Collaborative Decision Making (CDM) Year 2000 and Beyond

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Growing CDM Participation: 33 members

CDM Members (Including Sub-carriers)	
AAL	American Airlines
EGF	American Eagle Airlines
COA	Continental Airlines
BTA	Jet Link
DAL	Delta Airlines
CAA	
COM	ComAir
SWR	Swiss Air
NWA	Northwest Airlines
MES	Mesaba Airlines
SWA	Southwest Airlines
TWA	Trans World Airlines
UAL	United Airlines
AWI	Air Wisconsin Airlines
BLR	Atlantic Coast Airlines
GLA	Great Lakes Aviation
UFS	Union Flights
FDX	Federal Express Airlines
GAA	Business Express
ACA	Atlantic Coast Airlines
UPS	United Parcel Service Airlines

CDM Members (Including Sub-carriers)	
USA	United States Airlines
ALO	Allegheny Airlines
ASH	Air Shuttle
CDL	
CHQ	
JIA	
PDT	Piedmont Airlines
UCA	
AWE	American West Airlines
MEP	Midwest Express Airlines
LOF [1]	Trans World Express
SKW [2]	Skywest Airlines

Note 1: LOF is sub for UAL, USA, TWA.
Note 2: SKW is sub for UAL and DAL.

Not CDM Member, But MOA Signed	
CDN	Canadian Airlines
ONT	Air Ontario
ROA	Reno Air
TRS	AirTran Airways

FSM Deployment to Centers

▌ Flight Schedule Monitor (FSM)
  ▌ Primary operational/monitoring tool for GDPs
  ▌ Already in use at ATCSCC and at AOCs
▌ Now at 36 (U.S.) ATM Locations
  ▌ ATCSCC, 20 ARTCCs, 11 TRACONs
  ▌ FAA Academy, Technical Center in Atlantic City, Volpe Center
  ▌ NAV Canada, Canadian Centers, Toronto Center


FSM Deployment to Centers
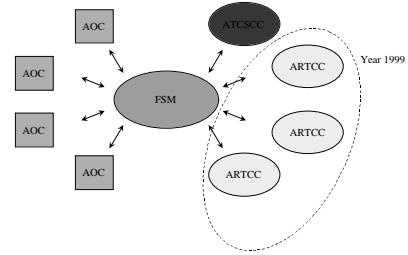
CDM Airport Arrival Information

▌ CDM Strings
  ▌ confluence of Airline operational info with ETMS
  ▌ GDP-oriented: aggregate demand lists
▌ 1999 Enhancements
  ▌ dual strings: redundancy, more robust, stronger firewall
  ▌ in addition: test string, development string
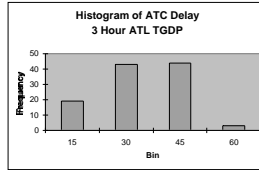▌ Future direction
  ▌ merge fully with ETMS

Tactical GDPs

▌ TGDP serves as
  ▌ "short notice" GDP
  ▌ alternative to ground stops
▌ Advantages of TGDP over Ground Stops
  ▌ better planning for airlines
  ▌ smoother delivery of traffic into airport
  ▌ less delay (ground + air)

Assigned Ground Delay Comparisons - ATL

Histogram of ATC Delay
90 Minute ATL Ground Stop

Frequency

Bin: 15, 30, 45, 60, 75
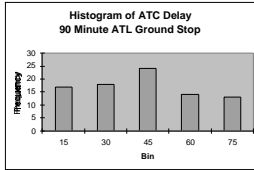
86 flights
avg = 35
standard deviation = 19.91
variance = 396
range = 73

Histogram of ATC Delay
3 Hour ATL TGDP

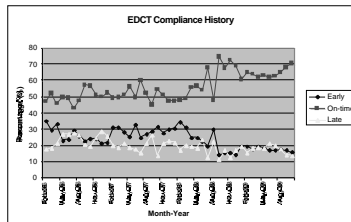Frequency

Bin: 15, 30, 45, 60

109 flights
avg = 26
standard deviation = 11.88
variance = 141.03
range = 53

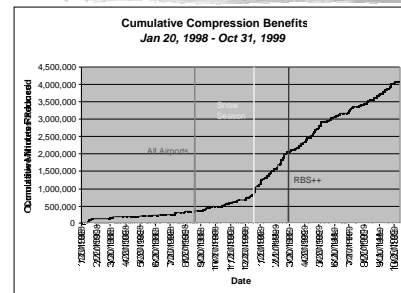## CDM Benefits and Performance

❚ On-going analysis
  ❚ Metron
  ❚ NEXTOR
  ❚ CDM Analysis Sub-group
❚ Benefits Assessment
  ❚ FFP1 Program Office
  ❚ NEXTOR Benefits Report

EDCT Compliance during a GDP

EDCT Compliance History

Percentage (%)

Early
On-time
Late

Month-Year

Compression Benefits Trend
Jan. 20, 1998 - Oct. 31, 1999

Cumulative Compression Benefits
Jan 20, 1998 - Oct 31, 1999

Cumulative Minutes Released

Snow Season

All Airports

RBS++

Date

CDM Proven Track Record

❚ GDP-E Proven Track Record
  ❚ Increased flexibility
  ❚ Increased predictability
  ❚ More efficient tools
  ❚ Situational awareness
  ❚ Community involvement
❚ The New Frontiers
  ❚ Departure/Arrival Balancing
  ❚ Collaborative Routing

Departures and Arrival Balancing

❚ Departure and Arrival Balancing
  ❚ So far, CDM has been arrival oriented
  ❚ CDM approach must be preserved
  ❚ MIT PhD Thesis by W.Hall (under A.Odoni)
    ❙ integrates E.Gilbo Model (Volpe), CDM paradigms
  ❚ MIT models: N.Puget, JPClarke, L.Kang

Collaborative Routing

- Apply GDP concepts/paradigms to the en-route environment
  - RBS, compression algorithms
  - User preferences
  - Situational Awareness
- Main problems
  - weather
  - congestion

En-Route Issues

- Rerouting around congested areas
  - routes vs. sectors
  - aggregate demand lists (ADLs)
  - off-loading to other sectors/routes
- Ground Delays
  - Use GDP-like tools to ground delay flights?
- Air Delays (assigned)
  - Use of Miles-in-Trail (MIT) restrictions
  - Integration with other control measures

Why CR is harder than GDP

- Stochastic demand
  - Deterministic at airport: just need good data
  - But 20% of sector/route traffic is "unpredictable"
- Multi-dimensional nature
  - space allocation as well as time allocation
  - rolling planning horizon
  - multiple resources (arrival fixes, sectors, routes)
- Capacity Metrics
  - airspace harder than arrival resource

Why CR is harder than GDP (2)

- Lack of RBS in the SKY
- Integration with other ATM initiatives
  - linking of multiple centers with distinct operational behaviors
- Data Issues
  - Order of magnitude more data necessary than for runway resources

Community Solutions

- Air Transport Community Involvement
  - collaborative paradigms/rationing schemes
  - mixture of user rerouting and ATC delay
- Can GDP concepts carry over?
  - Rationing of en-route resources
  - Compression analog (T.Vossen, T.Butler, M.Ball, UMD)
- Coded Swap Routes (CDR)
  - need for simplified identification of routes

Stochastic Solutions

- Stochastic Modeling
  - ADL modifier for demand (R.Hoffman, M.Ball, UMD)
  - Statistical Models for Capacity Prediction (T.Inniss, M.Ball, UMD)
  - Departure predictions (L.Kang, JPClarke, MIT)
- General Education:
  - ATM/AOC use of probabilistic information

The Proper Role of Optimization

❚ What is "optimal"?
  ❚ Balance between global efficiency and user preferrence
  ❚ The Yardstick: How far off are we?
❚ Integer Programming/Network Flow Models
  ❚ J.Goodhart, (C.Yano) PhD Thesis, UCB
 ❚ S.Stock, D.Bertsimas, MIT

Other Solutions

❚ Simulation
  ❚ Historical playback
  ❚ T, the fifth dimension
  ❚ What-if modeling
❚ Game Theory
  ❚ How to specify options/preferences
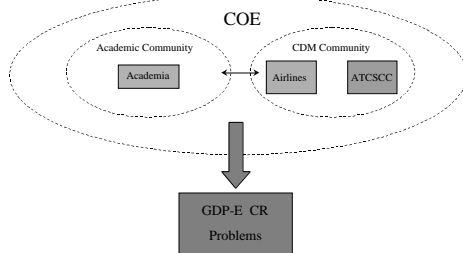 ❚ Choices made w/o knowing choices of competitors

CR Analysis Tools (2)

❚ Post-operative Analysis Tools
  ❚ Metron/OSU POET software for en-route anlaysis
  ❚ Off-loading to other sectors/routes
❚ Off-loading to other sectors/routes
  ❚ identify potential off-loads
❚ Constraint identification products
  ❚ MITRE's CCFP

The Working Paradigm
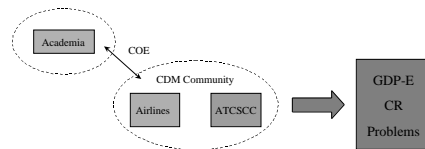
Year 2000 and Beyond

CDM Academic-Industry Coordination

Background Info:
CDM http://www.metsci.com/cdm/
NEXTOR http://www.isr.umd.edu/NEXTOR/home.html

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