Session II
Collaborative Decision Making

CDM Research
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RESEARCH RESULTS IN COLLABORATIVE DECISION MAKING

NEXTOR Research Symposium

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Project Participants

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  - Students: Taryn Butler, Bob Hoffman, Tasha Innis, Thomas Vossen
- MIT
  - Faculty: Dimitris Bertsimas, Eric Ferron, Amedeo Odoni
  - Students: Bill Hall, Ryan Rifkin, Sarah Stock
- Metron: Mike Wambsganss
- FAA: Jim Wetherly
- CDM/RTCA Working Group: a cast of thousands

CDM Status

- Agreement on new paradygn for ground delay programs
- Flight Schedule Monitor (FSM)
- Monthly meetings with airlines, FAA, developers, researchers, etc.
- Extensive pre-operational testing
- AOCNet
- Implementation imminent

CDM Focus Areas

- Ground delay programs (GDPs)
- NAS Status
- Collaborative Routing

Fundamental Motivators for CDM in GDP Context

- FAA (ATCSCC): desire for more up-to-date information on status of aircraft/flights to make better GDP decisions
- Airlines: desire for more control over allocation of delays to their flights

Basic Resource/Slot Allocation Process

FAA: initial "fair" slot allocation
[Ration-by-schedule]

Airlines: flight-slot assignments/reassignments
[Cancellations and substitutions]

FAA: final allocation to maximize slot utilization
[Compression]

NEXTOR Research Projects

- Representation and modeling of weather uncertainly within GDP procedures **
- Formal models for CDM
  - Model based approach to ration-by-schedule and compression **
  - Formal models of collaboration in ATM
- Data analysis
  - support for uncertainty modeling
  - evaluation of CDM effectiveness

** Discussed today

Model-Based Approach to Ration-by-Schedule and Compression

MOTIVATION:

- Use of well-understood process:
  - can predict impact on new/unusual situations
  - generates ideas for improvements
  - easier to transfer to new areas, e.g. collaborative routing
- More robust software
- Easier to upgrade/add new features

Fundamental Model Input: Airline "Goals"

OAG Schedule (Airport Accept Rate - 60/HR):	Goals (Degraded Airport Accept Rate - 30/HR):
1600:AAL826	[1600-1601: AAL]
1601:AAL290	[1602-1603: AAL]
1602:UAL687	[1604-1605: UAL]
1603:USA322	[1606-1607: USA]
1604:UAL950	[1608-1609: UAL]
1605:COA211	[1610-1611: COA]
1606:UAL543	[1612-1613: UAL]
1607:AUL334	[1614-1615: AAL]
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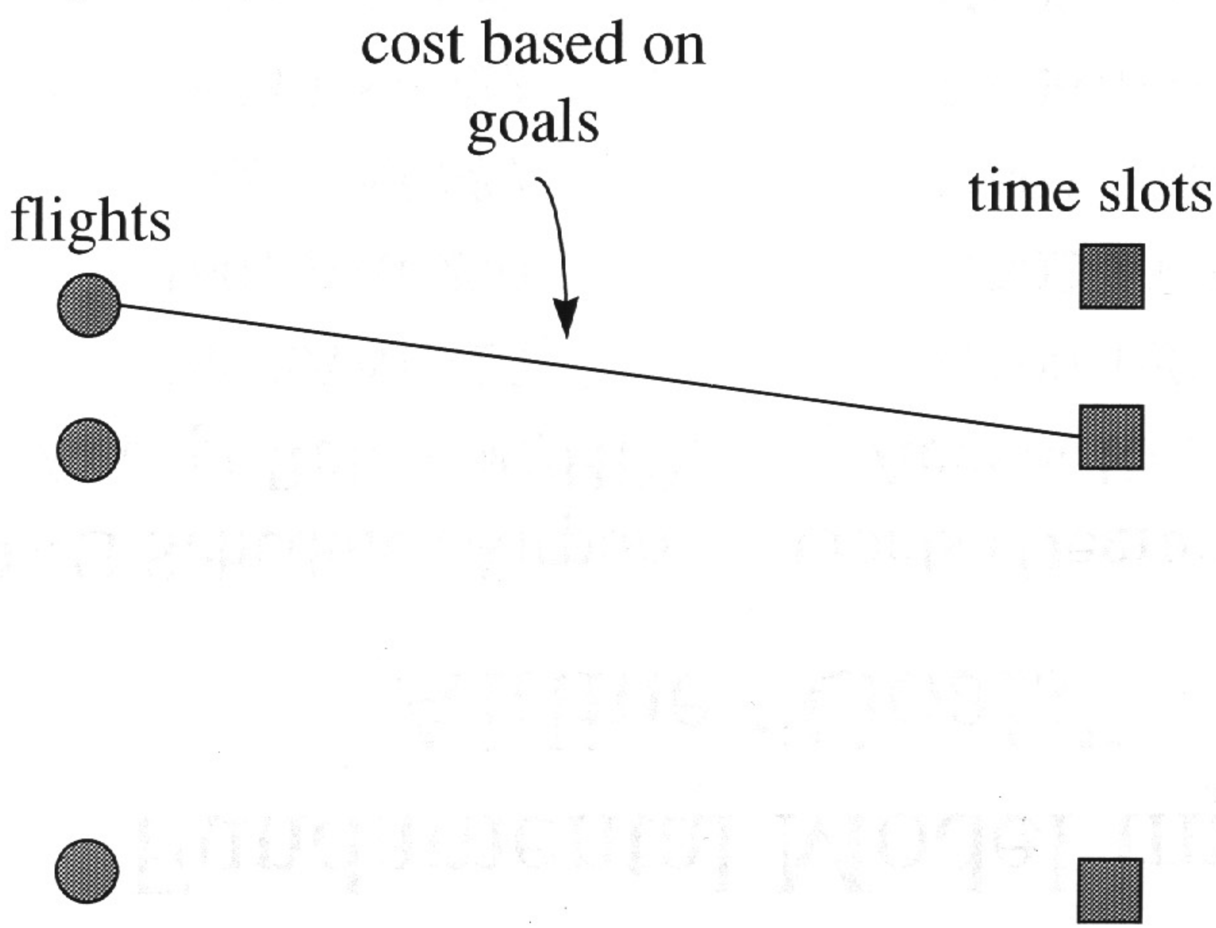
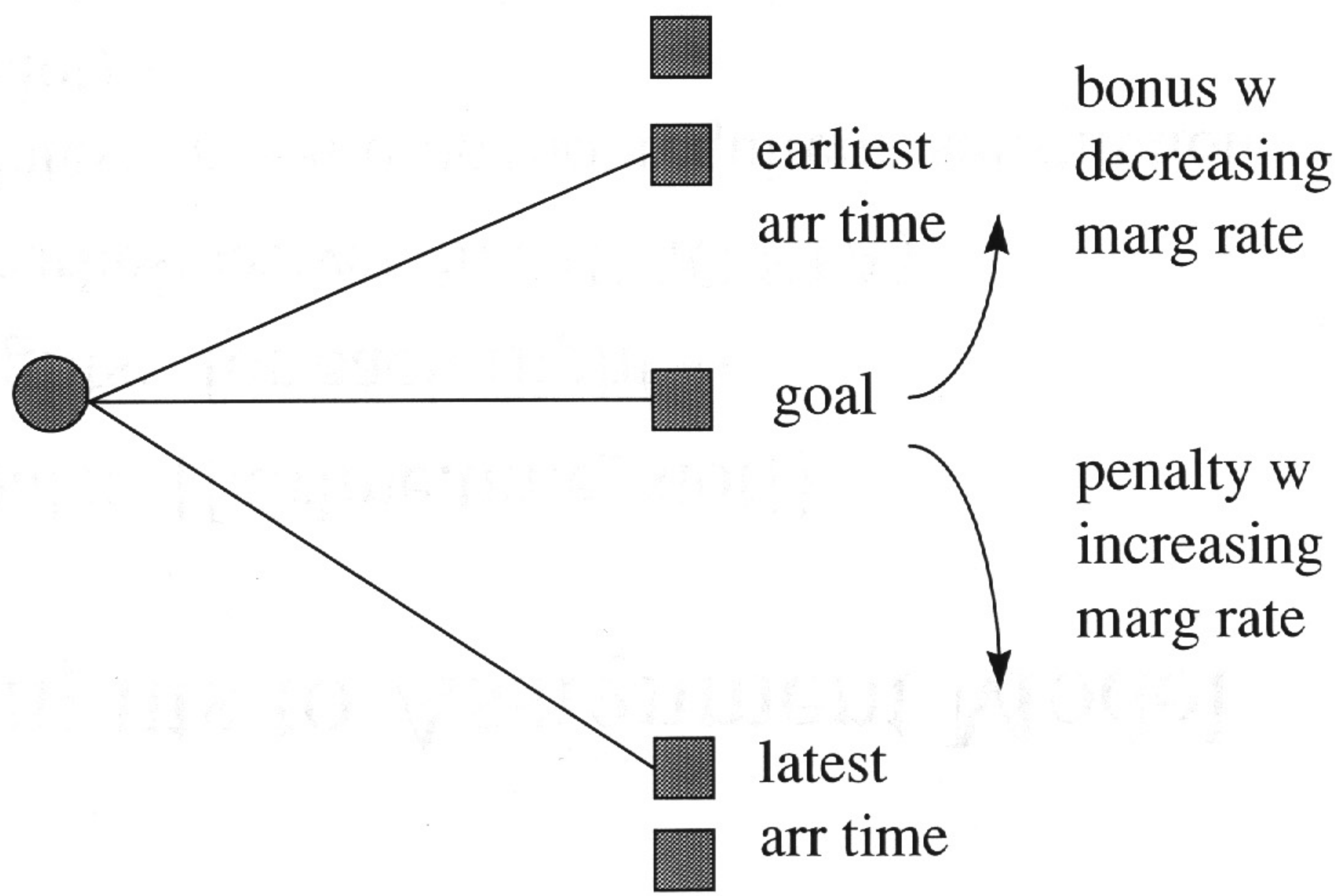
Min-Cost Assignment Model



Inputs to Assignment Model

- Goals: {[airline,time_slot]}
- Flights: for each flight --
  - earliest arrival time (OAG ETA)
  - latest arrival time (not required; substitution slot)
  - goal (at most 1 flight per goal)

Assignment Cost Definition



Comparison with RBS/Compression

- Assignment model has more flexible input requirements:
  - "current" inputs (flight/goal association + latest arrival time)
  - only flight/goal associations
  - ordered flight lists
- Computational results: two approaches give very similar results -- with a few exceptions:
  - Value of goal/slot
    - RBS/Compression gives advantage to airline only if "bridge" can be formed from slot owned by airline to flight
    - Assignment model (currently) values all goals equally
  - Results of assignment model are independent of order of airline response

Representation and Modeling of Weather Uncertainty within CDM Procedures

- **ISSUE:** Currently FSM bases all decision support on a single forecasted airport acceptance rate (AAR) scenario
- **SOLUTION:**
  - allow representation of multiple AAR scenarios and their likelihood's within FSM
  - provide tools which aid planner in making decisions based on new information

Multiple Arrival Acceptance Rate (AAR) Scenarios

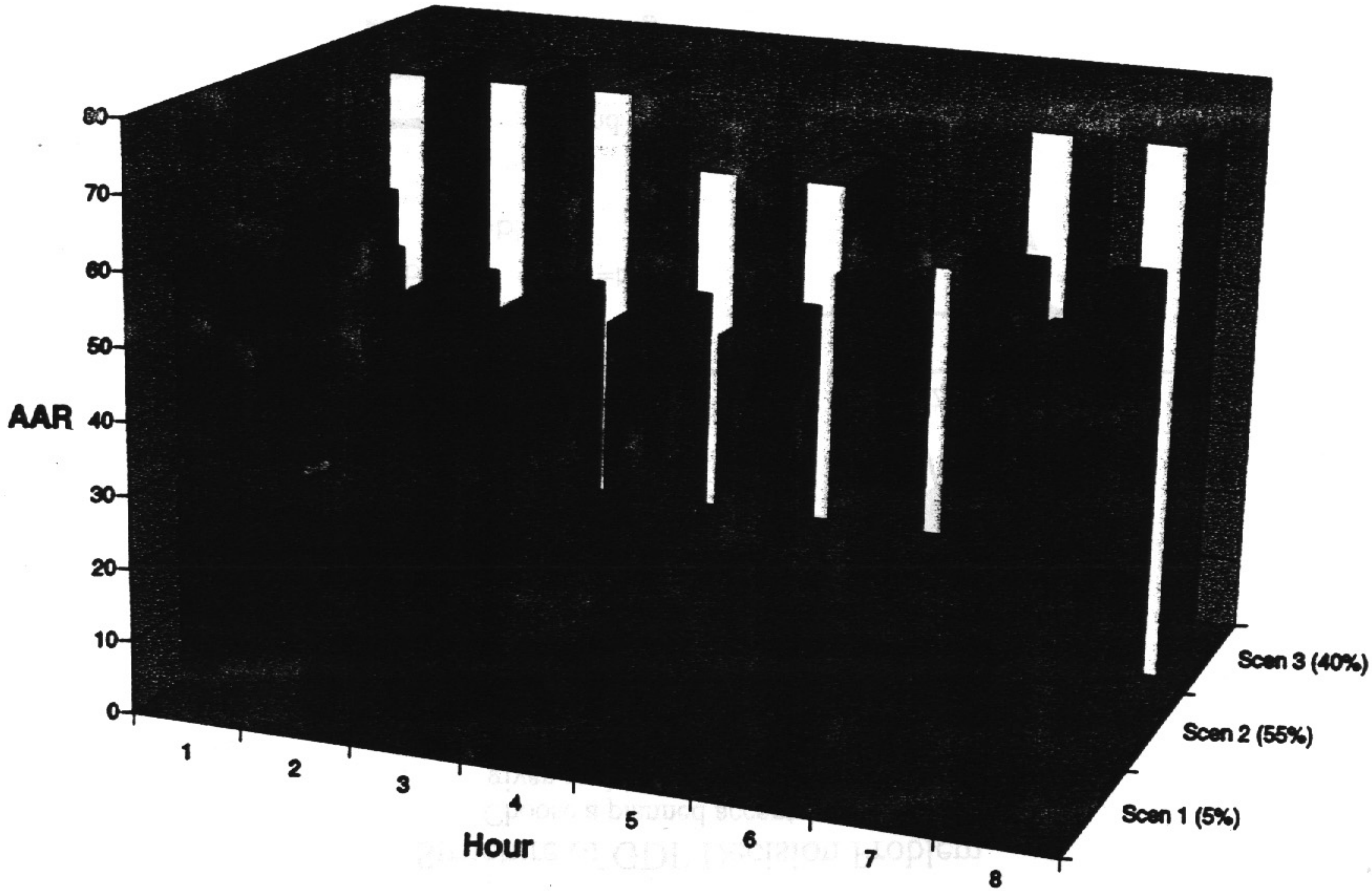
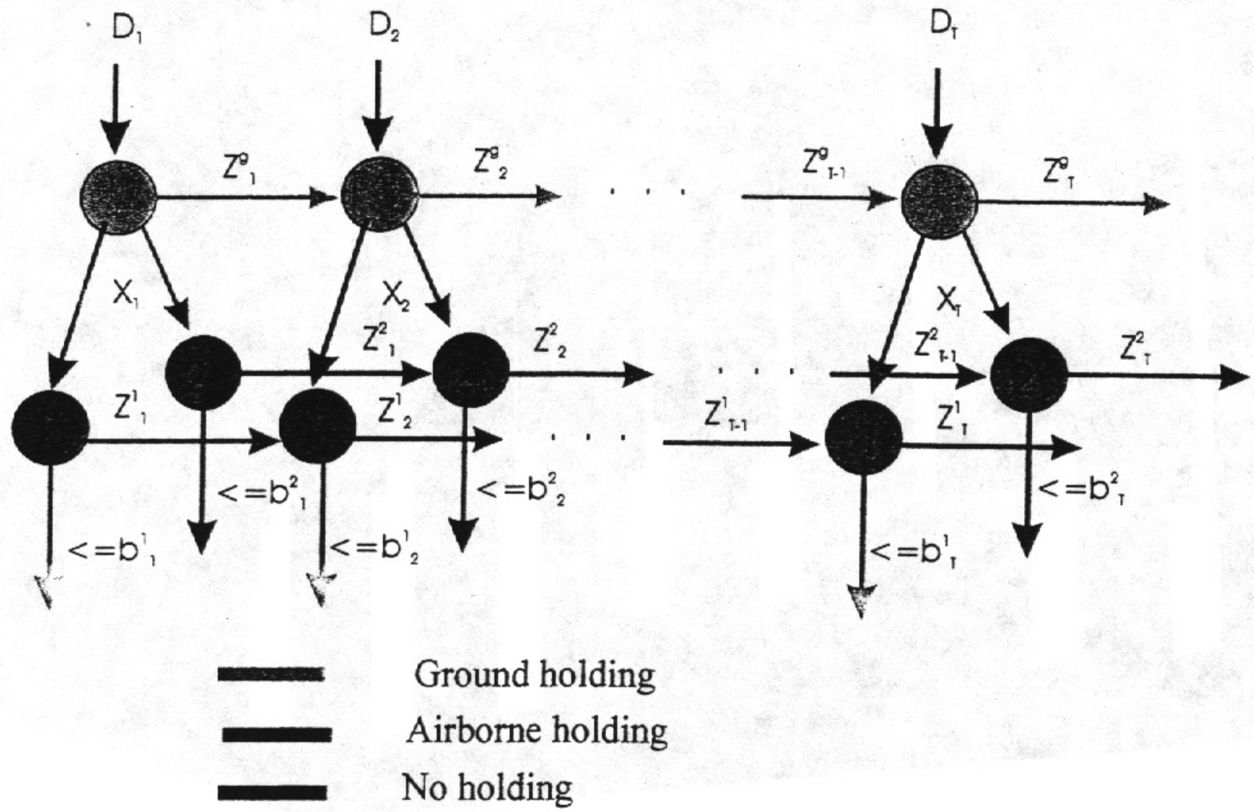


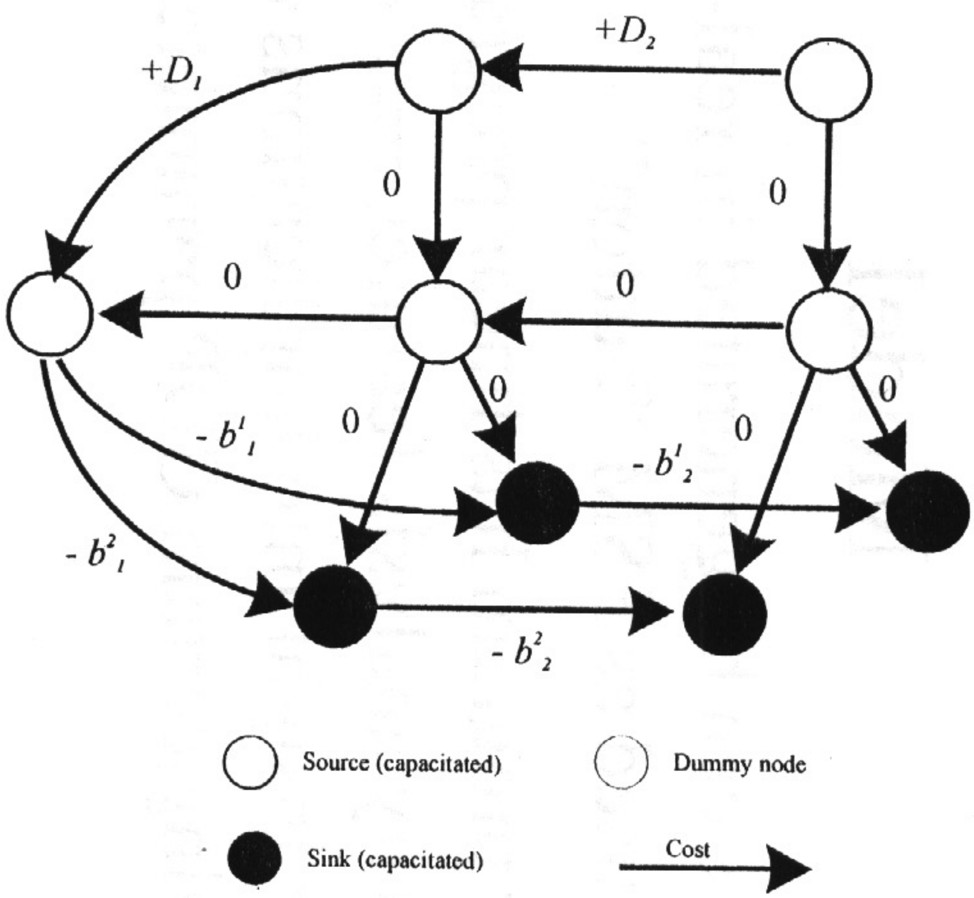
Chart 1

Structure of GDP Decision Problem

Choose a planned acceptance rate,
given multiple weather scenarios:



Transformation of Original Model to "Dual Network" Model



Implications of Dual Network Model

- PAAR's can be generated in real-time ==> can be used as FSM "button"
- Integer program has linear program-like sensitivity analysis features ==> can give planner insight into implications of modifying certain GDP parameters

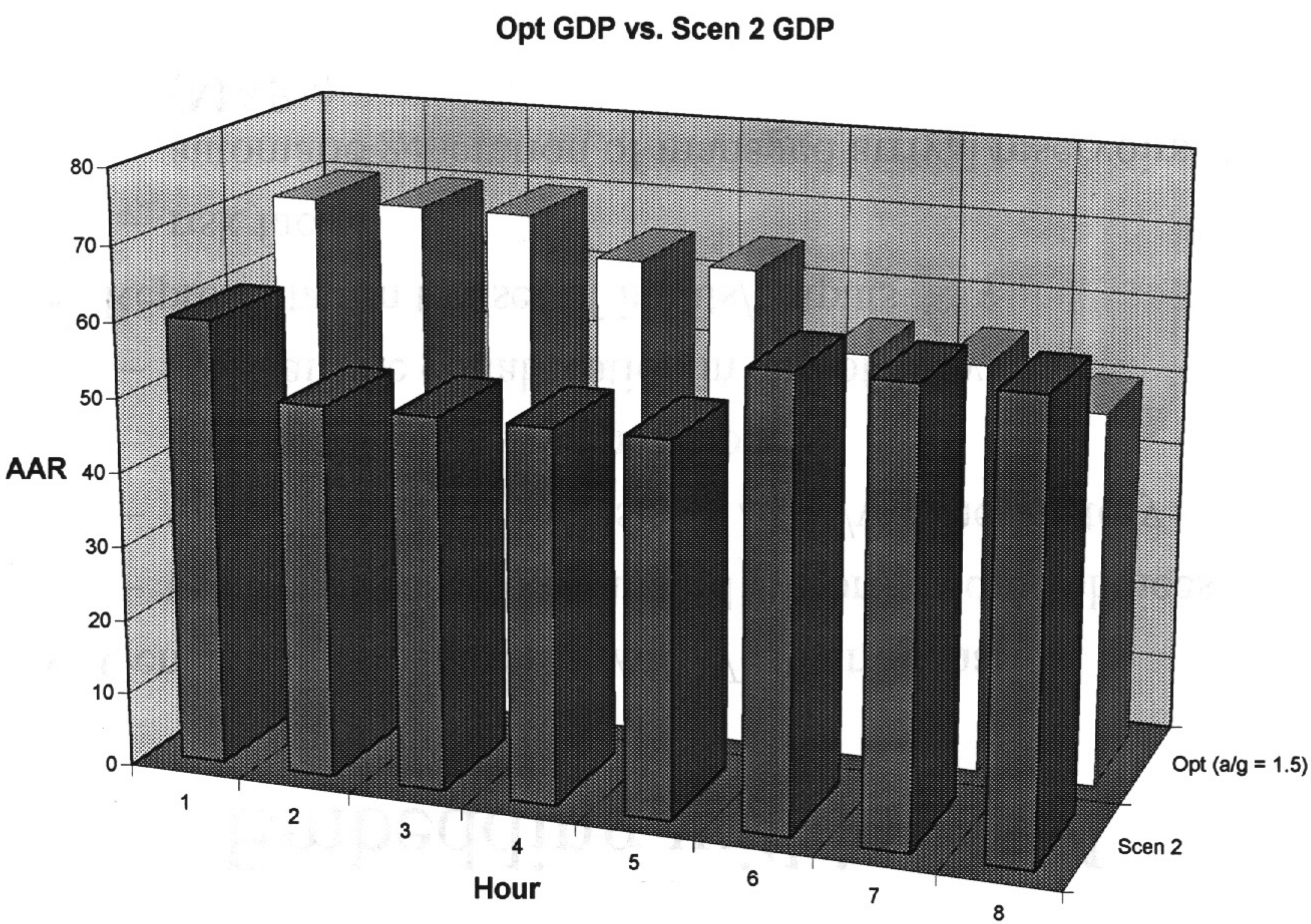

Opt GDP vs. Scen 2 GDP
AAR
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Hour
Opt (a/g = 1.5)
Scen 2

Chart 2

Embedding within FSM

- Generation of Multiple AAR/Weather Scenarios
  - user input based on standard airport-specific choices
  - model driven by analysis of AAR/weather history
  - model driven by weather models
  - FAA/airline collaboration in any of above
- Representation to user of inputs/outputs
  - risk factor
  - automatic generation of managed arrival reservoirs (MARs)