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FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT.

VOLUME 2.

Requirements Compilation and Analysis.

Part 3. Characteristics Summaries and Network Analysis.

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This document has been prepared in partial fulfillment of CDRL line item A004 of System Development Corporation's Air Force Global Weather Central System Architecture Study contract. Efforts for this report were expended under Task 6, "Conceptual Design and Development Plan", performed under contract F04701-75-C-0114 for SAMSO, under the direction of Col. R. J. Fox, YDA.

The purpose of this study has been to optimize the entire AFGWC data process-

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) ing system from the vantage point of current and future support requirements, addressing the AFGWC data processing system over the 1977 through 1982 time frame. This study was performed under a unique plan which allows complete traceability between user requirements, Air Force Global Weather Central operational functions, requirements levied upon the data system, a proposed component configuration which meets the data system requirements, and a system specification designed to acquire a system which meets these requirements.

The resultant system described has a number of unique features, including total hardware authentication separation of security levels, load leveling accomplished by assigning main processors in accordance with a dynamic priority queue of tasks, and a system-wide network control capability. Other key features include a central data base processor to fill requests for data from other processors, computer operations centers, the use of array processors for accomplishing difficult numerical problems, and sophisticated forecaster console support. These elements have been designed to provide 99.5% reliability in meeting user requirements.

The proposed system architecture consists of five dual processors each of which is about 3.5 times as powerful as an existing AFGWC processor (a Univac 1108). Each dual processor has an array processor which will be capable of very high performance on vector arithmetic. The array processors are used to assist on the difficult numerical problems, including the Advanced Prediction Model for the global atmosphere, as well as very fine grid cloud models and cloud probability models. Some of the new requirements that will be supported with this system are a one minute response to query interface, reentry support for Minuteman, and limited processing of high resolution (0.3 nautical mile) meteorological satellite data. In addition, cloud cover prediction for tactical weapon systems, ionospheric prediction for radio frequency management, and defense radar interference prediction will be supported by this system.

Volumes of this final System/Subsystem Summary Report are as follows:

Volume 1 - Executive Summary

Volume 2 - Requirements Compilation and Analysis (Parts 1, 2, and 3)

Volume 3 - Classified Requirements Topics (Secret)

Volume 4 - Systems Analysis and Trade Studies

Volume 5 - System Description

Volume 6 - Aerospace Ground Equipment Plan

Volume 7 - Implementation and Development Plans

Volume 8 - System Specification

System Development Corporation

AIR FORCE GLOBAL WEATHER CENTRAL

SYSTEM ARCHITECTURE STUDY

FINAL SYSTEM/SUBSYSTEM SUMMARY REPORT

VOLUME 2
REQUIREMENTS COMPILATION AND ANALYSIS

PART 3
CHARACTERISTICS SUMMARIES AND NETWORK ANALYSIS

1 MARCH 1976

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PART 3

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- Volume 7 - Implementation and Development Plans
- Volume 8 - System Specification

This volume consists of three separately bound parts, with each part oriented towards specific areas covered in Task 1. Part 1 includes user requirements analyses in Section 1.0 that summarize the impact of current and new requirements on the proposed architecture. Part 1 also contains descriptions of proposed new models for the 1977-82 time period in Section 2.0, with emphasis on data processing requirements.

In Part 2, this volume contains detailed descriptions of current and future functional characteristics of AFGWC in Section 3.0.

In Part 3, an in-depth network analysis (Section 4.0) that depicts various key interrelationships between these functions is presented. This network analysis has been instrumental in leading to the determination of processing capability that is required of this new architecture.

Another important analysis that has led to the determination of data system parameters has been the Task 1 data system characteristics summarization effort. This activity involved the compilation of a wide variety of important data system parameters across functional areas, eventually leading to the establishment of component values of the architectural domain in subsequent tasks. Results are summarized in Part 3, Section 5.0. The extensive working papers generated in this compilation process have been provided under separate cover.

SDC has also compiled a presentation of several topics involving growth, maintainability, and other aspects of general system performance. These topics appear in Part 3, Section 6.0.

Finally, SDC has compiled extensive glossaries of the terms and abbreviations encountered and used in this study. These glossaries include the abbreviations encountered in assessing user requirements (described in Section 1.0), plus many other emanating from AFGWC, technical literature, and other sources, and are included after Section 6.0 in Part 3 of this volume.

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RELATIONSHIP OF VOLUME STRUCTURE TO DOMAINS

This part of ~~Volume~~ 2 summarizes the results of the translation of user, model, and functional requirements into the Characteristics Domain. This has been enabled by performing a detailed network analysis of planned AFGWC operations, was performed and ~~by assembling~~ the results assembled according to various detailed and general data system characteristics. The network analysis summarized in Section 4.0 is organized according to both the Functional and Characteristics Domains. AFGWC functions have been studied with an orientation that developed detailed answers to a wide variety of questions in the Network analysis portion of the Characteristics Domain. This network analysis process is described in Section 4.0, and ~~employed~~ uses the following categories of data:

N10: Activation,

N20: Characteristics,

N30: Order, and

N40: Conflict.

This process was expanded and further summarized according to the structure of the Characteristics Domain in Sections 5.0 and 6.0, so as to provide the eventual translation to the architecture domain in subsequent tasks. In Section 5.0, characteristics are thus assembled in accordance with this detailed The Characteristics Domain structure ~~i.e.,~~ is further analyzed according

C10: Data Storage,

C20: Data Transfer and Routing,

C30: Computation and Software,

C40: Terminal Interface,

C50, C60: Consoles and Displays,

C70: Personnel,

C80: Management, and

C90: Facilities.

The general performance characteristics are analyzed fo

Cont on p

(cont fr p ix)

Section 6.0 complements these detailed summarizations by extending analyses into the following general categories of the Characteristics Domain:

G10: Growth Potential,
G20: Maintainability,
G30: Reliability,
G40: Integrity,
G50: Testability,
G60: Adaptability, and
G70: Availability.

APPLICABLE DOMAIN VS. PAGE NUMBERS

VOLUME/DOMAIN RELATIONSHIPS*

CHARACTERISTIC	ARCHITECTURE COMPONENT**
N00	
N10	A10-A70 (all), A813, A82, A92
N11	↓
N12	↓
N13	↓
N14	↓
N15	↓
N20	
N21	A31
N22	A31
N23	A10
N24	A20
N25	A31, A511, A813
N26	A31, A511, A813
N30	
N31	A31, A511, A813
N32	A31, A511, A813
N40	
N41	A31
N42	A511, A813
N43	A31
C10	A10 (all)
C11	↓
C111	↓
C112	↓
C113	↓

*See Section 1.5.2 of Volume 1 for more detail regarding domain interrelationships

**See Volume 5 for descriptions of architecture domain components

C114	A10 (all)	
C115		
C116		
C117		
C12		
C121		
C122		
C123		
C124		
C125		
C13		
C131		
C132		
C133		
C134		
C14		A821, A934
C141		
C142		
C143		
C144		
C15		
C151		
C152		
C153		
C154		
C16		
C20	A20 (all)	
C21		
C211		
C212		

C213	A20 (all)	
C214		
C215		
C216		
C22		
C221		
C222		
C223		
C23		A821, A934
C231		
C232		
C233		
C234		
C235		
C24		
C241		
C242		
C243		
C244		
C245		
C25		
C251		A511, A813
C252		
C253		
C254		
C255		
C256		
C26		

C30	A30 (all), A511, A813
C31	
C311	
C312	
C313	
C314	
C315	
C316	
C32	
C321	A31, A321
C322	A31, A322, A323
C323	A31, A321, A33
C324	A31, A323, A324
C325	A31, A341, A344
C326	A31, A323
C327	A31, A343
C328	A31
C329	A30 (all)
C33	A31
C331	
C332	
C333	
C34	A30 (all)
C341	
C342	
C343	
C35	
C351	
C352	
C353	

C36	A30 (all)	
C361		A10 (all)
C362		
C363		
C364		
C37		
C40	A40 (all)	
C41		
C411		
C412		
C413		
C414		
C42		
C421		
C422		
C423		
C424		
C43		
C431		
C432		
C433		
C434		
C44		A821, A934
C441		
C442		
C443		
C45		
C451		
C452		

C46	A40 (all)
C461	
C462	
C47	
C50	A50 (all), A61-A65
C51	
C511	
C512	
C513	
C52	
C521	
C522	
C523	
C524	
C525	
C526	
C527	
C53	
C531	
C532	
C533	
C534	
C535	
C54	
C541	
C542	
C543	

C55	A50 (all), A61-A65	A821, A934
C551		
C552		
C553		
C56		
C60	A64-A66	
C61		
C611		
C612		
C613		
C614		
C615		
C62		A831, A934
C621		
C622		
C623		
C624		
C625		
C63		
C631		
C632		
C633		
C634		
C64		
C641		
C642		
C643		
C644		
C65		
C651		
C652		

C66	A64-A66	
C661		
C662		
C67		
C70		
C71	A71, A72	
C711		
C712		
C713		
C714		
C715		
C72		
C721		
C722		
C723		
C724		A821, A934
C73	A73	
C731		
C732		
C733		
C80		
C81	A81	
C811		
C812		
C813		
C814		
C82	A83	
C821		
C822		

C83	A84
C831	
C832	
C833	
C84	A86
C841	
C842	
C843	
C844	
C90	
C91	
C911	A911
C912	A912
C92	
C921	A921
C922	A922
C923	A86
C924	A90 (all)
C925	A934
C93	
C931	A931
C932	A932
C933	A912
C934	A934
C935	A912
C936	A912

G00	A10-A60 (all)
G10	
G11	
G12	
G13	
G14	
G15	
G20	
G21	
G22	
G23	
G24	
G30	
G31	
G32	
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G41	
G42	
G50	
G51	
G52	
G53	
G54	
G60	
G61	
G62	
G70	

4.0 NETWORK ANALYSIS

4.1 INTRODUCTION

This analysis describes aspects of the network relationships between AFGWC functions by addressing a set of specially designed questions to each function. The goal is not to categorize the functions (in many cases this is impossible) as much as to thoroughly describe them. The questions are primarily meant to stimulate response in the hope of studying each function as completely as possible.[1]

The network analysis has been broken up into four specific areas. The questions asked in each area are listed below followed by a discussion of the information sought.

ACTIVATION:

N11 - Process ordered queue
  Is the function activated by arrival in a priority queue?

N12 - Time or time span
  Is the function activated by identifying the time at which processing may begin and the span over which it must be accomplished?

N13 - Query/Response
  Is the function motivated by an external request/order?

N14 - Random
  Is the arrival of a request to activate the function at a random (pseudo-random) event?
  Is there a time for accomplishment associated with this?

N15 - Event
  Does the activation of this function depend on some external event being accomplished or upon parameter criteria being satisfied?

NOTE: The numbers N11, N12, etc., are listed with each question to establish a permanent identity for it. This will be particularly helpful when the data is presented in matrix format.

---

[1] It should be noted that in some cases, slightly different functional areas have been used to compile this network analysis data than the structure depicted in section 3.0. This results from the fact that the functional domain has been refined several times throughout this study to properly reflect functional requirements. However, while some organizational changes were made to this functional domain, the quantitative results of this network analysis are still valid.

The first area of consideration is <u>activation</u>. The intent of this area is to determine the manner in which the function was initiated. Is it one of many similar functions awaiting accomplishment and is it activated only by rising to the top of the priority queue? Is it time dependent and can it only satisfy its requirement if accomplished within a predetermined time span? (A display from a weather data base or other forecaster aid may fit into this category.) Many functions are activated as a response to one specific request--a, CFP, for example. Sometimes such requests may be random and on other occasions their arrival is predictable since they occur more during specific hours of the day. If a function is activated by one of these requests, is there a time for it to be accomplished? Still other functions are motivated by the occurrence of some event; data receipt is one example. Considerations under <u>activation</u> are very useful in determining the motivations behind a system network and where it might lend itself to change and optimization.

<u>CHARACTERISTICS</u>:

N21 - Wall time

What is the expected time to accomplish this function?

What are the maximum and minimum?

N22 - Computation

What is the time required to accomplish this function via the CPU?

How many instructions are required?

N23 - Storage

How many words are required to support this function in storage?

How much time is required to perform the storage function including search and transfer?

N24 - Transfer

What is the time required to transfer these data and what is the rate of transfer?

N25 - Wait

What is the amount of waiting time associated with this function including operational preparation or program delay waiting for component activation or program request for operator action?

N26 - Overlap

What is the degree to which storage, computation, and/or transfer can be accomplished simultaneously within this function? This answer should be complete enough to confirm or compute wall time.

Under the area of characteristics the goal is both to describe the internal workings of a function and to show its impact on the resources of the system. Some questions center around the time required for a function to run from start to completion. The actual component time required to accomplish a function is known as well as its wall time. Wall time is broken into: computation time (when the function is active in the CPU), transfer time (when data are being transferred within one or between several devices), or wait time (due to busy channels or necessary operator intervention).

A function may be designed to allow some degree of simultaneous computation and transfer. Since a given function probably does not yield the same result each time it is run, the ideal description is the probability distribution of a large sample. Since this is difficult to construct, a range of times will usually fulfill the requirement.

System storage is a large system resource yet to be considered. Storage used by a function can be considered in three categories: core storage, temporary mass storage, and permanent mass storage. Permanent mass storage is sized independent of the using functions since most is used by many functions. A clarifying question then is: which portions of permanent mass storage are accessed by this function? In summary, the characteristics area describes the impact of an individual function on a computer system.

ORDER:

N31 - Predecessor

What functions must necessarily precede this function?

Is the precedence a required, contiguous one?

What is the normal time between the precedent and the antecedent?

N32 - Successor

What functions must necessarily succeed this function in the normal accomplishment of the AFGWC mission?

Is this a contiguous successor?

What is the time between this function and its predecessor function?

Order considers a function's predecessor and successor relationships. Related functions must not only be named, the contiguity of the relationships must also be described (what is the time gap?). Functional order serves as an important aid in the modeling and simulation process.

CONFLICT:

N41 - Frequency

On the average, how often during the day is this function executed? If not uniformly distributed throughout the day, what is the probability density function associated with this frequency?

N42 - Start time

What is the normal start time associated with this function? If this is not constant, identify a probability distribution over the day.

N43 - Execution Span

What is the length of time from the start time over which this function can be executed without violating the requirement? If this is not a constant function, what is the probability as a function of time of day?

The questions under conflict consider the final step in relating the functions together in a completed network. This requires the number of executions of a function per day to be known and how these executions are distributed in time. Further, it describes the time span involved with the start and finish times of the function before the requirement for it has been violated. These areas may be covered by identifying the probability distribution associated with each function.

In summary, the goal of this analysis is to describe the probability distribution associated with the start time and run length of each AFGWC function and establish the predecessor-successor relationships associated with each. In order to adequately identify these properties, SDC has considered the general categories of Activation, Characteristics, Order, and Conflict. Referring back to specific questions already named, start time can be established from information gained in N11 - N15 (Activation) and N41 and N42 (Conflict), run length was described by N21 - N26 (Characteristics) and N43 (Conflict), and finally, predecessor-successor relationships were identified by N31 and N32 (Order).

4.2 DATA PRESENTATION

The following contains the data obtained from the 16 Network Analysis questions described. The questions are addressed in the operational functions:

a. Input Data Processing

b. Data Base and Related Computations

c. Output Processing

d. Support Processing

IWX Monitoring Inputs (F1110)

	AWN (1111)	AUTODIN (1112)	SOON/RSTN (1113)	OTH Data (1114)
N11 queue	no			
N12 time	yes			
N13 query	no			
N14 random	no request			
N15 event	data arrival			
N21 wall	2.5 min		may represent large increase in system resources	12 min
N22 CPU	1-1.5 min (50K core)			6-8 min (35K core)
N23 storage	(unclass) 20 pos (class.) 35 pos		(same for 1110 & 1120)	
N24 transfer N25 wait N26 overlap	not available			
N31 predecessor	data receipt			
N32[1] successor	F2101[2] F2103-6 F2109		F2106	F2102 F2104 F2105
N41 frequency	24/day (hourly)			
N42 start	hourly			
N43 execution	must support 2 min. response to solar events			

[1] not necessarily contiguous

[2] references are to functional areas as listed in this section

Bulk Data Processing Inputs (F1120)

	DSP (1121)	ERL/NOAA (1122)	Classified Oper. (1123)	STS (1124)
N11 queue	no			
N12 time N13 query N14 random N15 event	activated by data arrival via RTOS		manually activated	activated by data arrival via RTOS
N21 wall	order of sec.		20-22 min.	order of sec.
N22 CPU	order of sec. (5K core)		18 min. (35K core)	order of sec. (5K core)
N23 storage	(unclass) 20 pos (class) 35 pos	(same for 1110 & 1120)		
N24 transfer N25 wait N26 overlap	not available			
N31 predecessor	RTOS	data receipt		
N32[2] successor	F2106 F2109	F2106 F2109		
N41 frequency	every 100 sec.	every hour plus some	random	routine?
N42 start	variable			
N43 execution	must support 2 min. response to solar events			

[2] not necessarily contiguous

Surface Data (F1210)

	Decode (F1211)	Sort (F1212)	Validation (F1213)	Real-time Data Base (F1214)
N11 queue	no →			
N12 time	decode function is more or less random, it is part of RTOS & is accomplished when max data received or max time elapsed	yes, time span is identified by production control personnel →		
N13 query		no →		
N14 random		no request →		
N15 event		see N31 →		
N21 wall	32 min/day	ave 342 sec	statistics for sort also contain those for F1213 & F1214	
N22 CPU		ave 78 sec		
N23 storage		data base batch file & region areas		
N24 transfer		127 sec.		
N25 wait	not available →			
N26 overlap				
N31 predecessor	data receipt, see N12	decode	sat	decode
N32 successor	sort and real-time data base update	validation	none	displays
N41 frequency	variable, see N12	32/day every base at 0 + 15 and every 3 hours from 1 + 40 →		
N42 start				
N43 execution	N/A real-time	variable ave 2 1/2 hr →		

Upper Air Data (F1220)

	Decode (F1221)	Sort (upper air aircraft) (F1222)	Validation (F1223)	Real-time data base (F1224)
N11 queue	no			
N12 time	decode function is more or less random, it is part of RTOS & is accomplished when max data received or max time elapsed	yes, time span is identified by prod. control personnel		
N13 query		no		
N14 random		no request		
N15 event		see N31		
N21 wall	6 min/day	ave 346 sec	statistics for sort also contain those for F1213, F1214, F1232, & F1233	
N22 CPU		ave 95 sec		
N23 storage		data base batch file & region areas		
N24 transfer		93 sec.		
N25 wait	not available			
N26 overlap				
N31 predecessor	data receipt, see N12	decode	sort	decode
N32 successor	sort and real-time data base update	validation	none	displays
N41 frequency	variable see N12	24/day, variable, approx. 1 per hr.		
N42 start				
N43 execution	n/a real-time	variable ave. 1/2 hour		

Aircraft Data (F1230)

	Decode (F1231)	Validation (F1232)	Real-time Data Base (F1233)
N11 queue	no		
N12 time	decode function is more or less random, it is part of RTOS & is accomplished when max data received are max time elapsed	yes, time span is identified by production control personnel	
N13 query		no	
N14 random		no request	
N15 event		see N31	
N21 wall	estimate 5 min/day	for these statistics, see F1212	
N22 CPU			
N23 storage			
N24 transfer			
N25 wait	not available		
N26 overlap			
N31 predecessor	data receipt see N12	sort (F1212)	decode
N32 successor	sort and real-time data base update	none	displays
N41 frequency	variable see N12	24/day, variable, approx. 1 per hour	
N42 start			
N43 execution	n/a realtime	variable ave 1/2 hour	

POLAR SATELLITE DATA (F1310)

	DMSP (1311)		TIROS-N (1313)
N11 queue	possibly since large amts of data is available in spurts		
N12 time	no, near real-time		
N13 query	no		
N14 random	no request but data arrival is random (see N42)		
N15 event	data arrival (see N31)		data arrival & maybe backup to DMSP (see N31)
N21 wall	ONLINE ave 300(sec) max 600 min 180	GRIDDER/MAPPER ave - 420 max - 900 min - 240	TIROS-N same as DMSP
N22 CPU	real-time (see N21)	ave - 180 max - 270 min - 150	
N23 storage	2-8440 disks	150 pos	
N24 transfer	all I/O	ave - 90 max - 135 min - 75	
N25 wait	N/A real-time		
N26 overlap	N/A real-time	I/O 80% buffered	
N31 predecessor	readout from satellite, then ONLINE, then MAPPER/ GRIDDER		
N32 successor	displays & cloud analysis		
N41 frequency	14 orbits/day/bird		
N42 start	variable depends on bird location being near readout facility		
N43 execution	near real-time operation, although some data has higher priority than others		near real-time operation, although this data is lower priority than DMSP

Geostationary Satellite Data (F1320)

	GOES (F1322)
N11 queue	no
N12 time	no, near real-time
N13 query	no
N14 random	no random request
N15 event	data receipt (see N31)
N21 wall N22 CPU	greater than 10 and less than 30 min.
N23 storage	500 positions
N24 transfer N25 wait N26 overlap	programs will be near real time and I/O bound
N31 predecessor	data receipt
N32 successor	displays and cloud & wind analysis
N41 frequency	every 30/min.
N42 start	see N42
N43 execution	near real-time operation although some data has higher priority than others (10 min for readout)

SECONDARY SENSOR DATA (F1330)

same for DMSP(F1331), GOES(F1332), and TIROS-N(F1333)

	E package (VTPR)	ALL package (spec.E-pk)	J package (election)	L package (lightning)	B package (gamma)	H package (wet VTPR)	M package (micro)	D package (density)
N11 queue	no							
N12 time	no							
N13 query	no			yes	no			
N14 random	activation depends on data arrival which is random			random but rare (see N41)	activation depends on data arrival which is random			
N15 event				data arrival				
N21 wall	2-3 min	2-4	3-4	4-5	3-4	2-4	3	3
N22 CPU	1-2 min	1.5-2.5	1.5-2	2-3	1.5-2	1.5-2.5	1	1
N23 storage	1 pos	3	3	2	6	8	2	2
N24 transfer	approx 1/2 of CPU							
N25 wait	minimal							
N26 overlap	I/O is well buffered with computation							
N31 predecessor	data arrival from ONLINE							
N32 successor	computation programs			none	computation programs			
N41 frequency	10/dy			20/year	10/dy			
N42 start	see N14							
N43 execution	most data is low priority, approx. a one hour span							

CFP REQUESTS (AUTODIN) (1410)

	Automatic Requests (1411)	Manual Requests (1412)	Future ('77)
N11 queue	no		
N12 time	no		
N13 query	yes		
N14 random	see N42		
N15 event	no		
N21 wall	0.1 sec 9.2K instructions		
N22 CPU	see N21		
N23 storage	45 positions		90 positions
N24 transfer	device rate		
N25 wait	none		
N26 overlap	N/A (realtime)		
N31 predecessor	RTOS		
N32 successor	RTOS		
N41 frequency	400/day	100/day	
N42 start	90 % 12-14Z 10% random	90% 18-22Z 10% random	
N43 execution	realtime, must respond immediately		

N11 queue	no
N12 time N13 query N14 random N15 event	function activation will be dependent on data receipt which will be sequential but frequency will vary (see N41)
N21 wall N22 CPU	4 min for analysis 2 min for outputs
N23 storage	(50-60K core) 19 million 36 bit words
N24 transfer	programs will probably be I/O bound
N25 wait	real-time for receipt unknown for analysis
N26 overlap	none
N31 predecessor	data receipt via RTOS
N32 successor	input to analysis to output
N41 frequency	normal, every 30 min. peak, every 15 min.
N42 start	see N12
N43 execution	variable (event dependent)

Special Project A (F1610)

	SNDSX	SXSND
N11 queue	no	→
N12 time	yes	yes, data base receipt
N13 query	yes, deck load	→
N14 random	yes	random
N15 event	yes	→
N21 wall	10-15 min.	ave 1 min. max 5 min 0.5
N22 CPU	0.5-15 min. (64.5K core)	ave 10 sec. max 30 min 3 (64.5K core)
N23 storage	5-50 pos	5 pos
N24 transfer	3-30 sec.	5 min. I/O 3 sec. tape
N25 wait	20 sec.	→
N26 overlap	10%	→
N31 predecessor	3DNEPH, SFC, upper air regions & analysis, ETAC B2, SF UA, B3, TKN30A	upper air regions & analysis, 3DNEPH, surface data
N32 successor	WIZARD or PAPAPA	→
N41 frequency	2/month	1/day
N42 start	random	→
N43 execution	72 hours	12 hours

Special Project B (F1620)

	PUNCHG	DRUMG	STR440	STR610
N11 queue	no	→	→	→
N12 time	no	→	→	→
N13 query	yes	→	→	→
N14 random	random	no (see N43)	time window	
N15 event	no		→	→
N21 wall	ave 30 sec. range 20-50	2 min.	1 min.	4 min.
N22 CPU	10 sec. (5K core)	15 sec. (17K core)	2 sec. (5K core)	2.5 min. (15K core)
N23 storage	42 cards punched	2000 words	→	150,000 words
N24 transfer	see N23	1.5 min.	30 sec.	usual
N25 wait	none		→	15 sec.
N26 overlap	none	60% I/o buffered	none	100% buffered
N31 predecessor	none	→	→	→
N32 successor	none	PLOT6	SXOATS	MAPIT TARLMT BKBND MAPSIX
N41 frequency	8/yr	1/day		
N42 start	n/a	21-23 Z	→	→
N43 execution	anytime	2 hrs after request	→	2.5 hrs.

Special Project B (F1620) (Cont'd)

	STRG30	REDOG2	CAL685
N11 queue	no		
N12 time	no		
N13 query	yes		
N14 random	yes	random	
N15 event	yes	yes, data tape receipt	yes, REDOG2 must fin
N21 wall	3 min.	ave 8 min. range (6-10)	ave 6 min. range (5-7)
N22 CPU	2 min. (20K core)	2 min. (7K core)	2 min. (13K core)
N23 storage	50K	3 pos	2 pos
N24 transfer	usual		
N25 wait	15 sec.	30 sec.	15 sec.
N26 overlap	100%	none	
N31 predecessor	none		see N15
N32 successor	BEAVER BATMAN	CAL685 follows immediately	none
N41 frequency	6/day (variable)	4/year	
N42 start	varies	n/a	
N43 execution	variable		

Special Project C (F1630)

	STR924	IN415	STR450	ASSMD2
N11 queue	no →	→	→	→
N12 time	no →	→	→	→
N13 query	yes →	→	→	yes, tape arrival & deck load
N14 random	requests are predictable	no	time window →	→
N15 event	no →	→	→	→
N21 wall	30 sec.	1 min. →	→	2-3 min.
N22 CPU	5 sec. (48K core)	5 sec. (19K core)	2 sec. (5K core)	1 min. (74K core)
N23 storage	2 pos	small	20,000 words	2 pos
N24 transfer	10 sec.	20 sec.	30 sec.	usual
N25 wait	60 sec.	none →	→	5 min.
N26 overlap	none →	→	→	→
N31 predecessor	IN415	none →	→	→
N32 successor	HPRECP SPIDER	PLOT10 STR924 HPRECP	SXOATS	none
N41 frequency	1/day →	→	→	16/day
N42 start	random but approx. 22 Z	21-23 Z →	→	variable but 1st around 03 Z
N43 execution	3 hours →	→	2 hours	3 hours

Special Project C (F1630) (Cont'd)

	FMERGE	HVERF
N11 queue	no	→
N12 time	no	→
N13 query	yes	→
N14 random	random	→
N15 event	yes, must receive data tape	→
N21 wall	ave 18 min. range (15-25)	ave 10 min. range (8-20)
N22 CPU	5 min. (27K core)	3 min. (28K core)
N23 storage	2 pos plus tape	1/2 pos plus tape
N24 transfer	usual	→
N25 wait	none	→
N26 overlap	none	→
N31 predecessor	none	→
N32 successor	HVERF follows immediately	none
N41 frequency	2/year	1/week
N42 start	n/a	→
N43 execution	anytime	→

Special Project D (F1640)

	KHNF	KPLFRP
N11 queue	no	
N12 time	no	
N13 query	yes	
N14 random	requests involve time window	yes
N15 event	no	
N21 wall	5 min.	20 min.
N22 CPU	2 min. (50K core)	5 min. (50K core)
N23 storage	11 pos	3 pos
N24 transfer	3 min.	5 min.
N25 wait	none	
N26 overlap	none	50% buffered
N31 predecessor	none	
N32 successor	KIPPER	KPFPRG
N41 frequenc y	32/day	1/week
N42 start	evenly distributed	1000 & 2300
N43 execution	variable	not later than 400 & 15 Z

Ionospheric Models (F2110)

	Magnetic Field (2101)	HF Propagation (2102)	Electron Density (TEC) (2103)		Applications (ray trace) (2104)	Ionospheric Analysis Field (2105)
N11 queue	no →					
N12 time	yes	no	yes		no	yes
N13 query	no	yes	no		yes	no
N14 random	no	yes	no		yes	no
N15 event	see N31 →					
N21 wall	2 min.	10 min.	unclass. 5 min.	class. 18 min.	10 min.	5 min.
N22 CPU	1 min. (< 15K core)	5 min. (53K core)	3 min. (35 K core)	13 min.	5 min. (35K core)	5 min. (35K core)
N23 storage	data base plus → 1 pos	1 pos	1 pos	5 pos	1 pos	1 pos
N24 transfer, N25 wait, N26 overlap	not available →					
N31[2] predecessor	F1111 F1122 F1332	F1111 F1114	F1111 F1331		F1111 F1114 F1331	F1111 F1114 F1331
N32[2] successor	F3113-4 F3121 F3131	F3112 F3122	F3113 F3127-8		F3122 F3126	F3112-3 F3122 F3126 F3128
N41 frequency	4/day	5/day[1]	3/day	8/day	5/2 hrs	class.-8/dy unclass.-12/d
N42 start	evenly distributed	random during daylight	evely distrib.		random	evenly distrib.
N43 execution	in general: must support 2 min. response to solar events →					

[1] by '77 increasing to 300/dy
by '81 increasing to 700/dy

[2] not necessarily contiguous

Ionospheric Models (F2110) continued

	Proton Flare (2106)	Ray Trace (2107)	Improved TEC (2108)	Conjugate Aurora (2109)
N11 queue	no			"This is not an operational model but rather a program used to determine whether S.H. assumptions are correct. The results have been implemented subjectively."
N12 time	no		yes	
N13 query N14 random N15 event	activation depends on external request		no no see N31	
N21 wall	1 min.	300 sec.	480 sec.	
N22 CPU	30 sec. (20K core)	240 sec. (75K core)	420 sec. (50K core)	
N23 storage	data base	data base & 30 tracks 2000 lines Fortran	data base & 35 tracks 1000 lines Fortran	
N24 transfer N25 wait N26 overlap	not available			
N31[1] predecessor	F1111 F1113 F1121-2 F1332-3	F2105	F2103	
N32[1] successor	F3111	hardcopy display	F3113 F3127-8	
N41 frequency	4/year	4/day	4/day	
N42 start	random		evenly distributed	
N43 execution	in general: must support 2 min response to solar events			

[1] not necessarily contiguous

Ionospheric Models (F2110) continued

	Ionospheric Propagation (2110)	Improved TEC (2111) (replaces 2108)	Improved F Region Storm (2112)	Improved Ionization Magnatosphere (2113)
N11 queue	no	→	→	→
N12 time	yes	→	no	regularly scheduled plus external request
N13 query	no	→	activation depends on external request	regularly scheduled plus external request
N14 random	no	→	activation depends on external request	regularly scheduled plus external request
N15 event	see N31	→	activation depends on external request	regularly scheduled plus external request
N21 wall	480 sec.	600 sec.	300 sec.	600 sec.
N22 CPU	360 sec. (50K core)	480 sec. (100K core)	240 sec. (50K core)	480 sec. (125K core)
N23 storage	data base & 30 tracks 4000 lines Fortran	data base & 100 tracks 2000 lines Fortran	data base & 200 trks 1000 lines Fortran	3000 lines Fortran
N24 transfer, N25 wait, N26 overlap	not available	→	→	→
N31[1] predecessor	input data	F2103	input data	→
N32[1] successor	hardcopy display	F3113 F3127-8	hardcopy display	→
N41 frequency	6/day	4/day	4/day	12/day
N42 start	evenly distributed	→	random	random plus scheduled
N43 execution	in general: must support 2 min response to solar events		→	→

[1] not necessarily contiguous

COMPUTER FLIGHT PLANS (2210)

	Automatic Responses (2211)	Semi-automatic Responses (2212)	Manual Request Responses (2213)
N11 queue	yes		
N12 time	no (first in, first out)		
N13 query	yes		
N14 random	yes (see N42)		
N15 event	no		
N21 wall	ave. 4-7 sec range 1-20 9.2K instructions		
N22 CPU	same as N21 (for realtime)		
N23 storage	45 positions		
N24 transfer	device rate		
N25 wait	none		
N26 overlap	N/A for realtime		
N31 predecessor	RTOS		
N32 successor	RTOS		
N41 frequency	400/day	100/day	
N42 start	90% 18-22 Z 10% random	90% 12-14 Z 10% random	
N43 execution	50 minute turnaround	1 hour turnaround	

	Enhanced CFP Models
N11 queue	yes
N12 time	no (first in, first out)
N13 query	yes
N14 random	yes (see N42)
N15 event	no
N21 wall	ave 5-8 sec range 1-24 10K instructions
N22 CPU	same as N21 (for realtime)
N23 storage	90 positions
N24 transfer	device rate
N25 wait	minimal
N26 overlap	N/A for realtime
N31 predecessor	RTOS
N32 successor	RTOS
N41 frequency	1500-2000/day
N42 start	no change
N43 execution	1 hour turnaround

N11 queue	no
N12 time	request is generated by customer at appropriate time frame
N13 query	see N12
N14 random	no (see N12)
N15 event	yes (see N31)
N21 wall	10-15 minutes written in Fortran
N22 CPU	1.5 min sups
N23 storage	5 positions (43K core)
N24 transfer	device rate
N25 wait	none
N26 overlap	not available
N31 predecessor	satellite global data base update
N32 successor	hardcopy of product to customer
N41 frequency	1/day
N42 start	09 Z
N43 execution	0600 Z - 1100 Z

N11 queue	no
N12 time	request is generated by user at appropriate time
N13 query	see N12
N14 random	requests for special executes arrive randomly
N15 event	yes (see N31)
N21 wall	2.5-5 min written in Fortran
N22 CPU	1.2 sups
N23 storage	3 positions (62K core)
N24 transfer	device rate
N25 wait	non
N26 overlap	not available
N31 predecessor	on time tropical wind analysis
N32 successor	hardcopy of product to customer
N41 frequency	2/day (20 special executes/year)
N42 start	7:30 Z & 19:30 Z
N43 execution	2 hour and 15 minutes

N11 queue	no
N12 time	user establishes time requirements
N13 query	see N12
N14 random	special requests will arrive randomly
N15 event	yes (see N31)
N21 wall	48 minutes written in Fortran
N22 CPU	30 minutes
N23 storage	3 positions 55K core
N24 transfer	device rate
N25 wait	none
N26 overlap	not available
N31 predecessor	CFLOS forecast model
N32 successor	hardcopy of product to customer
N41 frequency	2/day (plus specials)
N42 start	
N43 execution	special within 3 hrs. of receipt. others within 12 hrs. of ontime.

COMMAND & CONTROL SYSTEMS (F2250)

	WWMCCS (F2254)	Minuteman X (F2253)	SACCS (F2252)
N11 queue	no →	→	→
N12 time N13 query N14 random N15 event	probably near real-time data base update	activated by time requirement established by customer (also see N42)	activated by customer request which has time requirement
N21 wall N22 CPU	response time about 1 min	12 hr	1 min
N23 storage	1.5 million words	5 pos (45K core)	50 million words (55K core)
N24 transfer	not significant	unknown →	→
N25 wait		none →	→
N26 overlap	double buffering to be used	unknown →	→
N31 predecessor N32 successor	RTOS	after 00Z & before 06Z global data base update	SACCS data base update product to customers
N41 frequency	6/day	1/day	normal 125/day crisis 250/day
N42 start	see N12	between 06 & 11 Z	30% between 11-15 Z 30% between 20-24 Z
N43 execution	two minutes	06 Z-11 Z	one minute

Surface Data Analysis (2311)

	Hemispheric (2311)	Tropical (2312)	Window (2313)
N11 queue	no →		
N12 time	no →		
N13 query	no →		
N14 random	no random request →		
N15 event	see N31 →		
N21 wall	ave - 230 (sec) min - 50 max - 600	ave - 121 min - 40 max - 220	ave -374 min - 75 max - 900
N22 CPU	ave - 82 min - 15 max - 150	ave - 45 min - 30 max - 60	ave - 51 min - 30 max - 70
N23 storage	RTGWCF RTGWCA RNHG51 RNGRDA RSGWCF RSGWCA RSHG51 RFIX64	RTTROA plus 1 position	RTGWCF RTGWCA RTFENA RTFINA
N24 transfer	ave - 12 min - 1 max - 26	ave - 9 min - 8 max - 10	ave - 10 min - 5 max - 15
N25 wait	minimal →		
N26 overlap	1/2 I/O buffered →		
N31 predecessor	surface data sort immediate →		
N41	30 times/day	4 times/day	6 times/day
N42 start	4 executed at 2 + 30 ± every 3 hrs after ± 30 min	1 executed every 6 hrs starting at 1 + 00 ± 30 min.	1 executed at 1st 3 hr of each cycle ± 30 min
N43 execution	within 30 min of start time →		

Surface Data Analysis (F2310) continued

	Global Analysis (F2314)	Window Analysis (F2315)	Variational Analysis (F2316)
N11 queue	no →		
N12 time	no →		
N13 query	no →		
N14 random	no random request →		
N15 event	see N31 →		
N21 wall	ave 40 min.	ave 20 min.	ave 80 min.
N22 CPU	ave 33 min.	ave 17 min.	ave 60 min.
N23 storage	(65K core) 2 pos	(65K core) 2 pos	(140K core) 2 pos
N24 transfer	unknown →		
N25 wait	minimal →		
N26 overlap	some I/O buffering →		
N31 predecessor	immediate after surface data sort →		
N32 successor	surface forecast →		
N41 frequency	4 primary executes/day, up to 26 other shorter executes to clean up small data amounts	4/day	replaces global analysis, see F2314
N42 start	see N31 →		
N43 execution	estimate 30 minutes →		

Upper Air Analysis (2320)

	Hemispheric (2321)	Tropical (2322)	Window (2323)
N11 queue	no		
N12 time	no		
N13 query	no		
N14 random	no random request		
N15 event	see N31		
N21 wall	ave - 600(sec) min - 100 max - 1700	ave - 480 min - 200 max - 800	ave - 160 min - 2 max - 350
N22 CPU	ave - 273 min - 75 max - 600	ave - 305 max - 550 min - 125	ave - 65 min - 2 max - 100
N23 storage	RTPRB RTAIR RTGWCF RNHG51 RTRPFX RTTROA RTGWCA RSGWCF RSHG51 RTRPFX RSGWCA plus 1 position	RTTROA plus 1 position	RTAIR RTPRG RTFINA RTFENA plus 1 position
N24 transfer	ave - 18 min - 5 max - 30	ave - 22 min - 15 max - 25	ave - 10 min - 1 max - 20
N25 wait	minimal		
N26 overlap	1/2 I/O buffered		
N31 predecessor	surface analysis and upper air sort immediate start		
N32 successor	forecast model immediate start		
N41 frequency	16 times/day	4 times/day	9 times/day
N42 start	2 executed every 3 hrs begin. 00Z (± 30 min)	every 6 hrs beginning at 1Z	1 executed at 1st 3 hrs of each cycle(± 30 min)
N43 execution	within 30 min of start time		

	Global Analysis (F2324)	Window Analysis (F2325)	Variational Analysis (F2326)
N11 queue	All of these programs have been costed under F2320. The same function will most likely perform surface as well as upper air analysis. See F2314, F2315, and F2316.		
N12 time			
N13 query			
N14 random			
N15 event			
N21 wall			
N22 CPU			
N23 storage			
N24 transfer			
N25 wait			
N26 overlap			
N31 predeccessor			
N32 successor			
N41 frequency			
N42 start			
N43 execution			

Satellite Data Processing (F2330)

	Initial VTPR (F2331)	Final VTPR (F2332)	Temp & Humidity Sounding (F2333)	Microwave Data Processing (F2334)
N11 queue N12 time N13 query N14 random N15 event	activation will depend on data receipt (see N41-42), a priority queue may be necessary if large enough quantities of data are supplied →			
N21 wall	ave 3 min	ave 2 min	ave 8 min	ave 3 min
N22 CPU	ave 2 min	ave 0.5 min	ave 2 min	ave 1 min
N23 storage	1 pos	17 pos	2 pos	2 pos
N24 transfer N25 wait	unknown →			
N26 overlap	I/O is buffered →			
N31 predecessor	data receipt (see N11) →			
N32 successor	data base update →			
N41 frequency	13/day/bird →			
N42 start	variable na more often than every 100 min →			
N43 execution	estimate 1 hour →			

3DNEPH Computation (2340)

	Analysis Processors (2341) sprint	synoptic	Enhanced (some VHR, WHR) (2342)	Enhanced (most VHR,WHR) (2343)
N11 queue	no			
N12 time	yes			
N13 query	yes	no		
N14 random	random w/in 30 min.	no		
N15 event	see N31			
N21 wall	ave 300(sec) min 200 max 500	ave 953 min 500 max 1200	(additive) est. 10 min.	(additive) est. 5 - 15 min.
N22 CPU	ave 200 min 150 max 400	ave 610 min 400 max 750	est. 5 min.	est. 3 - 10 min.
N23 storage	ACFTRG CORREL SFCREG UPPREG RFIX64 RNGRDA RNGRDF RNHTPC RNSATG RSATCO RTGWCA RTGWCF RTBRGT	RTTROA RSGRDA RSGROF RSHTPC RSSATV RSSATI RSGWCA RSGWCF IVACURVE ISFCCURVE SATNORPOLIR SATNORPOLVIS SATSOUPOLIR SATSOUPOLVIS	plus 29 positions	
N24 transfer	ave 60 max 100 min 30	ave 120 max 175 min 50	est. 5 min.	est. 5 - 10 min.
N25 wait	minimal			
N26 overlap	75% buffered I/O			
N31 predeccessor	surface sort & satellite data immediate		N/A	
N32 successor	high reso- lution cloud prog	coarse mesh cloud prog	N/A	
N41 frequency	6/day dur. 00Z cycle	12/day		
N42 start	randnm	1/6 hrs after 00Z 1/6 hrs after 03Z	N/A	
N43 execution	see N14	w/in 30 min	N/A	

Miscellaneous Analysis (2350)

	AMBROZ (2351)	SNODEP (2352)
N11 queue	no	→
N12 time	yes	→
N13 query	no	→
N14 random	no random request	→
N15 event	see N31	→
N21 wall	ave-330 (sec) min-270 max-400	ave-500 (sec) min-350 max-650
N22 CPU	ave-125 min-100 max-150	ave-160 min-140 max-200
N23 storage	RT4ANL RNGRDA RTGWCA RTGWCF RHGWCF plus 3 positions	RSNDEP RTSFC RTBRG7 RFIXG4 plus 5 positions
N24 transfer	ave-27 min-25 max-30	ave-12 min-10 max-15
N25 wait	minimal	→
N26 overlap	little overlap	→
N31 predecessor	immediately follows cloud analysis	→
N32 successor	none	→
N41 frequency	8/day	once/day
N42 start	every 3 hrs after 2 + 30 (see N31)	after 12Z cloud analysis
N43 execution	2 hours	6 hours

General Purpose Fields (F2410)

	Hemisphere (F2411) (SHGCVC)	(AWSPE)	Advanced Prediction Model (F2411) '78
N11 queue	no →	→	→
N12 time	yes →	→	→
N13 query	no →	→	→
N14 random	no random request →	→	→
N15 event	see N31 →	→	→
	southern hemisphere	northern hemisphere	
N21 wall	ave - 2200 (sec) min - 20 max - 5000	ave 1 hr	est. 10 hrs (U1108)
N22 CPU	ave - 1651 min - 20 max - 4000	ave 35 min	est. 8 hrs (U1108)
N23 storage	RSHG51 RSGWCF RFIX51 RSGWCA RTGWCF RFIX30 plus 5 positions →	→	→
N24 transfer	ave - 165 min - 5 max - 400	ave 6 min	unknown
N25 wait	minimal →	→	→
N26 overlap	1/2 buffered I/O →	→	unknown
N31 predecessor	immediately follows upper air analysis →	→	→
N32 successor	immediately followed by cloud programs →	→	→
N41 frequency	(total both hemispheres) 16/day 4 executed every 6 hrs after 00Z →	→	2 major executions/day with several shorter one on smaller data inputs
N42 start			
N43 execution	30 min →	→	unknown

General Purpose Fields (F2410) continued

	Tropical (F2412)	Global Spherical Harmonic Model (F2412)	Tropical Window APM (F2412)
N11 queue	no	→	→
N12 time	yes	→	→
N13 query	no	→	→
N14 random	no random request	→	→
N15 event	see N31	→	→
N21 wall	ave - 106 min - 75 max - 130	ave 1 hr	ave 30 min
N22 CPU	ave - 55 min - 45 max - 65	ave 45 min	ave 30 min
N23 storage	RTTROF plus 9 positions	RTTROF plus 3 positions	→
N24 transfer	ave - 11 min - 7 max - 15	unknown	→
N25 wait	minimal	→	→
N26 overlap	1/2 buffered I/O	Unknown	→
N31 predecessor	immediately follows upper air analysis	→	→
N32 successor	immediately followed by cloud programs	→	→
N41 frequency	2/day	→	→
N42 start	1235Z 1924Z	→	→
N43 execution	30 min	→	→

General Purpose Fields (F2410) continued

	Window (F2413)	Zoom Window (F2413)	Global Applications Data Base (F2415)
N11 queue	no →	→	→
N12 time	yes →	→	→
N13 query	no →	→	→
N14 random	no random request →	→	→
N15 event	see N31 →	→	→
N21 wall	ave - 1242 min - 1000 max - 1500	est. 40 min	ave - 475 min - 150 max - 800
N22 CPU	ave - 860 min - 750 max - 950	est. 40 min	ave 120 min - 40 max - 250
N231 storage	RTFINA RTFENA RTFINF plus 13 positions	RTFINA RTFENA RTFINF plus 10 positions	RTGBLF RTTROA RTGWCA RSGWCA RSGWCF
N24 transfer	ave - 50 min - 45 max - 60	unknown	ave - 90 min - 75 max - 125
N25 wait	minimal →	→	→
N26 overlap	1/2 buffered I/O	unknown	1/2 buffered I/O
N31 predecessor	immediately follows upper air analysis →	→	follows forecasting routines
N32 successor	followed by boundary layer model →	→	none
N41 frequency	6/day →	→	8/day
N42 start	3 executed every 12 hrs at about 3 + 00 →	→	every 3 hrs starting at 14 + 00
N43 execution	30 min →	→	→

SPECIAL PURPOSE FIELDS (F2420)

	Turbulence (F2421)	Clouds (F2422) present	cloud ZOOM ('77)	Contrails (F2423)
N11 queue	no →			
N12 time	no	yes		no
N13 query	no →			
N14 random	no random request →			
N15 event	see N31 →			
N21 wall	ave - 150 sec min - 75 max - 650	ave-1155 sec min-200 max-2000	30 min	ave - 45 sec min - 5 max - 15-
N22 CPU	ave - 22 min - 5 max - 100	ave-680 min-80 max-1200	30 min 30 min	ave - 12 min - 5 max - 26
N23 storage	GWC data base	RNGRDA RSGRDA RFXGWC RSGWCA RFIX30 RSGWCF RTGWCA RHTERR RTGWCF RTTROA RTBNDF RTTROF	RTRPFY RVERDB RTF1NA RTFINF RTSHCF RHTROF RTFENF plus 2 pos.	GWC data base
N24 transfer	ave - 4 min - 2 max - 10	ave-206 min-15 max-350	unknown	ave - 4 min - 1 max - 7
N25 wait	minimal →			
N26 overlap	1/2 buffered I/O →			
N31 predecessor	follows SFC sorts or boundary layer	immediately follows cloud analysis		immediately follows tropopause forecast
N32 successor	none	none		followed by global application data base
N41 frequency	9/day	24/day	variable	8/day
N42 start	random three 12Z cycle	approx. 1/hr at 30 past hour		random
N43 execution	1 hour	30 min		1 hour

Special Purpose Fields (2420) continued

	Severe Weather (2424)	Precipitable Water (2425)	Air Stagnation (2426)
N11 queue	no		
N12 time	no		
N13 query	no		
N14 random	no random request		
N15 event	see N31		
N21 wall	ave - 52 min - 5 max - 120	ave - 402 min - 300 max - 500	ave - 430 min - 350 max - 500
N22 CPU	ave - 15 min - 8 max - 35	ave - 105 min - 75 max - 125	ave - 60 min - 45 max - 75
N23 storage	RTSFC RTPRB RTFINA RTFINF RTBNDF	RTPRB RFIX30 RTGWCA RTGWCF plus 2 positions	RTBNOF REUBLM RTGWCF RTFINF RTFENF RTPOLL
N24 transfer	ave - 6 min - 1 max - 15	ave - 26 min - 20 max - 30	ave - 35 min - 30 max - 40
N25 wait	minimal		
N26 overlap	little overlap		
N31 predecessor	assorted predecessors	forecast model	boundary layer model
N32 successor	none	none	none
N41 frequency	18/day	2/day	2/day
N42 start	random, mostly in 12 Z cycle	12 hrs apart at 5+50	12 hrs apart at 4+40
N43 execution	1 hour		

Special Purpose Fields (F2420) continued

	Tropopause	Cloud Free Line of Sight	Erosion
N11 queue	no →	→	→
N12 time	no	yes →	→
N13 query	no →	→	→
N14 random	no random request →	→	→
N15 event	See N31 →	→	→
N21 wall	ave - 60 min - 10 max - 100	est. 32 hrs	est. 59 hrs.
N22 CPU	ave - 15 min - 10 max - 25	est. 14 hrs.	est. 25 hrs.
N23 storage	RTPRB RTGWCA RTGWCF RTTROA	60 positions	32 positions
N24 transfer	ave - 8 min - 5 max - 15	unknown →	→
N25 wait	minimal →	→	→
N26 overlap	1/2 buffered I/O	unknown →	→
N31 predecessor	follows analysis or forecasting routines	data receipt →	→
N32 successor	contrail forecast	none →	→
N41 frequency	9/day	2/day →	→
N42 start	every 3 hrs starting at 0+30	unknown	→
N43 execution	30 min	unknown	→

Special Purpose Fields (F2420) continued

	Terminal Forecast Model	Horizontal Weather Depiction Model
N11 queue	no →	
N12 time	yes →	
N13 query	no →	
N14 random	no random request →	
N15 event	see N31 →	
N21 wall	est. 3.5 min.	est. 10-15 min.
N22 CPU	est. 1.5 min.	est. 2-3 min.
N23 storage	boundary layer and cloud data bases →	
N24 transfer N25 wait N26 overlap	unknown →	
N31 predecessor	data base build →	
N32 successor	data access routines →	
N41 frequency	2/day	16/day
N42 start	once/12 hr cycle	03 + every 6 hours execute 3 windows & 1 octagon
N43 execution	unknown →	

Boundary Layer Model (F2430)

	Present Model	Future ('78) ZOOM BLM
N11 queue	no →	
N12 time	yes →	
N13 query	no →	
N14 random	no random request →	
N15 event	see N31 →	
N21 wall	ave - 2090 min - 1400 max - 2700	est. 40 min
N22 CPU	ave - 835 min - 650 max - 1200	est. 40 min
N23 storage	RTFENA RTGWCF RTFENF RTGNDF RFIX30 REUBLM RTPRG RTFINA RNGRDA RTFINF RNGWCF plus 9 positions →	
N24 transfer	ave - 135 min - 120 max - 150	unknown
N25 wait	minimal →	
N26 overlap	1/2 I/O overlap	unknown
N31 predecessor	upper air analysis →	
N32 successor	none →	
N41 frequency	6/day →	
N42 start	3 executes every 12 hrs at 4+00	unknown
N43 execution	1/2 hour →	

Special Project A (F2510)

	NHSVDX	SHSVDX
N11 queue	no →	
N12 time	partially, every 3 hrs.	partially, every 6 hrs.
N13 query	no →	
N14 random	no →	
N15 event	yes, NH 5-layer fields	yes, SH 5-layer fields
N21 wall	5-8 min. →	
N22 CPU	2 min. (43K) →	
N23 storage	20 pos →	
N24 transfer	2 min. →	
N25 wait	15 sec. →	
N26 overlap	70% overlap →	
N31 predecessor	NH FIVLYR NH 3DNEPH TROP FIVLYR NH MSC	SH FIVLYR SH 3DNEPH TROP FIVLYR SH MSC
N32 successor	none →	
N41 frequency	3/day	4/day
N42 start	see N12 →	
N43 execution	-1½ to +3 hrs.	-3 to +6 hrs.

Special Project B (F2520)

	GLADD	PLOT6	VERG10	BIGPAV
N11 queue	no →			
N12 time	yes	no →		
N13 query	no →		yes →	
N14 random	no →		yes	no
N15 event	yes →			no
N21 wall	1 min	5 min	8-20 min	2.5-5.5 min
N22 CPU	15 sec (16.7K core)	2 min (14.2K core)	6-18 min (80K core)	2-3 min 55K core)
N23 storage	40 pos	1.5 pos	2 pos	45K words
N24 transfer	45 sec	3 min	usual	15 sec
N25 wait	none →			
N26 overlap	no	60% overlap	100%	minimal
N31 predecessor	DRVDRG DRVMG PLOT6	DRVMG	autostarted by BEAVER	BEAVER plus upper air, surface,, air stag. data
N32 successor	PUTON DSPLAL	POLAR6 MALINZ	None	SENDER but not contiguous
N41 frequency	2/day	1/day	6/day (varies)	once/day
N42 start	after DRVGRD	after DRVMG	variable	near 20Z
N43 execution	DISPLAL must end by 22 Z	see N42	N/A	8 hrs

Special Project B (F2520) cont.

	SIXGUN	TEALMT	BLKBND	BEAVER
N11 queue	no →			
N12 time	no →		yes	no
N13 query	no	yes →		
N14 random	no	time window	no	random
N15 event	yes →			
N21 wall	min - 1 min max - 2	2 min	2-5 min	5-8 min
N22 CPU	40 sec (33K core)	30 sec (22K core)	1-3 min (69.5K core)	3 min (45K core)
N23 storage	1/2 pos	none	SAVDOX ¢ 30K words	data base plus 2 pos
N24 transfer	usual	n/a	1 min	usual
N25 wait	15 sec	5 sec	10 min for card deck input	15 sec
N26 overlap	100%	100%	none	100%
N31 predecessor	continguous with SAVDOX	5 min after DRUMG	TARLMT STR610 NHSVDX SHSVDX DRVMG	Surface & 3DNEPH data &STR630
N32 successor	all environ- mental data	BLKBND	CHKBND	BATMAN
N41 frequency	10/day	1/day	18/day	6
N42 start	evenly distributed 19Z to 12Z	19-21 Z	every 1½ hrs	random
N43 execution	varies,average is 10-15 min	must finish before 1st BLKBND	± 3/4 hrs	varies but usually from 032- 15 Z

Special Project B (F2520) cont.

	GIPPER or RIPPER or BIPPER	TWOSHO	BOOS	Others
N11 queue	no →			DRUMG (see F1620)
N12 time	no →			STR440 (see F1620)
N13 query	no →			STR610 (see F1620)
N14 random	no →		18-21 Z	
N15 event	yes →		no	STR630 (see F1620)
N21 CPU	1-2 min	4 min	ave 10 min range (8-15)	SHSVDX (see F2510)
N22 CPU	40 sec (27K core)	3-5 min (37K core)	6 min (30K core)	
N23 storage	1/2 pos	1 pos	1 pos	NHSVDX (see F2510)
N24 transfer	1.5 min	usual →		
N25 wait	15 sec	none →		
N26 overlap	100%	60%	none	
N31 predecessor	SAVOOX data base	STR630 PLOTG REDSHO	none	
N32 successor	none →			
N41 frequency	10/day	1/day →		
N42 start	19Z-12Z	approx 16Z	18-21Z	
N43 execution	10-15 min average	variable	6 hours	

Special Project C (F2530)

	CARDSV	HPTPOS	INSERT	PLDT10
N11 queue	no →			
N12 time	no	yes	no →	
N13 query	yes	no	yes	no
N14 random	20-23 Z	no	yes	no
N15 event	yes, input data	see N31	no	see N31
N21 wall	ave 10 min range (8-15)	ave 3 min range (2-5)	2 min	5 min
N22 CPU	6 min (63K core)	1.5 min (51K core)	1 min 23K core)	2 min (21K core)
N23 storage	tape, cards, 25K words	minimal	1 pos	1.5 pos
N24 transfer	usual →			3 min
N25 wait	15 sec	none	card deck preparation time	none
N26 wait	none →			60%
N31 predecessor	none	NH 3DNEPH	none	contiguous with IN415
N32 successor	none →		SPIDER	POLAR, MAP10
N41 frequency	1/day	8/day	1/day	1/day
N42 start	20-23 Z	00Z + 3 hrs etc	variable	21-23Z
N43 execution	6 hrs	1½ to 2 hrs	24 hours	see N42

Special Project C (F2530) cont.

	HRECP	HLADD	others
N11 queue	no	→	IN415 (see F1630)
N12 time	no	yes	STR924 (see F1630)
N13 query	no	→	STR450 (see F1630)
N14 random	no, predictable	no	TWOSNO (see F2520)
N15 event	see N31	yes	SHSVDX (see F2510)
N21 wall	2.5 min	1 min	NHSVDX (see F2510)
N22 CPU	1.5 min (21.5K core)	15 sec (17.7K core)	
N23 storage	1 pos	40 pos	
N24 transfer	1 min	45 sec	
N25 wait	none	→	
N26 overlap	none	→	
N31 predecessor	STR924	DRVGRD IN415 POLT10	
N32 successor	SPIDER	PUTON DSPLALL	
N41 frequency	1/day	2/day	
N42 start	immediately follows STR 924	after DRVGRD	
N43 execution	up to 30 min after STR924	before 22 Z	

Special Project D (F2540)

	MASS	KMLRGE	others
N11 queue	no →		KNNF (see F1640)
N12 time	yes	no	TWOSNO (see F2520)
N13 query	no	yes	NHSVDA (see F2510)
N14 random	no	random	SHSVDX (see F2510)
N15 event	see N31	yes, must receive data	
N21 wall	ave 3 min range (2-5)	ave 10 min range (8-15)	
N22 CPU	1.5 min (50K core)	6 min (28K core)	
N23 storage	2 pos →		
N24 transfer	usual →		
N25 wait	none →		
N26 overlap	none →		
N31 predecessor	NH 3DNEPH	none	
N32 successor	none	HVLRF follows	
N41 frequency	8/day	2/mon	
N42 start	00Z + every 3 hrs	n/a	
N43 execution	1½-2 hrs	any time	

Special Project E (F2550)

	PUTON	DSPLALL	DRVGRD	others
N11 queue	no →	→	→	NHSVDX (see F2510)
N12 time	yes →	→	→	SHSVDX (see F2510)
N13 query	no →	→	→	
N14 random	no →	→	→	
N15 event	yes →	→	no	
N21 wall	20 min	30 min	20 min	
N22 CPU	7 min (37.6 core)	10 min (18.7K core)	7 min (37.6K core)	
N23 storage	40 pos →	→	→	
N24 transfer	13 min	20 min	13 min	
N25 wait	none →	→	→	
N26 overlap	no →	→	→	
N31 predecessor	DRVGRD GLADD HLADD	DRVGRD PUTON	none	
N32 successor	DSPLALL	none	HLADD GLADD	
N41 frequency	2/day →	→	→	
N42 start	follows GLADD	afternoon local →	→	
N43 execution	DSPLALL must end by 22 Z →	→	→	

Special Project E (F2560)

Special Project G (F2570)

Special Project H (F2580)

SHSVOX
(see F2510)

SNSVOX
(see F2510)

SESS Computer Assisted Outputs (F3110)

	Particle Event (3111)	Radio & Propagation Reports (3112)	Solar, Geomagnetic, Geophysical (3113)	Event Warning (3114)
N11 queue	no →			
N12 time	no	automatic output by F2102	yes	no
N13 query N14 random N15 event	activation depends on request by customer		most scheduled some requested	activation depends on request by customer
N21 wall	sec.		5 sec.	5 sec.
N22 CPU	sec. (10K core)		5 sec.	5 sec.
N23 storage	no significant mass storage			
N24 transfer N25 wait N26 overlap	not available →			
N31 [1] predecessor	F2106		F2101 F2103 F2105 F2109	F2101
N32 successor	output to customer →			
N41 frequency	8/year		12/day	10/day
N42 start	random		see N13	random
N43 execution	in general: must support 1 min response to solar events →			

[1] not necessarily contiguous

SESS Automatic Outputs (F3120)

	Satellite Data Analysis (3121)	Radio & Propagation Reports (3122)	Solar, Geomagnetic, Geophysical (3123)	Auroral Oval (3124)
N11 queue	no			
N12 time	most yes	automatic output by 2102	no	no
N13 query, N14 random, N15 event	most scheduled some requested		activation depends on request by customer	scheduling coincides with DMSP passes
N21 wall	5 sec.		5 sec.	10 sec.
N22 CPU	5 sec. (10K core)		5 sec. (10K core)	10 sec. (35K core)
N23 storage	no significant mass storage			
N24 transfer, N25 wait, N26 overlap	not available			
N31 [1] predecessor	F2101			F2109 plus see N13
N32 successor	output to customer			
N41 frequency	24-48/day		30/day	128/day
N42 start	evenly distributed		random	see N13
N43 execution	in general: must support 2 min. response to solar events			

[1] not necessarily contiguous

SLSS Automated Outputs (F3120) continued

	Proton Predections (3125)	Ionospheric Summary (3126)	Electron Density Forecast (3127)	OTH-B (3128)
N11 queue	automatic output by F2100	no		
N12 time		most yes	automatic output by other model	yes
N13 query		most scheduled some requested		no
N14 random				no
N15 event				see N31
N21 wall		1 min.		2 min.
N22 CPU		30 sec (20K core)		1 min (25K core)
N23 storage		no significant mass storage		
N24 transfer		not available		
N25 wait				
N26 overlap				
N31[1] predecessor		F2104 F2105		F2105
N32 successor		output to customer		
N41 frequency		12/day schd. 3/day requested		12/day
N42 start		evenly distributed		
N43 execution		in general:must support response to 2 min. solar requests		

[1] not necessarily contiguous

SLSS Manual Outputs (F3130)

	Satellite Data Analysis	Event Verification
N11 queue		
N12 time		
N13 query	actuated by customer request	scheduled
N14 random		
N15 event		
N21 wall		
N22 CPU		
N23 storage		
N24 transfer		
N25 wait	manual →	→
N26 overlap		
N31 predecessor		
N32 successor		
N41 frequency	30/day	12-15/day
N42 start	see N11 →	→
N43 execution	in general: must support 2 min. response to solar events	

Manual Facsimile Products (3210)

	STRATFAX (3211)	EURFAX (3212)	PACFAX (3213)	RAFAX (3214)	WEATHER GRAPHICS (3215)
N11 queue					
N12 time					
N13 query					
N14 random					
N15 event					
N21 wall					
N22 CPU	manually prepared				
N23 storage					
N24 transfer					
N25 wait					
N26 overlap					
N31 predecessor	manual chart preparation →				
N32 successor	none →				
N41 frequency/day	11 prods. 28 trans.	7 prods. 17 trans.	12 prods. 24 trans.	5 prods. 12 trans.	
N42 start	product dependent →				
N43 execution					

Automated Facsimile Products (F3220)

	STRATFAX (3221)	EURFAX (3222)	PACFAX (3223)	RAFAX (3224)	WEATHER GRAPHICS (3225)
N11 queue	no →				
N12 time	yes →				
N13 query	no →				
N14 random	no request →				
N15 event	see N31				
N21 wall	ave 600(sec) min 200 max 1300		ave 120(sec) min 60 max 180	ave 600 min 500 max 700	
N22 CPU	ave 125(sec) min 25 max 250		ave 30 min 20 max 40	ave 125 min 100 max 150	
N23 storage	GWC general data base →				
N24 transfer	ave 150 min 10 max 350		ave 30 min 20 max 40	ave 80 min 60 max 100	
N25 wait					
N26 overlap	I/O bound little computation →				
N31 predecessor	data base update →				
N32 successor	none →				
N41 frequency/day	10 products 26 transmissions		3 prods. 5 trans.	2 prods. 4 trans.	
N42 start	product dependent →				
N43 execution					

Computer Assisted Satellite Products (F3320)

	Digital FAX (F3321)	SGDB Displays (F3322)	S10 (F3323)
N11 queue N12 time N13 query N14 random N15 event	All displays will be activated by a real-time driver. Some of these displays will be scheduled periodically (time dependent), others will be data dependent, and some will be random requests.		
N21 wall	ave - 4 (min/display) min - 3 max - 16	ave - 8 min - 7 max - 11	this area is pretty much unknown but could become the main satellite display requirement using very significant system resources
N22 CPU	ave - 6 (sec/display) min - 2 max - 60	ave - 3 min - 1 max - 20	
N23 storage	data base plus 300-5,000 K (overlap)	data base plus 300-5,000K	
N24 transfer	ave - 3 (min/display) min - 1 max - 12	ave - 7 min - 6 max - 20	
N25 wait	not available		
N26 overlap	these programs are almost entirely I/O		
N31 predecessor	see N11		
N32 successor	none		
N41 frequency	ave 100/day range 80-200	max 40/day	see N21
N42 start	see N11		
N43 execution	time requirement varies; most critical could be seconds		

AWN Products (F3400)

	Manual AWN Products (F3410)	Automated AWN Products (F3420)
N11 queue		no
N12 time		most products are transmitted routinely at set times during the day; however, specific events (such as severe weather) also activate some products
N13 query		
N14 random		
N15 event	manual products	
N21 wall		
N22 CPU		
N23 storage		normal AFGWC data bases
N24 transfer	device rate	
N25 wait		
N26 overlap		
N31 predecessor	RTOS	
N32 successor	RTOS	
N41 frequency	50 products covered by 30 transmissions	120 products covered by 530 transmissions
N42 start	product dependent	
N43 execution		

Computer Assisted AUTODIN (F3510)

	Giant Lance (F3511)	ZADG WF (F3512)	CFP's (F3513)	TERDS (F3514)
N11 queue	no	no	no	
N12 time	customer request is time phased	yes	no	
N13 query		no	yes	
N14 random	see N12	no	random	
N15 event	no	wind forecast	no	
N21 wall				
N22 CPU				
N23 storage	global applications data base	→	global applications data base	→
N24 transfer				
N25 wait				
N26 overlap				
N31 predecessor	RTOS	→	→	→
N32 successor	RTOS	→	→	→
N41 frequency		2/day		
N42 start				
N43 execution				

Automatic AUTODIN Products (F3520)

	72 Hour Trajectory Report (F3521)	36 Hour Wind Forecast (F3522)	CFPs (F3523)	Terbs (F3524)
N11 queue				
N12 time				
N13 query				
N14 random				
N15 event				
N21 wall				
N22 CPU				
N23 storage	analysis & forecast wind data base →	→	global applications data base →	→
N24 transfer				
N25 wait				
N26 wait				
N31 predecessor	RTOS →	→	→	→
N32 successor	RTOS →	→	→	→
N41 frequency				
N42 start				
N43 execution				

Manual AUTODIN Products (F3530)

	CINCEUR Brief. Bulletin (F3531)	DCA EUR Forecast Bulletin (F3532)	MAC Ops Center Brief Bulletin (F3533)
N11 queue			
N12 time			
N13 query			
N14 random			
N15 event	manual products		
N21 wall			
N22 CPU			
N23 storage			
N24 transfer			
N25 wait			
N26 overlap			
N31 predecessor	RTOS		
N32 successor	RTOS		
N41 frequency	2/day	1/day	2/day
N42 start			
N43 execution			

	BEALE DATA (F3611)
N11 queue	no
N12 time	data is relayed when max amount received or 8 min. pass
N13 query	no
N14 random	no request
N15 event	see N12
N21 wall	
N22 CPU	
N23 storage	
N24 transfer	
N25 wait	
N26 overlap	
N31 predecessor	RTOS
N32 successor	RTOS
N41 frequency	
N42 start	
N43 execution	ave 2 min after data receipt

Dedicated Circuits, Automated (F3620)

	FUOC 35 (F3621)	SAGE WIND FCSTS (F3622)	8 AF WSU DATA (F3623)	9WRW OPS CTR TAF/OBS F3624)	15 AF WSU DATA (F3625)	21 AF OPS CTR DATA (F3626)
N11 queue	no →					
N12 time	yes →		data is relayed when max amt received or 18 min. pass →			
N13 query			no →			
N14 random			no request →			
N15 event	wind forecast model →		see N12 →			
N21 wall						
N22 CPU						
N23 storage	wind data base →					
N24 transfer						
N25 wait						
N26 overlap						
N31 predecessor	RTOS →					
N32 successor	RTOS →					
N41 frequency						
N42 start						
N43 execution	data useful from 6-12 hrs after analysis time		2 min after receipt	<8 ave 2	2 min after receipt →	

Dedicated Circuits, Automatic (F3620) cont.

	22 AF OPS CTR DATA (F3627)	SCS DATA (F3628)	HQ USAF DATA (F3629)	AUTOMATED MAC DATA (F362A)	SAC DATA (F362B)	FNWC DATA (F362C)
N11 queue	no	→	→	→	no	
N12 time	data is relayed when max amt is received or 8 min pass	→	→	→	no	
N13 query	no	→	→	→	real time request	
N14 random	no request	→	→	→	see N13	
N15 event	see N12	→	→	→	see N13	
N21 wall						
N22 CPU						
N23 storage						
N24 transfer						
N25 wait						
N26 overlap						
N31 predecessor	RTOS	→	→	→	→	→
N32 successor	RTOS	→	→	→	→	→
N41 frequency						
N42 start						
N43 execution	2 min after receipt	8 ave 2	→	→	real time	

Special Project A (F3310)

	WIZARD	ECOVER
N11 queue	no →	
N12 time	no	yes
N13 query	yes, deck load	no
N14 random	random	n/a
N15 event	yes, see N31 →	
N21 wall	ave 30 sec min 15 max 60	30 sec
N22 CPU	ave 2 sec min 1 max 3	10 sec (13K core)
N23 storage	2 tracks	minimal
N24 transfer	12 sec	1500 micro sec
N25 wait	wait 15-30 min	none
N26 overlap	20% overlap	total
N31 predecessor	3 DNEPH SXSND surface upper air	none
N32 successor	none	none
N41 frequency	1/day	8/day
N42 start	1 hour after SXSND	00Z + every 3 hrs
N43 execution	24 hours	can be started up to 3 hrs earlier

Special Project A (F3810) cont.

	BBMAP	SXOATS	MAPIT	MERLIN2
N11 queue	no	→	→	→
N12 time	no	→	→	→
N13 query	no	yes	→	no
N14 random	no	→	→	→
N15 event	no	see N31	yes	yes, PLOT10
N21 wall	8-10 min	2 min	3-5 min	3 min
N22 CPU	2 min (18K core)	5 sec (12K core)	1 min (32.4K core)	1 min (16.6K core)
N23 storage	background brightness	20K words	1 pos	1.5 pos
N24 transfer	5 min	1.5 min	2 min	2 min
N25 wait	none	→	→	→
N26 overlap	none	→	→	→
N31 predecessor	none	STR440 STR450	STRG10	PLOT6
N32 successor	none	→	→	→
N41 frequency	1/wk	1/day	→	→
N42 start	between 13-22Z Thursday	see N31	after STRG10	after PLOT6
N43 execution	see N42	N13 plus 2 hrs	N13 plus 1 hr	see N42

Special Project A (F3810) cont.

	POLAR6	BATMAN	SNPLOW	CHKBND
N11 queue	no →	→	→	→
N12 time	no →	→	→	→
N13 query	no →	→	→	→
N14 random	no →	→	→	yes
N15 event	yes →	→	→	→
N21 wall	3 min	1 min	4 min	30 sec
N22 CPU	1 min (21K core)	45 sec (28K core)	3.5 min (102K core)	15 sec (25K core)
N23 storage	1.5 pos	none	1 pos	none
N24 transfer	1.5 min	usual →	→	n/a
N25 wait	none	15 sec	none →	→
N26 overlap	none	100%	60%	100%
N31 predecessor	DRVMG PLOT6	BEAVER	STR610 PLOT6 REDSNO	BLKBND
N32 successor	none →	→	→	SIXGUN
N41 frequency	1/day	4-6/day	1/day	8-10/day
N42 start	after PLOT10	varies between 3 & 15Z	approx 1530Z	random between 19-21Z
N43 execution	see N42	varies	2.5 hrs	1.5 hrs max

Special Project A (F3810) cont.

	SENDER	others
N11 queue	no	CAL685 (see F1620)
N12 time	no	REDOG2 (see F1620)
N13 query	no	BOOS (See F2520)
N14 random	random	GIPPER,RIPPER, BIPPER (see F2520)
N15 event	yes	BEAVER (see F2520)
N21 wall	2-5 min	BLKBND (see F2520)
N22 CPU	40 sec-2 min	TARLMT (see F2520)
N23 storage	1/2 pos	SIXGUN (see F2520)
N24 transfer	usual	
N25 wait	none	
N26 overlap	none	
N31 predecessor	BIGPAN	
N32 successor	none	
N41 frequency	1/mon	
N42 start	anytime	
N43 execution	any length	

Special Project A (F3810) cont.

F3813

	MERCMP	POLAR9	CHECKH	SPIDER
N11 queue	no →	→	→	→
N12 time	no →	→	→	→
N13 query	no →	→	→	time womdpw
N14 random	no →	→	→	→
N15 event	yes	see N31	yes	see N31
N21 wall	3 min →	→	30 sec	1 min
N22 CPU	1 min (16.5K core)	1 min (14K core)	5 sec (20K core)	usual (18.4K core)
N23 storage	1.5 pos →	→	minimal	tape + 2 tracks
N24 transfer	3 min	1.5 min	15 sec	30 sec
N25 wait	none →	→	15 sec	30 sec
N26 overlap	none →	→	→	→
N31 predecessor	PLOT10	IH415 PLOT10	SPIDER	HPRECP and/or INSERT
N32 successor	none →	→	→	→
N41 frequency	1/day →	→	16/day	18/day
N42 start	after PLOT10 →	→	20 min after SPIDER	variable but about every 90 min.
N43 execution	see N42 →	→	N42 + 30 min	±45 min

Special Project A (F3810) cont.

F3813 continued

	ELTAPE	others
N11 queue	no	SXOATS (see F3812)
N12 time	no	BBMAP (see F3812)
N13 query	no	HVERF (see F1630)
N14 random	random	PMERGE (see F1630)
N15 event	yes	ASSMDZ (see F1630)
N21 wall	ave 12 min range (10-15)	
N22 CPU	3 min (15K core)	
N23 storage	3 pos	
N24 transfer	usual	
N25 wait	15 sec	
N26 overlap	none	
N31 predecessor	none	
N32 successor	none	
N41 frequency	10/year	
N42 start	n/a	
N43 execution	anytime	

Special Projects (F3810) cont.

F3814

	KPFPRG	KIPPER
N11 queue	no	
N12 time	yes	
N13 query	no	yes
N14 random	n/a	no
N15 event	see N31	
N21 wall	30 min	5 min
N22 CPU	10 min (50K core)	2 min (50K core)
N23 storage	6 pos	11 pos
N24 transfer	20 min	3 min
N25 wait	none	20 min
N26 overlap	50%	none
N31 predecessor	KPLFRP	KNNP
N32 successor	none	
N41 frequency	2/day	32/day equally distributed
N42 start	NLT 1530 & 930	115 min after KNNF
N43 execution	NET 30 min prior to N42	from finish of KNNF to N42

Special Projects (F3810) cont.

F3815

	SACWX	SACPAV	TARRAL
N11 queue	no	→	→
N12 time	no	→	→
N13 query	no	→	yes
N14 random	no	yes	→
N15 event	yes, see N31	→	no
N21 wall	1-2 min	3 min	15-40 min
N22 CPU	30 sec (50K core)	15 sec (7.5K core)	14 min (21.6K core)
N23 storage	3 pos	→	2 pos
N24 transfer	20 sec	2 min	4 min
N25 wait	none	10 min	1 hour (card deck)
N26 overlap	60%	none	60%
N31 predecessor	SACPAV	TARRAL	none
N32 Successor	none	SACWX	SACPAV SACWX
N41 frequency	3/month	→	→
N42 start	after SACPAV	after TARRAL	see N43
N43 execution	24 hours after event	→	→

Special Projects (F3810) cont.

	F3810	F3817	
	POLCAT	PAPAPA	SNDSX
N11 queue	no →		(see F1610)
N12 time	no →		
N13 query	yes →		
N14 random	17-19Z	random	
N15 event	yes, must receive input tape	yes	
N21 wall	ave 8 min range (5-15)	15-60 sec	
N22 CPU	5 min (49K core)	3 sec (21K core)	
N23 storage	data base	2 tracks	
N24 transfer	usual	12 sec	
N25 wait	15 sec	15-30 min	
N26 overlap	none →		
N31 predecessor	none	SXSND 3 DNEPH surface data	
N32 successor	none →		
N41 frequency	1/day	5/day	
N42 start	see N14	after SNDSX or SXSND	
N43 execution	3-6 hours	24 hours	

N11 queue	yes
N12 time N13 query N14 random N15 event	are jobs submitted to be handled on a first-come first-serve basis (but a priority system is also used)
N21 wall	475 sec
N22 CPU	152 sec
N23 storage	7 positions & 2 tapes
N24 transfer N25 wait	tape access is biggest access and wait problems
N26 overlap	none (little buffering in development)
N31 predecessor N32 successor	priority queue
N41 frequency	2229/week
N42 start N43 execution	n/a; see N12

The remainder of the Support Processing functional area (functions F4200 through F4600, as shown in Figure 10 of Section 3.0) impose negligible architectural requirements on AFGWC. For example, data base storage requirements associated with loadable program versions in F4600, "Data Base Construction and Maintenance" (i.e., "program absolutes") are a very small percentage of the total storage required, as illustrated in Figure 14. Moreover, many of these areas have implicitly or explicitly been covered in other discussions; e.g., F4400, "Real Time Computer Operations" form integral portions of virtually every program executed. For these reasons, detailed network analysis of the Support Processing functional area is not warranted.

4.3 SUMMARY

The following summarizes the main points resulting from the network analysis data collected at AFGWC. It will consider the activation, characteristics, order, and conflict of operational functions at AFGWC. To summarize: "activation" considers the way a function is initiated, "characteristics" describes the system resources necessary to accomplish the function, "order" names the predecessor-successor relationships between functions, and "conflict" identifies problems involved in relating all the functions together into an integrated network.

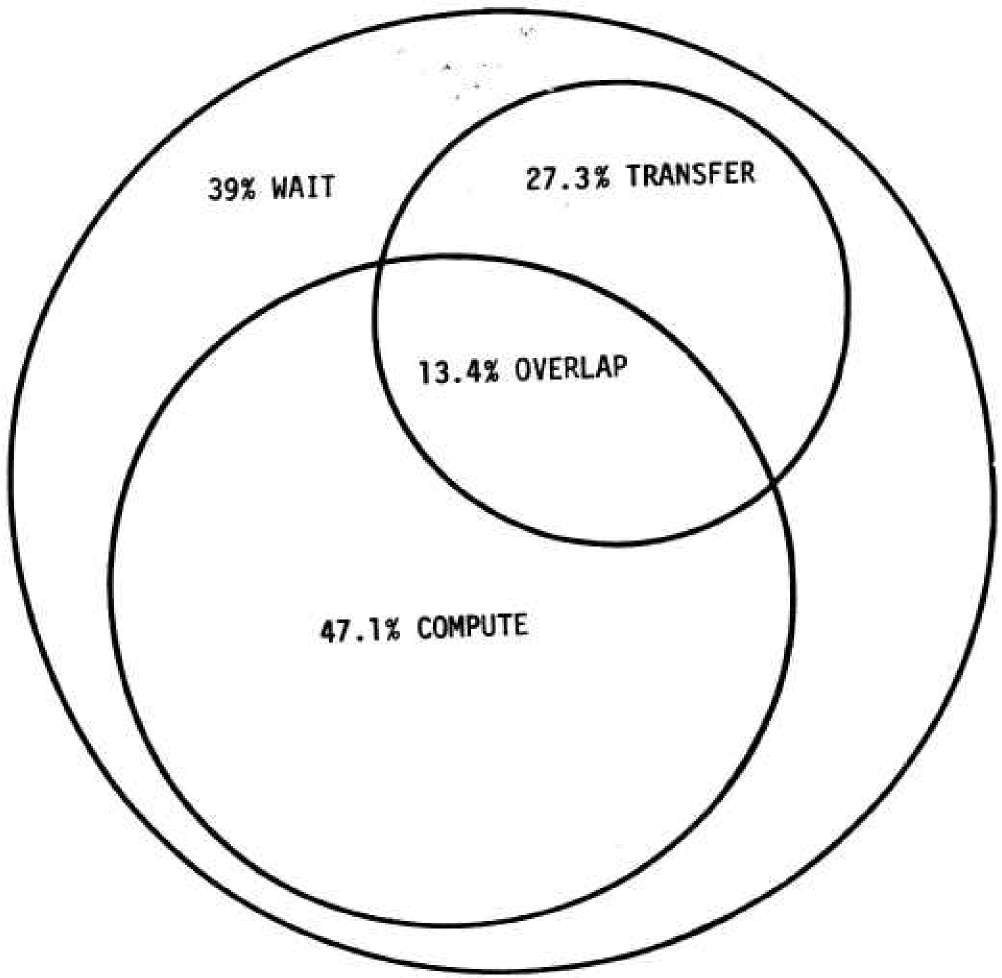
Study of the activation process proved to be more complex a problem than expected. Uniquely classifying a function into one of the four activation areas (random, time dependent, event dependent, and priority queue) was difficult since most were involved in more than one category. Once a function is activated by a time requirement--for example, it is placed in a priority queue-- the same is true of randomly activated events. The only functions uniquely associated with a priority queue are development and maintenance routines. Even functions activated as the result of external events can be classed additionally as either random or time dependent (but for the purposes of this discussion, most satellite data handling routines are still considered activated by the "event" of data arrival). With these ambiguities in mind, here is a breakdown of the approximately 6500 functions which run per day at AFGWC: 52% are random, 33% are activated by a time requirement, 15% are event dependent, and an insignificant number can only be identified with a priority queue.

Ignoring the last group of functions, examination of the routines falling into each of the other three groups shows more in common than the method of activation. The random area is primarily made up of CFPs. These runs are fast (less than 10 seconds wall), small in core size (20K), and require little or no temporary mass storage, but there are large numbers of them. The programs sensitive to time span requirements are mainly analysis and forecasting models and their associated routines. They are responsible for updating most permanently catalogued AFGWC data bases. Demand for storage is not expected to grow at the high rate as other permanent storage requirements. The programs are expected to be larger (up to 260K) and require significantly more computation time by 1982; in fact, they will probably be the determining factor for the computer speed requirement. The final grouping of event dependent functions are those associated with satellite data assimilation and display. In the future, these programs will remain moderate in size (70K or less) and compute time (less than 5 minutes), but will have significant impact on mass storage (both temporary and permanent).

Computer resources involved with CFPs, models, and satellite data processing functions have been briefly mentioned. These, however, fail to give the overall picture of the whole system burden. Wall time and its component parts are more easily discussed in terms of the "average" (or "expected" in the statistical sense) function in operation at AFGWC in 1982. These statistics have been computed from data gathered on all functions in the characteristics area. Where exact numbers were not available, educated estimates were used. Figure 11 shows factors involved in wait and overlap time and recommends practical maximum efficiency limits.

Assuming the ability to schedule around all conflicts and using average numbers for run time, it would take approximately 24.4 U1108s to meet AFGWC requirements in 1982. Figure 12 demonstrates this, but also shows that if all wait time could be eliminated (requiring 2.19 such functions per 1108 operating simultaneously), 11.4 U1108s could handle the workload. Because of the assumptions used, these numbers are of course theoretical, but they do help show the state of the software at AFGWC and suggest limiting computer power which might handle it. (The use of the U1108 standard does not necessarily suggest it as the answer for this architectural study; it is merely a convenient and well known denominator for AFGWC software.)

For purposes of discussion, three types of storage are considered: temporary mass storage, permanent mass storage, and core (main memory) storage.



WAIT FACTORS:	EST % (1977)
OPERATION INTERACTION	6
CHANNEL BUSY	3
RESOURCE CONFIGURATION	1
NO COMPUTATION REQUIRED	28
NO CODE AVAILABLE	1

PRACTICAL MAXIMUM EFFICIENCY:
WAIT 10%

OVERLAP FACTORS:
- COMMON CHANNELS
- MODULE SIZE/ROLL IN-OUT CAPABILITY
- RUN DEMAND DISTRIBUTION

PRACTICAL MAXIMUM OVERLAP: 20%

Figure 11. Processing Time Allocation.

Most AFGWC functions do not use a significant amount of temporary mass storage. SDC's analysis shows the primary users of this to be the satellite data processing routines, displays, and (to a lesser extent) the 3DNEPH cloud analysis programs. Figure 13 compares the almost steady temporary storage requirements for these and other classified data handling routines along with requirements established by all analysis and forecasting routines over a normal 12 hour production cycle.

While the temporary mass storage requirement is expected to remain relatively constant between 1977 and 1982, needs for other system resources are not. Figure 14 demonstrates the expected increase in requirements for permanent mass storage. As with temporary storage, the satellite data files (in this case the gridded and mapped Satellite Global Data Base) are the principal contributors. Note that the numbers in Figure 14 do not allow for the data base redundances not at AFGWC. SDC assumes only one copy of the entire data base rather than one per system as is presently the case.

Total daily CPU demands will undergo significant increases. This is illustrated by Figure 15. The primary reasons for the yearly change can be traced to new and modified analysis and forecasting functions (the effect of the major model changes is also noted in Figure 15). Before discussing the temporal distribution of CPU demand, it is necessary to understand predecessor-successor relationships and entire system interaction. After these factors have been brought out, CPU usage with time will be addressed.

The primary functions involved in the predecessor-successor relationships considered under the heading "order" are those associated with the analysis and forecasting data cycles. Figures 16 and 17 show a simplification of the major relationships and fit them into the 12 hour production cycle. The two figures refer to 1977 and 1982 respectively. The positioning in time of a particular function roughly indicates expected start times and the arrows link successive programs. The 1982 start times shown in Figure 17 have been determined by linking new programs with those they are replacing or where there is no replacement, by insuring that both the predecessor and the new model will have the best opportunity to finish before the requirement is violated. Two programs being linked in Figure 17 does not imply that no problem will be encountered in meeting this relationship. It is not being suggested that AFGWC's present system can support all related functions; it will be shortly pointed out that it cannot. At this point, <u>only</u> start times and predecessor-successor relationship are being stated as requirements.

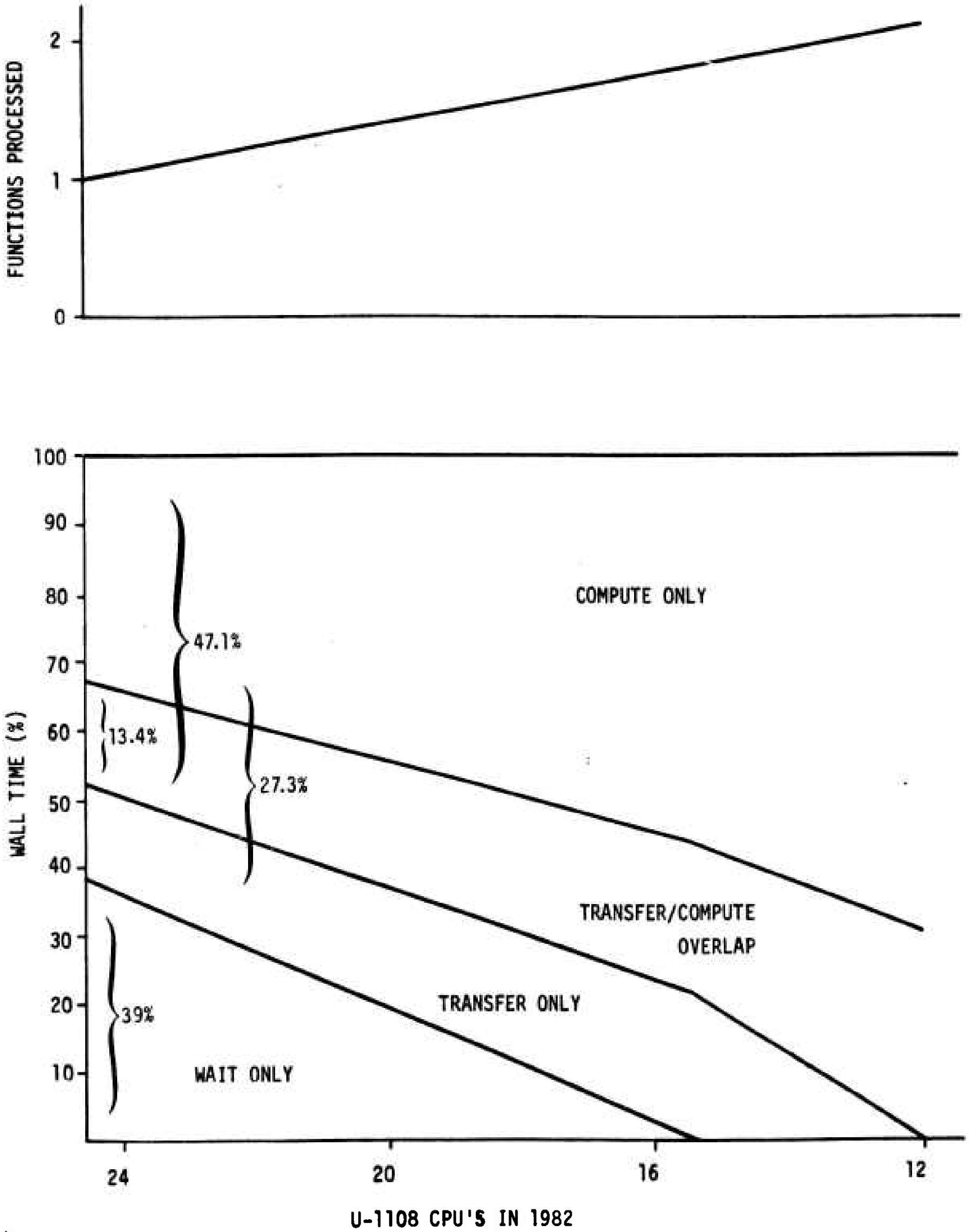


Figure 12. Theoretical Potential Gain by Overlapping Functions.

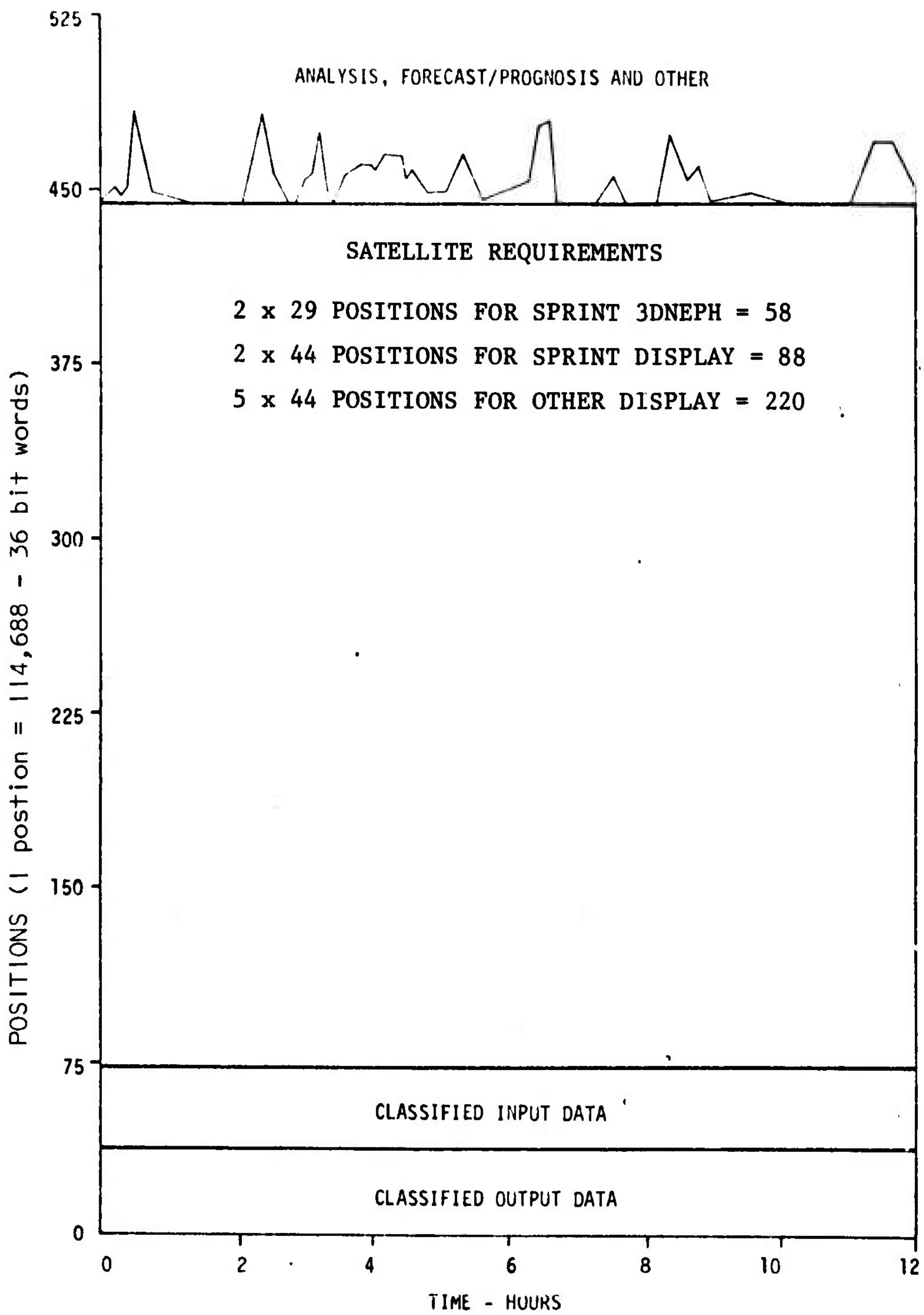


Figure 13. Temporary Storage Requirements (1977 through 1982).

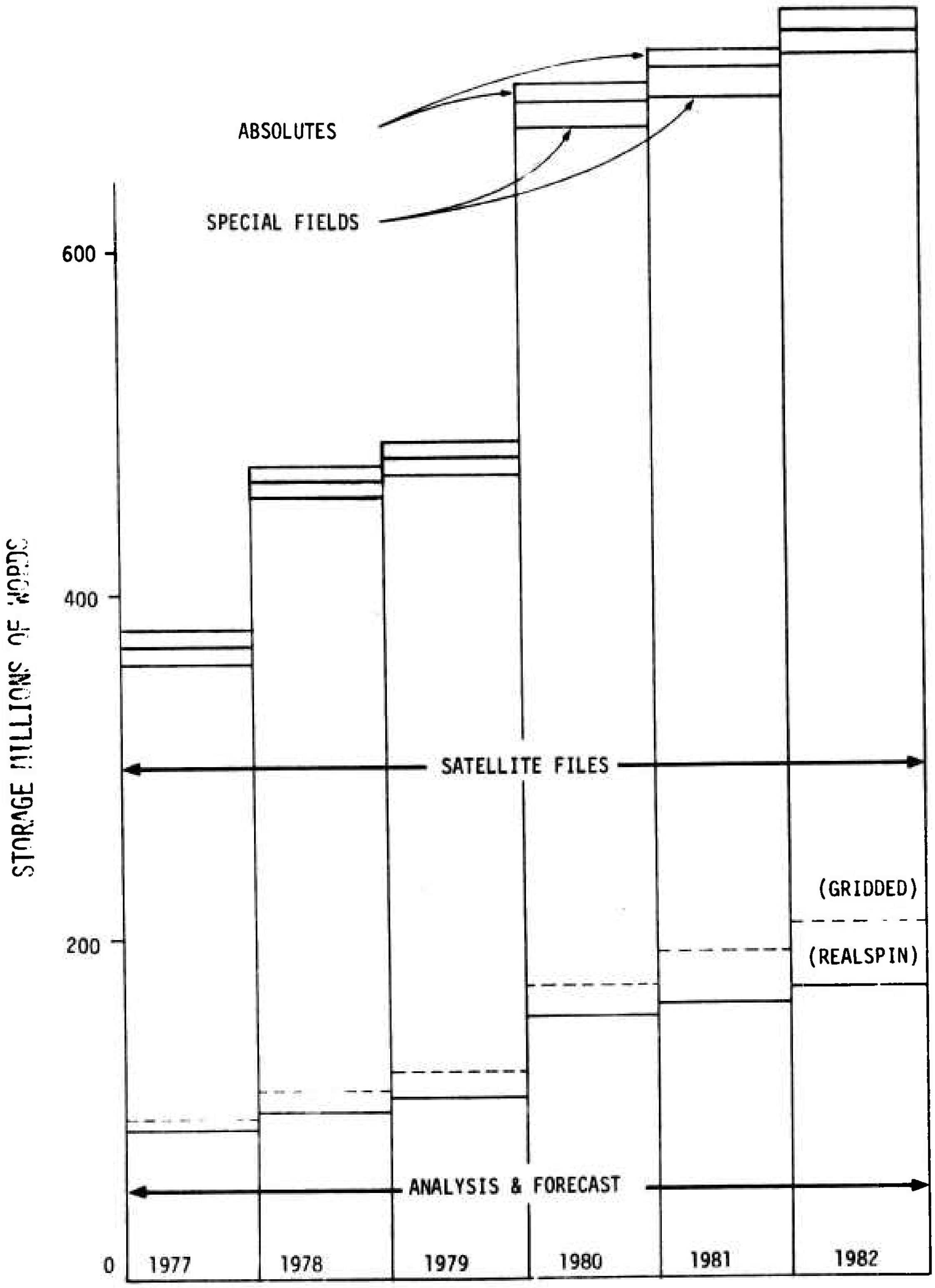


Figure 14. Permanent Mass Storage Requirements (1977 through 1982).

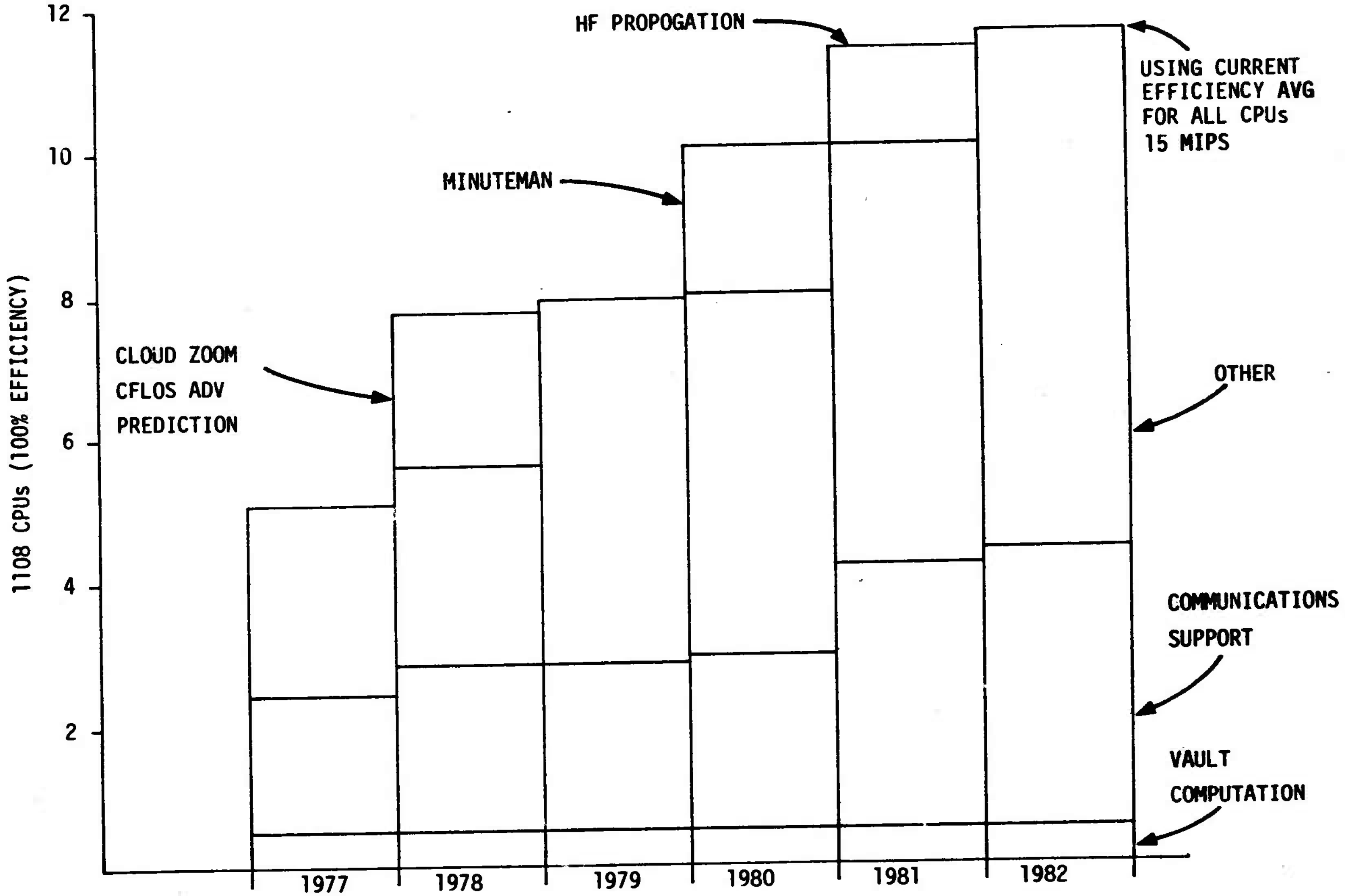


Figure 15. CPU Throughput Requirement.

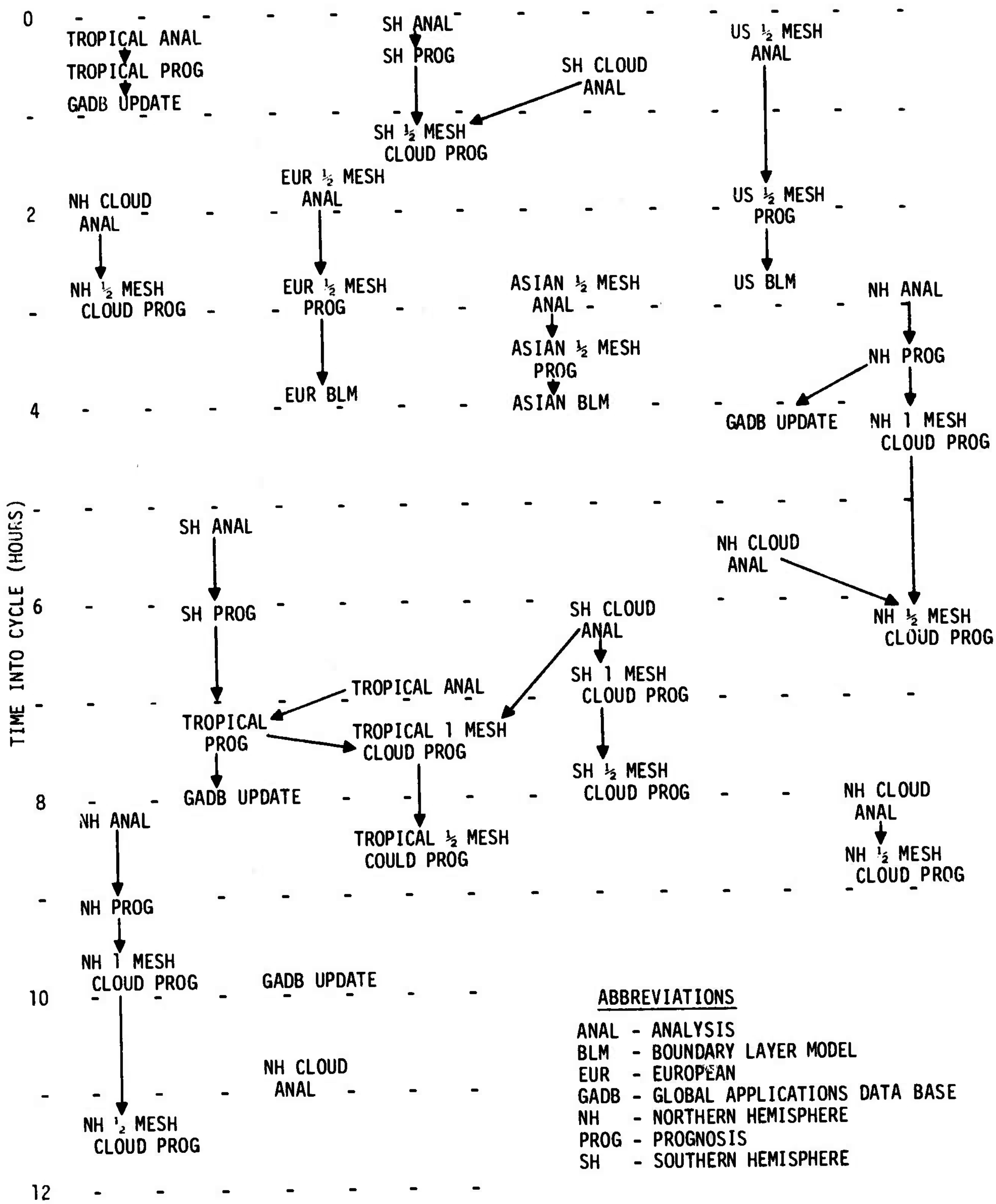


Figure 16. Primary Function Relationships with Time (1977).

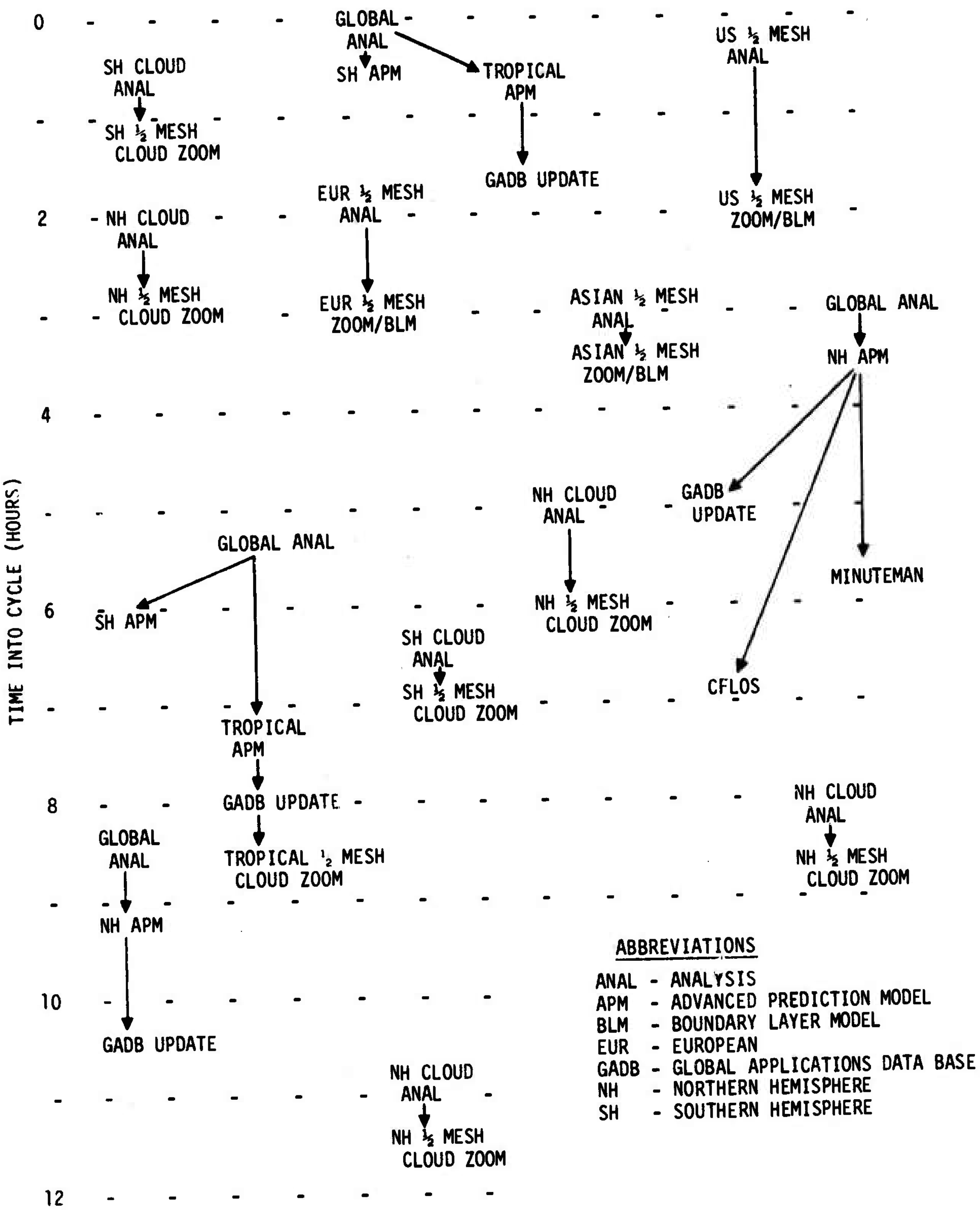


Figure 17. Primary Function Relationships with Time (1982).

Once all individual functions have been described and the necessary relationships established, it remains to fit the network together showing conflicts and restraints. 1977 and 1982 projected CPU usage on U1108 computers is given in Figure 18. The problem is that the job is not being performed properly because most time requirements have been violated. CFLOS and Minuteman programs, for example, are run constantly through the 12 hour cycle (and far beyond) when in fact they are required to start and finish within a two to three hour period. This bluntly says that a 0.8 MIPS computer is not adequate for all future requirements. To fulfill the predecessor-successor relationships within established time lines, a computer with a speed of 10 MIPS is required (at least for CFLOS and Minuteman).

As indicated earlier, the final group of figures shows core requirements with time. It is seen from the discussion of Figure 19 that a 0.8 MIPS computer is not adequate for all 1982 needs, so 1977 data is sized on a 0.8 MIPS computer (Figures 19 and 20) and 1982 data is sized on a 10 MIPS computer (Figures 21 and 22).

A definition of peak and nominal is in order to make the situations depicted by these figures easier to understand. The nominal case occurs when all scheduled programs are beginning and finishing according to average times scheduled by the checklist. Random programs and especially those in large enough numbers to demand almost constant core use are assumed to be running at about 1/2 their maximum. The nominal case should not be considered the minimum since cancellation of scheduled routines, low data receipt, disappearance of random events, and other factors can cause requirements below the nominal.

The peak circumstances does not violate start times or other time requirements but assumes that scheduled programs start at the correct time and continue running until the last moment when the requirement could still be met. Predecessor-successor relations are also honored and the programs requiring almost constant core are assumed to be running at a maximum level. To exceed the peak case program start times would have to be changed which would most likely lead to many requirement violations. In short, the peak case as used here "breaks no rules" and allows all aspects of the AFGWC mission to be accomplished on time.

In the 1977 case, Figure 19 represents the nominal core use case which is more likely to be exceeded than undershot. The large rectangle on the bottom of the figure represents functions with a nearly constant demand on system core. The smaller boxes on top represent the core requirements and the spans of time of the primary analysis and forecasting routines.

ASSUMPTIONS

- U1108 WALL TIME USED
- SPRINT GIVEN 2 CPU's
- SATELLITE DISPLAYS GIVEN 2 CPU's
- CFLOS AND MINUTEMAN EACH GIVEN 1 CPU

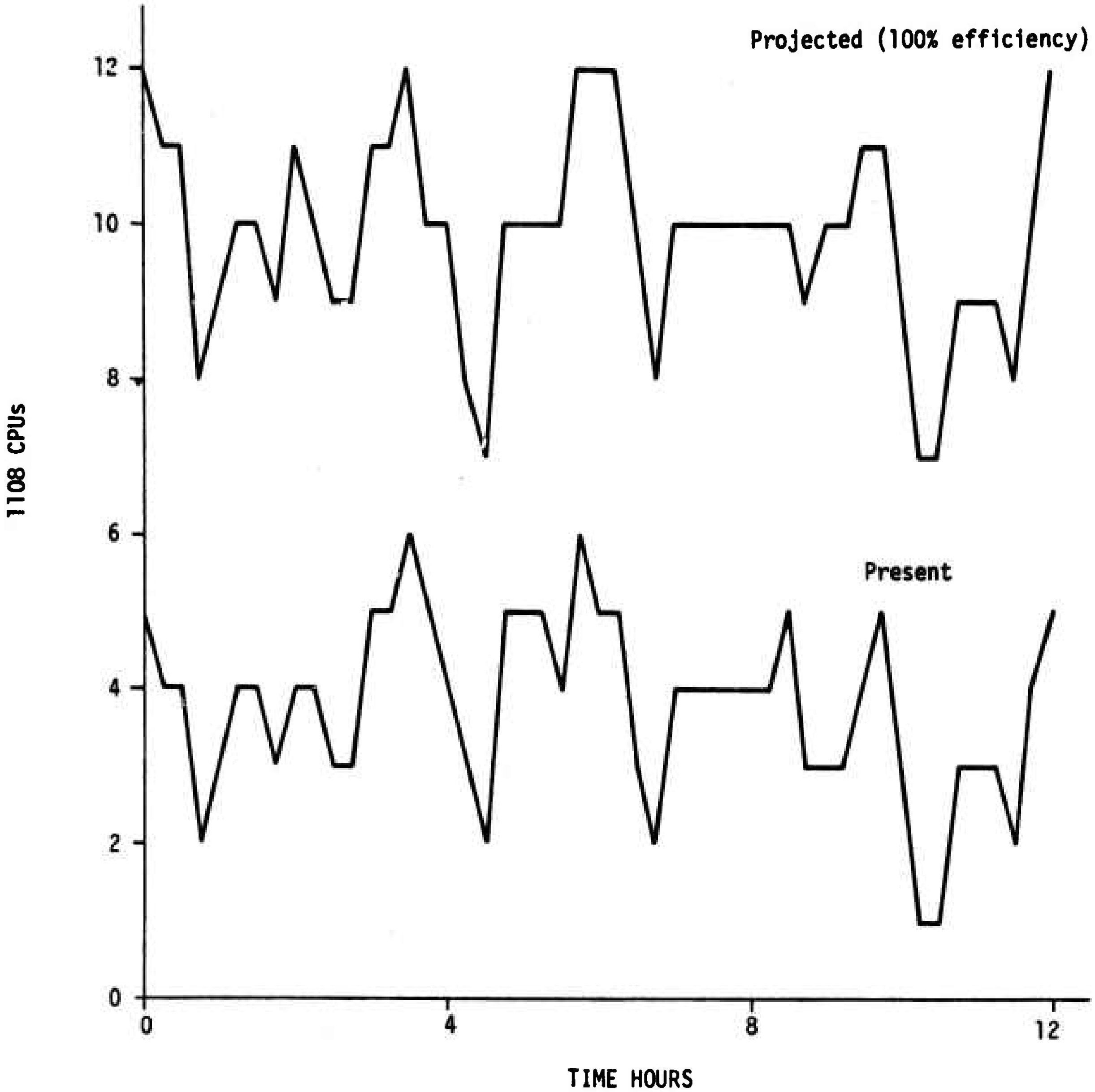


Figure 18. Twelve Hour CPU Usage.

KEY

1	SH ANALYSIS (WHOLE MESH, OR WM)	13	EUROPEAN 1/2 MESH FORECAST
2	TOPICAL ANALYSIS (WM)	14	ASIAN 1/2 MESH ANALYSIS
3	TROPICAL FORECAST (WM)	15	US BLM
4	GLOBAL APPLICATIONS DATA BASE UPDATE (WM)	16	NH ANALYSIS (WM)
5	SH 1/2 MESH CLOUD FORECAST	17	ASIAN 1/2 MESH FORECAST
6	SH FORECAST (WM)	18	EUROPEAN BLM
7	US 1/2 MESH ANALYSIS	19	ASIAN BLM
8	SH CLOUD 1/8 MESH CLOUD ANALYSIS	20	NH FORECAST (WM)
9	NH CLOUD 1/8 MESH CLOUD ANALYSIS	21	NH CLOUD FORECAST (WM)
10	US 1/2 MESH ANALYSIS	22	SH CLOUD FORECAST (WM)
11	EUROPEAN 1/2 MESH ANALYSIS	23	TROPICAL CLOUD FORECAST (WM)
12	NH 1/2 CLOUD FORECAST	24	TROPICAL 1/2 MESH CLOUD FORECAST

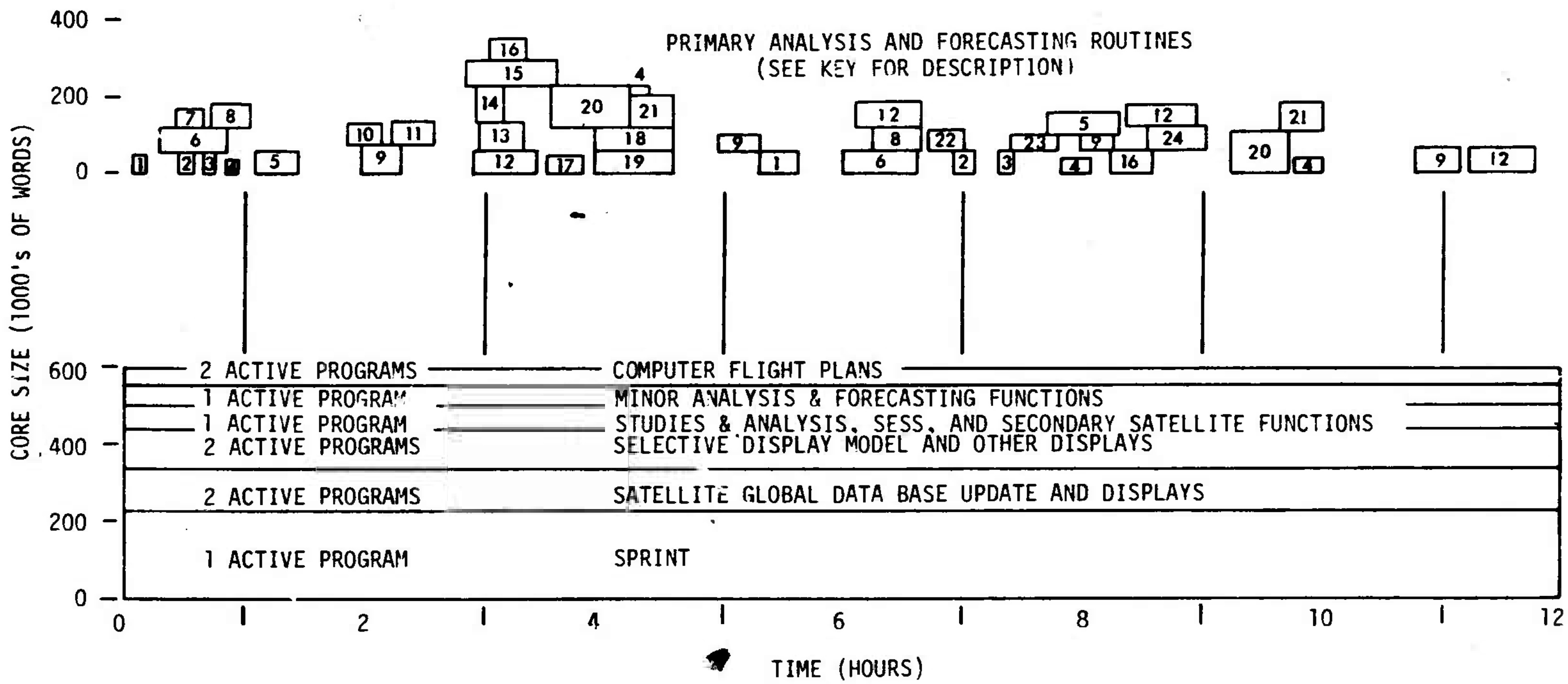


Figure 19. Nominal Core Use (1977).

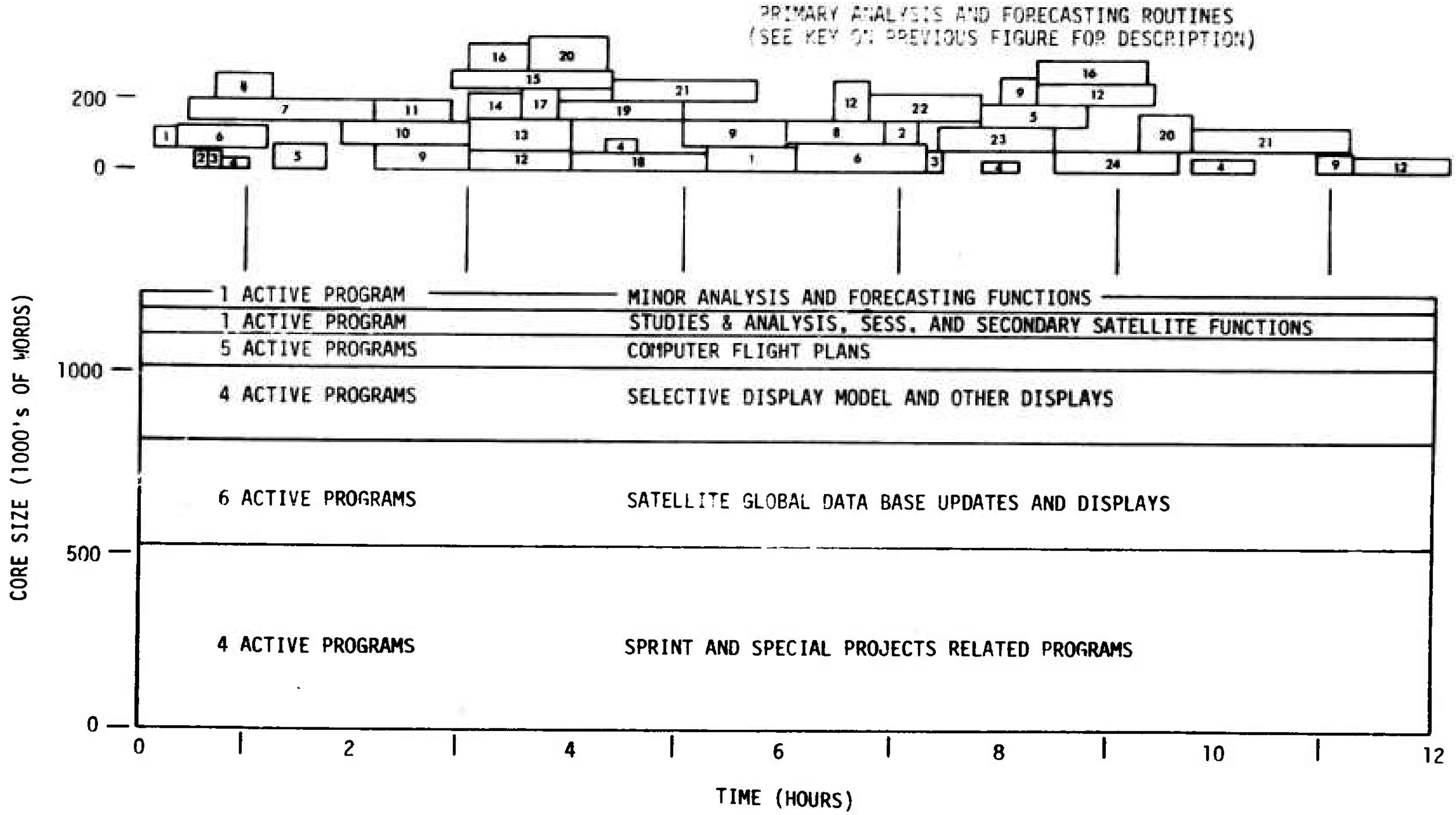


Figure 20. Peak Core Use (1977).

KEY

1	GLOBAL ANALYSIS (WHOLE MESH, OR WM)	10	US 1/2 MESH ZOOM/BLM
2	US 1/2 MESH ANALYSIS	11	NH 1/2 MESH CLOUD ZOOM
3	SH 1/8 MESH CLOUD ANALYSIS	12	EUROPEAN 1/2 MESH ZOOM/BLM
4	SH ADVANCED PREDICTION MODEL (APM) (WM)	13	ASIAN 1/2 MESH ANALYSIS
5	TROPICAL APM (WM)	14	ASIAN 1/2 MESH ZOOM/BLM
6	SH 1/2 MESH CLOUD ZOOM	15	NH APM (WM)
7	GLOBAL APPLICATIONS DATA BASE UPDATE (WM)	16	MINUTEMAN
8	EUROPEAN 1/2 MESH ANALYSIS	17	CFLOS
9	NH 1/8 MESH CLOUD ANALYSIS	18	TROPICAL 1/2 MESH TROPICAL CLOUD ZOOM

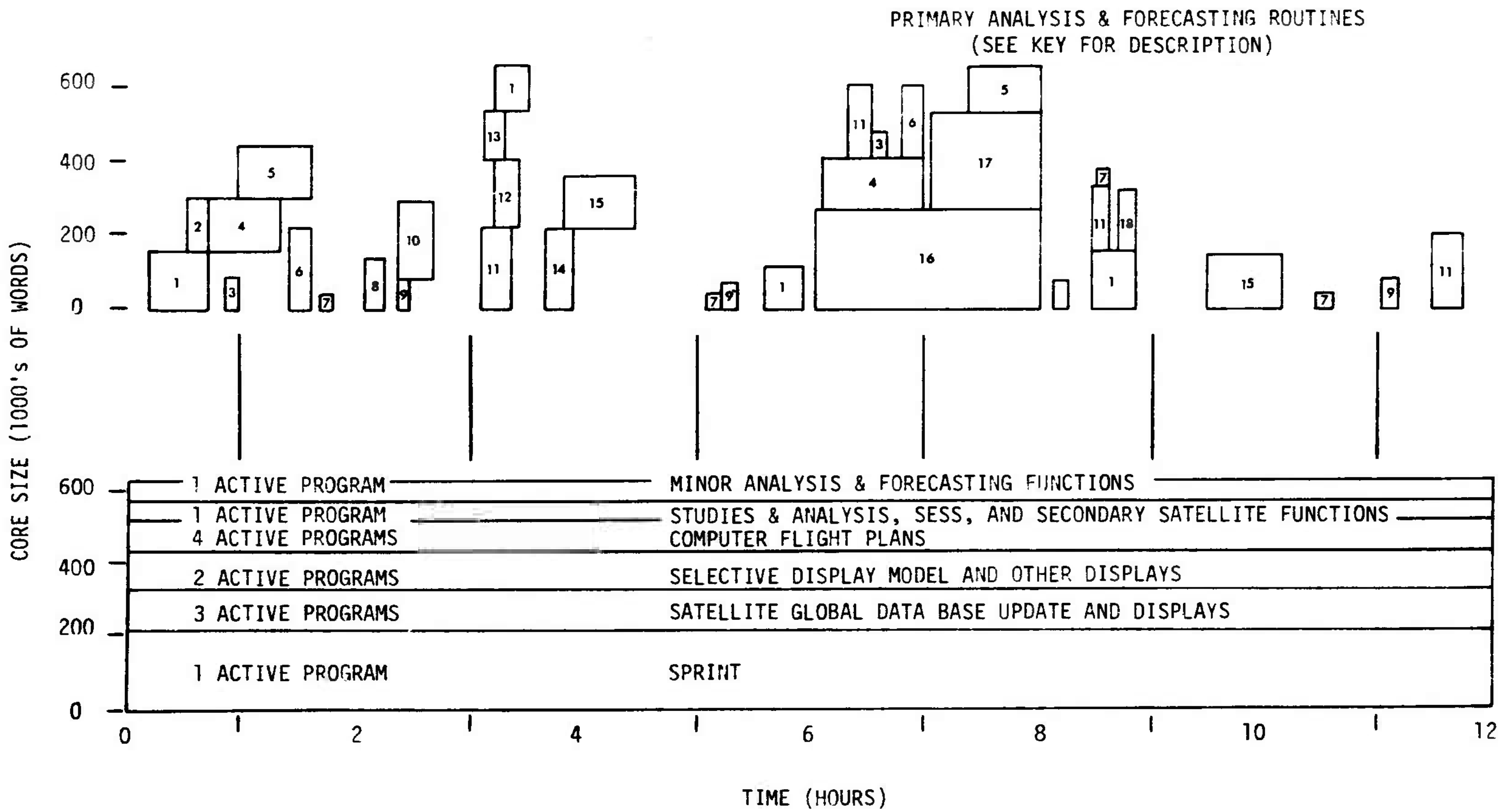


Figure 21. Nominal Core Use (1982).

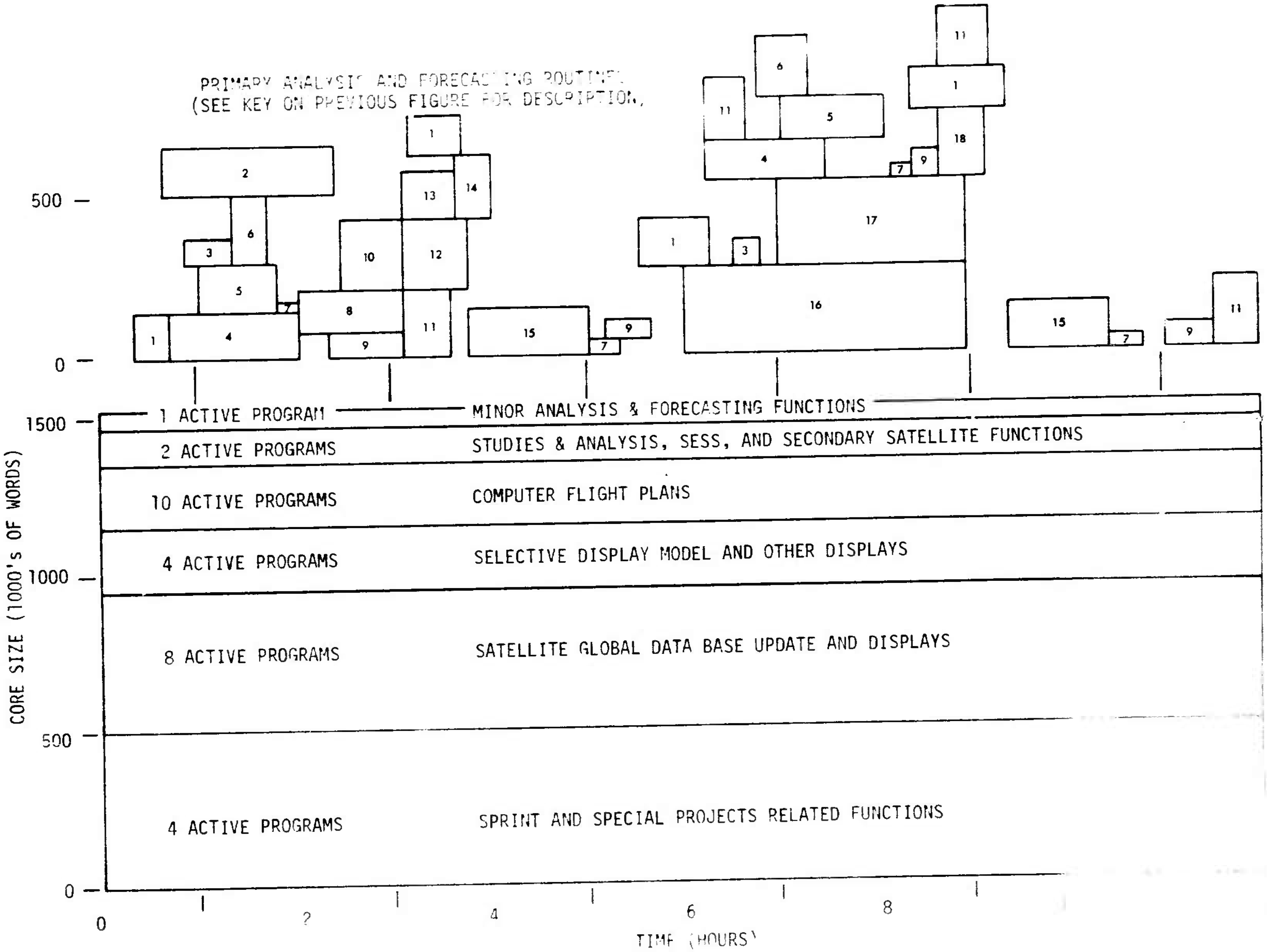


Figure 22. Peak Core Use (1982).

In Figures 19-22, no attempt has been made to modify start times, thus possibly reducing core requirements at any one period in time. Figure 20 represents the peak core use case for the same 1977 period. The effect has been to double the constant demand on system core use and significantly "fill in the holes" of core left by the primary analysis and forecasting routines.

The comments made above apply to the 1982 case as well as 1977. The functions with a nearly constant demand for core need clarification, especially in the 1982 case. They have been represented as continuous because of the large number of functions and their randomness. There will most likely be significant periods of time when none or few of these "constant" jobs will be active, but there is no way of predicting when this will occur. These functions can probably be accomplished with 0.8 MIPS computer speed, both in 1977 and 1982. A faster computer would probably reduce the constant core use and therefore the number of CPUs.

Data on the 1977 "Primary Analysis and Forecasting Routines" depicted in Figures 19 and 20 is based on average wall times. Five simultaneously active programs does not mean 5 CPUs are needed. Since the programs are not all computation (as was shown by Figure 11), the CPU drifts from one to another while several are in core. Picking time of maximum activity such as the third hour of the cycle, there are 14 and 26 programs active for the nominal and peak cases respectively. Using the maximum efficiency factor of 2.19 introduced earlier, this corresponds to 6.4 and 11.8 CPUs.

The plotting of 1982 "Primary Analysis and Forecasting Routines" data was based on CPU times and not wall times (the assumption being made here that they are equal). For the nominal case, 4 models and 12 other active programs result in four 10 MIPS CPUs and 5.5 of the 0.8 MIPS CPUs, respectively. For the peak case, 5 models and 29 other active programs correspond to five 10 MIPS CPUs and 17.8 of the 0.8 MIPS CPUs.

If some programs (primarily the many constant CPU users) can be moved around to fill some empty spots, then the CPU estimate could probably be reduced. What results now appears to be upper bounds estimates.

In summary, the following points have been made and discussed:

a. Primary activation processes have been named;

b. A statistical "average" AFGWC function has been described and areas suggested where it might be improved;

c. Wall time requirements necessary to complete a days worth of "average" functions are plotted against CPUs needed to give an initial estimate of 1982 computer requirements in terms of U1108s;

d. Temorary and permanent mass storage requirements are given for the 1977-1982 time frame, with primary users identified;

e. CPU throughout requirements for 1977-1982 are estimated and primary users are identified;

f. Predecessor-successor relationships for 1977 and 1982 are identified, along with start times for the major analysis and forecasting models;

g. Predecessor, successor, and time requirements have been considered to estimate compute speed necessary to accomplish some of the major 1982 goals;

h. Core size requirements have been determined for:

   1) the 1977 time frame assuming 0.8 MIPS computer speed, and

   2) the 1982 time frame assuming 10 MIPS computer speed

i. Maximum number of CPUs needed are estimated (1977 and 1982).

5.0 DATA SYSTEM CHARACTERISTICS

During task 1, a detailed analysis of the processing characteristics of AFGWC functions (both current and planned) was undertaken. Categories of pertinent data system characteristics were established by which an eventual data system architecture could be developed. These categories of the characteristics domain are:

a. Data Storage

b. Data Transfer and Routing

c. Computation and Software

d. Terminal Interface

e. Data Display (local output)

f. Local Input

g. Personnel

h. Management

i. Facilities

Within these categories, numerous specific questions were developed to assemble answers concerning the various functions. SDC then performed several interviews with AFGWC, AWS, and SAMSO personnel to obtain answers to these questions, and also relied heavily on user and model requirements documentation provided by AWS and AFGWC, respectively. A list of the spectrum of questions used in this effort is as follows:

C10
DATA STORAGE

C11 - FORM:

C111 Quantity
What is the total storage capacity for instructions and data (main and auxiliary storage), required for to perform the function, in terms of words (____ bits), bytes (____ bits), or bits? How much storage must be reserved for executive or control programs?

C112 Retention
How much storage (instructions and numerical data) is retained for future and/or other functional use? For how long?

C113 Structure Complexity
What structure types are employed for data storage? (e.g., simple, hierarchical, indirect addressable chained.) What amounts of this storage are structured by the various methods?

C114 Storage Variability
What are the expected maximum and minimum amounts of data which are to be stored for each data type and structural entity?

C115 Significance
What optimum word sizes are required for storage type?

C116 Logical Records
What are the data sizes which are optimal for data base transfer or structure and usage?

C117 Multiple Source/Sink
Identify number of functions which may update data and number of users including relative frequency.

C12 - ADDRESSABILITY:

C121 Random/Sequential
How is the data normally addressed? What is the relationship of current addressing to previous?

C122 Pattern
Does the operational program perform a specified pattern or sequence for all data storage operations? (i.e., is data stored and retrieved by a fixed process?)

C123 Search/Deterministic
Is there a means for identifying data location within structure for specific requested information or must it be searched?

C124 Frequency
What is the nature of the data addressed and the frequency of access for specified amounts of storage.

C125 Structural Repetition
Are the data structured such that patterns repeat?

C13 - <u>ACCESSABILITY</u>:

C131 Required Response Time
What is the required response time for reads from data storage in words/sec, bytes/sec, or bits/sec?

C132 Multiple Access
Can (or should) multiple storage locations be accessed simultaneously?

C133 Write Lock
To what extent must storage be protected against write (i.e., write lockout)?

C134 Process Input/Output Overlap
Is there potential for input/output overlap (multiple channel techniques, stacking, etc.)?

C14 - <u>SECURITY</u>:

C141 Number/Distribution of Levels
For the secure data, how many levels of security access are employed and what is the quantity distribution by level?

C142 Isolation
What are the isolation requirements between levels?

C143 Inadvertant Access
Is there a requirement for methods and/or procedures to preclude inadvertant access to secure data?

C144 Forced Access
What are protective requirements against forced access?

C15 - RECOVERABILITY FROM FAILURE OR MALFUNCTION:

C151 Reconstructability
How much and what stored data must be reconstructed?

C152 Recovery Time
Within what amount of time must the reconstruction of the data be completed?

C153 Allowable Errors
To what degree does the data allow errors before it is not useable?

C154 Transportability
Is data amount sufficiently small, timing demands sufficiently loose, and structure appropriate that it can be written as tape either during the job or after a failure for transfer to another configuration?

C16 - TIME-PHASED CONSIDERATIONS

a. When is this function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C20
DATA TRANSFER/ROUTING

C21 - DATA FORM/DYNAMICS:

C211 Quantity
What volume of data (in bits or characters) is to be transferred per day, hour, etc. (specify appropriate time unit)?

C212 Frequency/Distribution
What is the time distribution at which transfer occurs, and what is the quantity distribution?

C213 Required Speed
For noncontinuous transfer, what is the maximum acceptable time between transmission of the first bit of data receipt of the last bit of a block transfer?

C214 Structure
What characteristics of the data provide routing information; i.e., is there a cyclic pattern in the data, are keys imbedded which identify types of data blocks, are lengths of data blocks derivable from data in the blocks, etc? What is the unit of transfer and the size? Is there a predictable transfer quantity?

C215 Synchronization
What synchronization of sender and receiver is required for transfer of the data? Indicate if modes must be established for the sender, receiver, and comm link for the transfer to take place. Does the data to be transferred contain synchronizing signals?

C216 Simultaneous Compute Capability
Is there a possibility for simultaneous compute buffer/transfer?

C22 - SWITCHING:

C221 Key
Are there alternate sources or paths by which specific data can be obtained? What methods are to be employed in selecting a source or path and establishing it for transmission?

C222 Channels
How many sources or destinations exist in the data? What relationship does establishment of a transmission path have on other transmissions in progress or enqueued?

C223 Response
What is the maximum time allowed between determination that a transmission is to take place and initiation of the transmission?

C23 - <u>SECURITY</u>:

C231 Checking
Is data transferred to be checked for proper security level?

C232 Levels
How many classification levels are dealt with in transmission?

C233 Guarantee
What reliability must be placed on security protection?

C234 Physical
What physical security must be provided for data transfer components (e.g., closed area, radiation protection)?

C235 Nesting
What compartmentalization and nesting is imposed on the security levels present in this application?

C24 <u>ERROR INTEGRITY</u>:

C241 Error Detection
How many simultaneous errors must be detected?

C242 Error Correction
How many simultaneous errors must be corrected?

C243 Allowable Error Rate
What error rate is allowable in this application?

C244 Retransmissibility
What provisions can be made for feedback on receipt state of transferred data, in order to provide correction from the transmission source? How does this affect the retention requirement for data at the transmission source?

C245 Correctability
What level of error detection and correction redundancy/delay can the transfer application withstand?

C25 - CONTROL:

C251 Initialization:
Is there any functional initialization or contact that must be made prior to transfer/routing of these data?

C252 Impetus
In this application, what is the motivation for transfer/routing of data (i.e., data presence, recipient request, transfer component availability, time, or event such as comparative result)?

C253 Interpretation
Must any part of the data be interpreted or coded/decoded as part of transfer or routing (e.g., header message)?

C254 Response
Does the transfer function require a response as an integral part of transfer?

C255 Enable/Disable
Must transfer or routing be enabled and/or disabled for any reason? Must transfer in its entirety take place or can it be selective?

C256 Interrupt
Is there the capability and/or the need for transfer interrupt restore in this application?

C26 - TIME-PHASED CONSIDERATIONS

a. When is the function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C30
COMPUTATION

C31 - CONTROL:

C311 Batch
Do the function and related functions lend themselves to batch processing (i.e., short, modular, with long or no specific response requirement and not part of an ordered sequence)?

C312 Interactive
Is the function unusually controlled? Is the controller a user or operator? What type of monitoring/response is required?

C313 Real-Time
Is the function forced in relationship to external activity and is it necessary to perform simultaneous computation?

C314 Data Base Feedback and Control
Is the computation motivated by, dependent upon, or controlled by non-core data base interaction?

C315 Interrupt
Is the computation apt to require interrupting and is it structured in such a way as to accommodate interruption?

C316 Secure
What security level are the computation instructions? What security level is the computation process?

C32 - TYPE:

C321 Assembly/Compilation
Is the computation instruction, assembly or compilation in nature?

C322 Executive
Does this computation primarily control the system hardware and software source?

C323 System
Is this computation general purpose in nature pertaining to common/universal tools?

C324 Data Manipulation
Is the purpose of the computation to change data form or structure?

C325 File Maintenance
Is the purpose of this computation to maintain the Data Base?

C326 Math/Statistical
Is this task arithmetic in the performance of math or statistical computations?

C327 Data Routing
Is the purpose of this computation data routing and transfer?

C328 Component Control
Is this computation designed for automatic interface with, and control of, hardware components?

C329 Instruction Mix
What is the mix of the types of computations?

C33 - FORM:

C331 Word Size
What word sizes are used for instructions, computation and data representation (bits, byte, word, double/triple precision)?

C332 Number Base
What number base is best used for data representation (2, 10, or other)?

C333 Floating
Is computation accomplished in fixed or floating point? What is the mix?

C34 - INDEPENDENCE:

C341 Parallelism
Is a large portion of the problem adaptable to parallel computation? If yes, how many simultaneously?

C342 Redundancy
Is there computation which repeats processing previously performed by previous computation or other components (e.g., repeated unpacking of data by different routines)?

C343 Repetition
Is the same computation repeated again and again over the same data sets?

C35 - DATA INTERFACE:

C351 Simultaneous Compute/Transfer
Can (or should) simultaneous compute/transfer operations be performed?

C352 Parallel Transfer
Can data be transferred in parallel as well as being transferred in serial manner to increase the effective transfer rate?

C353 Repetitious Transfer
Is the same data transferred during different phases of an operation?

C36 - QUANTITY:

C361 Storage Required
How much data is required for instruction in this computation? How much is required for direct computation support? How much is required for efficient processing of bulk processed data?

C362 Computation Rate
How fast in terms of the application is computation performed (e.g., files of data per record)?

C363 Number of Instructions Executed
For an average application how many instructions are executed?

C364 Throughput
What is the expected throughput for this application in terms of instructions per record?

C37 - TIME-PHASED CONSIDERATIONS

a. When is this function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C40
TERMINAL INTERFACE

C41 - FORM:

C411 Word Structure
How is the bit stream to be subdivided into meaningful fields for the terminal (i.e., describe control or command fields, data fields, parity and synchronization fields, etc., in form and expected content)?

C412 Blocking
If the bit stream to/from a terminal is not continuous, what are the rules for blocking into individual transmission?

C413 Error
What are all of the detectable error conditions which may pertain to the terminal, or to the data which are sent/received by the terminal?

C414 Users
How many different addressees are on this line?

C42 - CONTROL:

C421 Initialization
What method is required to establish communication with the terminal?

C422 Termination
What conditions does the terminal impose on data transmission in order to continue or break off transmission and/or communication? (i.e., can the rate of transmission vary, can parity errors be treated or ignored, can path switching occur, can synchronization by disrupted and reestablished?)

C423 Query
Can the condition of the terminal be tested at any time, or must a communication path first be established before it can be queried?

C424 Communication Mode
Is the line simplex or duplex? Is the rate at which data is made available constant or variable (based on error correction, retransmission or compression)?

C43 - TRANSFER:

C431 Interpret
What subfield sizes and bit patterns are required by the terminal to represent various entities such as display or print characters, numeric values, controls, etc?

C432 Transform
Are data transformed into explicit representation?

C433 Identification
If the terminal is accessed via communication equipment, what is the polling (input) or addressing (output) method used?

C434 Buffer
Does (or should) the terminal have a buffering capability for repetitive data? If so, how (if for output) are data areas in the buffer to be addressed for modification?

C44 - SECURITY:

C441 Levels
How many levels of security exist for data which can be transmitted?

C442 Policing
How is the interface secured for these various levels of classified data transmission?

C443 Cryption
What encrypting methods are employed for communication with a terminal in classified modes of operation?

C45 - INTEGRITY:

C451 Error Detection
How many simultaneous errors can be detected?

C452 Error Correction
Are errors automatically corrected? If so, how many?

C46 - QUANTITY:

C461 Expected Rate
What is the average data rate requirement for this function?

C462 Maximum Rates

What is the maximum data rate which is required/desired for this function?

C47 - TIME-PHASED CONSIDERATIONS

a. When is this function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C50
DATA DISPLAY

C51 - <u>RATES</u>:

C511 Response
What is the minimum and maximum access/response time?

C512 Data Frequency
What is the frequency of the output in sec/min/hours?

C513 Update Frequency
What is the frequency of update in secs or minutes?

C52 - <u>FORM</u>:

C521 Graphic
Is the output to be in graphic form?

C522 Tabular
Is the output to be in tabular form?

C523 Alarm
Is an audible output required, such as alarms or warnings?

C524 Preformatting
To what degree can the output make use of preformatting and is a general capability warranted?

C525 Granularity
What display granularity is required?

C526 Resolution
What display resolution is required?

C527 Information
What approach should be taken in terms of information/status for this application?

C53 - ACCESS/RETENTION:

C531 Data Selectivity
Is or will there be a priority level for required outputs? Will outputs on certain output devices supersede or cancel each other? Will there be a validity check on availability of data time-wise or otherwise? Rejection of data? For what reasons?

C532 Permanence
Is hard copy required?
Is a transient display required?
On transient displays, what is the permanence required in time (e.g., ms/sec/min/permanent/until cancelled)?
Will flashing displays be required?

C533 Physical Storage
Will mass sequential storage be required for local outputs and if so, for what types and how many bits/words/records/files/pages? Will random access storage be required for local outputs and if so, for what types and how many bits/words/records/channels?

C534 Total versus Subset
For which local outputs will total access be required?
For which local outputs will total retention be required?
For which local cutputs will a subset of total access by required?
For which local outputs will a subset of total retention be required?

C535 Update
For each of the required local outputs, what will be the validity threshold time-wise?
Which local outputs can be, or have to be, updated by manual action/intervention? Which of these are dependent on updated inputs? Which of these can be updated through analyses of present data? Which local outputs will be updated upon outside request? Which local outputs will be updated by local request? Which local outputs will be updated periodically, without request or automatically?

C54 - FORMAT SPECIFICATION:

C541 Prespecified
Does this local output require a pre-specified format? Is this variable enough to be data base defined as opposed to hard coded?

C542 Canned Specification
Does this local output require a general basic form with only changes in the data but not the format?

C543 Real-Time
Is there a requirement for real-time format definition?

C55 - SECURITY:

C551 Level
Which local data outputs will have a security classification attached, and to what level?
Which output data will require a need-to-know?
Which local output requires encryption?

C552 Isolation
Which data must be secured in a separate protected storage?
Will communications security be required for classified data?
Will hardware security be required for classified data?
Will operating system security be required for classified data?

C553 Access Control
Which data must be protected by multi-level access code and keyword control?
Which output data can be protected by single level access/keyword control?
Will audible alarms be necessary in case of violation?
Will multiple reporting be necessary for violation and if so, to what persons? Automatically? Simultaneously? Sequentially?
Will password, or user-ID, or privacy code, or security flag, or retention check, or access-level keyword, or a combination of these be required for output data?

C56 - TIME-PHASED CONSIDERATIONS

a. When is this function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C60
LOCAL INPUT

C61 - INITIALIZATION:

C611 Motivation
What is the key-factor in local inputs for starting the initial acceptance and processing (user interaction, status, time, resource availability, or component availability)? How will inputs be assigned for process control? Are any subject to manual control?

C612 Interrupt
Does the automatic local input require an immediate input/output interrupt?

C613 Polling
Which automatic local inputs will be periodically read out of a retaining device?

C614 Alarm
Which local inputs will cause an alarm/alert condition?

C615 Validation
Will validity and acceptance checks be performed prior to initial processing?

C62 - SECURITY:

C621 Levels
Will security be implemented as a multiple-level structure? Is System Integrity sufficient? Is File Integrity required? Is Data Item Integrity required?

C622 Identification
How will security classification, clearance level, and access control be specified for local inputs?

C623 Assignment
Will any security classification have to be assigned to local inputs at the time of input?

C624 Access
Will a user's profile be set up for local inputs? Will special code-words to extend access privileges and need-to-know category designators be assigned to input data items?

C625 Isolation
To what extent must local input areas be physically isolated?

C63 - TYPE:

C631 Frequency
Specify local data item inputs that arrive on a periodic or cyclic basis. Specify local data inputs that occur on an incidental basis.

C632 Bulk
Do the local data item inputs arrive in bulk? How will these bulk inputs be identified? How will these bulk inputs be stored or retained?

C633 Control
Is data input for control purposes? What is routine of control?

C634 Editorial
Is data input interactive in the sense of editing existing data?

C64 - FORM:

C641 Physical
What physical form are these local inputs (e.g., tape, cards, or manual entry)?

C642 Structure
How will local inputs be structured?
Which local inputs will be digital and which will be analog?
Will inputs be assigned according to structure or type? Which ones?

C643 Priority
In case of input conflict, will a priority system be utilized? How many levels?

C644 Local Copy
For what types of inputs will a local copy be required?

C65 - QUALITY:

C651 Validation
Will a validity check be made on all incoming data items? Will a validity check be made on all manual intervention actions?

C652 Action
On what inputs will automatic corrective action be attempted? What quantities of inputs? What type of inputs will be discarded upon inconclusive validity check? How much?

C66 - QUANTITY:

C661 Amount
What amount of data needs to be input on the average? What are the maximum and minimum amounts?

C662 Frequency
How often are these data inputs and what is the distribution?

C67 - TIME-PHASED CONSIDERATIONS

a. When is this function to be operational (month and year) — and/or — when is this function to be phased out? What other functions and capabilities is this function dependent upon?

b. For the requirements listed above, what is the required time-phasing (i.e., what capabilities are required at what times)? Identify by month and year.

C70
PERSONNEL

C71 - POSITIONAL CHARACTERISTICS:

C711 Position Name and Description
What is the name and general description of the operator/analyst position required for this function?

C712 Time Distribution
What is the total time required by this position for the function and when is it required?

C713 Data System Interface
What is the nature of the interface of this position with the data system?

C714 Qualification/Specialty
What is the time required qualification or specialties required to perform this function?

C715 Security Level
What level of security clearance is required to perform this function?

C72 - CONSTRAINTS:

C721 Quantity of Personnel
What people are available to perform this function?

C722 Quality/Specialties
What specific specialties are available (computer operators, data analysts, etc.)?

C723 Source
What is the source for personnel to perform the function (organization; task sharing with other operator positions)?

C724 Security Level
What security levels are available from these personnel?

C73 - DATA SYSTEM TRAINING:

C731 Component/Area
What hardware/software training is required to perform this function?

C732 Quantity
What courses of what duration should be anticipated and for how many people?

C733 Level
What are the levels (depth) of courses required? Are training capabilities (personnel and facilities) adequate at AFGWC?

C80
MANAGEMENT

C81 - CONTROL:

C811 User Versus Site
To what extent will this function affect control responsibilities and procedures between GWC and User organizations? Upon whose control does the function depend?

C812 Data System Responsibility
How will this function affect AFGWC's level of control over in-house data system operations? Where does responsibility for data system performance/support reside operationally?

C813 Command and Control Source
Will this function affect command and control of AFGWC operation? Organizationally where does local control responsibility reside?

C814 Resource Allocation
Will this function affect the allocation of resources within AFGWC (e.g., reorganization, etc.)? Does it fit into the current scheme of resource allocation? Is there any special resource control required for this function?

C82 - LOGISTICS:

C821 Phase-over
To what extent can operations be interrupted or suspended to permit installation and checkout of new hardware and software?

C822 Spare Parts Philosophy
What are the requirements for spare parts inventory? Amount? Accessibility?

C83 - PLANNING:

C831 Readiness Exercise
To what extent will data system resources be required to verify readiness to perform this function?
Is this function required to support readiness tests for other functions?

C832 System Simulation
Is system simulation required by this function?

C833 Scheduling
What affect does this function have on data system scheduling?

C84 - MAINTENANCE:

C841 Program
What is the effect of maintaining new programs required to perform this function?

C842 Failure Response
What response is required when hardware/software failure occurs?

C843 Reliability
What reliability of hardware is required?

C844 Degradation
How can graceful degradation be achieved? To what degree is it required?

C90
FACILITIES

C91 - SUPPORT:

C911 Power
What are the electrical power requirements for performing this function (average, peak, backup)?

C912 Environment
What environment (e.g., heat and air conditioning) is required? Are there any special environmental considerations for this function?

C92 - PERSONNEL WORK AREAS:

C921 Data Processing Terminals
What kinds and how many terminals (input/output) are required to automate this function?

C922 Work Environment
What are the pertinent environment considerations (e.g., light, noise level, temperature control)?

C923 Support Equipment
What Aeorspace Ground Equipment (AGE) is required to operate and maintain the hardware/software for this function?

C924 Size
To what extent (square feet and % increase) should facilities be increased to permit this function to be performed adequately?

C925 Security
What security requirements affect the utilization of space for this function (levels of access, need for isolation, out-house personnel and communications considerations)?

C93 - STORAGE AND SUPPORT AREAS:

C931 Size
What additional floor space (square feet and % increase) is required to support this function?

C932 Structure
What new structural requirements (e.g., strengthening) are necessary?

C933 Environment
What are average and peak load environmental requirements in storage and support areas (temperature, humidity)?

C934 Security
What security requirements affect the utilization of space for this function?

C935 Electromagnetic Pulse (EMP)
What levels of EMP protection must be provided?

C936 Radio Frequency Interference (RFI)
What protection against electromagnetic radiation and RFI must be provided?

GOO GENERAL PERFORMANCE SPECS

G10 - Growth Potential

Historically, how has this function grown (over the last 5 – 10 years)? What resources has it used more of and how much? What requirements caused this growth?

What is the growth potential and what requirements are forcing growth?

What is the error size for your estimate of future growth?

G11 Input Data

What is the growth in resources needed due to more input data?

G12 Computation

What is the growth due to more accurate computation?

G13 Output Data

What is the growth due to more users or more products?

G14 Automation

What will be the increase in load on computer system resources due to automation of a manual function?

G15 Interaction

If a batch function is to be made interactive, what increase in system load will occur due to interaction overhead and due to the increased frequency of usage of the machine?

G20 - Maintainability

G21 Modularity/Isolation

What system components need the highest reliability because their failure cripples access to a large amount of system resources?

G22 Fault Detection

How is the status of equipment and software obtained today? Is there an historical record used to identify troublesome components?

G23 Fault Isolation

How is fault isolation currently performed between hardware components, hardware and software components, and Exec-8 and AFGWC programs? What are the shortcomings of this approach? What are the good points of it?

G24 Repair

What equipment currently (and in the future) cannot be taken off line for preventative maintenance? Has this measurably affected reliability?

What is the average system capacity lost during a month to preventative and restorative maintenance?

G30 - Reliability

What percent reliability does the user require (expect) of AFGWC in providing this function?

G31 Mean Time to Failure

How reliable has the computer system been historically relative to the need for reliability for this function?

G32 Ability to Degrade

How is a failure recovered from? Can lower priority functions be dropped? Which components can fail with only partial loss of throughput?

G33 Redundancy

What computer resources are used uniquely for this function whose failure would prevent its accomplishment? Are these resources backed up redundantly?

G40 - Integrity

What level of error can be afforded in this function?

G41 <u>Self Checking</u>

What safeguards exist to prevent annhilation of the function's data base?

G42 <u>Error Detection</u>

How is quality control accomplished for this function?

G50 - <u>Testability</u>

G51 <u>Modularity</u>

Does a set of components have to be taken from the operational system to test this function or changes to this function? If so, what are they?

G52 <u>Simulation of Dynamics</u>

Is it feasible to drive the function by simulated input and dummy responses?

G53 <u>Flow Visibility</u>

Is it possible to know that all paths through the code or all functions have been exercised?

G54 <u>Data Uniqueness/Dependency</u>

Does testing require historical files of weather data? Does testing require comparison with empirical data or output of other programs?

G60 - <u>Adaptability</u>

What reaction would be necessary if the missions supported by this function changed relative priorities? If related events or missions changed priorities?

G61 <u>General Form/Purpose</u>

What effect on the performance characteristics (e.g., run time) does modularity, or lack of it, have?

Are any future requirements cause for this function to be split up?

G62 Modularity of functions

How is this function coupled to others (e.g., control, loading, timing, scheduling, common data, boundary conditions, first-guess fields, resource conflicts, etc.)?

What is the relative binding (cohesiveness or homogeneity) of this function? In other words, are subfunctions present because of historical accident or is there a logical relationship?

G70 - Availability

What % of the time does the computer system interface for this function have to be available in order for it to be accomplished?

What flexibility exists to perform other tasks if the machines are unavailable?

What critical data is lost due to unavailability of the computer system?

Does this function lend itself to "catch-up" processing?

What resources are wasted if the computer system is unavailable?

Can input to the computer be buffered (collected and stored) for transmission when the system comes up again?

Does a fully "loaded" system effectively mean that the system is unavailable to this function?

The result of this effort was an extremely extensive compilation of data system characteristics relating to the various defined functional areas. Information was assembled in matrix form on a function-by-function basis, as illustrated below for the SESS Input area (F1100):

FUNCTION / CHARACTERISTICS	SESS INPUT (F1100)			
	F1111 AWN	F1112 AUTODIN	F1113 SOON/RSTN	F1114 ... OTH
C10 STORAGE				
C11 FORM				
C111 QUANTITY				
NOW	160K			
1982	300K		1,000K	800K
C112 RETENTION	IONOSPHERIC DATA - 10 DAYS			
⋮	MAGNETIC DATA - 10 DAYS			

This assembly resulted in the production of several highly specialized working paper summaries that provided the basis for overall data system requirements development. These detailed data have been provided under separate cover.

The compilation of basic overall characteristics was then accomplished by "summing" characteristics areas across all functions. For example, overall storage requirements were established by totalling the C10 requirements for all functional areas from F1100 through F4600. Similar procedures were followed for C20 (Data Transfer and Routing), C30 (Computation and Software), and other characteristics areas through C90 (Facilities). The results of these compilations appear in Sections 5.1 through 5.8. These assemblies, in conjunction with the network analyses of Section 4.0, formed the foundation for the eventual selection of data system architecture characteristics in subsequent tasks.

5.1 DATA STORAGE

Data storage has been broken into four classifications for discussion: main memory, permanent mass storage, temporary storage, and archival storage.

Main memory is the CPU-associated storage required for instructions and accompanying data. FORTRAN programs run routinely like 3DNEPH (3 dimensional nephanalysis) use main memory as do real-time assembler programs like RTOS (real-time operating system). Figure 23 depicts the demand on main memory requirements in 1977. This represents a minor extrapolation of a) present system checklists used to operate the AFGWC systems, b) data obtained by interviews conducted by SDC at AFGWC. The average case is the expected run time according to the checklists, and the peak case assumes a reasonable variation of start and finish times. Figure 24 portrays the average case projected to 1982. It is based on:

a. Sizing of new models expected to be in operation by that time;

b. Analysis, forecast, and prognosis type programs running primarily between 2Z-6Z and 14Z-18Z;

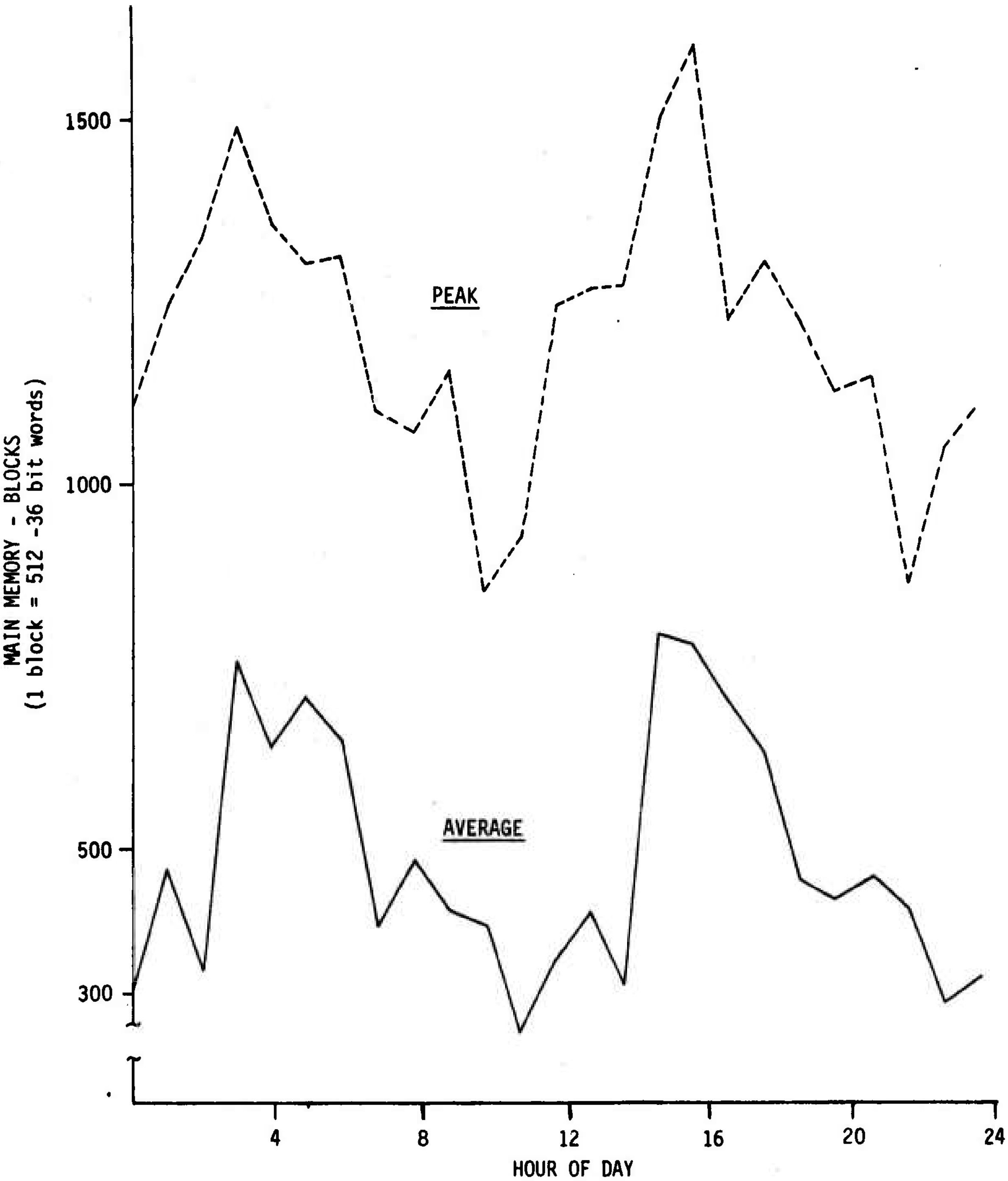


Figure 23. Main Memory Utilization for 1977.

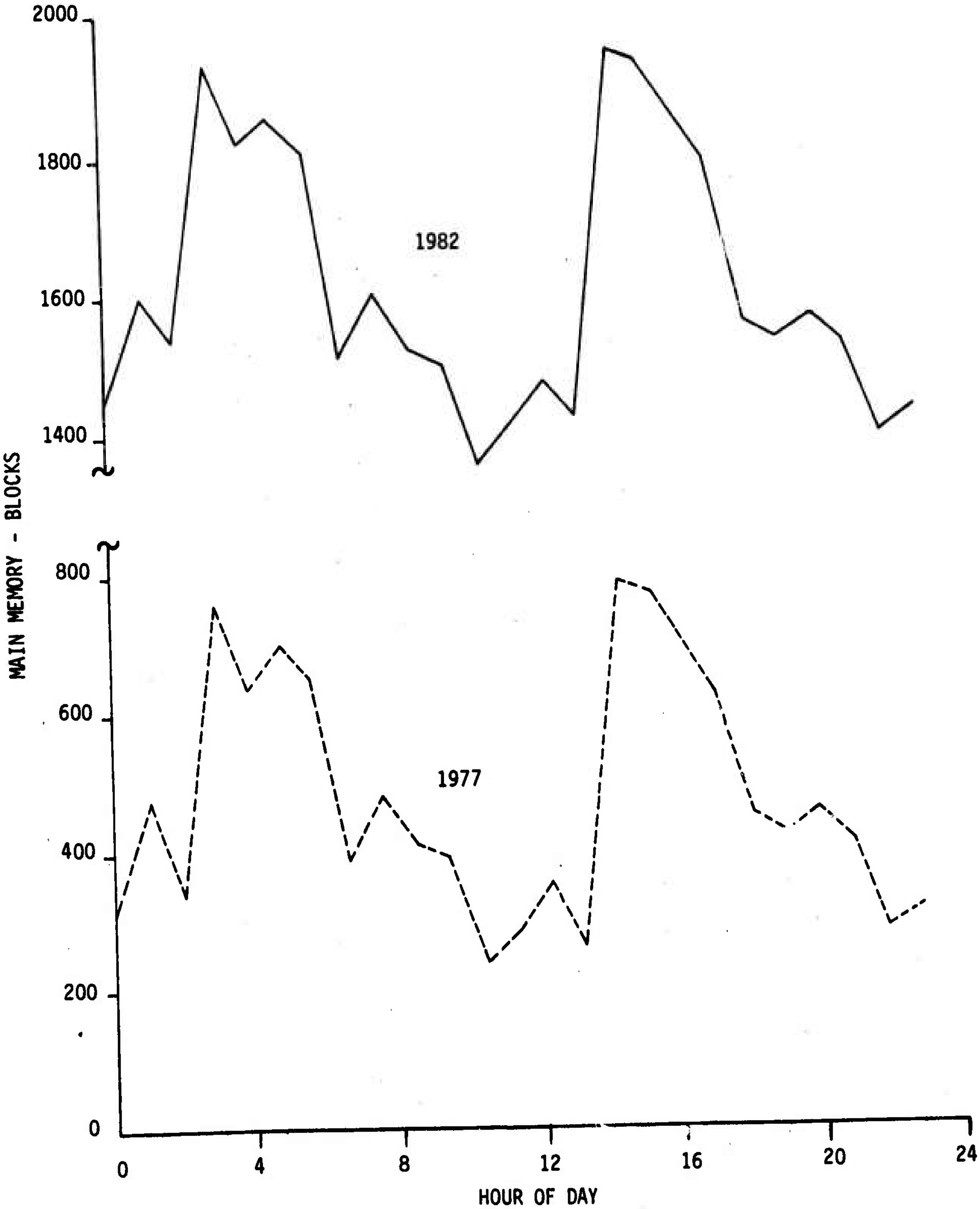


Figure 24. Average GWC Main Memory Utilization for 1977 and 1982.

c. Request, image and special type programs evenly distributed within a 12-hour period; and

d. Line of sight and minuteman models being run almost continuously thru the 24-hour period.

Permanent mass storage is primarily required for intercommunication between programs. For example an analysis program will put its output in permanent mass storage where the forecast program can obtain it for use as a continuity field. Similar applications exist in satellite processing where satellite data stored in the data base (on permanent mass storage) by reduction techniques will subsequently be used by analysis algorithms. The demand on permanent mass storage is constant throughout a given cycle and will only vary over much longer periods of time as functions are added to or deleted from the system. A determination of the 1977 through 1982 permanent mass storage requirements expressed in Figure 14 is based on the assumption that fine satellite data files are compressed on a 4 to 1 basis and that the listed growth rates of the following major users apply:

a. Analysis and forecast files — 10%

b. Gridded satellite files — 6 times 1977 baseline

c. Save satellite files — 6 times 1977 baseline

d. Special fields — 40%

e. Absolutes — 3%

Temporary storage is required for operations (such as buffering) within a program and is released immediately when a function's need for it disappears. Most operational analysis, forecasting, and display programs at AFGWC use such temporary storage but those involved with satellite data ingest and display and SPRINT have the largest requirements. For the estimates expressed here, it will be assumed there is a need for continuous recording of 2 vehicles and

5 other weather satellites. This situation is illustrated in Figure 13. This diagram assumes a constant demand of 35 positions (114,688 36-bit words each) for each the classified input and output functions; 366 positions in constant use for 2 SPRINT 3DNEPHs, 2 SPRINT satellite displays, and 5 other displays; and finally a temporal variation in demand by the remaining routines based on average run times specified in a 1975 checklist. The unchanging nature of requirements associated with SPRINT and satellite processing and the assumption that new routines at AFGWC will not use significantly more temporary mass storage than their predecessors leads to the belief that the information presented in Figure 13 will remain accurate throughout the 1977 to 1982 period.

Archival and save data are considered to be those data requiring no immediate access requirement. This type of data is normally stored sequentially off-line on magnetic tape. To determine the archival and save storage requirements for the 1977 through 1982 time period, the 1975 magnetic tape capacity and utilization were extrapolated to 1977. All AFGWC magnetic tapes were considered even though their characteristics were not the same. The 1982 requirements were defined by determining the number of tapes required for a 90-day ETAC data save and by allotting a 10% growth to the 1977 baseline.

To accommodate the 90-day archive save for ETAC, 1,336.5 x 10^6 words (36 bits/word) must be stored.

Magnetic tapes with the following characteristics are assumed:

a. Density of 6,250 bytes/inch,

b. Block size of 16,536 bytes,

c. Inter-block gap (IB6) of 0.3 inches,

d. Usable tape length = 2,350 feet = 28,200 inches, and

e. 6 bit BCD byte code = 6 bytes/36 bit word.

The total number of tapes required to store the 90-day ETAC data can be computed as follows:

Bytes to be stored = 1.3365×10^9 words x 6 bytes/word = 8.019×10^9

Tape blocks required = 8.019×10^9 bytes ÷ 16,536 bytes/block = 4.849×10^5

Tape length per block = $\frac{16{,}536 \text{ bytes/block}}{6{,}250 \text{ bytes/inch}} + 0.3$ in = 2.95 inches/block

Single tape capacity = $\frac{2.82 \times 10^4 \text{ inches}}{2.95 \text{ inches/block}} = 9.56 \times 10^3$ blocks

Allowing a single tape capacity of 9.0×10^3 blocks/tape, the total number of tapes required is,

$$\frac{4.849 \times 10^5 \text{ blocks}}{9.0 \times 10^3 \text{ blocks/tape}} = 53.9 \text{ or } 54 \text{ tapes.}$$

For adequate operational contingencies the number of tapes required should be increased by a minimum of 10%, therefore the total number of magnetic tapes required would be 59.

If the assumptions made in this summary of data storage characteristics remain valid, then the following points have been established:

a. An additional capacity of at least 1,150 blocks of core storage ($\approx$ 600 K words) will be required by 1982.

b. 75% of the new main memory storage will be in continuous operation in order to meet line of sight and Minuteman requirements.

c. Permanent mass storage requirements will double from the 1977 baseline to a total of about 750×10^6 words by 1982, with primary growth occurring in 1980.

d. The principal cause of mass storage growth is due to gridded satellite file requirements.

e. Temporary storage requirements will not change significantly from the 1977 baseline of about 57×10^6 words.

f. Archive storage capacity requirements will require a capability to store an additional 138×10^9 bits (over 1000 additional tapes) by 1982.

Table 4. AFGWC Archive and Save Storage 1977 - 1982.

1977

• Available Capacity		10,000 Magnetic Tapes
• Utilization:		
Programmer Save		5,000 Tapes
Scratch (6 Day Save Cycle)		600 Tapes
Takers and Miscellaneous Save		1,400 Tapes
Special Projects Save		288 Tapes
Write Protect		1,112 Tapes
Satellite Analog Save		500 Tapes
Satellite Save Scratch		200 Tapes
	Total	9,100 Tapes
• Reserve		900 to 1,000 Tapes

1982

- New Requirements between 1977 and 1982

  90-Day ETAC Data — 59 Tapes

  10% Increase from 1977 — 1,000 Tapes

- Estimated 1982 Requirement — 11,059 Magnetic Tapes

5.2 DATA TRANSFER AND ROUTING

5.2.1 General

The requirements and system characteristics delineated below reflect analysis of data from a variety of sources, and encompass a number of pertinent functional areas. Primary information sources included DO personnel as well as personnel in the 1911th communications squadron, plus statistical data compiled by the DO staff. Included also was information assembled by ESD personnel in their recent data communications study for AFGWC. Overlaying all of these analyses was the extensive package of user requirements documentation provided by AWS.

Pertinent functional areas included virtually all of the major data processing and dissemination areas. Key among these were:

- F1200: Conventional Data Input Processing
- F1400: Product Requests Input Processing
- F2300: Analysis Computations
- F2400: Forecast/Prognosis Computations
- F3600: Dedicated Circuit Output Processing
- F4500: Real-Time Computer Operations

5.2.2 Data Transfer Routing Requirements

5.2.2.1 Communications Processing Characteristics

Statistics compiled in conjunction with the recently completed ESD study regarding the AFGWC communications processor indicate that although all 16 input/output channels are allocated, the traffic on many of these channels is quite low. The highest activity is on one of the two 8440 disk channels (46%), while the other 8440 channel only experiences about 14% utilization. This suggests that one avenue for investigation is a reorganization of the files accessed by these channels, such that less computer time is wasted waiting on input/output.

Several of the other channels, however, receive very low utilization. As can be seen in Table 5, activity is well below 1% on several channels, suggesting that future architectures should consider combining low level channel users on individual channels (providing such mixes of device controllers can be tolerated).

This grouping of channel "customers" is essential, if new users are to be accommodated. Presently, there are no available channels on Systems I or IV; i.e., all 16 channels connected to the input/output controllers are used. If a similar configuration is to be employed in a future architectural design, either such a grouping or an additional IOC must be acquired to permit the hookup of IPADS equipment and/or gear for Automated Work Centers.

The effective balance of overall CPU and input/output time also warrants consideration. Statistics indicate that for System I, the CPU and input/output channels are simultaneously busy only 45% of the time (see Figure 25). Note that as shown in this figure, the CPU was active with no input/output activity for 13% of the time, while input/output was occurring with no computing about 32% of the time (10% of the time there was neither CPU nor input/output traffic). While it is admittedly difficult to achieve very high percentages of overall system utilization, it should be possible in future architectures to improve the efficiency of CPU operation over that shown for System I.

CPU & I/O IDLE	CPU IDLE AND I/O ACTIVE	CPU AND I/O BOTH ACTIVE	CPU ACTIVE ONLY
10%	32%	45%	13%

$\underbrace{32\% \qquad 45\%}_{\text{AT LEAST ONE CHANNEL BUSY — 77\%}}$

MAC CHANNEL RATE: 250,000 wds/sec
MAX IOC RATE: 1,333,000 wds/sec (TO 16 CHANNELS)

Figure 25. System I CPU and I/O Activity

Table 5. Average Channel Data Traffic on System I

Channel	Type	% Busy	% STD DEV 1 Min	% STD DEV 5 Min
0	8440 Disc	14.0	10.3	6.3
1	8440 Disc	46.0	18.9	16.0
2	1782/432	16.0	8.0	6.6
3	TAPE	10.0	19.5	12.0
4	432	0	-	-
5	CTMC	0.4	0.16	0.11
6	CTMC	0.2	0.00	0.05
7	ICCU	2.7	**	**
8	ICCU	1.3	**	**
9	1004 REM	21.0	15.0	10.1
10/11	AUTODIN	0.3	**	**
12/13	PRINTERS	0	17.5	0.4
14	RDR/PCH	0.3	**	**
15	CONSOLE (NEW)	18.0	23.6	15.2
	(OLD)	35.0	*	*

* No data available

** High dispersion

5.2.2.2 In-House Dedicated Circuit Traffic

AFGWC communications must now serve a variety of in-house users in WPF, WPE, and WPJ, who use CRTs, DCT printers, and KSR teletypes on a variety of circuits varying in speed from 75 to 3600 baud. Statistics indicating the levels of this traffic appear in Tables 6 through 8.

Indications are that these levels will expand considerably in the future as greater quantities of more effective interactive devices are implemented. Service will probably be extended to WPA, WPP, and WPD personnel, particularly to support the proposed Automated Work Centers. There will continue to be requirements for mixes of classified and unclassified data for in-house traffic, probably with a significantly higher proportion of secure traffic than currently exists.

These needs infer the use of a local minicomputer to accommodate this internal information transfer. Such an option might be especially feasible if external communications to service terminal interfaces are delegated to a front-end processor.

5.2.2.3 Data Base Transfers and Specialized Considerations

Several of the requirements for storage of high volumes of data and for their rapid transfer within AFGWC will be significant design factors for the 1977 - 1982 architecture. As the sheer size of the AFGWC data base increases, there will be corresponding increases in the levels of data that must be exchanged between auxiliary storages, main memory, communications terminals, and other devices. Moreover, if the trend will be to more of a physically centralized data base, there will be more possibilities for storage access interference, requiring more attention to possible problems of access control.

Satellite data input requirements may be especially stringent in this regard. With the advent of TIROS-N and GOES, and with the influx of greater amounts of data from DMSP, AFGWC will be faced with extremely high volumes of data that must be transferred between terminals, auxiliary storage, and main memory. Moreover, this data must be transferred and accessed rapidly to make full timely use of this information.

Other user requirements provide unique timing constraints. To support WWMCCS, Computer Flight Plans must be processed at rates up to 250 per hour. While accompanying storage requirements may not be inordinate, the volume of these products will require very rapid transfers of associated data, which in turn will demand judicious priority and routing control considerations. In addition, the ingestion of large amounts of digital radar data will require high burst transfers of about 10^6 bits of data in a few seconds from a dedicated terminal to temporary storage, with almost immediate transfer to main memory for analysis by the digital radar model. Again, while the total volume may not be excessive, transfer rates must be sufficiently high to permit rapid transmission of the information so as to make optimum use of this timely data.

Error integrity, security, and standardization all impose unique requirements. With a broader spectrum of internal "customers" in the post-1977 era, capabilities must be available for retransmission of critical information whenever messages or data are not properly received. Classified data is especially important in this regard — security requirements demand that information is exchanged in accordance with rigid security standards, so as to guarantee access only by proper level recipients. This will be especially important with the advent of WWMCCS in 1978. Also, the greater amounts of information transfer to a wider range of internal users demands more standardized approaches to priority addressing and systematized control techniques. This is necessary to maintain simplicity in the hardware and software used to disseminate data, as well as to further quarantee error integrity and reliability.

Thus, although several user requirements will have significant impact on the AFGWC architecture in the post-1978 era, requirements for internal data transfer and routing will be more heavily influenced by quality of data traffic rather than by quantity. Error integrity and security constraints will demand more stringent software control and reliability for internal dissemination, but the timing requirements for data transfers — even considering large high-burst volumes of data that will be required in the future — can be met by current state-of-the-art technologies.

The post-1977 architecture should consider alternative methods of configuring input/output channel customers, allowing enough channels to accommodate anticipated users such as IPADS and Automated Work Centers. In addition, software and hardware methods must be developed to achieve better balances of computer and input/output times, so as to make more optimum simultaneous use of computing and data transfer components.

Table 6. CRT Terminal Traffic (All 3600 baud circuits)

Channel	Address	Addressee	Avg Input (ch/sec) all Unclassified	Avg Output (ch/sec) all Unclassified	Net Average
5	1C1	WPF	2.1	5.2	7.3
5	1C3	WPF	2.3	6.5	8.8
6	1C4	WPF	2.0	5.7	7.7
			6.4	17.4	23.8 ch/sec

Table 7. DCT Terminal Traffic (All 3600 baud circuits)

Channel	Address	Addressee	Avg Input (ch/sec) Secure	Avg Input (ch/sec) Unsecure	Avg Output (ch/sec) Secure	Avg Output (ch/sec) Unsecure	Net Average Traffic
5	1D1	WPF	-	0.9	-	32.0	32.9
5	2D2	WPF	-	2.3	-	96.0	98.3
5	1D3	WPJ	-	0.4	-	15.0	15.4
5	2D1	WPE	-	0.1	-	5.0	5.1
5	1D2	WPF	-	1.6	-	6.0	7.6
6	1D7	WPF	-	1.1	-	23.0	24.1
6	1D4	WPJ	-	0.7	-	31.0	31.7
6	1D9	WPF	-	0.7	-	29.0	29.7
6	1D6	WPF	-	0.7	-	28.0	28.7
6	1D5	WPF	1.1	-	17.0	-	18.1
			1.1	8.5	17.0	265.0	291.6 ch/sec
			9.6		282.0		

Table 8. KSR Terminal Traffic

Channel	Address	Addressee	Speed (baud)	Avg Input (ch/sec) All Unclassified	Avg Output (ch/sec) All Unclassified	Net Average Traffic
5	3K3	WPF	300		10.0	10.0
5	3K6	WPF	300	-	7.4	7.4
5	2K4	WPE	300	-	8.8	8.8
5	1K2	WPJ	110	0.02	0.26	0.28
5	1K3	WPF	110	0.05	0.50	0.55
5	3K8	In=WSU Out=WPJ	75	-	0.70	0.70
6	1K7	WPF	300	-	13.2	13.2
6	3K7	Admin Inhse	75	-	2.9	2.9
6	3K4	WPJ	300	-	8.7	8.7
6	3K5	WPF	300	-	13.1	13.1
6	1K1	WPF	110	0.1	0.9	1.0
6	3K2	WPF	300	-	8.5	8.5
6	2K3	Inhse Monitor TTY	75	-	4.9	4.9
				0.17	79.86	80.03 ch/sec

5.3 COMPUTATION AND SOFTWARE

Several sources of information were pursued to develop the following AFGWC requirements for computation and software. Interviews were conducted with personnel in every organizational branch of AFGWC, and extensive analyses were made of pertinent listings and related documentation. Statistics and initial information regarding current programs were obtained from system checklists and the 77 baseline Data Automation Requirement. Another key source of data regarding analysis and forecast models was the Advanced Models summary provided by the SA (now WPA) staff. This document, in conjunction with supplemental interviews with SA personnel, provided extensive information concerning sizing, timing, implementation dates, and other pertinent data regarding anticipated models. As with all data system characteristics areas, extensive use was made of the user requirements documentation provided by AWS.

Pertinent function areas were those in the Data Base Computations area, as well as some in support processing, including:

- F2100: SESS Computations
- F2200: Request Processing Computations
- F2300: Analysis Computations
- F2400: Forecast/Prognosis Computations
- F2500: Special Projects Computations
- F4100: Software Development and Maintenance Support Processing
- F4200: Special Studies and Analyses Support Processing
- F4500: Continuity of Operations Support Processing

An extensive analysis has been performed of all current and future computational requirements impacting AFGWC. In terms of 1108 wall time utilization, a 12 hour profile of current computer usage was presented as the lower curve of Figure 18. As might be expected, peak situations require the equivalent of five to six 1108 CPUs to effectively process required workloads, even though the "average" utilization might be between three and four CPUs.

The upper curve of this figure illustrates an analogous timeline for 1982, wherein new major requirements for 1982 have been superimposed on the 1975 profile, and phased-out requirements have been deleted. The following key assumptions were made:

a. Cloud free line of sight and Minuteman were each allocated 1 CPU,

b. Satellite displays were allocated 2 CPUs,

c. SPRINT Satellite Data Processing (2 vehicles) was allocated 2 CPUs.

It can be seen that the 1982 profile closely parallels that of 1975; i.e., changes to requirements other than those major items indicated above do not appreciably affect the shape of the 1982 curve. However, it is important to note that "100% efficiency" was assumed in extrapolating to the 1982 profile; that is, inefficiencies for wait times and the like have not been factored in as yet. Thus, the 1982 curve presented in Figure 18 should be considered to represent a theoretically ideal minimum number of CPUs.

A profile of how CPU usage requirements will vary over the 1977 – 1982 time frame was shown in Figure 15. The primary reasons for the yearly changes are requirements for new and modified analysis and forecasting functions, resulting in a requirement for the equivalent of approximately twelve 1108 CPUs operating at 100% efficiency in 1982 (as was illustrated in Figure 18), assuming a throughput rate of 1.25 mips per CPU and based on an overall requirement for an average computation rate of 15 mips by the AFGWC computer complex.

However, as is indicated in Figure 11, examination of the "average" AFGWC function shows it makes use of the CPU only 47.1% of the time, leaving it idle the remainder (while it is involved in transfer or waiting for other activities such as operator interface). Such an efficiency suggests it would really take ($15 \div 0.471$) or almost 32 mips to perform AFGWCs requirements which translates to 25.4 1108 CPUs.

Loading multiple "average" functions within a given CPU has the promise of making better use of the available computers by raising the efficiency. Figure 12 suggests this solution and shows how a maximum CPU usage with 2.19 simultaneous "average" functions would reduce the necessary 1108 CPUs from 25.4 down to about 12. Keep in mind, however, that this ideal loading solution ignores all time lines and demands an ideal interaction between programs suggesting very careful coding.

Regardless of the number of computers required, it has been determined in trying to classify AFGWC automated functions that the following percentages of "CPU power" will be required for the stated tasks:

	1977	1982
Mathematical Computations	57%	75%
Data Manipulation	41%	24%
File Maintenance	2%	1%

The figures and computations to this point have ignored time deadlines and functional predecessor-successor relationships so important in determining how efficiently computer resources can be utilized. The Network Analysis presents the discussion involved with these considerations. At this time we will just refer back to Figures 16 and 17 to emphasize the complex relationships surrounding just the primary analysis and forecasting functions.

To accommodate AFGWC requirements and fully utilize available computer resources, several hardware and software factors must be carefully considered. Table 9 lists several pertinent considerations for specialized processors that could be employed to simultaneously operate on multiple segments of a single problem. In addition, a number of current and potential functions can be enhanced by the addition of new software. This summary appears in Table 10. Other pertinent observations include the following:

a. The software multi-tasking potential is great, but this requires the development and rigid use of strict standards, centralized control, and program modularity. Particular attention should be paid to transfer/compute overlap, task prediction, and preprocessing in anticipation of jobs.

b. Reliability, integrity, and maintainability can be enhanced through extensive software checks.

c. Strict protocol standards will simplify system design.

Table 9. Special Arithmetic Processors

a. Special processors include all fast array (vector, pipeline, or parallel) processors

b. Candidates for special computation are —

    Satellite data input processing ('78, '80)

    Cloud free line of sight ('78)

    Advanced prediction model ('78)

    Minuteman support ('80)

    HF propagation ('81)

c. Computational approach is in no case readily adaptable; it requires significant design

d. All computations are complex (many parts/sequences) and require significant coding

e. Recovery must not require recomputation of valid data

f. Processing is Unclassified or Secret

g. Significant training or outside contract is required for special processor programming

Table 10. Potential Improvement With New Software

		Possible Vendor Supply
a.	Network Control	*
b.	Data Base Management	*
c.	Communications Management	*
d.	Generalized Automated Work Center Interface	
e.	Study Analysis Language/System	*
f.	Programmer Interface	*
g.	Security Control	
h.	Benchmark Software for Performance Monitoring	*
i.	Hardware/Software Diagnostics	*

5.4 TERMINAL INTERFACE

5.4.1 General

Data from several sources were analyzed to produce the data described below. Sources included AFGWC staff and operations personnel, plus 1911th communications squadron personnel, and also included documentation relating to the recently completed ESD System I performance analysis summary, preliminary information regarding a proposed DAR for a System I communications processor, and the AWS User Requirements package.

Pertinent functional areas included all input and output data processing functions, specifically:

- F1100: Space Environmental Data Input Processing
- F1200: Conventional Data Input Processing
- F1300: Metsat/Imagery Data Input Processing
- F1400: Product Requests Input Processing
- F1500: Digital Radar Input Processing
- F1600: Special Projects Input Processing
- F3100: Space Environmental Support Products Output Processing
- F3200: Facsimile Products Output Processing
- F3300: Satellite/Imagery-Related Products Output Processing
- F3400: AWN Products Output Processing
- F3500: AUTODIN Products Output Processing
- F3600: Dedicated Circuits Output Processing
- F3700: WWMCCS Intercomputer Network Output Processing
- F3800: Special Projects Output Processing

Specifics regarding projected requirements pertaining to these functional areas are presented in the following paragraphs.

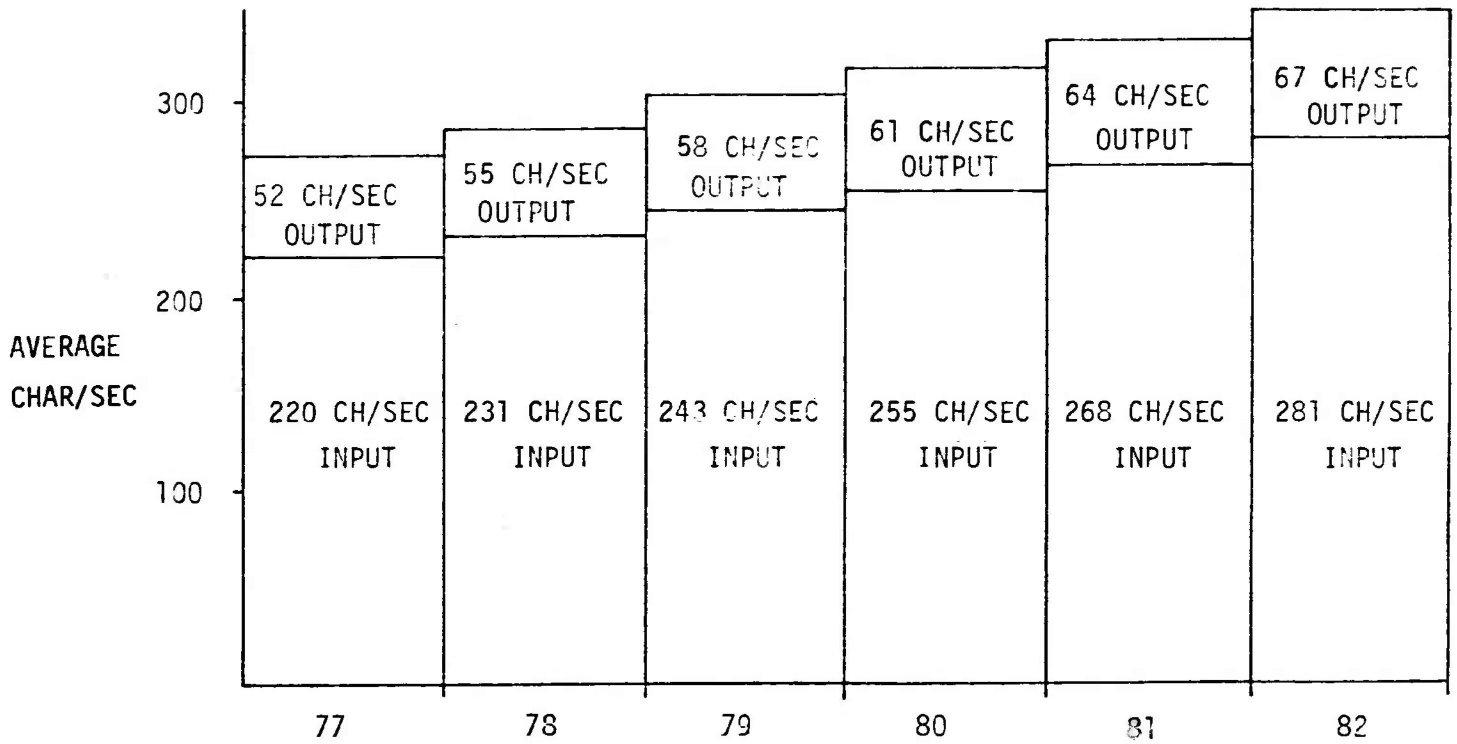
5.4.2 Terminal Interface Requirements

5.4.2.1 AWN Input and Output

At present, statistics compiled by DO personnel indicate that average AWN input traffic (i.e., data from the Carswell link) is 220 characters/second, while output traffic on this link averaged 52 characters/second. This compares favorably with another set of statistics documented in the ESD study for a different sampling period when AWN input and output rates were found to be 226 and 54 characters/second, respectively. This also compares well with the total load presently input to Carswell from the AWN. Statistics compiled by Detachment 7 at Carswell indicate that an average of approximately 281 char/second are received at Carswell from all sources (230 ch/sec of which are specifically AWN sources) prior to reformatting and retransmission of this source data to AFGWC at the average rate of 204 char/second in the 4800 baud Carswell/AFGWC link.

Analyses indicate that although AFGWC may experience marked increased in data and message traffic over other communications links, significant increases are not anticipated on the Carswell line. A growth rate of 5%/year has been postulated for this traffic, resulting in an average input load of 281 characters/second in 1982, and an average output load of 67 characters/second in that same time period, based on extrapolations of statistics provided by DO. At 6 bits/character, this amounts to 1686 bits/second input and 402 bits/second output - well within the capabilities of the 4800 baud full duplexed Carswell link. (At times, large volumes of messages may temporarily build up for this link, causing short-term backlogs. This is not expected to be a major problem. Currently, only one side of the duplexed link is used for both input and output, with no serious delays.) The anticipated growth pattern of this AWN traffic is illustrated in Figure 26.

However, while line capacities and current transfer rates of associated devices and channels do not appear to present problems, there are distinct limitations



- QUANTITIES, CAPABILITIES - EXTRAPOLATION OF AVERAGES BASED ON MODEST GROWTH RATE (5%/YEAR) - CURRENT LINK CAPABILITY WELL WITHIN ANTICIPATED PEAKS
- CONTROL - REAL-TIME HANDLING OF DATA VIA RTOS MODULES - POSSIBLY IN DEDICATED COMM PROCESSOR(S)
- SECURITY - NO REQUIREMENTS

Figure 26. AWN Input and Output.

in the computational capabilities for accepting, decoding, and routing this data. The limiting factor in System I is lack of core memory rather than CPU execute time.

The large size of RTOS leads to complications in the U1108 addressing scheme. With a core allocation of over 90 thousand words, it is possible to access the farther addresses only by indirect addressing. Thus any new element added to the program can cause a need to rewrite one or more other elements.

Several other disadvantages are inherent in the present configuration for processing real time data in System I, including reliability, operational, and efficiency aspects. Initial approaches for a separate front end communications processor have been developed by the 1911th comm squadron and have been documented by SDC in a Preliminary Design Concept Paper. This concept will be addressed by SDC in developing alternate system architectures.

However, it should be noted that in the event of the loss of the Carswell facility, AWN data must be routed directly to AFGWC from current Carswell "customers" in order for AFGWC to back up the Carswell communication function. Currently, Carswell outputs an average of about 554 characters/second to 19 specific customers, including AWN subscribers. (If AFGWC is indeed expected to perform such backup, it also would need the appropriate decoders and associated software to process related inputs.) Thus, the requirement for full backup to Carswell dictates a significantly higher output load requirement for AFGWC, or, in periods when such support is required, a load of 554 characters/second instead of the current output load to Carswell to support AWN of about 52 characters/second.

5.4.2.2 AUTODIN Input and Output

Traffic on the AUTODIN link is well within current transmission capabilities. Average rates for channels 10 and 11 of System I, which service AUTODIN, are as follows:

	Channel 10	Channel 11	Totals
INPUT	3.8 wds/sec	2.0 wds/sec	5.8
OUTPUT	5.8 wds/sec	1.8 wds/sec	7.6
	9.6 wds/sec	3.8 wds/sec	14.4 wds/sec (≈518 bits/sec)

Even at peak loads, this rate is adequately handled by the 2400 baud AUTODIN circuit.

However, a major impact on AFGWC communications will occur with the advent of WWMCCS in 1980. The WWMCCS Intercomputer network will basically be a significantly enhanced version of the current AUTODIN network, and may have a rate as high as 50 kilobits to service the WWMCCS community. As with other WWMCCS installations, AFGWC computers will interface with WWMCCS via a Datanet 355 input/output controller, and will continue to maintain secure and unclassified communications.

Although there will be marked increases in AFGWC AUTODIN traffic to service larger volumes of CFPs and to directly support WWMCCS agencies, these should easily be accommodated within expected traffic capabilities of this network, provided that other C&C systems do not usurp AUTODIN capacities. Secure communications through 1979 will continue to be supplied via AUTODIN 1 and RTOS - however, no new handlers or protocols will be employed during this time period.

5.4.2.3 Dedicated Circuits (External) - Input and Output

Although traffic load patterns for users other than AWN or AUTODIN sometimes vary considerably during a 12 or 24 hour cycle, some pertinent information can be obtained by inspecting averaged rates as recently compiled by AFGWC. These current figures are as follows:

		Line Speed	Input	Output	Totals
VELA (all secure)	:	2400 baud	106 ch/sec	6.5 ch/sec	113 ch/sec
FNWC (all unclassified)	:	4800 baud	15 ch/sec	87 ch/sec	102 ch/sec
SAC HQ (all secure)	:	2400 baud	1.3 ch/sec	30 ch/sec	31 ch/sec
NOAA/SELS	:	3600 baud		insignificant	
Other out-of-house KSR, DCT circuits (secure and unclassified)	:	56-3600 baud	16.5 ch/sec	172 ch/sec	189 ch/sec
			139 ch/sec	296 ch/sec	535 ch/sec

These rates are expected to be the same in 1976. Commencing in 1977, however, changes to VELA and FNWC data requirements can be expected, to be followed by the influx of digital radar data in 1980. Details are as follows:

a. VELA

Inputs from VELA to AFGWC, as well as related transmission back to Sunnyvale from AFGWC, will be phased out by 1977.

b. FNWC

In 1976, it is assumed that the Navy will require about the same output traffic from AFGWC as it requires today for a variety of non-DMSP data, averaging about 87 characters/second on the dedicated FNWC circuit. In 1977, this load should drop to about one-half its current volume, to about 40 characters/second. However, large amounts of DMSP data will be sent to FNWC, averaging about 480 characters/second. This figure is based on transmission of the following outputs.

	Data Type	Amount of Stored Data	Transmission Frequency	Total Transmitted Characters/Day
1.	Smooth Data (Global)	4,096,000 bytes[1]	once/day	4,096,000 char/day[1]
2.	Fine Data (Selected Areas)	16,384,000 bytes	once/day	16,384,000 char/day
3.	Vertical Sounding Profiles	500,000 bytes	eight times/day	4,000,000 char/day
4.	Sea Surface Temperature Mapper	500,000 bytes	once/day	500,000 char/day
5.	Microwave Mapper	500,000 bytes	eight times/day	4,000,000 char/day
6.	Active Radar	500,000 bytes	eight times/day	4,000,000 char/day
				32,980,000 char/day = 382 char/sec

[1]This amount of transferred data assumes that the size of the global satellite data base (16,384,000 bytes) can be reduced by a factor of 4 by prefiltering of selected geographical areas prior to dissemination to FNWC.

The average rate of 382 char/sec (2292 bits/second), however, involves the "burst" transmissions of high volumes of data for very short periods of time. Thus, a high speed digital line, directly interfacing with System V (or its equivalent) will be necessary to accommodate this data. The CTMCs can theoretically handle rates up to 62.5 kilobits/sec; therefore, a 50 KB link directly connected to the System V CTMC should accommodate these transmissions.

These requirements will be required through 1978, after which FNWC will receive all required weather satellite data from communications satellites, with no direct AFGWC support being required after 1978.

c. Digital Radar

The exact nature of interfacing digital radar inputs to AFGWC remains to be determined. It is assumed that preprocessing of digital radar data will be accomplished at several centralized remote locations, and that the net input to AFGWC would be 2×10^5 bits/second for 4 seconds, with this influx occurring as often as every 15 minutes under severe weather conditions. Thus, the "average" rate may only be about 889 bits/sec (148 characters/second), but the data would probably be received in short-duration high-volume bursts. Again, a dedicated high-speed link - possibly a communications satellite link that ties in all of the preprocessing sites - would be required to make the best use of this perishable data in the shortest amount of time.

The rationale for assuming these data rates is as follows:

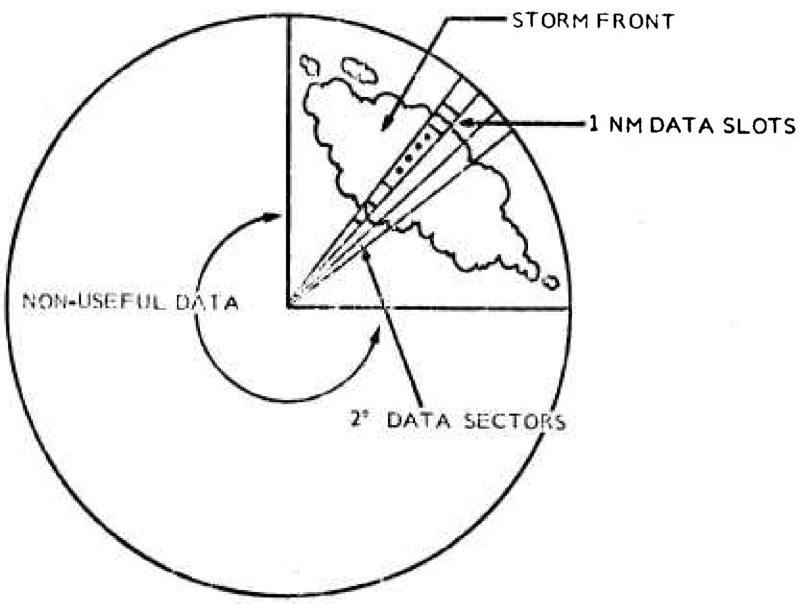


Figure 27. Assumed Storm Pattern

As shown in Figure 27, assume that one digital radar scans a storm that occupies 25% of its scan area (i.e., 270° of "data" would be eliminated at a preprocessing site). Assuming also that angular resolution is 2° and that the linear resolution is 1 nautical mile, there can be about 20 "bits" per sector for a storm front of 20 miles in depth, or 20 x 45 = 900 useful "slots" of information per radar plane per 90°. If the radar scans the front at 5 different elevation angles, this results in 900 x 5 = 4500 total slots of data for the radar, or, at 8 bits per slot, a total of 36,000 bits for the radar. If 6 radars are seeing the same storm under the same conditions, this would result in 36,000 x 6 = 216,000 bits or about 2×10^5 bits. If this data enters AFGWC from 4 preprocessing sites, there would be about 8×10^5 bits transmitted to AFGWC from the CONUS. This data should be sent in virtually real-time for maximum utility; therefore, no more than one second should be allowed for the data from each processor site. This, thus, infers a 200 kilobit uplink capability to the communications satellite from each preprocessing station and a 200 kilobit downlink to AFGWC.

This capability is expected to be initially incorporated in 1980, with full operational capability in 1982. Estimated "average" traffic loads of 1/3 capacity in 1980, 2/3 capacity in 1981, and full use of all digital radars in 1982 are as follows:

1980 - 50 char/sec
1981 - 100 char/sec
1982 - 148 char/sec

A summary of expected terminal interface traffic for the 1976-82 time period appears in Figure 28.

5.4.2.4 METSAT/Imagery Data Input

AFGWC will be faced with the ingestion of large amounts of imagery data from meteorological satellites in the 1977-82 time period, utilizing primary and

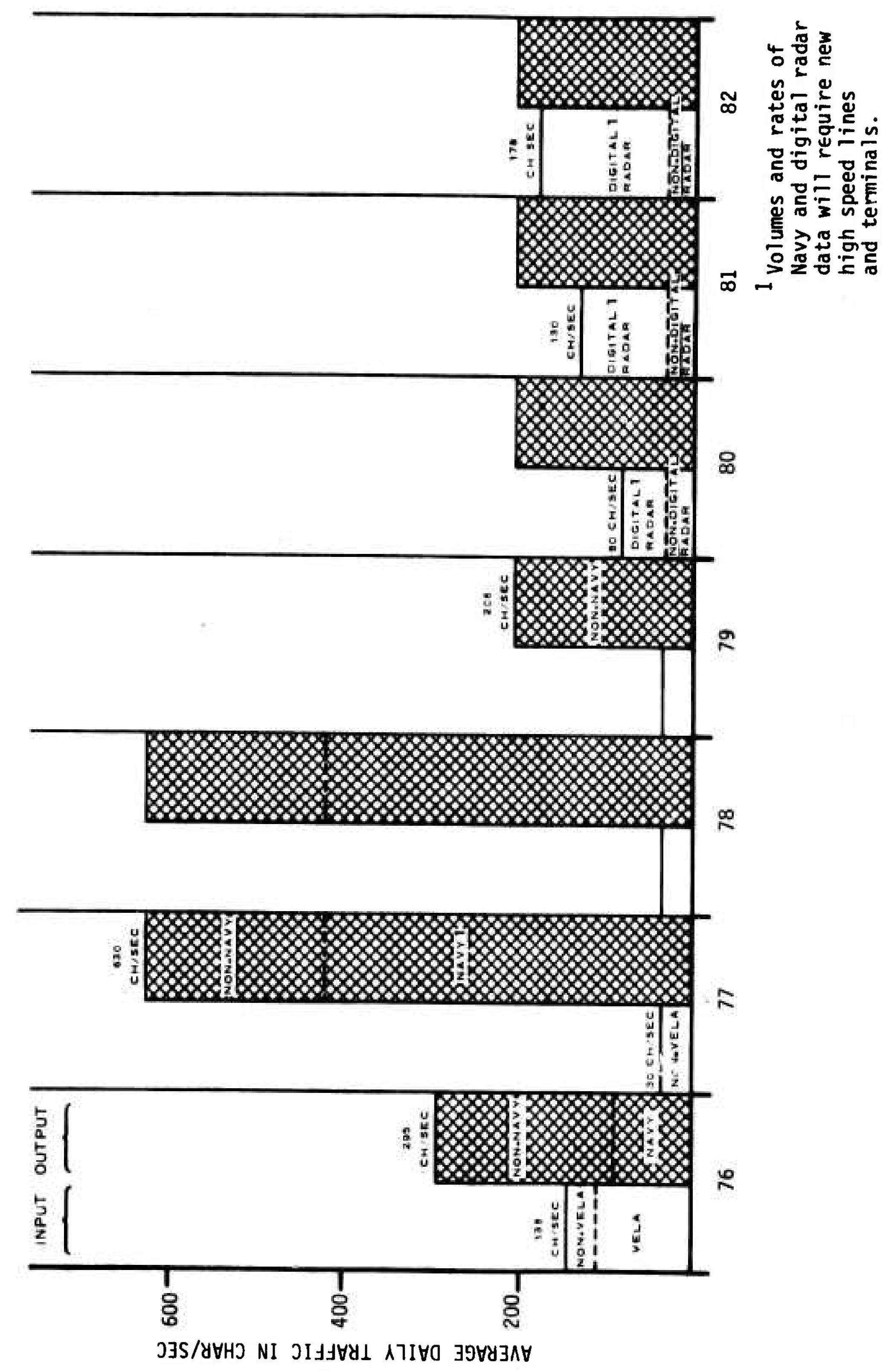


Figure 28. External Dedicated Circuits (Input and Output) - Average Traffic Utilization.

secondary sensor data from DMSP and TIROS-N, as well as primary data from GOES vehicles. Profiles of these inputs are presented in Figure 29. Development of the associated computations is as follows:

a. DMSP and TIROS-N Smoothed Data

This rate is based on total processing of available smoothed data from DMSP Block 5D satellites. Total available data is 2.66×10^8 36-bit words per day, based on the following:

1. 14 orbits/day for each of 2 satellites
2. Data is downlinked at a rate of 2.66 mbs (which is the vehicle recorder playback rate)
3. Readout time is 2.5 minutes/orbit
4. Data formatter conversion factor is 0.86 (i.e., 86% of transmitted data is actually usable imagery information).

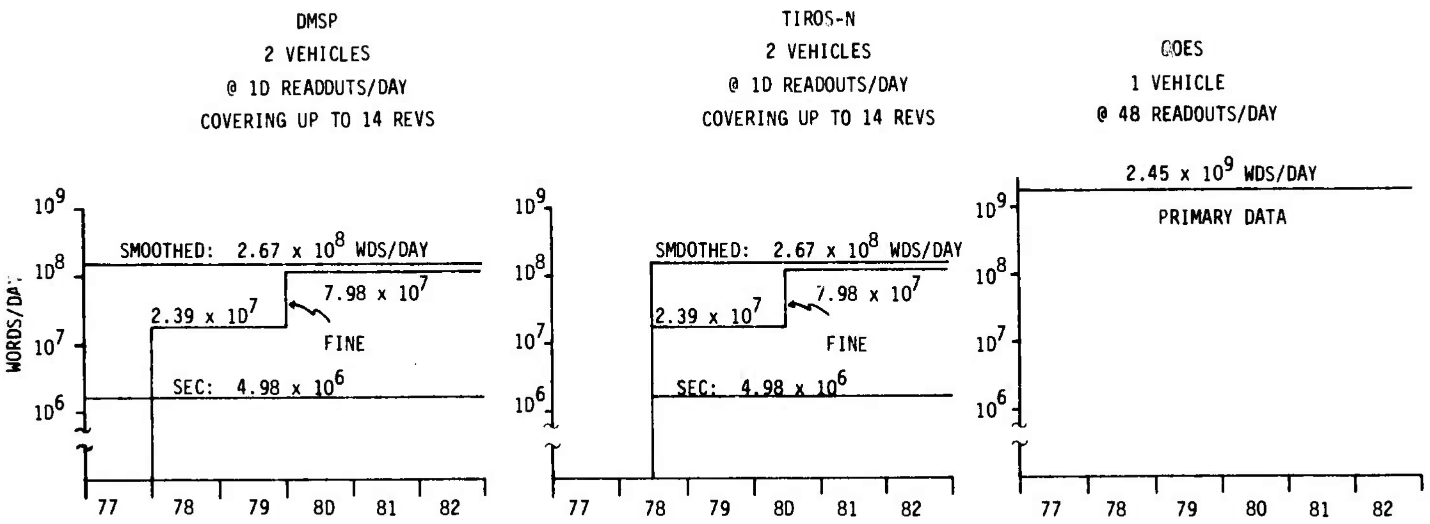
Thus, daily input rate is:

14 orbits/satellite x 2 satellites x 2.66×10^6 bits/sec x 60 sec/min x 2.5 min/orbit x 0.86 ÷ 36 bits/word = 2.67×10^8 words/day

b. DMSP and TIROS-N Fine Data

These rates are based on the input of portions of available fine data from these satellites and employ the following assumptions:

1. 10 orbits/day (maximum record capability for fine data) for each of 2 satellites
2. Downlink rate is 2.66 mbs
3. Readout time is 10 min/orbit
4. Data formatter conversion factor is 0.90.



- PEAK QUANTITIES -DMSP: SMOOTH DATA READOUTS - 3.81×10^6 WDS/MIN FOR 7.5 MIN READOUT (3 REVS)
  FINE DATA READOUTS - 3.99×10^6 WDS/MIN FOR 30 MIN READOUT (3 REVS)
  -TIROS-N: SAME REQUIREMENTS AS DMSP
  -GOES: 5.10×10^6 WDS/MIN FOR 10 MIN READOUT
- CONTROL - MAY REQUIRE AUGMENTED SATELLITE PROCESSOR/TERMINAL INTERFACE WITH SATELLITE PREPROCESSOR, UNLESS READOUTS CAN BE OPTIMALLY INTERLEAVED
- SECURITY - NO CLASSIFIED TERMINAL INTERFACE IMPLICATIONS

Figure 29. METSAT/Imagery Data Input.

Total available data is thus:

10 orbits/satellite x 2 satellites x 2.66 x 10^6 bits/sec x 60 sec/min x 10 min/orbit x 0.90 ÷ 36 bits/word = 7.98 x 10^8 words/day

In 1978, the requirement is to process 3% of the available data:

$\therefore$ 7.98 x 10^8 x 0.03 = 2.39 x 10^7 words/day

In 1980, the requirement is to process 10% of the available data, or

7.98 x 10^8 x 0.10 = 7.98 x 10^7 words/day

c. DMSP and TIROS-N Secondary Data

This rate is based on the following:

1. A recording rate of 1,000 bits per second
2. 86,400 sync words (one per second) per day
3. Data will be received from 2 vehicles.

This results in:

2 x (1,000 bits/second x 86400 sec/day ÷ 36 bits/word + 86,400 sync words/day) = 4.98 x 10^6 words/day

d. GOES Primary Data

Rates for GOES inputs are predicted on Mode A operation, which results in the highest expected data rates to AFGWC. If other modes are employed, the following figures would be reduced. Bases for these computations are as follows:

Visual Data

1. 1 vehicle at 48 readouts (disks) per day
2. 14,568 lines per earth disk

3. 15,288 pixels per line

4. 6 bits per pixel

This results in:

48 readouts/day x 14,568 lines/disk x 15,288 pixels/line x 6 bits/pixel ÷ 36 bits/word = 1.78×10^9 words/day

Infrared Data

1. 1 vehicle at 48 readouts per day

2. 14,568 lines per earth disk

3. 3,822 pixels per line

4. 9 bits per pixel

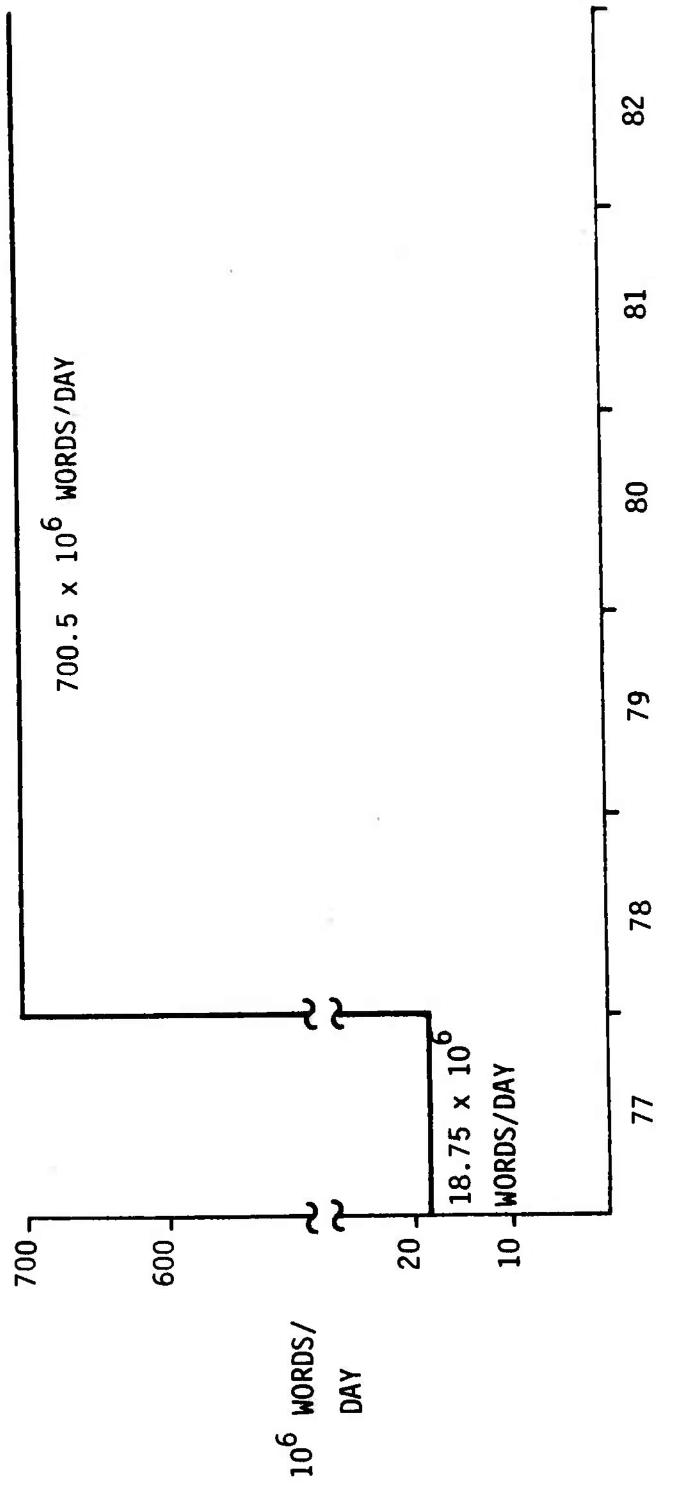
This results in:

48 readouts/day x 14,568 lines/disk x 3,822 pixels/line x 9 bits/pixel ÷ 36 bits/word = 6.68×10^8 words/day

Total per day is $\therefore$ $(1.78 + 0.668) \times 10^9 = 2.45 \times 10^9$ words/day

5.4.2.5 Satellite Facsimile Outputs

Facsimile outputs from satellite imagery data will retain their current level through 1977 (transmitting DMSP information) followed by a significant jump in 1978 with the advent of the Satellite Imagery Dissemination system for transmission of DMSP, TIROS-N, and GOES data, which will be based on scanning and transmission of data from positive transparency films to numerous world-wide AWS units. Computations are summarized in Figure 30, and are detailed below.



- QUANTITIES - BASED ON CURRENT DIGITAL FAX THRU 77, IMPLEMENTATION OF SID IN 78
- CONTROL - HIGH SPEED SID LINK WITH DIRECT COMPUTER INTERFACE TO TRANSMIT/ RECEIVE AT LEAST FOUR 8 x 8 INCH PICTURES PER HOUR
- SECURITY - NO REQUIREMENTS

Figure 30. Satellite FAX Outputs.

a. Facsimile outputs through 1977

These computations are based on the following:

1. 10 outputs every 6 hours plus 10 random outputs every 24 hours = 50 outputs every 24 hours.

2. Facsimile outputs at 1:15m scale requires 375×10^3 words per transmission

This results in:

50 transmissions x 375×10^3 words/transmission = 18.75×10^6 words/day

b. Facsimile outputs in 1978 and beyond

Assumptions for these computations are:

1. Facsimile transmissions for 1200 x 1200 nm regions will be at 1:60m scale.

2. Facsimile transmissions for areas (1 area = 4 regions) will be at 1:30m scale.

3. Global coverage transfers (10 transmissions at 4 areas each) will be at 1:15m scale.

Resultant computations are:

<u>Regions (1/2nm res)</u>

96 transfers @ 6×10^6 words/transfer = 576×10^6 words

<u>Areas (2nm res)</u>

9 transfers @ 1.5×10^6 words/transfer = 13.5×10^6 words

Areas (1/2nm res)

4 transfers, each of which is equivalent to 4 region transmissions at 6×10^6 words each, for a total of:

$$4 \text{ transfers} \times 4 \times (6 \times 10^6 \text{ words/transfer}) = 96 \times 10^6 \text{ words}$$

Global

4 transfers @ 3.75×10^6 words/transfer = 15×10^6 words

This results in a daily total of:

$$(576 + 13.5 + 96 + 15) \times 10^6 = 700.5 \times 10^6 \text{ words/day}$$

5.4.2.6 Non-Satellite Facsimile Outputs

CURRENT TRAFFIC:

a. Manually prepared charts (statistics as of 6 February 1975): Manually prepared facsimile charts are prepared by GF for transmission on the following circuits:

EURFAX	-	50	transmissions/day
STRATFAX	-	31	transmissions/day
PACFAX	-	32	transmissions/day
RAFAX	-	48	transmissions/day
		161	transmissions/day

These 161 transmissions result from the manual preparation of 121 charts per day, some of which are sent over more than one circuit (although not simultaneously - there is currently no capability at AFGWC to transmit FAX products to more than one circuit at a time). The 121 individual charts are comprised of a basic set of 63 types, various ones of which are produced from one to four times per day. These manually prepared charts (some of which must undergo a 50% image reduction to accommodate facsimile equipment) are either mounted on rotating drums or used by digital table-top scanners for analog transmission.

b. Automatically prepared charts (statistics as of 30 May 1975): Automatically generated facsimile charts are prepared by AD personnel using the program SDMFAX, and are transmitted on the following circuit:

STRATFAX	-	40 transmissions/day
PACFAX	-	11 transmissions/day
		51 transmissions/day

These 51 transmissions result from the automatic generation of 25 types of charts per day, each of which is sent twice daily (20 charts on STRATFAX and 5 on PACFAX), plus one chart which is generated and transmitted once/day on PACFAX. These transmissions involve the sending of data from COMPIX equipment, which reads the digital tapes produced by SDMFAX for digital dissemination.

FUTURE TRAFFIC:

a. Manually prepared charts:
The Weather Graphic System (expected to be operational in 1976 to replace current EURFAX FAX transmissions) will, according to Attachment 5 to TAB F of the AWS Requirements Package, be driven by" - - - essentially the same product mix as today. - - - By 1977, however, a modest increase in the number of products disseminated through the WGS can be expected (but not to exceed 200% of present volume." The WGS transmitter at AFGWC will digitally encode and transmit weather charts destined for eventual satellite relay to Europe. Thus, the 50 transmissions a day currently sent out on EURFAX will reach as

high as 100 charts in 1977. A more realistic estimate is a 150% increase to 75 daily transmissions in 1977, growing to a full 200% increase in 1982 (100 transmissions).

The remaining circuits (STRATFAX, PACFAX, and RAFAX), however, can be reduced in traffic volume for manually prepared charts as more automated chart production techniques evolve. (To some extent, this may also be true for EURFAX.) Assuming that a 1/3 reduction in non-EURFAX manual chart transmissions can result from automation, the 111 daily chart transmissions on these lines can be reduced to about 75 such transmissions by 1982.

b. Automatically prepared charts:
WPD personnel indicate that a modest increase in current traffic for automatically prepared charts is possible, with a 20% growth through 1982 to 61 chart transmissions per day. This figure, however, reflects current techniques for sending digital facsimile data, and could be raised by more automatic means such as the proposed Weather Facsimile Switching Center. Such methods, in conjunction with appropriate hardware and software improvements to support WPF personnel, can accommodate the necessary reductions in non-EURFAX traffic alluded to above. Thus, although increases in transmissions of manually prepared charts for Europe are expected, greater emphasis on current automatic methods (digital tapes sent through COMPIX equipment) and other automated techniques will offset some of these increases. Moreover, as more experience is gained with improved automatic techniques, even more of a tradeoff between manual and automatic facsimile transmissions for these users will be achieved. The resultant loading for non-satellite facsimile traffic using these assumptions appears in Figure 31.

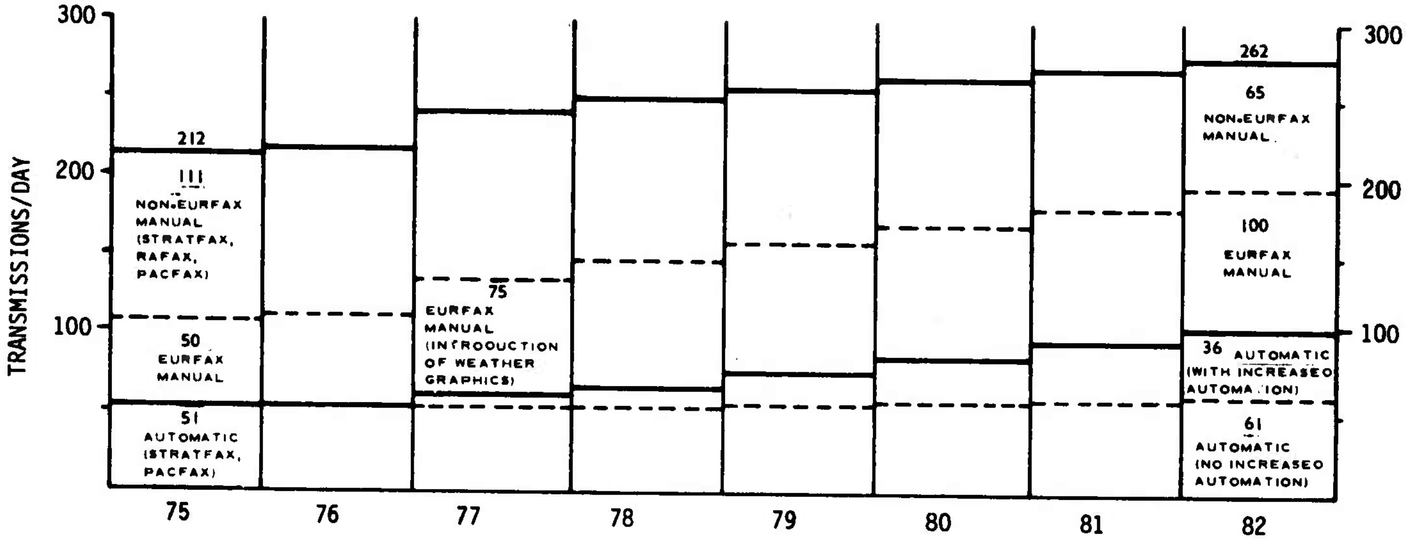


Figure 31. Projected Facsimile Traffic for Non-Satellite Related Products.

5.5 CONSOLES AND DISPLAYS

The requirements collection activity for the Console/Data Input and Display area encompassed a wide range of functional activities and user requirements. SDC, in the Task 1 requirements compilation effort, adopted AFGWC recommendations for TAF/METWATCH forecasting, and proceeded to define several automated console positions and associated tasks for forecasting, system support, and other types of work centers. New software and memory requirements were assessed, as were specific problem areas. Extensive hardware lists were developed for components that could fulfill these requirements, and tentative design approaches were developed.

In developing this design, SDC established the following guidelines and requirements:

a. Assume response requirement is on the order of seconds

b. Isolate display driving computation support

c. Standardize console hardware functions and features

d. Generalize and standardize console support software design as follows:

   1. Format definition
   2. Hardcopy interface/rules
   3. Console assignment flexibility
   4. Interconsole communications
   5. Display techniques (update, flash, zoom)
   6. Information update/connect capability
   7. Control language

The results of these analyses involved the categorization of console positions ("Automated Work Centers") into areas of System Control, System Support, and Forecasting. The types of work centers, the estimated number of such centers, and associated security classifications that were initially envisioned are described in Tables 11 - 13.

Within these categories, SDC proceeded to assemble numerous specific requirements for the input and output capabilities of these work centers. Topics that were assessed included:

a. Rapid response visual display

b. Multi-medium hardcopy displays

c. Miscellaneous status displays

d. Prestored inputs

e. Manual inputs

In the area of rapid response visual display devices, general requirements included low ambient noise, selective hardcopy output (digital and photo), and rapid full frame output. Specific requirements included the following:

- Provide forecaster AWC (automated work center) with contouring (example candidate - vector CRT)
- Provide selective AWC's with visual meteorological data (example candidate - high resolution CRT)
- Provide alphanumeric meteorological and system information (example candidate - alphanumeric CRT)
- Provide visual multi-dimensional display for use in functions like severe weather forecasting (example candidate - color CRT)
- Provide aggregate viewing display of selected CRT information (example candidate - wall projection)

Table 11. System Control Centers

Area	Work Positions	Security[1]
Network Control Resource/task scheduling, allocation, and status monitoring	2 (including 1 for full backup)	C
Computer Operations Consolidated CPU consoles, unscheduled production, error monitoring/response	2-6	C
Security Monitor Downgrade certification of classified handling of software check results/alarm (may include Remote Job Entry monitoring)	2-4	C
Communications Control of incoming and outgoing TTY and dedicated circuit data	2	C
Maintenance Support Isolated maintenance console for diagnostic and test	2-5	C

[1] C = Classified, U = Unclassified

Table 12. System Support Centers

Area	Work Positions	Security
Printer Support Centralized distribution/control centers for all system non-console related output	1-2	C
Archival Storage Support Semi-automated tape/cartridge/disk pack control in support of scheduled/unscheduled software	1-2	C
Satellite Data Support Similar to current operations but also supporting TIROS-N and GOES	2-3	U
Satellite Image Dissemination Control of dissemination of imagery data	2	U
Special Operations Relay and control of classified computer flight plan interface	1	C
Programmer Remote interactive support of coding and checkout	13-30	U,C
Studies/Analysis Remote control of standard and special studies (may be a version of a Programmer console)	2	U
Quality Assurance Analysis of data base, input of certain observations, and monitoring of data base quality	1	C

Hardcopy display analyses resulted in the following work center requirements:

- Provide for high resolution display of complex graphical data (example candidate - plotter)
- Providing long term, readily accessible data storage for tabular, graphic, and other miscellaneous data for use by studies and analysis (example candidate - microfilm)
- Provide maximum resolution output of satellite visual and I/R data (example candidate - facsimile)
- Provide purpose-tailored hardcopy output (example candidates are: high speed printers, high resolution printers, programmed character printers, typewriter, and teletypewriter)

Two primary requirements evolved for miscellaneous status displays:

- Provide system status indication to console personnel (example candidates - dedicated alphanumeric displays and light panel displays)
- Provide operator recall/attention technique (example candidate - audio alarm)

Analyses of potential prestored input characteristics led to the following requirements:

- Provide a medium volume general purpose technique for inputting data of a repeating nature (example candidates - punched cards, magnetic cards, magnetic cassettes)
- Provide a medium volume paper tape input for compatibility with existing tape input mediums (communication, system utilities and maintenance, etc.)

Table 13. Forecasting Centers

Area	Positions	Security
TAF/METWATCH	17	U
Space Environment (Unclassified)	2	U
Space Environment (Classified)	1	C
Special Projects Forecasting	4	C

- Provide a technique for inputting existing hardcopy information (example candidate - optical reader)

Finally, several requirements evolved pertaining to the handling of manual inputs:

- Provide operator/forecaster with a technique for graphical or image modification (example candidate - light pen)
- Provide the forecaster with a technique for inputting large scale contour (example candidate - magnetic cursor)
- Provide for input of alphanumeric and discrete control data (example candidate - alphanumeric and functional keyboard)
- Provide fail-safe input of system control data (example candidates - selection and binary switches)

These requirements were refined and expanded in subsequent phases of the architecture study. The numbers and types of specific console work centers were updated in conjunction with the development of the overall architecture in subsequent tasks. In particular, detailed sets of appropriate hardware components for these work centers were generated, so as to provide AFGWC personnel with optimum assemblies of equipment to perform these modified and newly developed functions. Summaries of these efforts appear in Volume 4, "System Description" and Volume 5, "Systems Analyses and Trade Studies."

5.6 PERSONNEL

5.6.1 General

This section represents the results of analyses conducted to estimate manning and training requirements for AFGWC during the 1977-82 time period. These levels indicate needs associated with numerous user and model requirements during this period, and reflect studies that were made into all AFGWC functional areas. Pertinent assumptions have been made concerning the degree to which manning levels can be reduced by the automation and reallocation of operations. Whenever positions are assumed to be manned on a 24 hour per day - 7 day per week basis, the assumption has been made that 5 slots will be required to ensure a round-the-clock staffing of one man.

5.6.2 Manpower Requirements

Total UDL Authorization for the Third Quarter, Fiscal Year 1975 (FY 3/75) is 757 positions. Based upon this authorization, the recent MACMET study recommended a reduction of 39 positions to a total of 718. The SDC study thus used this lower figure as a baseline from which to calculate future requirements.

New manpower requirements determined during Task 1, including Air Force redirection arising from the 22 May 1975 Task 1 briefing, are as follows:

Organization	Positions	FY Required	Reason
WPA	1	1976	Tropical Prediction Model
	1	1976	Global Atmospheric Prediction Model
	1	1977	VHR into 3DNEPH Model
	1	1977	CFLOS/Clear LOS Model
	1	1977	Digital Radar
	- 3	1978	Models Completed

Organization	Positions	FY Required	Reason
WPD	1	1977	Cloud ZOOM
	1	1977	Terminal Forecast
	1	1977	Horizontal Weather Depiction
	10	1977	Network Control
	1	1978	CFLOS/Clear LOS
	1	1978	ETAC Data Base
	1	1979	New ZOOM Model
	1	1980	Minuteman
WPP	15	1976	GOES
	5	1978	SID
WPF	15	1979	WWMCCS
	5	1980	Digital Radar
WPE	5	1977	Increased Solar Activity
	64		

Of these 64 new positions, the ten required for the automated network control functions can be obtained from the current computer operators, reducing the total requirement to 54.

In addition, there are certain current operations that can be performed more efficiently through automation. One area where savings can occur is in the development and maintenance of computer programs and models. A one-year study was recently performed at Aerojet General when the programming function was automated with interactive CRTs and automated peripherals. The result was that programs were developed four to six times faster.

In comparing the models developed at AFGWC with the programs developed during the one year study at Aerojet General, the AFGWC models are much more complex and scientifically oriented. Also, the uncertainties that currently exist regarding the final approved AFGWC architecture require a conservative estimate of the manpower savings due to automation. Thus, the SDC estimate for a more appropriate figure for the savings in the function of developing new programs is approximately 20%. Using this 20% as a guideline, the following figures resulted:

WPA (approximately 20 programmers)

70% of the programmers involved in new program development.

70% X 20 = 14

X 20% savings through automation

3

WPD (approximately 100 programmers)

30% of the programmers involved in new program development.

30% X 100 = 30

X 20% savings through automation

6

For program/model maintenance, a 3% savings was considered appropriate. This resulted in the following:

WPD

70% of the programmers involved in maintenance

70% X 100 = 70

X 3% savings through automation

2

WPF

With automation of many of the GF functions, there will be no requirement for some of the manual operations being currently performed. Thus it should be.

possible to reduce the number of observers supporting the forecasters. At this point, SDC estimates that approximately six observer positions would no longer be required.

TOTALS

The total approximate savings in current manpower through automation is therefore:

WPA	3	- Program Development
WPD	8	- Program Development and Maintenance
WPF	6	- Reduce Number of Observers
Total	17	

Thus, the total maximum manpower requirement, which will be during the FY80 - FY82 period, is 37 positions more than the baseline of the MAC MET study, or a total of 755. A profile of resultant manning requirements appears in Figure 32.

TRAINING

For maximum efficiency at AFGWC, SDC is proposing that there be 17 types of automated consoles. These automated consoles will perform the functions of data system operation and control, analysis/forecasting, and software development and maintenance.

Special training will be required for each type of console and for each of the automated work positions. Initially, the courses should be developed by the hardware contractor and initial training given by that same contractor. This training must be accomplished on a non-interference basis. Once the initial training has been accomplished, the Air Force can continue with follow-on training by OJT.

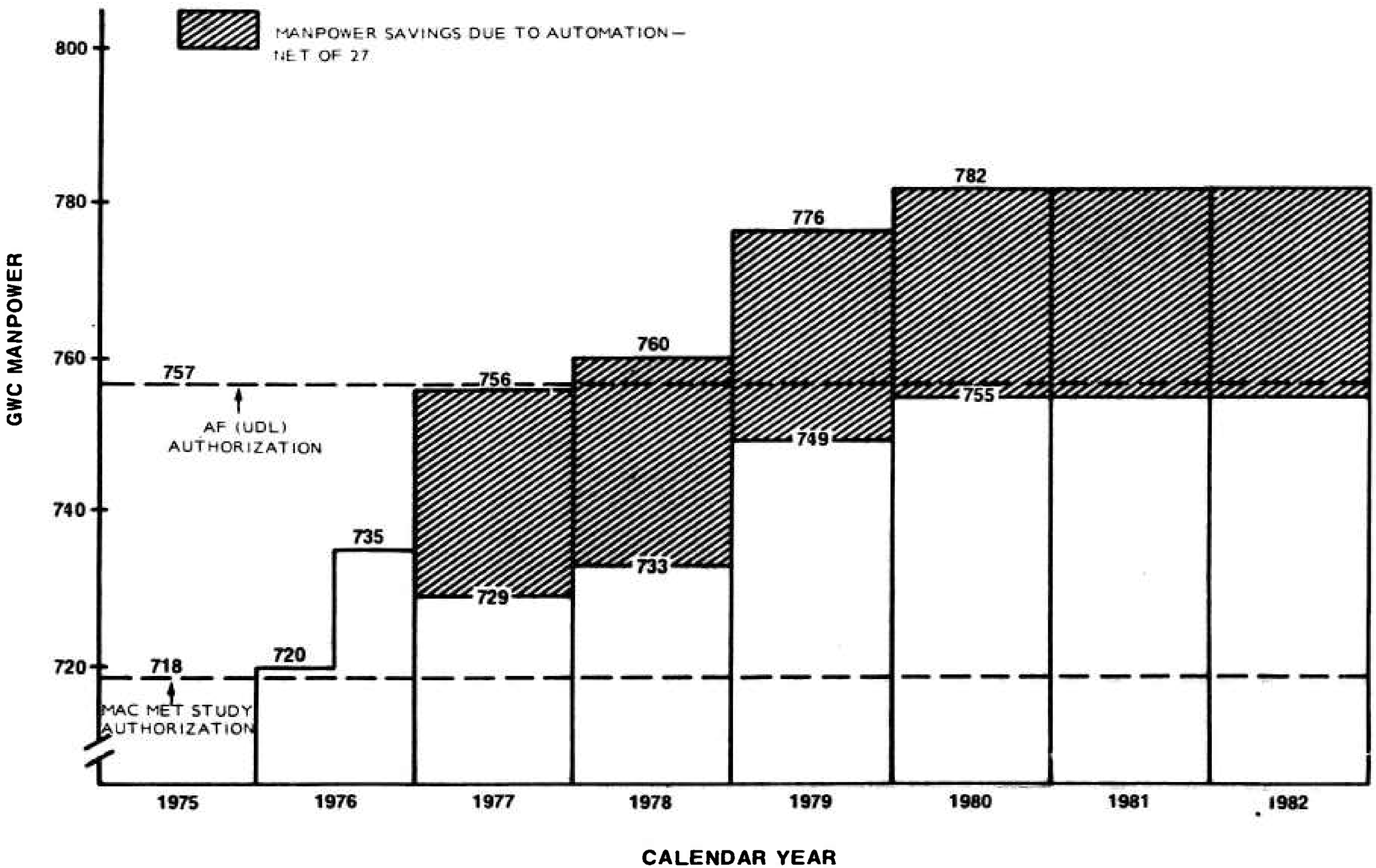


Figure 32. AFGWC Manpower Requirements

Thus, if AFGWC realizes no savings in manpower through automation or through reallocation of personnel to perform the network control function, an additional 64 slots will be required to perform required operations by 1982. These requirements involve support of GOES and SID by WPP (20 slots), WWMCCS and Digital Radar support by WPF (20 slots), a variety of model developments by WPA and WPD (19 slots), and increased requirements in WPA to accommodate increased solar activity phenomena (5 slots). However, if automation is implemented in 1977 and if WPD personnel can effectively perform network control with no increase in manpower, a net savings of 27 slots can be realized. Based on a baseline staffing level of 718 slots as authorized by MAC, this would reduce the level of 782 personnel that might be required in 1980-82 to 755, which is 37 slots above the MAC authorization and 2 slots below the Air Force UDL authorization of 757.

5.7 MANAGEMENT

5.7.1 General

During Task 1, extensive data was gathered concerning current and future management requirements. The primary sources for this information were interviews with DO personnel. Results of these interviews and analyses are presented in the following paragraphs.

5.7.2 Management Requirements

5.7.2.1 Organization

During Task 1, the organizational structure was evaluated to determine how well current requirements were being satisfied. Based upon the job to be done and the facilities available to perform that job, it was determined that the current internal organization is appropriate and effective. In addition, for the future automation of the various functions within AFGWC, no future changes to the current operational organization are anticipated or recommended.

5.7.2.2 Data System Control

a. External Access and Control

AFGWC will continue to maintain its independence from external control. All management functions wll be exercised at AFGWC, and external agencies will not exert any direct control. However, several types of support will be available for direct acquisition from using commands. That is, SACCS support will continue for the Selective Display Model and automatic response to queries (ARQ) and in the future, other selected users will have access to special data bases for automatic response to queries, such as computer flight plans.

b. Internal Control

In looking at future automated systems within AFGWC, it will be necessary to provide central operations control for all of the computer facilities. Network control console(s) will be available and will be utilized for all remote console scheduling and control. The network controller will handle the entire scheduling activities for AFGWC. Of particular importance is the requirement to assign the central responsibility for network operations to a single organization. SDC recommends that WPD be assigned this function.

c. Communications Computer

Under the current operations, System I acts as a communications computer for AFGWC. This creates some difficulties in that there is conflict between AFGWC and the Air Force Communications Service personnel over responsibility for the input and output communications interfaces. In addition, System I could be more effective if it were relieved of some of the communications requirements. Thus, SDC recommends that independent communications computers, controlled by Air Force Communications Service, be provided. This will standardize the AFGWC communications interfaces and relieve the conflict over the areas of responsibility between Air Force Communications Service and AFGWC.

5.7.2.3 Security

Current security measures used at AFGWC are appropriate for the levels of classification involved. For the future automated system, SDC has considered tradeoffs in various configurations for the most economical solution to the vault requirements.

5.7.2.4 Logistics

During the phaseover to the new system, AFGWC must continue in uninterrupted operation. This will require special consideration in order to attain this, due to movement of hardware and rearrangement of the current facilities. An important consideration is that there be no degradation in response or reliability, the overall reliability goal being 99.5%.

During tasks 2, 3 and 4, tradeoffs and configurations have been accomplished in order to provide the necessary built-in redundancy to achieve the required reliability. This will thus limit the need for spare parts. Those spare parts that are required should be supplied by a support contractor.

5.7.2.5 Planning

When the new systems have been installed, performance testing will be required. This will be followed by operational tests. Once the operational tests have been concluded, readiness exercises must be performed on the new systems to insure operability prior to going on-line and replacing the existing system. Requirements for simulation will be analyzed and simulations performed as required.

5.7.2.6 Maintenance

As the architecture is changed to meet future requirements, there will be many different manufacturers' products introduced into AFGWC. Instead of having each maintain his own products, AFGWC should consider consolidating maintenance functions with one contractor.

Organizational structures within AFGWC are thus adequate to perform current and expected activities. However, effective operations demand that GWC maintain its independence from user organizations, including the implementation of a new external communications processor and network control consoles (probably by WPD personnel), for effective internal scheduling and control. Current security measures are adequate, and the new architecture has been based on the thorough consideration of tradeoffs of classification constraints. Phaseover periods to this new architecture must be accomplished with minimum disruption to the system. For effective ongoing maintenance control, it is recommended that AFGWC consolidate all maintenance responsibilities under a single contractor.

5.8 FACILITIES

5.8.1 General

This section presents a summary of the surveys conducted by SDC regarding facility requirements for the 1977-82 era data system. Information was gathered in conjunction with AFGWC interviews on several functional topics, with primary inputs from DO staff personnel. While emphasis was placed on facility requirements for the proposed data system, consideration was also given to related topics, such as man-machine interfaces and work areas.

5.8.2 Facilities Requirements

5.8.2.1 Personnel Work Areas

a. Floor Space

Paragraph 13-3b of Air Force Manual 86-2 states, "The net office area per building occupant will not be less than 80 square feet nor more than 90 square feet." The manual also states that special-purpose space, such as rooms for housing electronic data processing equipment, are not to be included in the calculation of net office area per building occupant. The current situation at AFGWC is considerably below the manual requirements and varies from 55 to 70 square feet per building occupant. Thus, there is not adequate floor space available for the personnel assigned to AFGWC.

b. Work Areas

Office and operations areas are currently intermixed so that these different types of activities are being conducted simultaneously. This reduces the efficiency of the personnel assigned.

c. Secured Areas

Vaults are effectively established to provide the necessary security for AFGWC.

d. Environment

1. Air conditioning (heating/cooling) is adequate at AFGWC for all current activities.

2. Because of the intermixing of operations and office - related activities, noise levels in some areas are not conducive to maximum efficiency.

3. Lighting for the most part appears to be adequate throughout AFGWC. However, in some parts of the old cafeteria area, lighting could be improved.

5.8.2.2 Support

a. Electrical Power

1. Normal power appears to be adequate to support the activities at AFGWC.

2. Backup power supply has not previously been available that would be consistent with the data system reliability required in the future. However a new backup power supply system (UPS) has been installed to provide the necessary integrity in a reliable uninterruptable manner. This backup system has operated satisfactorily since its installation on 28 March 75. This system essentially consists of batteries for basic power, which are charged by commercial power sources. In the event of commercial power failure, the batteries merely continue operation. If the outage is of long duration, on-site generators are activated to continue charging of the batteries.

b. Data System Environment

The current environment (e.g., temperature and humidity control) for the system appears to be adequate. Detailed analyses in Task 4 have verified the adequacy of the environmental support for the selected data system as approved by the Air Force.

5.8.2.3 New Requirements Potentially Impacting Facilities

Major data system components that will impact the AFGWC facility are as follows:

a. Additional computers,

b. New communications and facsimile processors,

c. Automated consoles (especially during phaseover),

d. Additional mass data storage,

e. Additional satellite ground stations,

f. SID (Satellite Imagery Dissemination System) console and processor.

In accessing these requirements, SDC's goal has been to design the 1977-82 data system to fit within current and planned facility constraints. A 10% growth potential for facilities in the 1982-87 era has also been employed.

In addition to the recommendations outlined above, SDC suggests that AWS perform an overall facilities study, encompassing areas over and above the data system facility aspects that were emphasized by SDC. This AWS study should address the following:

a. Requirements specified by SDC for the data system;

b. Segregation of office, operations, and work area spaces;

c. The adequacy of floor space;

d. The adequacy of environmental conditions.

SDC recommends that this study coincide with the Data System Architecture Study, and that AWS eventually prepare a Military Construction Program request for needed facilities.

6.0 GENERAL PERFORMANCE CHARACTERISTICS

Introduction

During AFGWC data collection, SDC considered several areas of general performance. It was felt there must be a statement of general performance requirements to assess the ability of specific architectural configurations to adequately respond to the AFGWC needs. SDC intuitively thought general goals would be applicable across all AFGWC functions; however, in certain areas, the requirements might be greater or less for reasons unique to those areas. These results reflect primarily the initial discussions with Lt. Col. Coburn, Lt. Col. Blunk, and Lt. Col. West of AFGWC during tne early part of the data collection discussions. The areas considered as general performance parameters are: Growth Potential, Maintainability, Reliability, Integrity, Testability, Adaptability, and Availability. Each of these areas is addressed below, providing a general discussion of the performance requirements, followed by SDC's findings.

6.1 GROWTH POTENTIAL

This parameter pertains to the ability of a given portion of the architectural structure to grow beyond the defined configuration at any point in time beyond 1982. The requirement for growth was not constant; therefore, SDC found it necessary to address different portions of this system. The AWS growth requirement states that as of 1982 the system must have a potential for 20% of growth per year beyond what exists at the beginning of any given year over five years. This reduces to the ability to grow to 2.5 times the 1982 configuration with little impact. SDC also felt that the growth requirement is constrained by what appears to be more demanding requirements within AFGWC described by treating each of the areas of the architecture.

a. Data Base. The growth requirement as stated pertains only to mass storage. SDC does not believe, however, that in the case of core storage, it pertains to each CPU, but rather is proportional to the growth of the CPU requirement (for a given CPU, storage remains the same; an additional CPU requires equal additional core storage). In the archival storage, it does not pertain to immediately accessible storage, but rather reasonably accessible (within minutes) storage.

b. Computation. SDC assumes the growth figure does pertain to computation but refers primarily to mathematical model computation. The other computation such as communications and input data processing is proportional to the growth considerations in the areas as discussed below.

c. Terminal Interface. SDC does not foresee the number of communication channels coming into AFGWC increasing by more than 10% during the five-year period 1982 to 1987, nor do we project any large input data increases over a single channel; however, we feel that a 10% growth potential should be provided in case this assessment is incorrect. SDC did foresee an increase in the amount of data over the communications links. This increase should amount to 50%. The primary consideration is the ability of the AFGWC data system terminal interface to handle the increased line capacity. (Associated storage and computation is treated in a and b above.)

d. Interaction. This factor pertains to the human interface and participation as part of the data system. Increase in interaction is required by: (1) the potential increase in incoming data, (2) the sophistication of the mathematical models (and therefore monitoring function), (3) the increase in the number of CPUs, (4) the complexity of network control (scheduling of resources), and (5) the potential number of security complexities which may arise. At the same time, the proposed automation of manual functions resulting from this system redesign will be followed by another wave of automation once implementation has been accomplished. This automation will tend to decrease the amount of human interaction with the data system. Conservatively, SDC feels that this system should allow for a 10% increase in interactive devices with no significant increase in the amount of traffic for particular devices.

e. Personnel. SDC will assume no growth in manpower at AFGWC, thereby constraining growth to areas requiring no human support.

f. Facilities. SDC must make the assumption that in considering growth, this must be compatible with current facilities plus a maximum 10% increase.

The ability to grow is a primary consideration in this architectural study and must result in the selection of equipment/capabilities which are not pushed to their limits but rather allow necessary expansion. For this reason, in the SDC design, one may expect to see unused channels, general-purpose design, and a trend toward commonality in like hardware devices to minimize the impact of potential growth.

6.2 MAINTAINABILITY

This general performance area is very closely related to Testability and Availability but has some unique features. This pertains to the isolation of portions of the system, both hardware and software, for easy expeditious access by the maintenance team and test equipment or alternately simple replacement by spare parts for the purpose of preventive maintenance, failure testing, or failure repair. It also pertains to potential maintenance by a prime maintenance contractor other than the hardware vendor source (specifically in the case of non-CPU mass storage hardware and all software).

When error symptoms are detected, the time and manpower expended for isolation are important as is the response for total repair to the same status of reliability as previously existed. All of these performance factors should be considered in determining the general performance of a given architecture. The architecture must have considered and corrected deficiencies in maintainability to the extent that cost, reliability, integrity, and availability requirements are met. No specific maintainability requirement exists.

6.3 RELIABILITY

Several requirements state a specific reliability to be maintained by AFGWC in their accomplishment. These mission accomplishment reliabilities pertain not only to the portions of the system over which the scope of the architectural study is applicable, but also to any external influence (e.g., human performance, sensor performance, and external communication links). Also, SDC recognizes the inherent capability for graceful degradation within the AFGWC system where certain mission requirements do not possess the same reliability needs as others (e.g., ongoing support for mission enhancement cannot demand the same reliability as support for mission accomplishment or go/no go decisions). In addition, the consideration of mission importance and probability of impact based on AFGWC lack of support should ideally be addressed. The availability of an adequate yet degraded model or no impact manual support as opposed to automatic support has an ultimate impact on mission accomplishment.

We are stating the requirements based on our judgment of these factors, the maximum reliability requirements which exist, and the probable flexibility which will be inherent in the system design. We feel that a reliability of components (both hardware and software) of 99.5% must exist for the accomplishment of any AFGWC response to user request considering all associated aspects of data system dynamics.

Success is defined as the adequate (not necessarily best or nominal) response to user expectations in the time consistent with the overall time goal independent of external (to the AFGWC data system) influence (e.g., input sensor data input quality, human interaction and external communications). This pertains to all AFGWC requirements equally without consideration of priority or the availability of graceful degradation within the system (i.e., graceful degradation has been considered in arriving at the reliability factor). The primary considerations in measuring reliability shall be individual component mean-time-to-failure and propagated redundancy of components existing in all aspects of each requirement.

6.4 INTEGRITY

As used here, integrity pertains not just to the meteorological information content but to the correctness of <u>any</u> data propagated, manipulated or hosted by the AFGWC data system. The approach to Integrity shall be embodied in and consistent with the reliability requirement. Contradistinctively the reliability shall be assessed based on an assumed (and guaranteed) result in pursuing a self-check/ redundancy approach as part of the architecture. The required integrity of data depends inherently on their nature. (For example, protection of security and accuracy which is necessary to insure accomplishment of the mission objective shall be held at highest level. Checking of non-mission essential data or where recourse is available and probable will be treated at a different level.)

SDC proposes that no specific integrity requirement be levied with the exception of a detailed presentation of an approach taking into account the reliability of the components, the nature of the data and the reliability requirement. The impact of the implementation of integrity standards on both new and existing components to achieve the required reliability will be assessed and included in the total AFGWC data system specification and associated costs.

6.5 TESTABILITY

Testability is another implicit requirement. It must be assessed by the impact on reliability. The requirement pertains primarily to new components (hardware and software), and the ability to meet the implicit factor of the reliability computation. A portion of the architectural study should include a measure of the testability of individual components and an assessment of the adequacy of the architectural study test plan (Task 6). Also considered is the adequacy of specific software/hardware standards set forth which enhance testing of the function. In addition, the ability to simulate the dynamics of the system and the resultant cost for the simulation should be considered. Visibility of data flow and computation is key and an assessment of the unpredictable and perhaps undeterminable characteristics of data/paths. It has long been determined that the exercising of all possibilities within the data system is virtually impossible; that there is a real and undeniable tradeoff between assurance of an error-free system and the existence of other reliability enhancement features such as backup and redundancy. SDC is assuming that reliability must exist the day that the requirement exists and therefore includes as part of testing the functioning within the operational environment prior to that time. A conservative approach must be taken in the approximation of reliability based on probability of error resulting from inadequate testing.

6.6 ADAPTABILITY

Adaptability is required to the extent that growth potential is envisioned. Beyond that, SDC hopes to identify the set of standards and specifications which effect a modularity of functional and specify a generality of form and purpose which far exceeds the requirements of growth. This goal will be pursued and the cost impact will be identified with a probability of resultant payoff predicted over a ten-year usage span. In the case of vendor supplied standard components (hardware/software), the prospect of improvement shall be considered.

6.7 AVAILABILITY

Availability is a direct functional relationship to reliability and maintainability. The factors are the characteristics of potential system usage, the potential for conflict between two potential usages, the mean-time-to-failure of the component, the mean-time-to-repair, the span over which potential tasks must be accomplished and the abilities for recovery. Although no specific requirement exists, each of these must be assessed and factored into the reliability equation. The availability must be such that the reliability can be met.

A graphic description of these general performance requirements is presented in Figure 33 below.

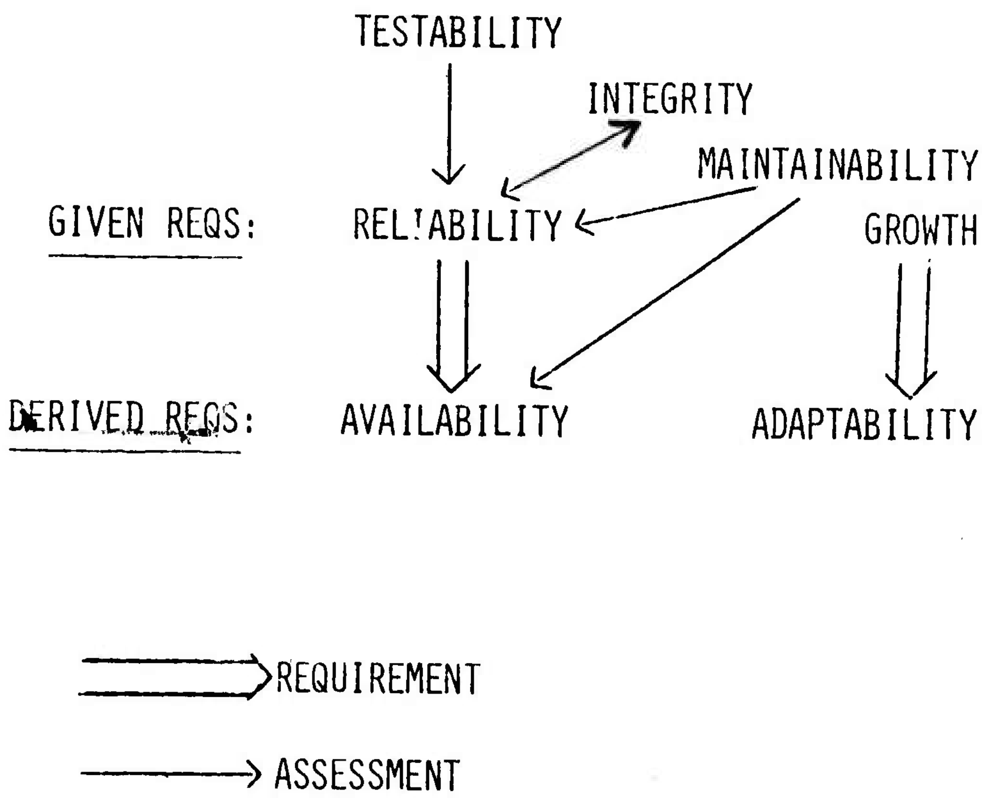


Figure 33. General Performance Requirements.

GLOSSARY OF TERMS

APM - Advanced Prediction Model. This numerical model will be more sophisticated and accurate than the current AFGWC global weather prediction program, the 6-level baroclinic model.

Array Processor - An array processor is a special purpose hardware processor capable of very fast computation due to its highly specialized characteristics. Each array processor is attached to a general purpose machine which serves as a host to the array processor for communication with the rest of the data system, and for performing those computations and calculations which are not amenable to array type processing.

Associative Memory - An associative memory is a main memory for a computer which can be accessed in bit slices as well as in the normal mode of word addressing.

Associative Processor - An associative processor consists of parallel processing elements attached to associative memory. Associative processors are capable of very rapid data manipulation such as sorts and searches.

Boundary Layer - Half mesh upper air forecast model producing wind, D-values, elevation, specific humidity, specific moisture and relative humidity fields for 8 levels from surface to 1600 meters. These levels are at a constant distance above the earth's surface and therefore considers terrain features. This model is used over high density data areas, i.e., U.S., Europe and Asian mainland.

Checklist - A schedule of events for each system indicating jobs to be run. The scheduled time for each and other associated information.

Coarse Mesh - An I,J grid, 47 x 51 in size, for a total of 2397 points. This mesh, used for hemispheric models, has spacing of approximately 200 nm between points at 50N.

Data Base - The sum total of all environmental data available in a system's mass storage. This data includes both information received from other sources as well as data created by AFGWC.

Eighth Mesh - An I,J grid, 64 x 64 per box in size, for a total of 4,096 points. This mesh, used for 3DNEPH, has spacing of approximately 25 nm between points at 50N.

Fine Mesh - Either an analysis or forecast model for surface or upper air using the half mesh scale. Forecasts are for 850-700-500 and 300MB levels. Additionally, the analyses include the 200 and 100MB levels. These models are used over high density data areas.

FIVLYR - Half mesh cloud forecast model producing cloud forecast for 5 levels plus total cloud, dew point depression for 850-700-500 and 300MB along with gradient level CPS. The forecast area is relocatable by AFGWC grid points (I,J).

Grid - A system of equal-spaced points overlaid on a geographical area. These coordinates, numbered sequentially along I and J axes, are used by AFGWC programs in lieu of lat/lon coordinates. Based on distance between points, it can be considered coarse, half or eighth mesh.

Half Mesh - An I,J grid, 93 x 101 in size, for a total of 9393 points. This mesh, used for FIVLYR, has spacing of approximately 100 nm between points at 50N.

HRCP - High Resolution Cloud Prog; produces cloud forecasts on an 1/8 mesh grid.

Major Blind - An orbit of the DMSP vehicle during which data cannot be read out.

Mass Memory - This is an archival type of storage device usually consisting of individual tape cartridges which are automatically retrieved and mounted on read-write heads. The data are staged from the tape cartridge to disk and then become available as a disk data set to the system. These devices are capable of storing on the order of 10^{12} bits of data.

MAXISC - A real time program which is maintained in all AFGWC computers. It is responsible for transferring data base files, batch data, other files, products and utility messages between systems.

ONLIN - A program that receives satellite data from the DF. This program builds a disk file containing the raw data and places the data in it.

Realspin File - The file built by Onlin. This file has the Raw Satellite data in it.

RP - Relative Performance, a scale for measuring the relative throughput of processors based on a Univac 1108 equaling unity. For example, a Univac 1100/40 is measured at approximately 3.5 times the relative throughput of the 1108.

Runstream - A series of system control commands required to properly execute a program.

SADPR-85 - "Support of Air Force Automatic Data Processing Requirements through the 1980's" - a report sponsored by the Air Force Electronic Systems Division.

SPRINT - A runstream to support Special Projects requirements consisting of:

a) satellite data ingestion and mapping,
b) 3DNEPH cloud analysis,
c) HRCP cloud forecast,
d) manual bogusing of cloud forecasts, and
e) statistical analysis of cloud fields by Special Projects programs.

Staging - Staging is the process of taking data from a slower speed memory medium to a higher speed memory medium, e.g., tape to disk.

Symbiont Processor - A slower, less expensive processor that handles the staging and destaging of data from slow speed peripherals to disk, concurrent with the execution of programs in a large mainframe to which the symbiont processor is attached. A symbiont processor can be shared between several mainframes.

Taker - A magnetic tape on which selected (by label) data base information from one system is written so that it may be input into another system. Since MAXISC normally does all data transfer functions, this program is usually run at the end of a data base package for backup purposes.

Terminal Forecast Model - A program which extracts appropriate information from the data base then constructs, from that data, a 24 hr TAF for selected stations.

Thrashing - Thrashing is the excessive motion of disk read/write heads due to the successive retrieval of individual records from cylinders widely dispersed across the disk. The effect is a dramatic slowdown in throughput of all routines attempting to access the disk because of the head motion. Thrashing is also used to describe excessive paging from main memory to disk in a virtual memory environment.

Tightly Coupled Multiprocessor - A central processing system in which two command-arithmetic units share main memory and a common executive.

Variable Perimeter - A machine room in AFGWC which can be switched between special and normal access perimeters.

ZOOM - Primitive equation relocatable window model which operates at about 1/8 mesh resolution.

3DNEPH - 1/8 mesh cloud analysis model for 15 levels producing low, middle, and high cloud types, present weather, min. bases, max tops and total percentage coverage along with the percentage coverage for each of the 15 layers.

6 Level - A coarse mesh upper air forecast model for 850-500-400-300-250-200-150 and 100MB producing stream functions, temps, D-values, U/V wind component omegas and 500MB vorticity. This model is used for the northern and southern hemisphere (the tropics area uses persistence).

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AABNCP - Advanced Airborne Command Post
ABNCP - Airborne Command Post
ACRT - Alphanumeric CRT
ADC - Aerospace Defense Command
ADWS - Automatic Digital Weather Switch (Carswell)
AFCS - Air Force Communication Service
AFETR - Air Force Eastern Test Range
AFGWC - Air Force Global Weather Central
AFOC - Air Force Operations Center
AFOS - Automation of Field Operations and Services
AFTN - Aeronautical Fixed Telecommunications Network
AFWTR - Air Force Western Test Range
ALCE - Airlift Control Element
ALCOM - Alaska Command
ANK - Alphanumeric Keyboard
ANMCC - Alternate National Military Command Center
AP - Array Processor
APM - Advanced Prediction Model
APT - Automatic Picture Transmission
ARPA - Advanced Research Projects Agency
ARQ - Automatic Response to Query
ASL - Atmospheric Sciences Lab. (U.S. Army)
ASR - Automatic Send/Receive
ATESS - Automated Tactical Environmental Sensor System
ATN - Astrogeophysical Teletype Network
ATWDDS - Automated Terminal Weather Display and Dissemination System
AUTODIN - Automated Digital Network
AWC - Automated Work Center
AWN - Automated Weather Network

AWRS	- Airborne Weather Reconnaissance System
AWS	- Air Weather Service
AWSPE	- Air Weather Service Primitive Equation Model
BLM	- Boundary Layer Model
BSSG	- Battle Staff Support Group
BUIC	- Back Up Interceptor Control
BWS	- Base Weather Station
C^2, CC, C&C	- Command and Control
CAWS	- Carswell Automated Weather Switch
CCRT	- Color CRT
CFLOS	- Cloud Free Line of Sight
CFP	- Computer Flight Plan
CHAD	- Changes to the route library (changes, add/delete)
CINCAL	- Commander in Chief Alaska
CINC CONAD	- Commander in Chief Continental Air Defense Command
CINC EUR	- Commander in Chief Europe
CINCLANT	- Commander in Chief Atlantic
CINCPAC	- Commander in Chief Pacific
CINC SAC	- Commander in Chief Strategic Air Command
CLOS	- Clear Line of Sight
CM	- Communications System
CN	- Console Subsystem
CNSW	- Console Switch
CO	- Control Only
COMSEC	- Communications Security
CONT	- Controller
CPF	- Centralized Production Facilities
CR	- Authentication Key Link
CRC	- Control and Reporting Center (TAC)
CRC/CRP	- Control and Reporting Center Post

CRP	-	Control and Reporting Post
CRT	-	Cathode Ray Tube
CTWG	-	Combined Test Working Group
DAIS	-	Digital Avionics Information System
DAR	-	Data Automation Requirement
DASC	-	Direct Air Support Center (TAC)
DB	-	Data Base Subsystem Switch
DC	-	Downgrade Subsystem
DCT	-	Data Communications Terminal
DDB	-	Distributed Data Base
DET	-	Detachment
DF	-	Digital Formatter
DFS	-	Digital Facsimile System
DML	-	Data Management Language
DMS	-	Data Management System
DMSP	-	Defense Meteorological Satellite Program
DOD	-	Department of Defense
DS	-	Disk System
DSARC	-	Defense Systems Acquisitions Review Council
DT	-	Digitizing Table
EDB	-	Environmental Data Base
EDS	-	Environmental Data Service (NOAA)
EO	-	Electro Optical
ESSA	-	Environmental Science Services Administration
ETAC	-	Technical Applications Center
EWO	-	Emergency War Order

FAC	- Forward Air Controller
FACP	- Forward Air Command Post
FDMA	- Frequency Division Multiple Access
FFK	- Fixed Function Keyboard
FH	- Fixed Head Disk
FNWC	- Fleet Numerical Weather Central
FOFAX	- Forecast Office Facsimile
FOFZX	- Forecast Office Facsimile Network
FORSCOM	- U.S. Army Forces Command
FSM	- Flight Simulation Model
GADB	- Global Applications Data Base
GOES	- Geosynchronous Operational Environmental Satellite
GPS	- Global Positioning Satellite
HC	- Hardcopy Device
HCRT	- High Resolution CRT
HEL	- High Energy Laser
HOL	- Higher Order Language
HPR	- High Speed Printer
ICCU	- Inter Computer Coupling Unit
IDN	- AUTODIN II
ILS	- Instrument Landing System
IPADS	- Interactive Processing and Display System
IR	- Infrared
JTWC	- Joint Typhoon Warning Center
K	- Authentication Chip Memory
KSR	- Designation for Teletype (keyboard send-receive) Terminal
KVDT	- Keyboard Display Terminal
KWRC	- Kindsbach Weather Relay Center (Germany)

LC	- Line Control
LCSD	- Low Capacity Storage Device
LHDR	- Line Handler/Decoder Router
LP	- Light Pen
MAC	- Military Airlift Command
MACIMS	- MAC Information and Management System
MAJCOM	- Major Command
MAJCOM WSU	- Major Command Weather Support Unit
mb	- millibars
MBWS	- Modernized Base Weather Station
MEM(MP)	- Main Processor Memory
METSAT	- Meteorological Satellite
MLS	- Microwave Landing System
MOB	- Main Operating Base
MP	- Main Processor
MP,I/O	- Main Processor I/O Unit
MPSW	- Multiprocessor Switch
MTF	- Mission Tailored Forecast
NA	- Normal Access
NAF WSU	- Number Air Force Weather Support Unit
NAFAX	- National Facsimile System
NAMFAX	- National and Aviation Meteorological Facsimile Network
NC	- Network Control
NCA	- National Command Authority
NCAR	- National Center for Atmospheric Research
NCC	- National Climatic Center (Asheville, N.C.)
NCMC	- NORAD Cheyenne Mountain Complex
NCSI	- National Communication System Instructions
NCSW	- Network Control Switch

NDC - National Distribution Circuit
NEACP - National Emergency Airborne Command Post
NEDS - Navy Environmental Data Service
NESS - National Environment Satellite Service (NOAA)
NEXRAD - National Weather Service Next Generation Radar
NHC - National Hurricane Center (Coral Gables, Florida)
NHRL - National Hurricane Research Laboratory
NMC - National Meteorological Center (Suitland, Md.)
NMCC - National Military Command Center
NOAA - National Oceanic and Atmospheric Administration
NOMSS - National Operational Meteorological Satellite System
NOS - National Ocean Survey (NOAA)
NOTAM - Notice to Airmen
NRCC - NORAD Region Control Center
NSA - National Security Agency
NSF - National Science Foundation
NSSFC - National Severe Storms Forecast Center (Kansas City)
NT - Not Real Time
NWS - National Weather Service
NWSED - Naval Weather Service Environmental Detachment (Asheville, N.C.)

OC - Operations Subsystem
OEP - Office of Emergency Preparedness (Washington, D.C.)
OLS - Operational Linear Scan
OPS - Operations Console
OPSEC - Operational Security

PACAF - Pacific Air Force
PEPCO - Potomac Electric Power Company (Washington, D.C.)
PIREP - Pilot Reports
PLT - Plotter

PMSV	- Pilot-to-Metro Service
PR	- Printer
PRS	- Printer Subsystem
PRS	- Prototype Radar System
PS	- Processor System
PWS	- Point Warning System
Q/R	- Query/Response
RADAP	- Radar Digitization and Processing System (National Weather Service)
RADC	- Rome Air Development Center
RAMOS	- Remote Automatic Meteorological Observing System (NWS)
RAWARC	- RAREP and Warning Coordination Circuit
ROC	- Required Operational Capability
ROD	- Required Operational Date
RP	- Relative Performance
RPV	- Remotely Piloted Vehicle
RSTN	- Radio Solar Telescope Network
RTOS	- Real Time Operating System
RWCC	- Regional Warning Coordination Center
SA	- Special Access
S/A	- Studies and Analysis
SADPR	- Support of Air Force Automatic Data Processing Requirements
SCC	- Space Computation Center
SD	- Security Downgrade
SD/RJE	- Security Downgrade/Remote Job Entry
SDM	- Selective Display Model
SDM	- Senior Duty Meteorologist (NMC)
SDO	- Systems Duty Officer (AFGWC)
SELS	- Severe Local Storms (Unit of NSSFC)

SES - Space Environmental Support
SESS - Space Environmental Support System
SGDB - Satellite Global Data Base
SID - Satellite Imagery Dissemination
SID - Sudden Ionospheric Disturbances
SIOP - Single Integrated Operations Plan
SM - Smart Switch
SMS - Synchronous Meteorological Satellite
SO - Special Operations Subsystem
SOI - Space Optical Imaging
SOON - Solar Observing Optical Network
SOUTHCOM - U.S. Southern Command
SP - Support Processor
SPU - Special Projects Units
SS - System Status Display
STSW - Satellite and Console Switch
SVR - Slant Visual Range
SW - Switch
SWI - Special Weather Intelligence
SWO - Staff Weather Officer

TABWS - Tactical Air Base Weather Station
TAC - Tactical Air Command
TACC - Tactical Air Control Center
TACP - Tactical Air Control Party
TACS - Tactical Air Control System
TAF - Terminal Area Forecast
TAF - Tactical Air Forces
TDMA - Time Division Multiple Access
TEDDS - Tactical Environmental Display and Dissemination System
TERB - Time Enroute Bulletin

TESS	- Tactical Environmental Support System
TFMS	- Tactical Frequency Management System
TFU	- Tactical Forecast Unit (Yokota and Kindsbach)
TUOC	- Tactical Unit Operations Center
TWA	- Tropical Wind Analysis
TWAC	- Tactical Weather Analysis Center
TWR	- Tactical Weather Radar
TWS	- Tactical Weather System
UA	- Upper Air
UP	- Upgrade
USAEUR	- U.S. Army, Europe
USARPAC	- U.S. Army, Pacific
USAF ETAC	- USAF Environmental Technical Applications Center
USAFE	- U.S. Air Force, Europe
USCINCEUR	- U.S. Commander in Chief Europe
USCINCRED	- U.S. Commander in Chief U.S. Readiness Command
USCINCSO	- U.S. Commander in Chief U.S. Southern Command
USEUCOM	- United States European Command
USREDCOM	- United States Readiness Command
VA	- Variable Access
VHR	- Very High Resolution Visual Imagery
VHRR	- Very High Resolution Radiometer
VPSW	- Variable Perimeter Switch
WAC	- World Aeronautical Chart
WCC	- Weather Communications Center
WFSC	- Weather Facsimile Switching Center
WGS	- Weather Graphics System
WHR	- Very High Resolution Infrared Imagery

WIN	- WWMCCS Intercomputer Network
WR	- Weather Radar
WSF	- Weather Support Facility
WSFO	- Weather Service Forecast Offices
WSO	- Weather Service Office
WSOM	- Weather Service Operations Manual
WWMCCS	- World Wide Military Command Control System