COLLABORATIVE DECISION MAKING FOR AIR TRAFFIC MANAGEMENT: A PRELIMINARY ASSESSMENT

Prepared by

NEXTOR

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Questions Considered

Has CDM led to improvements in the quality of information and information distribution?

What has been the direct impact on GDP planning at San Francisco and Newark?

Has CDM had an impact on overall airline decision making?

What are the prospects for future CDM benefits?

Inputs to Analysis

Direct analysis of air traffic data

Reports from airlines

Interviews with ATCSCC specialists

CDM Vision

Improve Air Traffic Flow Management by:

- generating better information by combining information generated by the FAA with information generated by National Airspace System (NAS) users;
- distributing the same information both to FAA managers and to NAS users;
- creating tools and procedures that allow NAS users:
  - to directly respond to capacity/demand imbalances,
  - to collaborate with FAA traffic flow managers in the formulation of flow management actions.

CDM Status

Agreement on new paradigm for ground delay programs (GDPs)

Regular meetings of all CDM players

Flight Schedule Monitor (FSM)

CDMNet

Prototype implementation

Work on future applications: NAS Status, Collaborative Routing

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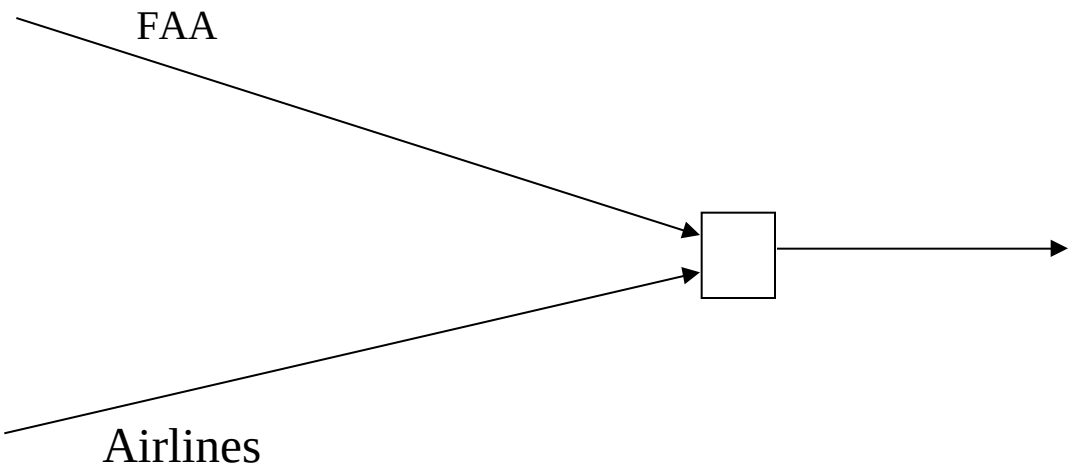
The Promise of CDM: Improved Information Quality



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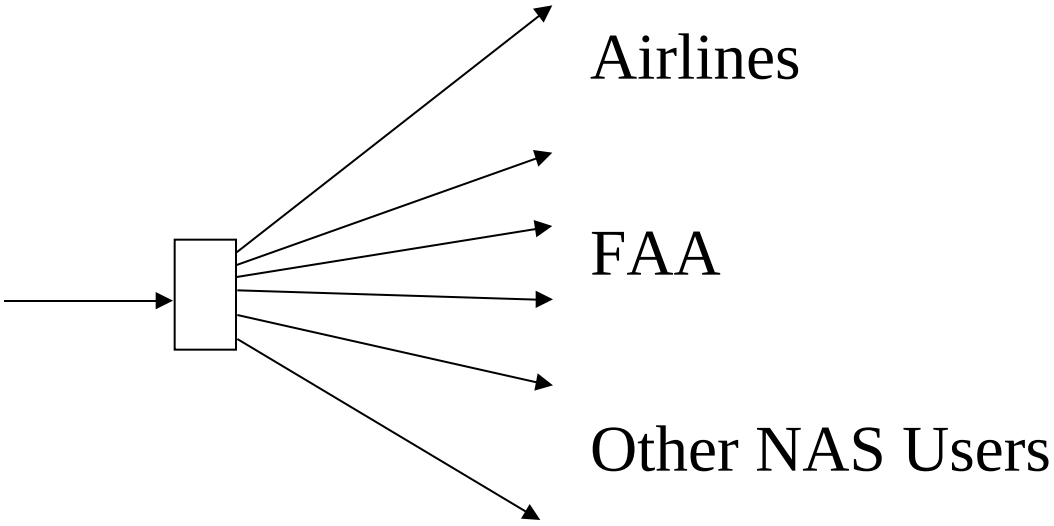
The Promise of CDM: Better Information Distribution



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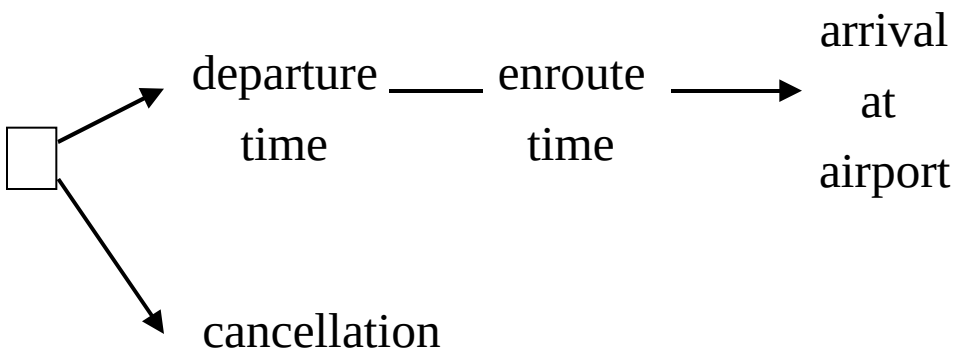
Information Quality Comparison

ETMS: current database of flight information and predictions (old system) -- monitored via “C-string”.

ATMS: CDM enhanced database of flight information and predictions (new system) -- monitored via “CDM-string”.

Predicting Arrival Demand

Accurate prediction of the arrival demand profile at an airport is essential to the calibration of a GDP.



Information Analyses

Departure Time Predictions

Cancellation Notices

Arrival Time Predictions

Arrival Demand Profile

Under CDM

- departure time predictions are based on FAA and airline provided information
- a new cancellation notice is available to the airlines

IPE metric

Measures performance of a stream of predictions for a single event

Assigns a single value to each flight over its entire history

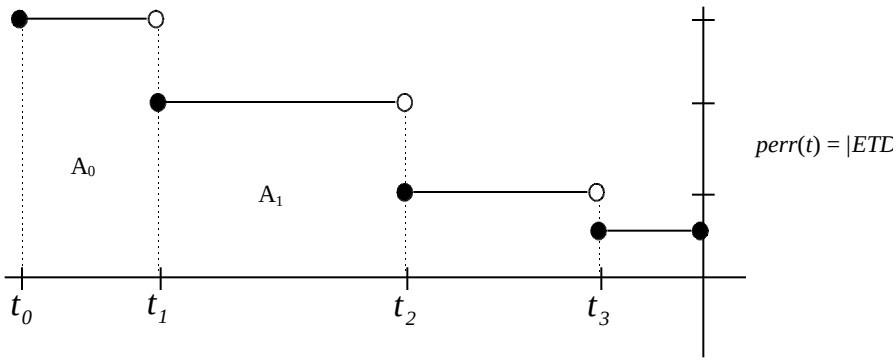
Robust w.r.t. bad flight records - more general than a snapshot

Can be applied to any stream of predictions for a single event (dep, arrv, cnx, etc.)

Allows for aggregate stats (e.g. by airline)

IPE Metric for Departure Time

$$IPE(f) = \sum_{t=0}^{t=n} ETD^{f}(t) = \sum_{k=0}^{n} (t_{k+1} - t_k)\, perr(t_k)$$



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IPE-6 performance (ETD)
Common flights only
Feb2 - Mar16 1998

GDP	Av IPE-6		Av Improvement		% of Flights Improved		
	CDM	C	CDM	C	CDM	Equal	C
SFO	27.21	30.86	13.27	14.44	44.88	39.23	15.89
EWR	28.19	35.40	18.71	6.21	46.69	31.63	21.69

non-GDP	Av IPE-6		Av Improvement		% of Flights Improved		
	CDM	C	CDM	C	CDM	Equal	C
SFO	9.74	12.51	9.85	4.21	23.08	68.00	8.92
EWR	13.34	14.72	10.99	12.13	23.56	67.49	8.96

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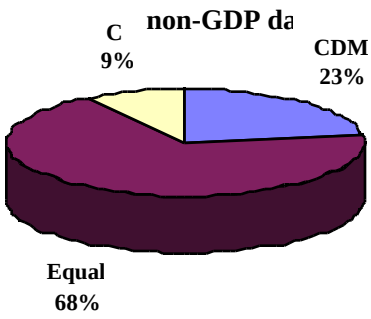
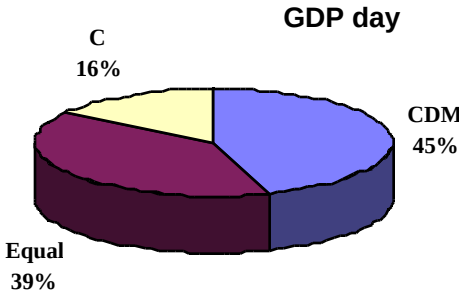
IPE-6 Improvements at SFO
Feb 2 - Mar 16 1998





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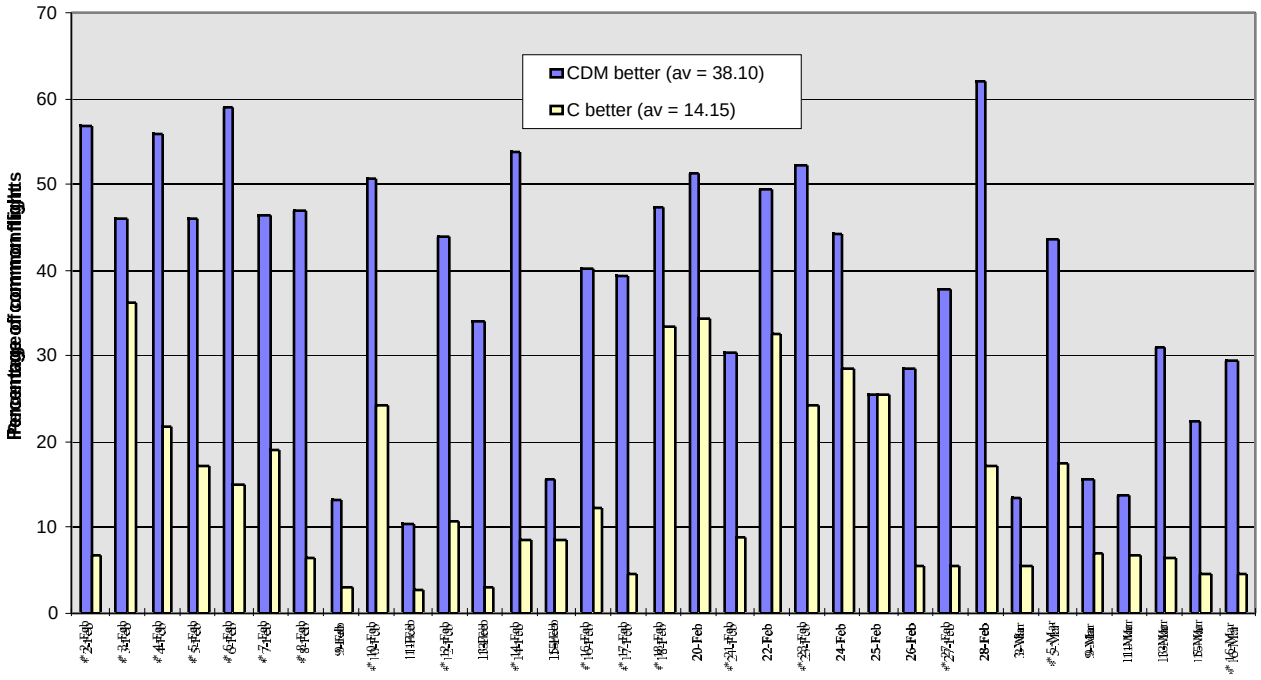
Strict improvements in IPE-6 performance (on ETD) at SFO



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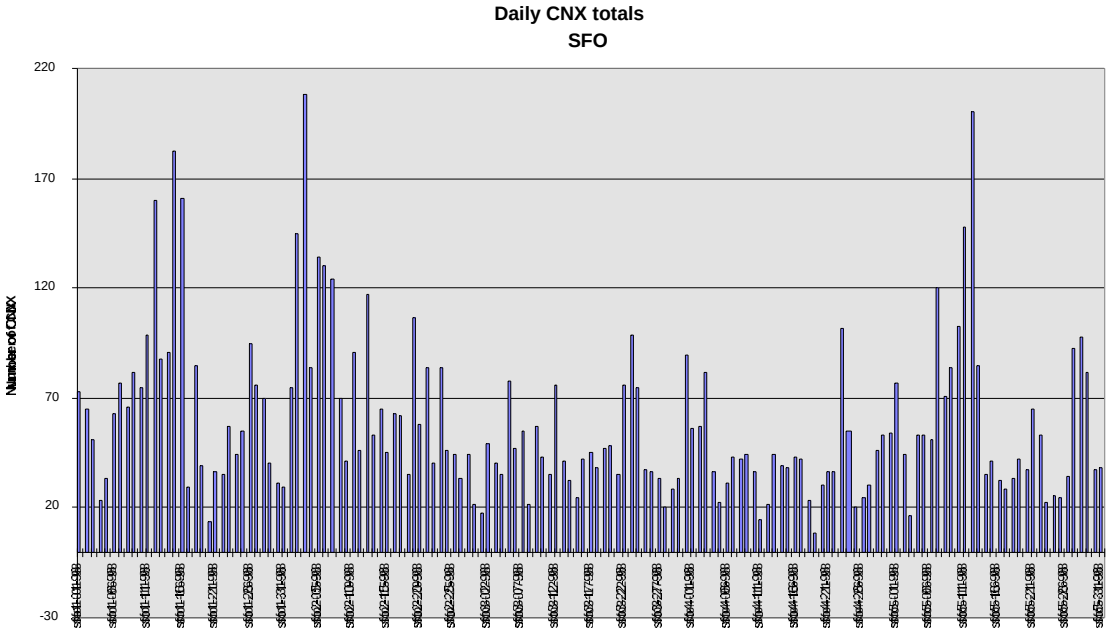
Cancellation Notices

Airlines can cancel flights for a variety of reasons.

The number of cancellations varies substantially from day to day and can be particularly high in the presence of GDPs.

During the Jan -- May 1998 period, on 79% of the days at SFO and 62% of the days at EWR, there was at least one period of heavy cancellations (4 hour period with 28 or more cancellations).

Daily CNX Volatility



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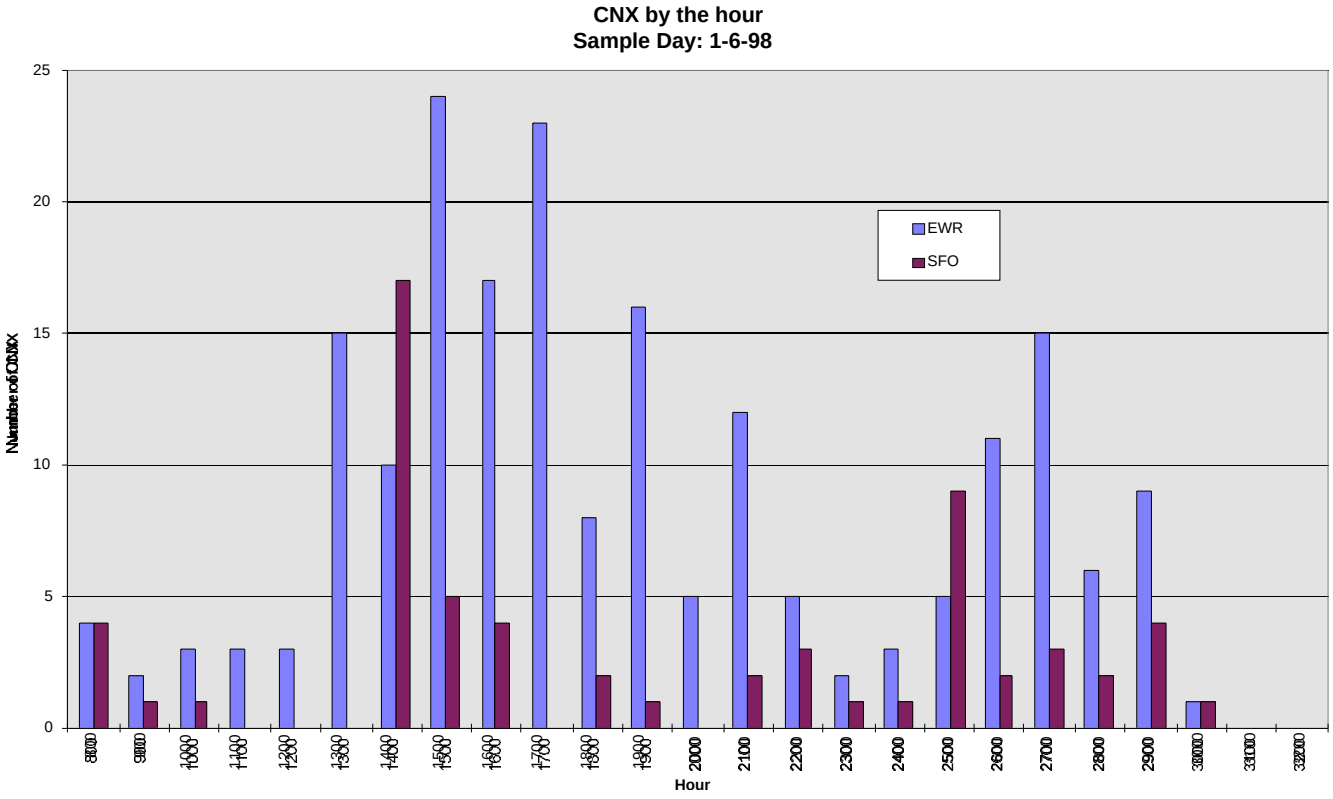
CNX Volatility over a Day



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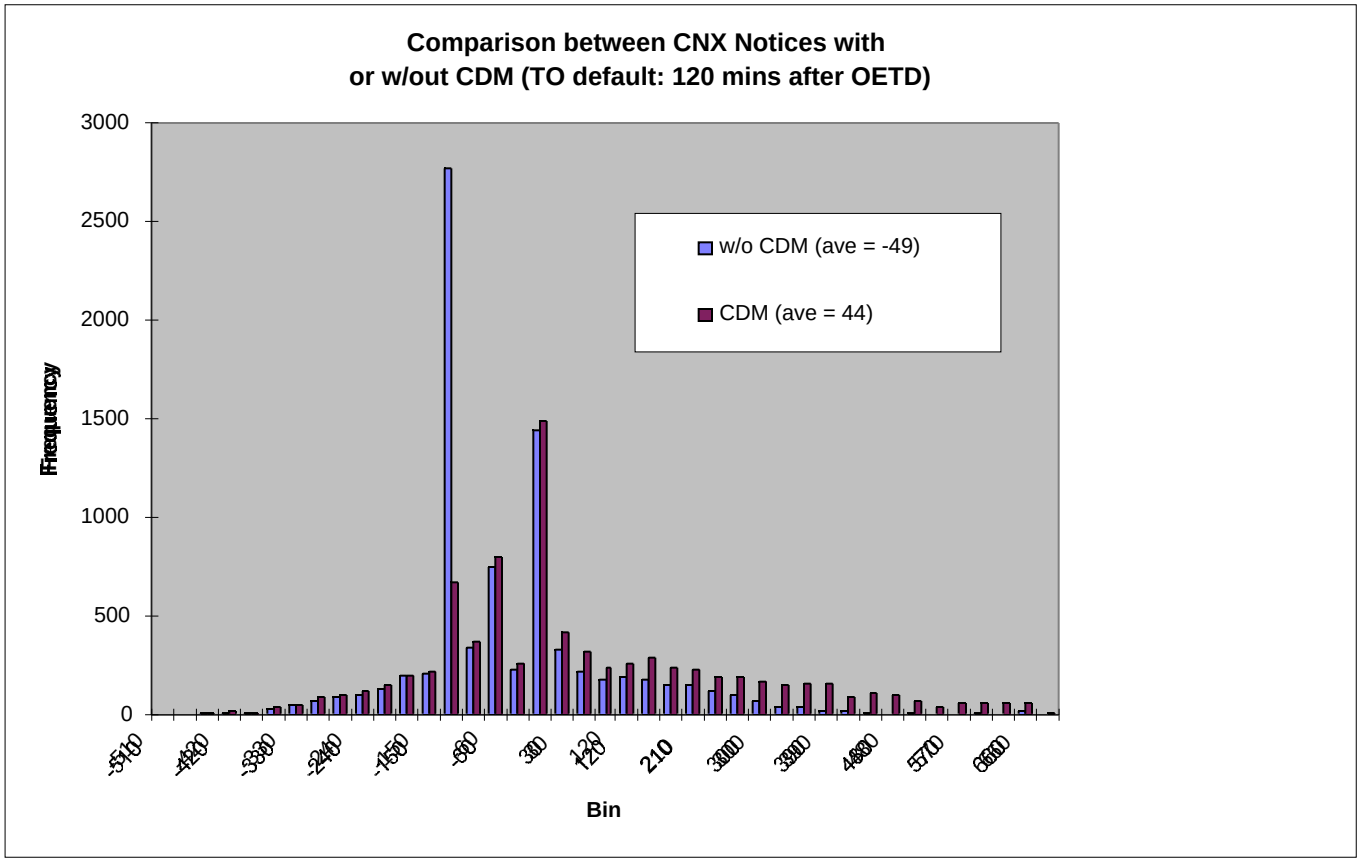
SFO Cancellation Notices



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Cancellation Notice Summary Statistics for Jan -- May Period

Under CDM flight cancellations were reported an average of 47 min *before ETD* at EWR and an average of 44 minutes *before ETD* at SFO.

Without CDM, we estimate that flight cancellations would have been reported, on the average, between 29 and 64 min *after ETD* at EWR and 19 and 49 min *after ETD* at SFO.

Significance of Cancellation Notices

Advance notice of cancellations is particularly important for GDP planning.

Improved cancellation information was cited by one ATCSCC specialist as the biggest benefit of CDM.

Based on the data analyzed to date, the most dramatic improvement in information quality due to CDM, is in the area of cancellation notices.

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Has CDM led to improvements in the quality of information and information distribution?

What has been the direct impact on GDP planning at San Francisco and Newark?

Has CDM had an impact on overall airline decision making?

What are the prospects for future CDM benefits?

Measurement of Impact on GDP Planning

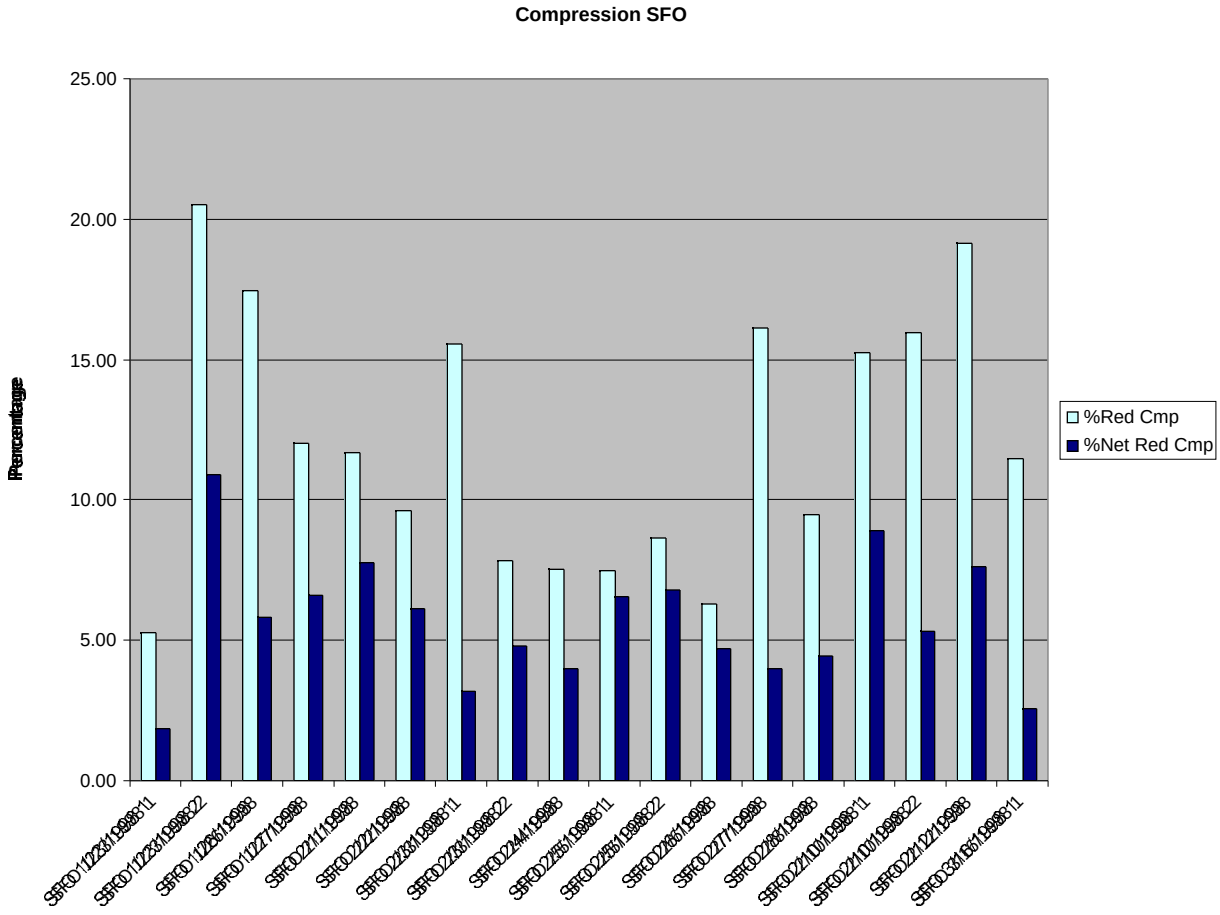
- Measurement of CDM's overall impact on GDP planning is difficult because:
  - CDM influences decision-making in many, sometimes subtle ways
  - measuring overall efficiency of a GDP is difficult
- Compression algorithm
  - unique to CDM
  - eliminates vacant slots and improves overall efficiency
  - compression impact on assigned ground delay can be quantified

Delay Reduction Due To Compression

During the period of January through May, the use of compression resulted in an average reduction in assigned ground delay of approximately 13% at SFO and 12% at EWR.

Slightly over half of this reduction could have been obtained by the airlines through substitutions.

The remainder (6% SFO and 5% EWR) could only be obtained using compression.


Compression SFO
25.00
20.00
15.00
10.00
5.00
0.00
%Red Cmp
%Net Red Cmp

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Value of Compression Savings

Using an industry-accepted value of $25 per minute of delay, the compression savings was $26,000 per GDP at San Francisco and was $29,000 per GDP at Newark. The respective average monthly savings were $269,000 and $100,000.

Airborne Delays

Within a GDP there can be a delicate balance between assigned ground delay, airborne delays and throughput.

Issues:

- What has been the impact of CDM on airborne delays?
- Do some of the ground delay savings represent a transfer of ground delay to airborne delay?

Airborne Delays:
Average Delay per Flight for SFO

	all	GDP	non-G
Jan -- March 97	70.44	72.06	8-0.8
Jan -- March 98	8.11	17.87	60.2
Nov 97	1.64	76.23	41.1

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Airborne Delay: Conclusions

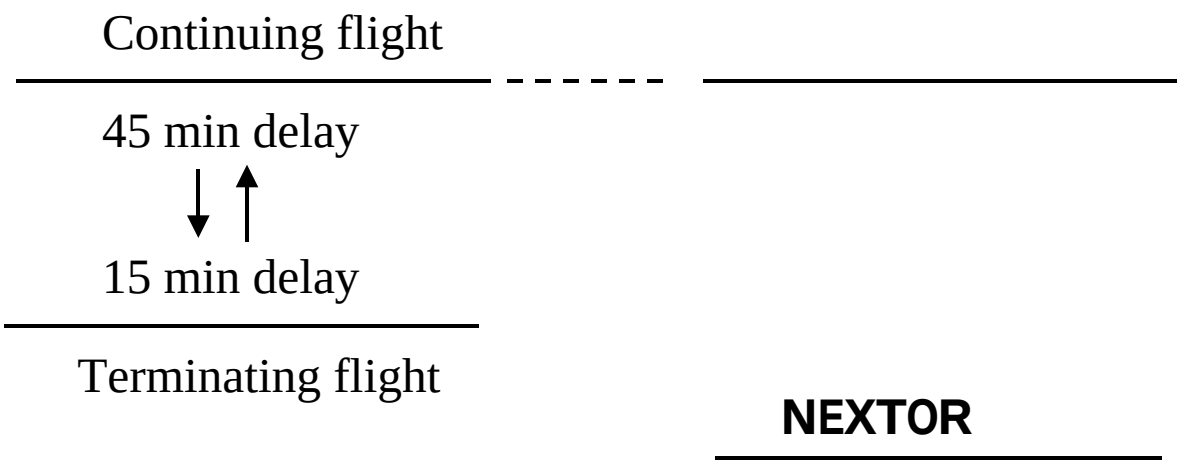
There have been substantial increases in airborne delay from Jan - March 1997 to Jan - March 1998.

Majority of increase was already evident in Nov 1997 (pre - CDM).

We are unable to conclude whether CDM has had a negative or positive impact on airborne delay --- more analysis is required.

Delay Cost Reduction

One could argue that the GDP improvements provided by CDM are more geared toward allowing the airlines to reduce the *cost of delays* rather than only reducing the total delay within a single GDP. We have not been able to estimate such savings in this initial analysis.



Evidence of Airline Delay Cost Savings

United Airlines reports that it has achieved significant delay cost reduction based on the use of GDP-E at SFO and EWR and also the use of FSM to plan its responses to GDPs at ORD. They estimate the value of the total savings over the initial 1 1/2 months of prototype operations to be between $3 to $4 M.

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Improvements in Overall GDP Efficiency

The majority of the ATCSCC specialists interviewed felt that, under CDM, they were able to produce better GDPs:

- FSM revision feature was used very effectively.
- Power run feature has enabled better decisions on which centers to include in programs.
- Improved data (demand predictions) has helped design more effective GDPs.

Impact of Distribution of CDM Information to Airlines

GDP planning at “non CDM” airports.

Airline flow management.

Fuel Planning.

GDP Planning

United Airlines has used information provided by CDM/FSM to help determine the number of flights to cancel at ORD under conditions of degraded capacity.

According to UAL, on at least two separate occasions, the number of canceled flights was reduced by 25% over the number that would have normally been canceled; the estimated total cost savings was $1.5 M.

Airline Flow Management

US Airways uses FSM to determine the size and characteristics of heavy arrival banks at hubs; this information is used by dispatchers for planning purposes.

In times of very high demand US Airways has used FSM to implement its own “internal GDP” to prevent grid lock at a hub airport.

Airline Flow Management

Delta uses FSM to estimate anticipated airborne delays on flights arriving into hubs during peak periods; this is used to determine whether diversions will be necessary.

Delta estimates that, based on the more accurate information provided by FSM, they have been able to allow flights that normally would have been diverted to go on to their destination airports.

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Fuel Planning

United Airlines, US Airways and TWA report using FSM to estimate airborne delay and thus obtain a more accurate estimate of fuel requirements.

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Prospects for Future Benefits

We feel the following factors indicate the prospect for future benefits is strong:

- movement out of prototype operations
- the current extension of CDM-based GDPs to all major US airports
- improved ability of airlines to take advantage of CDM capabilities
- improvements in GDP planning through better data quality and new FSM features
- application of CDM in other areas, including distribution of NAS status information and collaborative routing.