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Effect of Locus of Resource Control on Operational Efficiency in Distributed Operations

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OVERVIEW

PROBLEM

- SNC FROM THE CUSTOMER'S PERSPECTIVE
- REQUIREMENTS FOR COORDINATING COMM AND OTHER RESOURCES

LOCUS OF CONTROL IN DISTRIBUTED OPERATIONS

- DIFFERENT WAYS TO DISTRIBUTE CONTROL

EFFICIENCY

- GENERAL CONSIDERATIONS
- EFFICIENCY EFFECTS DEPENDING ON CONTROL DISTRIBUTION

RECOMMENDATIONS

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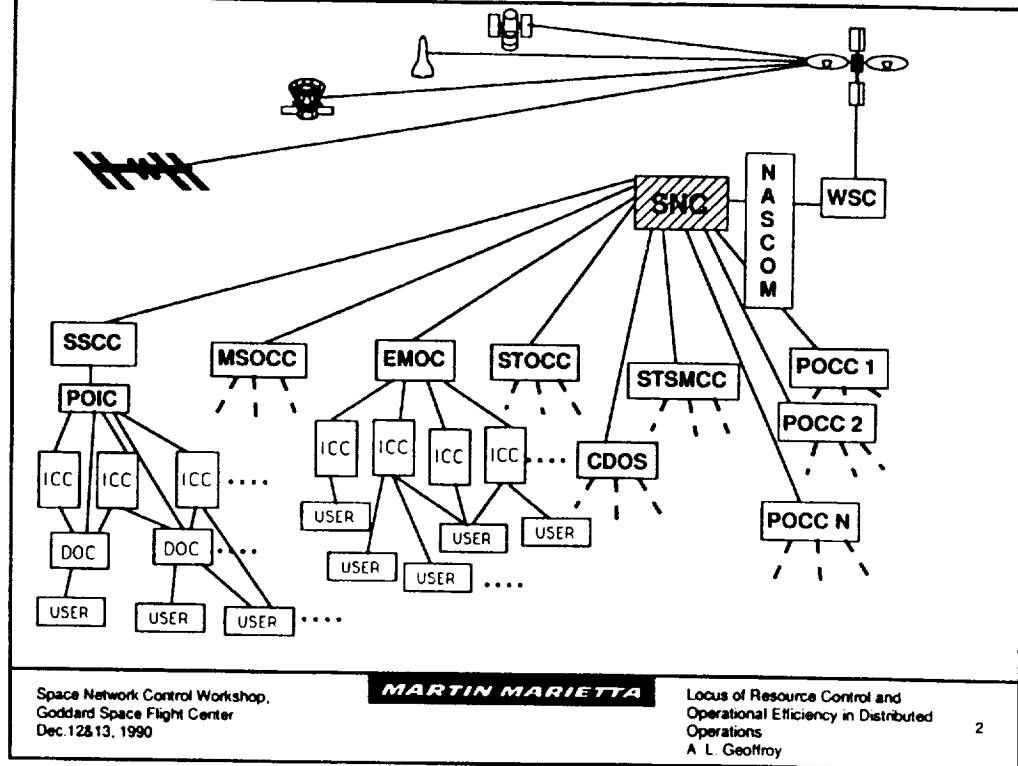Dec. 12&13, 1990

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SNC USAGE IN THE ATDRSS ERA

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ACRONYM & ICON LIST

ATDRS	Advanced Tracking and Data Relay Satellite	POIC	Payload Operations Integration Center
CDOS	Customer Data and Operations System	POCC	Payload Operations Control Center
DOC	Discipline Operations Center	SNC	Space Network Control
EMOC	Eos Mission Operations Center	SSF	Space Station Freedom
Eos	Earth Observing System	SSCC	Space Station Control Center
HST	Hubble Space Telescope	STOCC	Space Telescope Operations Control Center
ICC	Instrument Control Center		
MSOCC	Mission Support Operations Control Center	STS	Space Transportation System (Shuttle)
NASCOM	NASA Communications	STSMCC	Space Transportation System Mission Control Center
		WSC	White Sands Cpmplex
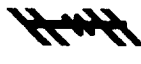
| ATDRS | SSF | HST | STS | Generic Satellite |

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DEMANDS ON THE SNC

LARGE NUMBER OF USERS

DIVERSE USER REQUIREMENTS

DIFFERENCES IN TIMING OF INPUT REQUIREMENTS
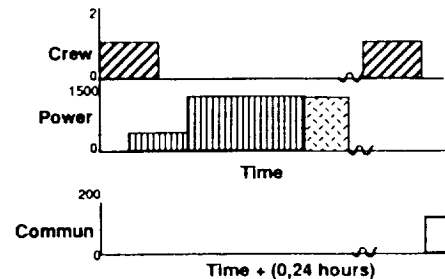
CONTINGENCY HANDLING

SYSTEM RESPONSIVENESS

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TIGHTNESS OF RESOURCE COUPLING
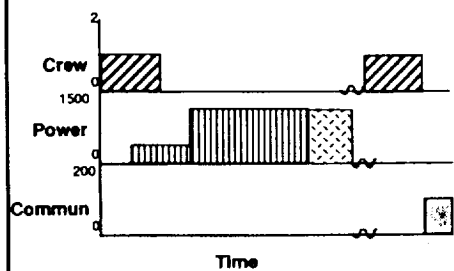
Communications requirements tightly
coupled with other resource requirements

Communications requirements loosely
coupled with other resource requirements

• TIGHTNESS OF RESOURCE COUPLING

• FIXED v. GENERIC REQUESTS

• CONJUNCTIVE v. INDIVIDUAL REQUIREMENTS

• REAL-TIME REQUIREMENTS

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SHARING INFORMATION and SHARING CONTROL

ACCESS IN ANY DISTRIBUTED NETWORK MUST BE DISTRIBUTED,
BUT *CONTROL* MAY OR MAY NOT BE

WHEN MANY NODES HAVE A LARGE NUMBER OF INTERACTIONS,
CENTRALIZED CONTROL EASES THE SCHEDULING PROBLEM

IN NETWORKS WHERE INTER-NODE INTERACTIONS ARE WELL
PARTITIONED INTO SMALLER LOCAL NETWORKS, DISTRIBUTED
CONTROL IS PREFERABLE

DISTRIBUTION OF CONTROL MAY BE REQUIRED EVEN WHEN THERE IS
A HIGH LEVEL OF INTER-NODE INTERACTION, BECAUSE OF :

- SECURITY/PRIVACY
- DISTRIBUTION OF AUTHORITY

FLEXIBILITY OR EFFICIENCY MAY BE LOST IN A NETWORK WITH
DISTRIBUTED CONTROL

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POTENTIAL WAYS OF DISTRIBUTING CONTROL

CENTRALIZED CONTROL WITH DISTRIBUTED ACCESS:

- GLOBALLY AVAILABLE INFORMATION

- DECISION MAKING BY CENTRAL AUTHORITY WITH ALL
  RELEVANT INFORMATION

- RELATIVE PRIORITIES GLOBALLY ESTABLISHED

DISTRIBUTED CONTROL OPTIONS:

- BLOCK RESOURCE ALLOCATION

- CROSS-SCHEDULER NEGOTIATIONS

- CONTROL RE-DIRECTION

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EFFICIENCY PROBLEMS UNRELATED TO DISTRIBUTION OF CONTROL

PROBLEM SIZE

- TOO LARGE FOR ANY KNOWN METHOD OF INTELLIGENT CENTRALIZED SCHEDULING

- TOO MANY INTERDEPENDENCIES FOR EFFICIENCY TO BE MAINTAINED
  WITH DECOMPOSITION

LEVEL OF PLANNING PROBLEM

- MOVING FROM STRATEGIC PLANNING TO EXECUTABLE SCHEDULES

  - CHANGES IN LEVEL OF DETAIL NECESSITATE EITHER INITIAL
    OVERBOOKING OR INNEFFICIENT MARGINS

  - CONCURRENCY OF REQUIREMENTS MUST BE TRUE FOR VALID
    SCHEDULES, BUT ONLY SUMMED REQUIREMENTS ARE AVAILABLE IN
    EARLY PHASES OF PLANNING

FLEXIBILITY

- THE MORE FLEXIBILITY ALLOWED IN RESOURCE ENVELOPES, THE MORE
  INEFFICIENCY INTRODUCED

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EFFICIENCY PROBLEMS RELATED TO DISTRIBUTION OF CONTROL

BLOCK ALLOCATIONS

- PREDICTABILITY OF REQUIREMENTS DETERMINES EFFICIENCY

INTERLOCKING SCHEDULES

- TRYING TO ACHIEVE EFFICIENCY IN MULTIPLE DIMENSIONS

SPECIFIC v. GENERIC REQUESTS

- GENERIC REQUESTS CAN BE MOST EFFICIENTLY SCHEDULED,
  BUT POSE DIFFICULTY IN DISTRIBUTED CONTROL OF TIGHTLY
  COUPLE RESOURCES

CONTINGENCIES IN DISTRIBUTED CONTROL SCENARIOS

- EFFECTS AT A SINGLE NODE RIPPLE THROUGHOUT NETWORK

- SPEED, RESPONSIVENESS AND COORDINATION PROBLEMS

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RECOMMENDATIONS

STUDY, STUDY, STUDY ....

- RESOURCE COUPLING, INDEPENDENCE

- REAL-TIME REQUIREMENTS

- "COORDINATION" CAPABILITIES
    - DESIRABILITY

    - FEASIBILITY

    - COST RISK & TIMING

DEVELOP APPROACH BASED ON STUDY OUTCOMES, INCLUDING:

- SYSTEM ARCHITECTURE AND DESIGN

- OPERATIONAL REQUIREMENTS/RESTRICTIONS FOR USERS EXPLICITLY GIVEN

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