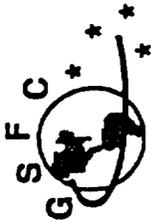




MISSION OPERATIONS
AND DATA SYSTEMS DIRECTORATE



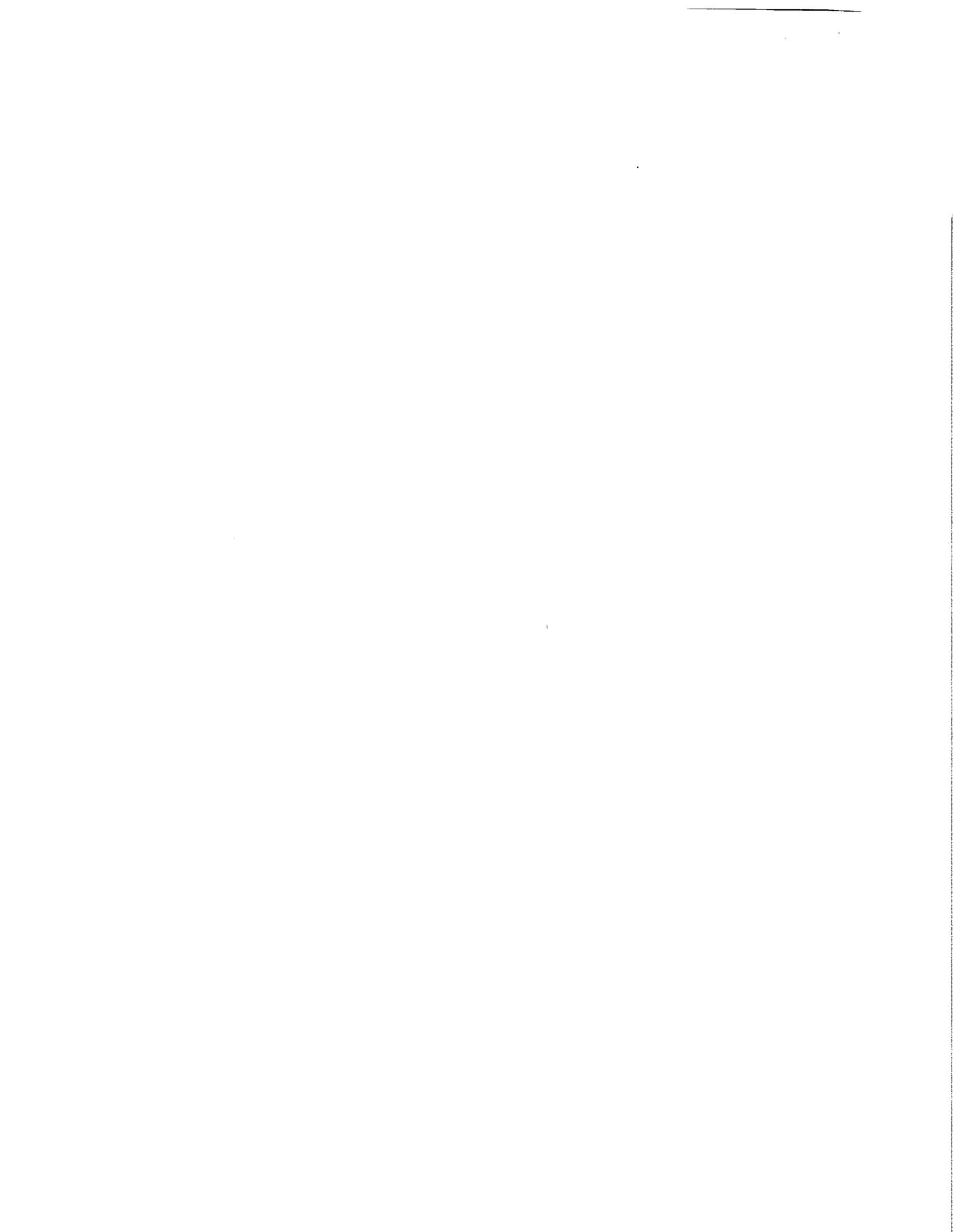
**SPACE NETWORK CONTROL (SNC)
CONFERENCE
ON
RESOURCE ALLOCATION
CONCEPTS AND APPROACHES**

December 12 & 13, 1990

N92-11040



— GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND



**SPACE NETWORK CONTROL CONFERENCE ON RESOURCE ALLOCATION
CONCEPTS AND APPROACHES**

DECEMBER 12 - 13, 1990

WORKING GROUP DISCUSSION QUESTIONS

SUGGESTION:

Keep a running list of concepts/issues that may be considered for SNC as you listen to the briefing.

Examples:

- Distributed systems and information access
- Locus of control
- Level of automation
- Timeline management
- Generic scheduling
- Impact of demand access
- Impact of "classes" of users on scheduling services

SESSION 1. CONCEPTS FOR SPACE NETWORK RESOURCE ALLOCATION

1. Identify the three most critical issues for Space Network Resource Allocation in terms of:
 - a. Management
 - b. Operations
 - c. SN User POCCs
 - d. System Development

Include a sentence or two, as needed, to explain/clarify each issue.

2. Select at least three of the critical issue above and suggest ways of resolving them. Address innovation and risk factors. Identify areas for further study and suggest study approaches.
3. Discuss how resource allocation might be performed for:
 - a. Rescheduling in the event of a failure to the ATRSS Ground Terminal.
 - b. Scheduling of previously allocated resources that unexpectedly become available (e.g., shuttle launch slips).
4. Discuss the pros and cons of dividing the schedule timeline into forecast (batch) and active (incremental updates) periods. Suggest alternative schedule timeline approaches for SNC consideration.
5. Given that there are different user classes, discuss the pros and cons of subdividing available resources into multiple subnetworks based on user classes and demands for use by each user class.

SESSION 2. SNC AND USER POCC HUMAN-COMPUTER INTERFACE CONCEPTS.

1. Using presentation materials as a baseline, provide a definition of "generic scheduling" and make recommendations for its use in terms of concept, requirements, and implementation approach. Discuss incentives to make generic scheduling an attractive option for user POCCs and provide rationale.
2. Discuss the pros and cons of redefining the user POCC scheduling interface in conjunction with defining the SNC scheduling interface to the POCCs. Address the potential for providing common tools for user POCCs.
3. Scheduling system user interfaces guidelines are not mature today and standards are not expected in the foreseeable future. Suggest steps that should be taken to incorporate human factors guidelines for the human computer interface into the system development process. Address risk areas.
4. Suggest an approach and discuss trade-offs for determining appropriate levels of automation for the SNC, for example, fully automated operations, human management by exception (supervisor role), human activated with computer assistance (computer recommends actions), or manual operations.

SESSION 3. RESOURCE ALLOCATION TOOLS, TECHNOLOGY, AND ALGORITHMS

1. Identify at least three key performance parameters for the following viewpoints:

- a. User POCC
- b. SNC operability
- c. SN schedule efficiency
- d. System Implementation

Include a sentence or two, as needed, to explain/clarify each parameter.

2. Select at least three of the performance drivers above and suggest ways of satisfying them. Address application of AI and other techniques and risk areas.
3. Identify candidate SN resource allocation prototyping objectives. Provide rationale.

Table of Contents

<u>Topic</u>	<u>Presenter</u>	<u>Page No.</u>
Conference Introduction		
• Introduction	W. Watson	A-1
• Conference Format	K. Moe	B-1
• SNC Scheduling Challenges	A. Levine	C-1
• MO&DSD Planning and Scheduling Lessons Learned	T. Robinson	D-1
Session 1: Concepts for Space Network Resource Allocation		
• Concepts, Requirements and Design Approaches for Building Successful Planning and Scheduling Systems	R. Hornstein/ J. Willoughby	E-1
• COMS Planning and Scheduling Concept Assessment	T. Welden	F-1
• An RF Interference Mitigation Methodology for Scheduling in Space Communications	Y. Wong/ J. Rash	G-1

Table of Contents (Cont'd)

<u>Topic</u>	<u>Presenter</u>	<u>Page No.</u>
• Automatic Conflict Resolution Issues	J. Wike	H-1
• Effects of Locus of Resource Control on Operational Efficiency in Distributed Operations	A. Geoffroy	I-1
• Resource Allocation Planning Helper - RALPH	D. Wertz	J-1
Session 2: SNC and User POCC Human-Computer Interface Concepts		
• User Interface Issues in Supporting Human-Computer Integrated Scheduling	L. Cooper	K-1
• Human Factors Issues in the Design of User Interfaces for Planning and Scheduling	E. Murphy	L-1
• A Planning Language for Activity Scheduling	S. Weinstein	M-1
• CHIMES Tool for HCI Analysis	W. Wieland	N-1
• TRUST - An Innovative User Interface for Scheduling	T. Sparr	O-1

Table of Contents (Cont'd)

<u>Topic</u>	<u>Presenter</u>	<u>Page No.</u>
• NCC User Planning System (UPS) User Interface	B. Dealy	OO-1
Session 3: Resource Allocation Tools, Technology, and Algorithms		
• AI Scheduling Techniques for HST	M. Johnston	P-1
• Intelligent Perturbation Algorithm for Space Scheduling Optimization	C. Kurtzman	Q-1
• Combinatorial Optimization Techniques for Activity Scheduling	S. Reddy	R-1
• Range Scheduling Aid	J. Logan	S-1
• Approaches to Contingency Rescheduling in ROSE	D. Zoch	T-1
• Managing Temporal Relations in MAESTRO	D. Britt	U-1
• Resource Representation in COMPASS	B. Fox	V-1



SPACE NETWORK CONTROL (SNC)
CONFERENCE ON
RESOURCE ALLOCATION CONCEPTS
AND APPROACHES

INTRODUCTION

DECEMBER 12, 1990

W. WATSON/530
ASSISTANT CHIEF FOR
NETWORK PLANNING

A-1

MO&DS DIRECTORATE	SPACE NETWORK CONTROL (SNC) CONFERENCE ON RESOURCE ALLOCATION CONCEPTS AND APPROACHES INTRODUCTION	
CODE 500	<p><u>GOALS FOR CONFERENCE ON RESOURCE ALLOCATION</u></p> <ul style="list-style-type: none"> • SURVEY EXISTING RESOURCE ALLOCATION CONCEPTS AND APPROACHES. • IDENTIFY SOLUTIONS APPLICABLE TO THE SN PROBLEM. • IDENTIFY FRUITFUL AVENUES OF INVESTIGATION IN SUPPORT OF SNC DEVELOPMENT. • CAPTURE KNOWLEDGE IN PROCEEDINGS AND MAKE AVAILABLE TO BIDDERS ON THE SNC CONCEPT DEFINITION PROCUREMENT. 	

A-2

MO&DS DIRECTORATE	SPACE NETWORK CONTROL (SNC) CONFERENCE ON RESOURCE ALLOCATION CONCEPTS AND APPROACHES	
CODE 500	INTRODUCTION	
<u>BACKGROUND</u>		
<ul style="list-style-type: none"> • THE CURRENT NCC WORKS, PROVIDING A VARIETY OF SCHEDULING AND TECHNICAL MANAGEMENT FUNCTIONS FOR THE SPACE NETWORK (TDRSS), THE GROUND NETWORK (MIL,BDA, DKR) AND INTERFACE TO OTHER NETWORKS (DSN, RTS) • THE SPACE NETWORK IS CHANGING: <ul style="list-style-type: none"> - TDRS CLUSTER ARCHITECTURES - WHITE SANDS GROUND TERMINAL COMPLEX - NEW ATRSS SERVICES - MIXED FLEET TDRS/ATDRS - INTERNATIONAL DATA RELAY SATELLITE INTEROPERABILITY • AS THESE CHANGES PROGRESS, THE CURRENT NCC SYSTEM AND SOFTWARE ARCHITECTURE BECOMES INCREASINGLY DIFFICULT TO MAINTAIN. 		

A-3

MO&DS DIRECTORATE	SPACE NETWORK CONTROL (SNC) CONFERENCE ON RESOURCE ALLOCATION CONCEPTS AND APPROACHES	
CODE 500	INTRODUCTION	
<u>GOALS FOR SPACE NETWORK CONTROL</u>		
<ol style="list-style-type: none"> 1. DEVELOP A SYSTEM ARCHITECTURE CAPABLE OF ACCOMMODATING CHANGE <ul style="list-style-type: none"> - HARDWARE - SOFTWARE - INTERFACES - SPAN OF CONTROL 2. IMPROVE SN USER SATISFACTION <ul style="list-style-type: none"> - SN USER INTERFACE - VARYING LEVELS OF USER SOPHISTICATION & NEED - % OF SUPPORT REQUESTS GRANTED - A SCHEDULING ISSUE 3. IMPROVE THE SN INSTITUTIONAL UTILIZATION AND EFFECTIVENESS <ul style="list-style-type: none"> - SNC LIFE CYCLE COSTS: OPERATIONS AND SYSTEM MAINTENANCE - INCREASE THE UTILIZATION OF THE SN <ul style="list-style-type: none"> • 5% INCREASE MAY SAVE THE COST OF AN ATRSS OVER THE 15 YEAR PROGRAM LIFE CYCLE (\$200M - \$300M) • THIS IS BOTH A SCHEDULING AND SYSTEM RELIABILITY ISSUE 		

A-4

MO&DS DIRECTORATE	SPACE NETWORK CONTROL (SNC) CONFERENCE ON RESOURCE ALLOCATION CONCEPTS AND APPROACHES	
	CODE 500	
<u>BACKGROUND</u>		
<ul style="list-style-type: none"> • THE CURRENT NCC WORKS, PROVIDING A VARIETY OF SCHEDULING AND TECHNICAL MANAGEMENT FUNCTIONS FOR THE SPACE NETWORK (TDRSS), THE GROUND NETWORK (MIL, BDA, DKR) AND INTERFACE TO OTHER NETWORKS (DSN, RTS) • THE SPACE NETWORK IS CHANGING: <ul style="list-style-type: none"> - TDRS CLUSTER ARCHITECTURES - WHITE SANDS GROUND TERMINAL COMPLEX - NEW ATDRSS SERVICES - MIXED FLEET TDRS/ATDRS - INTERNATIONAL DATA RELAY SATELLITE INTEROPERABILITY • AS THESE CHANGES PROGRESS, THE CURRENT NCC SYSTEM AND SOFTWARE ARCHITECTURE BECOMES INCREASINGLY DIFFICULT TO MAINTAIN. 		

A-3

MO&DS DIRECTORATE	SPACE NETWORK CONTROL (SNC) CONFERENCE ON RESOURCE ALLOCATION CONCEPTS AND APPROACHES	
	CODE 500	
<u>GOALS FOR SPACE NETWORK CONTROL</u>		
<ol style="list-style-type: none"> 1. DEVELOP A SYSTEM ARCHITECTURE CAPABLE OF ACCOMMODATING CHANGE <ul style="list-style-type: none"> - HARDWARE - SOFTWARE - INTERFACES - SPAN OF CONTROL 2. IMPROVE SN USER SATISFACTION <ul style="list-style-type: none"> - SN USER INTERFACE - VARYING LEVELS OF USER SOPHISTICATION & NEED - % OF SUPPORT REQUESTS GRANTED - A SCHEDULING ISSUE 3. IMPROVE THE SN INSTITUTIONAL UTILIZATION AND EFFECTIVENESS <ul style="list-style-type: none"> - SNC LIFE CYCLE COSTS: OPERATIONS AND SYSTEM MAINTENANCE - INCREASE THE UTILIZATION OF THE SN <ul style="list-style-type: none"> • 5% INCREASE MAY SAVE THE COST OF AN ATDRS OVER THE 15 YEAR PROGRAM LIFE CYCLE (\$200M - \$300M) • THIS IS BOTH A SCHEDULING AND SYSTEM RELIABILITY ISSUE 		

A-4

MO&DS DIRECTORATE		
CODE 500	<p>SNC Conference on Resource Allocation Concepts and Approaches</p> <p>Conference Format</p> <p>December 12, 1990</p> <p style="text-align: right;">K. Moe/522</p>	

B-1

MO&DS DIRECTORATE	SNC Conference Format	
CODE 500	<p><u>Conference Format</u></p> <ul style="list-style-type: none"> • Conference Introduction • Session 1: Concepts for SN Resource Allocation • Session 2: SNC and User POCC Human-Computer Interface Concepts • Session 3: Resource Allocation Tools, Technology, and Algorithms • Working group discussions will follow each session • Each presentation will be approximately 20 minutes • Conference proceedings will be published early in 1991 and will contain: <ul style="list-style-type: none"> - Presentation Slides/Presentation Papers - Working Group Results 	

B-2

MO&DS DIRECTORATE CODE 500	SNC Conference Format	
<u>Working Group Discussions</u>		
<ul style="list-style-type: none"> • Working groups will consist of: <ul style="list-style-type: none"> - Leader - Recorder - Approximately 8 members total • Working groups will address specific "questions to be answered" in the conference handout • Leader and Recorder will be responsible for the documentation of working group efforts • Everyone is encouraged to take notes during presentations to capture ideas • Your participation and contributions to working group discussions are essential elements of this conference 		

B-3

MO&DS DIRECTORATE CODE 500	SNC Conference Format	
<u>Working Group Discussions (Cont'd)</u>		
<ul style="list-style-type: none"> • Working Group Leaders <ul style="list-style-type: none"> - Dorothy Perkins - Pepper Hartley - Philip Liebrecht - Candace Carlisle - Vern Hall - Doug McNulty - BJ Hayden • Working Group Recorders <ul style="list-style-type: none"> - Eric Richmond - Beth Antonopoulos/Brian Dealy - Lisa Karr - Bill Potter - Nancy Goodman - Ken Johnson - Karen Thorn 		

B-4

MO&DS DIRECTORATE	<h1>SNC Conference Format</h1>	
CODE 500	<p><u>Agenda</u></p> <p>December 12, 1990</p> <p>8:00 - 8:30 Registration</p> <p>8:30 - 9:30 Conference Introduction</p> <p>9:30 - 11:15 Session 1: Concepts for SN Resource Allocation</p> <p>11:15 - 12:15 Lunch</p> <p>12:15 - 1:00 Session 1 (Cont'd)</p> <p>1:00 - 3:30 Session 1 Working Group Discussions</p> <p>3:30 - 5:00 Session 2: SNC and User POCC Human-Computer Interface Concepts</p> <p>December 13, 1990</p> <p>8:00 - 9:15 Session 2 (Cont'd)</p> <p>9:15 - 11:15 Session 2 Working Group Discussions</p> <p>11:15 - 12:15 Lunch</p> <p>12:15 - 3:15 Session 3: Resource Allocation Tools, Technology, and Algorithms</p> <p>3:15 - 5:00 Session 3 Working Group Discussions</p> <p>5:00 Concluding Remarks</p>	

B-5



SCHEDULING OVERVIEW AND CHALLENGES

NOVEMBER 1990

A. LEVINE
CODE 534.2

C-1

MO&DS
DIRECTORATE

CODE 500

SCHEDULING OVERVIEW AND CHALLENGES



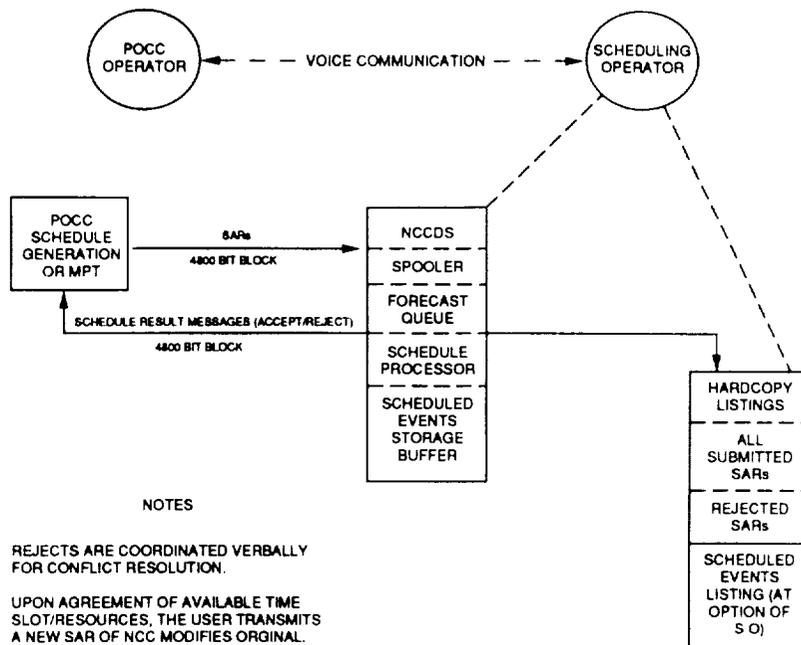
INTRODUCTION

- THE NCC IS RESPONSIBLE FOR THE ALLOCATION OF SPACE NETWORK RESOURCES TO MEET AUTHORIZED USER REQUIREMENTS.
 - SCHEDULES TDRS AND WSGT
 - SCHEDULES NASCOM
 - SCHEDULES NASA GROUND TERMINAL
 - SCHEDULES SDPF

C-2



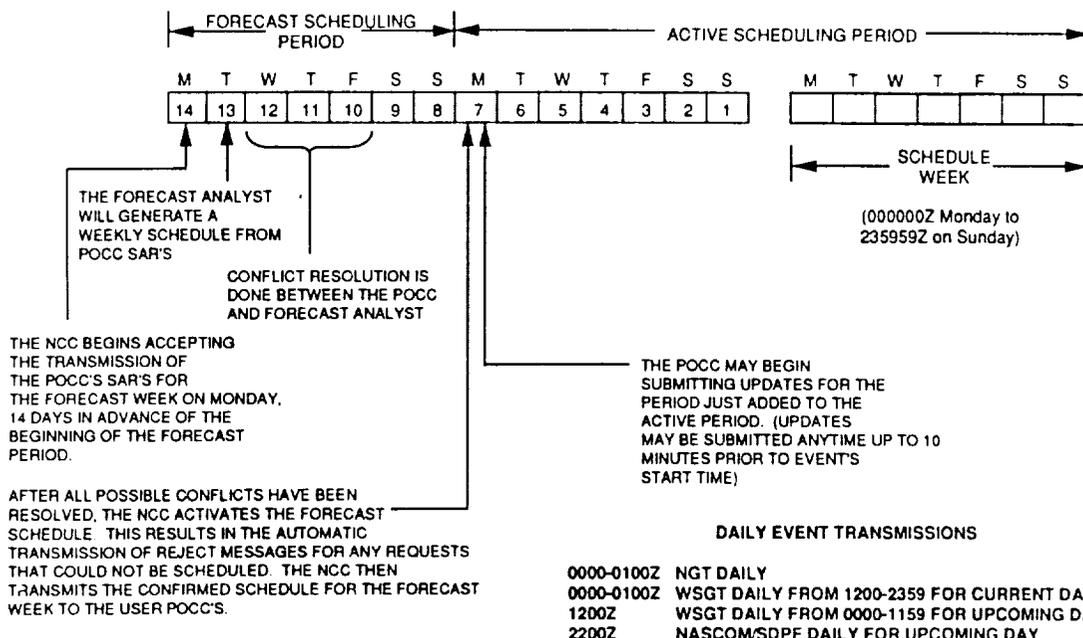
SCHEDULING PROCESS



C-3



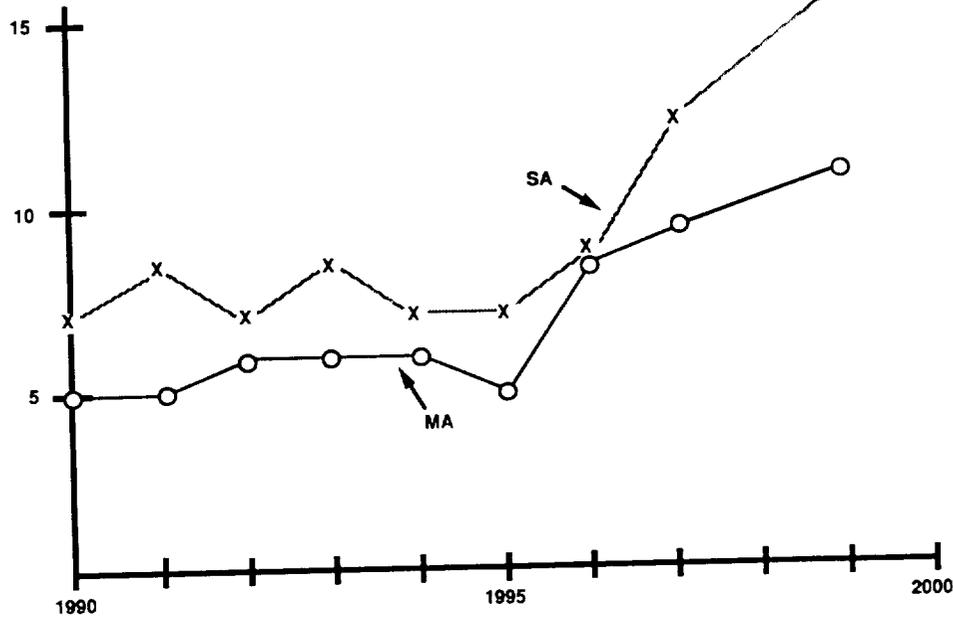
SCHEDULING TIMELINE



C-4



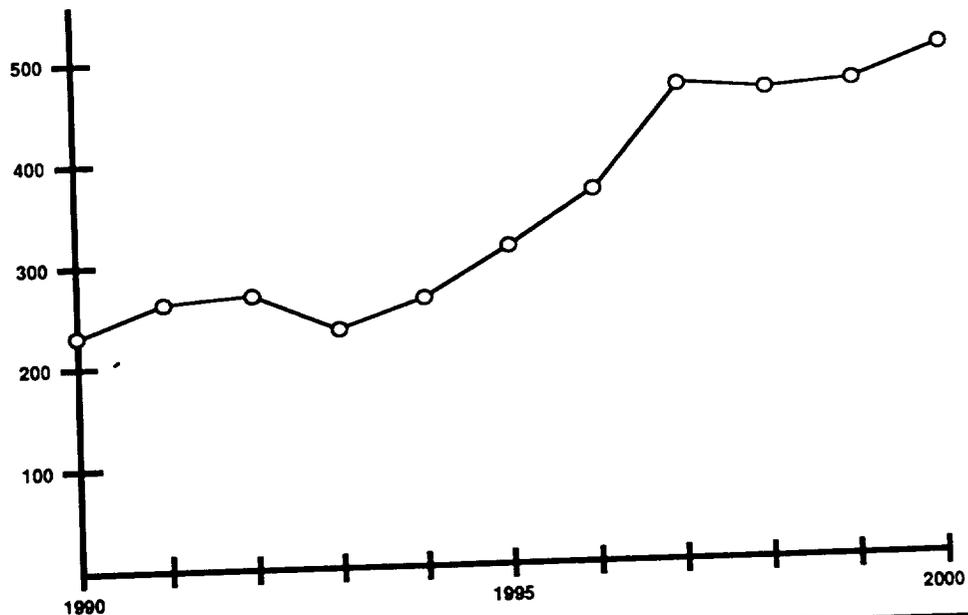
NUMBER OF SN USERS



C-5



SN EVENTS PER DAY PEAK DAILY LOADING



C-6

MO&DS DIRECTORATE	SCHEDULING OVERVIEW AND CHALLENGES 
CODE 500	
<h2>SCHEDULING CHALLENGES</h2> <ul style="list-style-type: none"> • CURRENT <ul style="list-style-type: none"> - EFFICIENT USE OF NETWORK RESOURCES - SCHEDULING SHUTTLE - MINIMIZE IMPACT ON OTHER USERS - USER POCC INTERFACE - REFINE FORECAST/ACTIVE PERIOD PROCEDURES - SCHEDULING AROUND RFI - BETTER TOOLS FOR CONFLICT RESOLUTION - EMPHASIS ON AIDING SCHEDULER, NOT REPLACE/AUTOMATE 	

C-7

MO&DS DIRECTORATE	SCHEDULING OVERVIEW AND CHALLENGES 
CODE 500	
<h2>SCHEDULING CHALLENGES (CONTINUED)</h2> <ul style="list-style-type: none"> • FUTURE <ul style="list-style-type: none"> - SCHEDULING CONTROL - MAN AND MACHINE FUNCTIONS - GENERIC SCHEDULING - TAKE INITIATIVE, DON'T REACT - TRANSITION <ul style="list-style-type: none"> • TDRSS TO ADRSS • NCC TO SNC - SSF SCHEDULING - INTERNATIONAL SPACE NETWORK INTEROPERABILITY - SPACECRAFT PROXIMITY OPERATIONS (E.G., SHUTTLE DELIVERY, SSF) - DEMAND ACCESS 	

C-8