To see how much each of the applications has increased real time or other SDM resource usage, the individual application users of the resources are identified on the Calcs sheet of the capacity sizing mechanism. That is not shown here to conserve space.

The transmission links have a considerable amount of activity. It would be a problem with 64 kilobit/second links, but is easily handled with the DS512 links toward the CM and the 10 megabit/second LAN toward the telco.

	Memory
61.8	Fixed Memory Required (megaBytes)
16.1	Variable Memory Required (megaBytes)
77.8	Total Memory Required (megaBytes)
256	SDM Memory Available (megaBytes)
30.4%	% SDM Memory Used
80.0%	% Memory Used Limit
Okay	Memory Resource Status

	Disk Swap and Storage Space
70.4	Fixed Swap/Paging Space Required (megaBytes)
22.2	Variable Swap/Paging Space Required (megaBytes)
92.6	Total Swap/Paging Space Required (megaBytes)
768.0	SDM Swap/Paging Space Available (megaBytes)
12.1%	% Swap/Paging Space Used
8,192.0	Total Disk Space (megaBytes)
7,200	SDM Disk Storage Configured (megaBytes)
6,047	Disk Storage Used (megaBytes)
87.9%	% Disk Space Configured/Available
84.0%	% Disk Space Used/Configured
90.0%	% Disk Space Used/Configured Limit
Okay	Disk Resource Status

	Real Time
10.3%	Fixed Real Time Required
43.0%	Variable Real Time Required
53.25%	Total Real Time Required
50.0%	% Real Time Limit
OK but high	Real Time Resource Status

	Communication Links
4.40	LAN-to-SDM (Kilobits/Second)
250.22	SDM-to-LAN (Kilobits/Second)
254.62	Σ LAN Activity
2.55%	% LAN Capacity Used
230.65	CM-to-SDM (Kilobits/Second)
2.31%	% CM-to-SDM Capacity Used
4.00	SDM-to-CM (Kilobits/Second)
0.50%	% SDM-to-CM Used

10. Capacity Sizing Mechanism

The resource usage of each of the software application packages are described in sections 6.1 through 6.4.

The calculation of the total resource usage by type is given in sections 7.1 through 7.5, for each category of resource. These algorithms from section 7 are provided in an Excel 5 spreadsheet which eases the calculations to check that a particular sized memory and disk system can support the applications at the required activity levels. This spreadsheet can be obtained from a regional performance engineer.

The Excel 5 workbook is entitled SDM08 Resources. It consists of three sheets,

EngrInfo,
Calcs and
SmryInfo

The EngrInfo sheet is used to input the same eight parameters as were necessary for the manual SDM resource calculations in sections 8.1 through 8.5.

The Calcs sheet picks up the configuration input information from the EngrInfo sheet and performs the detailed calculations, providing intermediate results.

The SmryInfo picks up selected information from the Calcs sheet and displays it without all the detailed calculation information.

For examples of the EngrInfo and SmryInfo sheets from the capacity sizing mechanism, refer to the sample model calculation in sections 9.1 and 9.2.

11. SDM System Monitoring

The SDM system has a wide range of information available on the health of the system as a whole and the individual applications running on it. To access the system menu level, select option 5 from the maintenance menu level of the RMI (remote maintenance interface). One can also access this menu by typing SYS from any maintenance menu level.

This screen provides information about the operating system, including current CPU usage, paging space, process space and the logical volumes. Resources that have exceeded their threshold are marked by an asterisk and trigger an ISTb alarm.

The detailed information provided includes

SDM node state,
SDM system state,
disk mirroring state,

CPU (run queue entries) current and threshold,
number of processes current and threshold,
number of zombies current and threshold,
paging space (% full) current and threshold,
number of paging queue entries current and threshold,
/ logical volume (% full) current and threshold,
/usr logical volume (% full) current and threshold,
/var logical volume (% full) current and threshold,
/tmp logical volume (% full) current and threshold,
/home logical volume (% full) current and threshold,
/sdm logical volume (% full) current and threshold.

The SDM CPU run queue entries are observed over a fifteen minute period. If the average number of jobs queued waiting for processor time over this period exceeds the run queue entry threshold it triggers an alarm. In normal mode this indicator should be below 3. A sustained high level is reported by the SDM system.

The default thresholds for each of the items are in the following table. These are defaults and are administrable.

Monitor Item	Default Threshold
CPU (run queue entries)	5
number of processes	250
number of zombies	3
paging space (% full)	70%
number of paging queue entries	2
/ logical volume (% full)	80%
/usr logical volume (% full)	90%
/var logical volume (% full)	80%
/tmp logical volume (% full)	90%
/home logical volume (% full)	70%
/sdm logical volume (% full)	90%

12. Acronyms and Abbreviations

AMA	Automatic Message Accounting
AMADNS	AMA Data Networking System
API	Application Program Interface
AuxCP	Auxiliary Call Processing Scheduler Class
b	bit
B	byte
BKG	Background Scheduler Class
CM	Computing Module
CP	Call Processing Scheduler Class
CPU	Central Processor Unit
DAT	Digital Audio Tape
DCE	distributed computing environment
DDMS	DMS Data Management System
DMS	Digital Multiplex System
DRAM	Dynamic Random Access Memory
EIU	Ethernet Interface Unit
ETA	Enhanced Terminal Access
FTP	File Transfer Protocol
I/O	Input / Output
IOC	Input Output Controller
kb	kilobit
kB	kilobyte
LAN	Local Area Network
MAINT	Maintenance Scheduler Class
NOSFT	NOS File Transfer Scheduler Class
OM	Operational Measurement
OSS	Operations Support System
SBA	SuperNode Billing Application
SEB	System Engineering Bulletin
SDM	SuperNode Data Manager
SDM/FT	SuperNode Data Manager / Fault Tolerant
SNIP	SuperNode Internet Protocol Scheduler Class
SNMP	Simple Network Management Protocol
TAS	Technical Assistance Service
UNIX	Operating System
WAN	Wide Area Network

13. References / Bibliography

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