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SCHEDULING TECHNIQUES IN THE REQUEST ORIENTED SCHEDULING ENGINE (ROSE)

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Agenda

- Introduction to ROSE
- NCC-ROSE (test results)
- ROSE Scheduling Approach
- Scheduling Techniques
- Summary

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ROSE Summary

- *ROSE* is a prototype scheduling tool that has demonstrated viable solutions to difficult scheduling issues such as:
  - Fast, automated, conflict-free schedule creation (> 4,000 request/hour @ 2,000 req's.)
  - Schedule enhancement through post-processing: Best First Search for Schedule Enhancement (BFSSE).
  - Rescheduling / contingency scheduling techniques
  - Operator tools for computer-assisted scheduling (graphical interfaces, etc.)
- The *ROSE* effort involves the cooperation of experienced users, operators, and implementors of spacecraft data systems
- The *ROSE* effort has had positive impacts far beyond its original scope

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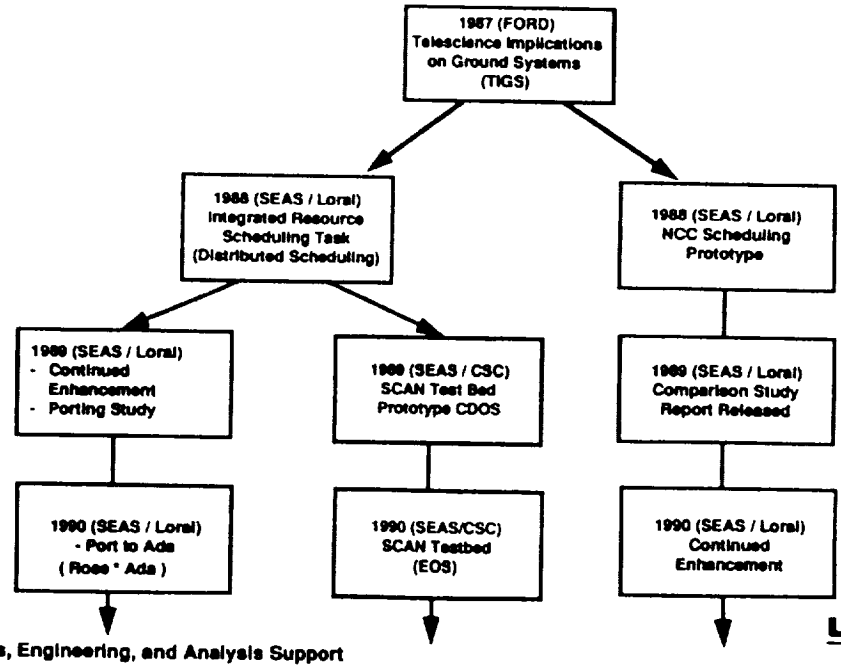
ROSE History



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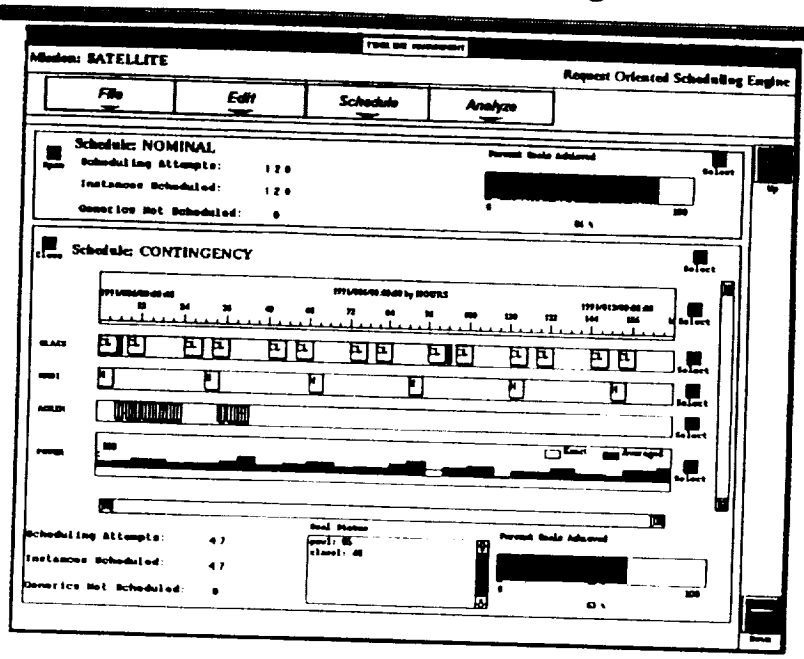
NCC - ROSE Task Goals

- Prototype a viable generic NCC request scheduling process with predicted load levels for the 1995 timeframe using:
  - Existing *ROSE* prototype
  - Different request selection and placement strategies
  - Different scheduling algorithms
- Use requests that represent a realistic contention for TDRSS resources with realistic view periods
- Prototype required user request flexibility
- Evaluate FERN language for use in the NCC environment
- Determine tradeoffs between *success rates* and *time-to-schedule* for different scheduling algorithms

Accomplishments

- Verified ability of FERN to represent realistic generic requests by building and scheduling generic requests:
  - 31 Generic user requests
  - 11 Missions
  - Requests for 1645 activities per week
  - Realistic TDRS view periods
  - Realistic resource contention
- Prototyped and compared scheduling architectures
- Results documented in *Scheduling Results Analysis Report for the NCC Prototype*
- Able to schedule over 94% of anticipated requests for week long schedule in 1995 in less than 2 hours

ROSE Timeline Manager



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Scheduling Concerns

- Need to reduce time needed to get a conflict-free schedule
- Satisfy customers
- Respond quickly to changes (Targets of opportunity, shuttle slips)
- Implement NASA policy

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Current Approach

1 Users submit requests for services at a specific time

2 INITIAL SCHEDULING (2 hours) - An initial schedule is created by computer

3 CONFLICT RESOLUTION (3 to 5 days) - operators phone users and ask
- what is the type of event? (orbit adjust, tape dump, etc.)
- can request be shortened?
- can request be moved?
- can request use a downgraded service (MA vs. SA)
- can request use the other TDRS?
- If neither conflicting user is flexible, choose the higher priority one.

4 Operators schedule PM and tests (hardware/software upgrades) around user requests

5 If there is a conflict with a user, do the conflict resolution process

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ROSE Approach

1 Users and Operators submit flexible requests with preferences, constraints, and alternatives

2 INITIAL SCHEDULING (1 to 2 hours) - An initial schedule is created (without conflicts). Some requested events are not scheduled

3 CONFLICT RESOLUTION (2 to 5 hours) - Algorithms that imitate the human conflict resolution process are executed to try to schedule the non-scheduled requests

4 (done)

5 (done)

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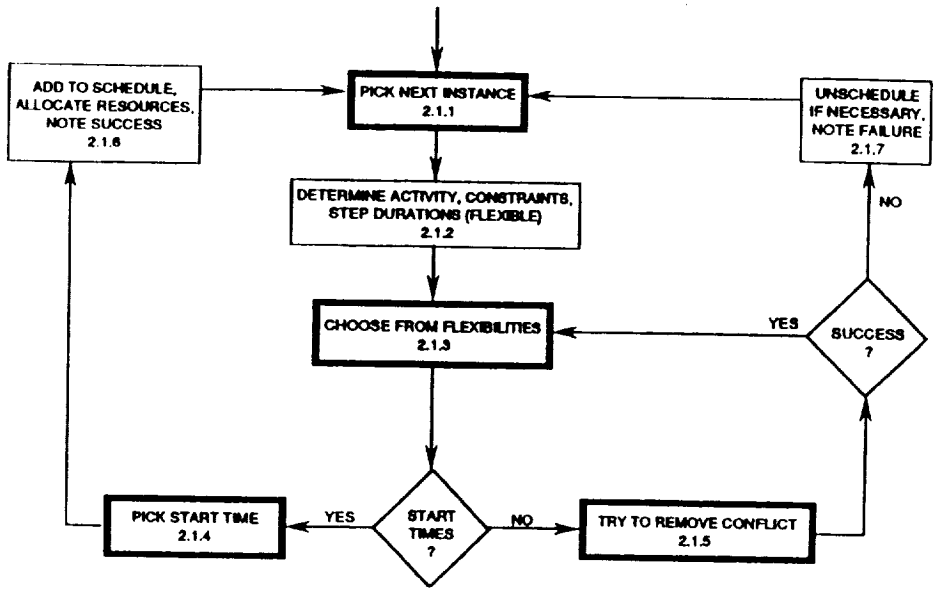
Initial Scheduling



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BFSSE Overview

- Start with an initial conflict-free schedule and some un-scheduled requests
- Identify one un-scheduled request that you would like to try to schedule
- The algorithm executes the following three steps repeatedly as needed until either a solution is found or a timeout occurs
  - SELECT
    Find places on the schedule where the request almost fits.
  - MOVE
    Determine what requests need to be moved to schedule the unscheduled request
  - RESCHEDULE
    Repeat the SELECT and MOVE steps for all moved requests

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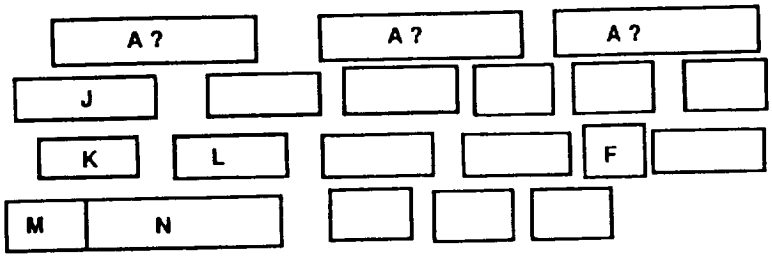
BFSSE Example

- Goal is to add request "A" to the existing schedule shown below
- Three potential times for request "A" are shown



- It is known that "A" cannot be scheduled anywhere if the rest of the schedule remains as is.

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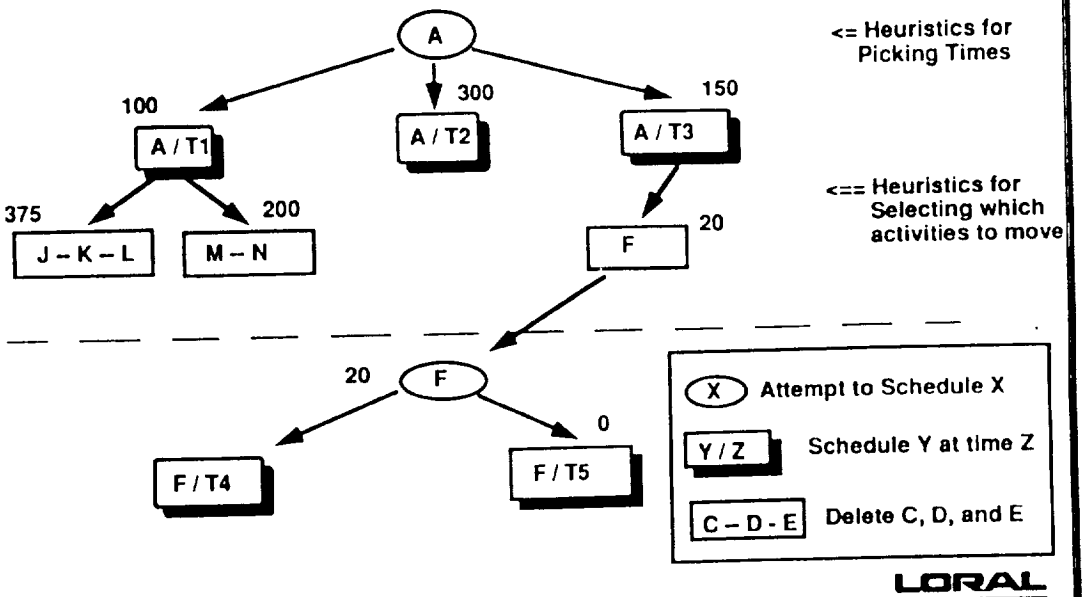
BFSSE Example (cont'd)



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Summary

- ROSE has shown to be an effective scheduler for solving the types of scheduling problems faced by the NCC
- The ROSE approach fully supports the NCC operations scenario
- Conflict-free schedules can be created in 2 to 4 hours instead of 3 to 5 days.
- ROSE can create schedules quickly enough that alternative contingency schedules are possible
- The ROSE conflict resolution strategy utilizes flexibilities in user requests to reduce conflicts