Class Outline

• Instructor background

• What is CDM? What is Traffic Flow Management (TFM)?
  – And why do we need to learn about TFM first?

• Collaborative Decision Making (CDM)
  – Overview of concept and purpose/goals of CDM
  – What needed improving? How does CDM address this?
  – CDM in action: workgroups, data flow, and benefits
  – Support for CDM
    • ATCSCC products and services
    • CDM Tools
  – Development of new concepts – CDM workgroups
  – The future of CDM

• TFM/CDM – a real-world example

• (Next Class): FAA and airline perspectives/approach to our RWE; opportunity for questions and discussion of TFM/CDM.
Who We Are

• **Michelle Somerday**
  – Ph.D. in Materials Science and Engineering.
    • ATCSCC QA department (TFM/CDM issues)
    • Free Flight Office Benefits Team (specifically CDM)
    • Project Lead for Flight Schedule Analyzer (CDM tool)

• **Andre Merling**
  – B.S. and M.S. in Aerospace Engineering.
  – Licensed aircraft dispatcher since 1993.
  – jetBlue flight operations performance manager.
  – Joined Metron Aviation as TFM/CDM analyst in 2002.

• **Patrick Harten**
  – FAA air traffic controller and manager in NY Metro area for 20 years.
  – ATCSCC National Operations Manager (NOM) for 10 years.

• **Mike Wambsganss** – President of Metron Aviation, Creator of FSM
• **Kevin Kollmann** – VP of C&IA at Metron Aviation, CDM Industry Co-Chair 1996-1998
• **Jack Kies** – Former Director of Tactical Operations at ATCSCC (Retired January 2005)
What is CDM?

- Collaborative Decision Making (CDM) is a joint government/industry initiative aimed at improving air traffic flow with collaborative technologies and procedures, and providing the greatest benefit to all parties.

- The principle behind CDM is that shared information on all sides will lead to a safer and more efficient National Airspace System (NAS).

- TFM system provides the basis for CDM; impossible to discuss one without the other.
What is (A)TFM?

- Traffic Flow Management (TFM) is the strategic planning and management of air traffic demand to ensure smooth and efficient traffic flow through FAA-controlled airspace.
- To support this mission, traffic management specialists (TMSs) at the ATCSCC* and traffic management coordinators (TMCs) at local facilities (ARTCCs+, TRACONs°, and towers) use a combination of automation systems, tools, and procedures.
- The Enhanced Traffic Management System (ETMS) is the core of the TFM Infrastructure (Volpe).

* - Air Traffic Control Systems Command Center
+ - Air Route Traffic Control Center
° - Terminal Radar Approach Control
ATCSCC

• The ATCSCC is the cornerstone of the FAA TFM effort and is relatively new (1994).
• Take “Command and Control” concept from military, apply to TFM within NAS.
• Prior to this time, facilities were responsible for coordination among themselves; no central coordination was performed.
• Responsibility for “working planes” is still left to enroute and terminal facilities (ARTCCs, TRACONs, towers).
ATCSCC Purpose and Scope

TMSs at the ATCSCC monitor traffic, weather, resource capacity, and equipment status across the NAS to develop a system-wide perspective of NAS traffic flows and determine the broader implications of local situations (i.e. situations that affect the operations of a single en route center or a single approach control facility). TMSs are trained to work toward system-wide efficiency without allegiance to an individual ARTCC, TRACON, or tower.
ARTCC and TRACON facility TMCs generally manage traffic situations affecting their airspace. They coordinate with neighboring facilities through the ATCSCC as needed and report status information to the ATCSCC. When traffic situations have broad impacts or when the underlying cause is extreme or long lasting, however, the ATCSCC takes the lead in planning and coordination.
Severe Weather Event

Traffic Situation Display (TSD) utilizes ETMS data feed.
NY Traffic Impact on NAS

Normal traffic flows into EWR
Planes spaced at 5 miles
The diagram illustrates the impact of traffic congestion on NAS due to low ceilings over EWR.

- **EWR** reduces the arrival rate at 9:00 due to low ceilings.
- **ADR drops from 100 to 80.**

The map shows the routes for flights to and from various airports such as ZAU, ZOB, ZNY, ZMP, ZBW, ZKC, and ZID.
Components of the ATSCC

- Weather Unit
- Severe Weather Unit
- Strategic Planning Telcon (SPT) / Strategic Plan of Operations (SPO)*
- Tactical Consumer Advocate*
- East and West Area Specialists
- Computer Systems Analyst
- CARF
- NOCC
Planning Horizon and Approach

• ATCSCC – national, strategic outlook, i.e. national weather picture. Longest planning horizon among all facilities – up to six hours in the future.

• ARTCCs and TRACONs – concerned with center/terminal arrivals, departures, and overflights. Generally flights are in/out of ARTCC and TRACON boundaries within an hour or less. Therefore TMCs focus on a two-hour window.

• Tower – extremely tactical. Traffic specialists are more concerned with getting flights that they can see on and off the ground rather than with predicting future demand/capacity imbalances.
TM Situation Awareness

1. Acquire Environmental Information (Section 5.1.1)
2. Determine Resource Capacities (Section 5.1.2)
3. Determine Current and Predicted Demand Profile (Section 5.1.3)

- Monitor Demand/Capacity Imbalance (Section 5.1.4)

Unacceptable TM Situation

TM Initiative Planning and Implementation

Do Until Demand/Capacity Imbalance is Resolved

1. Assess & Implement Restriction Strategies (Section 5.2.1)
2. Assess & Implement Metering Strategies (Section 5.2.2)
3. Assess & Implement Rerouting Strategies (Section 5.2.3)
4. Assess & Implement Other Airborne Delay Strategies (Section 5.2.4)
5. Assess & Implement Ground Delay Strategies (Section 5.2.5)

Operational Planning and Analysis

1. Operational Data Updating and Distribution (Section 5.3.1.1)
2. Operational Data Archival and Recovery (Section 5.3.1.2)
3. Plan for Special Government Events (Section 5.3.2)
4. Plan for Special Civilian Events (Section 5.3.3)
5. Analyze TM Initiative Effectiveness (Section 5.3.4)
Traffic Management Initiatives

• Traffic management personnel employ the least restrictive methods available to minimize delays. Dynamic initiatives are those imposed on an as-needed basis to manage fluctuations in traffic demands. The list of these initiatives is not exhaustive and does not preclude “innovation.” The objective is safety, efficiency, and improved customer service.

• In order from least restrictive to most restrictive methods, these include:
  – Altitude
  – Miles-in-Trail/Minutes-in-Trail
  – Speed Control/Vectoring
  – Airborne Holding
  – Sequencing Programs: Departure Spacing Program (DSP), Enroute Sequencing Program (ESP), Arrival Sequencing Program (ASP)
  – Rerouting
  – Ground Delay Programs
  – Ground Stop
Airline Perspective on TFM

• The primary goal of the airlines with respect to traffic management is to meet their flight schedules. The airlines would like the overall demand for limited air traffic resources to accommodate their specific traffic needs.

• For this reason, airlines are interested in current and predicted demand as determined by the NAS. Tools they may use for monitoring demand on the NAS are:
  – CCSD – web-based FAA product deployed under CDM. Like a scaled-down TSD. Allows airlines to view the same traffic demands and constraints as FAA traffic managers.
  – FSM – an FAA product deployed under CDM. It is used for monitoring capacity versus demand for both airport arrivals and departures.
How TFM Fits With CDM

- CDM brings together airlines, general aviation and business jet traffic, civil aviation authorities, and airports in an effort to improve air traffic management through information exchange, data sharing, and improved automation decision support tools.

- CDM enables information sharing and facilitates decision making processes by ensuring that stakeholders are provided with timely and accurate information, essential for the planning of their operations.
Questions?
What is CDM? (revisited)

- A philosophy
- A well-defined FAA R&D Program
- Workgroups
- Concept and tools development and implementation
- Avenues and processes for information exchange during TFM planning
- CDM is not an FAA “regulation”, nor is it mandatory.
How Can A User Participate in CDM?

- Anyone can become a CDM participant (FAA sites and NavCanada automatically qualify)
  - Airlines (passenger and cargo)
  - General aviation traffic (NetJets, Flexjets)
- Data must be of a certain standard and quality
- Sign MOA/MOU
  - FAA agrees that data will be masked to airlines
  - FAA agrees that data only used to support TFM/CDM
- Any product developed using CDM funds is “freeware”; participant is responsible for providing any needed hardware.
CDM Participants

CDM is a collaboration with Government, Airlines, Academia, and Industries

CDM Airline Users
AAL ACA AWE BLR COA DAL FDX FBULDFMEPNWANOntsSKWSWA
TRSTWAUALUCAPSUSA

CDM Airline Sub-Carrier Users
EGFBTABSECOMSWRFLGMESAWIGLALUSALO
ASHCDLCHQJIAPTD

FAA and Nav Canada Users
20 ARTCCs, 25 TRACONs, and 6 Canadian Centers
Goals of CDM

• Transfer business decisions to users.
• Distribute decision-making process among all participants.
• Ensure that the system is fair and equitable.
• Provide most accurate and timely information to all involved parties.
  – Better predictability.
  – Use available capacity efficiently by supporting and allowing more dynamic decision making.
Components of a Collaborative System

• **Information Exchange**
  – Common situational awareness
  – Infrastructure

• **Distributed Planning**
  – Procedures, processes, decision support, etc.
  – Roles and responsibilities

• A common goal
CDM Development History

1991

FAA ordered GDP Substitution Analysis

1992

Ground Delay Visualizer (later known as FSM)
Demonstrates GDP Substitution Problem

1993

FAA/Airline Data Exchange (FADE)
Conducted to assess affect on FAA’s traffic management’s decision

1994

Metron runs "War Game" to measure GDP power to save 10-35% delay

1995

FAA/Airlines conduct GDP/FSM Human-in-the-loop Tests

1996

CDM initiatives included in Free Flight Action Plan

1997

GDP Enhancement Pre-Operational
AOCnet Established (later becomes CDMnet)

1998

GDPE Prototype operations starts with EWR and SFO airports & a dozen large airlines

1999

GDPE Prototype operation expanded to include all CONUS airports

2000

Jane Gavey, FAA Administrator, orders FSM to all ATRCCs and major TRACONs
Garvey’s order completed; FSM in 20 ARTCCs & 10 TRACONs

2001

GDPE Prototype Operation expanded to Toronto Airport & Nav Canada
FSM Users include:
- 36 Airlines
- 46 FAA Facilities
- 7 Nav Canada Facilities

End of GDPE Prototype operation; GDPE becomes officially operational
GDP-E Comparison

**OLD**
- GroverJack
- OAG/Modeling
- ATCSCC Demand/Capacity Prediction
- FAA Tools
- Airline Substitutions
- Advisory
- ARINC Teletype

**NEW**
- RBS
- Data Exchange
- Common Situational Awareness
- FSM to FAA and Users
- Airline Substitutions and Compression
- Collaboration Advisory
- AOCnet/CDMNet
A ground delay program (GDP) is implemented at an airport when arrival demand exceeds capacity.

What is a GDP?

Demand is under capacity
=> no problem

Capacity has dropped below demand
=> problem for 4 hours
Ground Delay Program Goal

Balance capacity and demand at impacted airport.

- Reduces airborne congestion.
- Delivers smooth and reduced arrival rate to the airport.
- Better predictability in TFM system.

![Arrival Hour vs Number of Flights Chart]
How A GDP Works

- Number of arrival slots at airport is set by air traffic controllers (AAR).
- Each flight is assigned an arrival slot with a time associated with it.
- Based on flight ETE, an Estimated Departure Control Time (EDCT) is calculated.
- The airline knows in advance how long the flight will be delayed.
CDM Approach to the Problem

- Recognize that this is best addressed as a distributed optimization problem
  - FAA allocates arrival slots to airlines
    - *equitably and efficiently*
  - airlines assign flights to their allocated arrival slots
    - *optimize their own cost function*
  - iterative approach
    - *continual re-evaluation of demand vs. capacity and adjustments as necessary*
- Allocation of slots must be equitable, and reward rather than punish data exchange
Problems with Rationing by Reported Demand

- External circumstances can change an airlines schedule
- Flights are cancelled
- Flights are delayed
- Reporting these changes can help competitors more than the reporting airline (competitor is moved into your slot)
Equitable Allocation of Arrival Slots: Ration by Schedule

- Arrival slots are distributed according to published schedule rather than reported demand
Equitable Allocation of Arrival Slots: Ration by Schedule

- Arrival slots are distributed according to published schedule rather than reported demand.
- When flights are cancelled or delayed, airlines retain rights to those slots.
Equitable Allocation of Arrival Slots: Ration by Schedule

- Arrival slots are distributed according to published schedule rather than reported demand.
- When flights are cancelled or delayed, airlines retain rights to those slots.
- Airlines can assign flights to slots in whatever way best suits their business needs.
- Most accurate information in system (re: delays, cnx) facilitates best TFM.
Maximizing Available Resources: Compression

• Once allocated, often airlines are unable to use their allocated slots.
• Without FAA action, resources would be wasted.
• Compression, moving flights up to fill vacant slots, benefits everyone.
• Adds a dynamic, responsive element to TFM.
GDP Revisions: Adjust to Changing Conditions

• Original GDP parameters based on known demand
GDP Revisions: Adjust to Changing Conditions

- Original GDP parameters based on known demand
- When demand changes, existing GDP becomes invalid
GDP Revisions: Adjust to Changing Conditions

- Original GDP parameters based on known demand
- When demand changes existing GDP becomes invalid
- Revision of the program reassigns arrival slots to updated demand
- Balance between demand and capacity is restored
Pre-CDM GDP Process

- No opportunity for the airlines to solve the problem and avoid the GDP
- No ability for the FAA to respond to changing conditions with revisions or compressions
- Ration by reported demand is a disincentive for airlines to share their updated flight info; demand picture is inaccurate.
Current CDM GDP Process

FAA/Airline Evaluation Demand Vs. Capacity

GDP Modeling
Send Proposed GDP Advisory

Is GDP still required?

Yes

Issue GDP
(Ration by schedule)

Airline Response
(Substitutions & Cancellations)

GDP Revision /Extension

Compression

No

End

Exit loop when program expires or is cancelled.
Questions?
General CDM Meetings semi-annually
- Workgroups meet more often – every 4-6 weeks
- Workgroups consist of FAA representatives, Volpe, FAA contractors, industry representatives (airlines, GA)
- Focus on near-term operational enhancements (~24 months)

Sample projects/results:
- Distance-based GDPs
- Slot Credit Substitution
CDM Data Flow

NAS Data
(FZ, AZ, DZ, TZ, RZ)

ETMS

EDCTs

ATCSCC & NavCanada

ADL

ADLs

VOLPE

OAG

CDM Data

Schedule Updates
CDM Flight Messages (FX, FM)

ADL

ARINC Network

GDP Program Parameters

FAA field facilities

FSM

AOC* Airline Operations Center

AOCNet

ETMS

CDMnet
CDM Data Flow (Simplified)

CDMnet
(various vendors)

AOC*
FSM

AOC*
FSM

ATCSCC**
FSM

Volpe

Firewall

ADL Server

*Airline Operations Control center
**Air Traffic Control System Command Center
CDM Awarded

**Reno Award** (1998) from the Air Transport Association for outstanding performance

**Special Achievement Award** (1999) from the FAA for pioneer work on CDM that reduced over 3 million minutes of delay

**Hammer Award** (2000) from the FAA for innovations

**Edelman Award Finalist** (2000) from INFORMS for outstanding work in operations research
Benefits Delivered by CDM

- Airport demand situational awareness (GDPs are more accurate, scope reduced)
- Compression – delay savings
  - 20M minutes of delay, Jan-98 to Dec-01
- EDCT compliance increased
- POET and FSA case studies of airline operations (reroutes, noncompliance)
- Awareness and inclusion of equity
EDCT Compliance History

January 1996 - April 2001

Percentage (%)

Month-Year

Early*  On-Time*  Late*

January 1996 - April 2001
Controlling only those flights within a 200 nmi radius

An illustration of equity considerations in GDP planning

100% of delayed traffic is NWA

Average delay of 88 minutes per flight
Controlling only those flights within a 800 nmi radius

Increasing the scope spreads the delay over more users. However, controlling flights from a carrier's hub may create inequities.
Controlling only those flights within a 1200 nmi radius

Approximately 65% of delayed traffic is NWA

Initiatives that control more flights increase chances of spreading delay. However, geographic scope must be balanced with GDP length (avoid “unrecoverable delay”).
Questions?
ATCSCC Positions Facilitate CDM
ATCSCC Positions Facilitate CDM

- **TCA** – Tactical Consumer Advocate
  - ATCSCC FAA position dedicated to answering NAS user questions and addressing operational issues (e.g., reroute exemptions, delayed flights)

- **NBAA** – National Business Aviation Association
  - Primary representative of business aviation (usually seen as representative of general aviation air traffic)

- **ATA** – Air Transport Association
  - Trade organization of principal U.S. airlines
The SPT develops a comprehensive plan of action for the NAS.

The SPO is developed collaboratively 2 to 4 hours in advance by the SPT.

The SPO is updated and distributed every two hours throughout the day, as needed, with the collaboration taking place in the interim hours.

After collaboration, the strategic plan of operations is:
- Posted on the ATCSCC web page
- Issued as a numbered advisory
Communication Flow Chart

INT’L  MILITARY  AIRLINES  GA  WX  ATCSCC  FAA Field

STRICTIC PLANNING TELCON

STRATEGIC PLAN of OPERATION
Typical SPO

ATCSCC ADVZY 066  09/07/2001 STRATEGIC PLAN OF OPERATIONS

MESSAGE:
SPO ISSUED:  09/07 1600 - Z
NEXT UPDATE: 09/07 1800- Z

ANTICIPATED CONSTRAINTS

ENROUTE:
CONVECTIVE ACTIVITY IN ZMP/ZAU/ZKC.

WILLOW GROVE AIRSHOW

TERMINAL:
ATL- LOW CIG AND VSBY.
DTW-RAINSHOWERS, CHC TSTMS.
ORD/MDW-LIGHT RAIN AND TSTMS VCNTY.
MSP-RAINSHOWERS, CHC TSTMS.
LAX-LOW CEILINGS.
Typical SPO

SHORT TERM PLAN
[09071800-09072000]
1. ZAU/ORD- DEVIATIONS AND TACTICAL REROUTES FOR ENROUTE TRAFFIC.
CDRS AND SWAPS FOR DEPARTURES. POSSIBLE PLAYBOOK OPTION.

2. ZMA-DEVIATION, EXPANDED MIT, LIMITED AIRBORNE
HOLDING, TACTICAL ROUTE ADJUSTMENT, POSSIBLE LIMITED
SCOPE GROUND STOP.

3. ZMP/MSP- DEVIATIONS AND TACTICAL REROUTES, CHANCE
LIMITED AIRBORNE HOLDING, AND CDRS. EAU2 PLAYBOOK IMPLEMENTED.
POSSIBLE LIMITED SCOPE GROUND STOP.
POSSIBILITY OF LAADR.

4. ZLA/LAX-EXPECT EXPANDED MIT, ESP DELAYS. POSSIBLE
GROUND DELAY PROGRAM.

5. TRANSCON ROUTES- ZSE/ZLC/ZDV/ZOA TO ZBW/EWR/JFK VIA MODIFIED
WEST MSS. ZLA/ZAB TO /BOS/EWR/JFK/PHL VIA GAG
TUL J46 ARG PXV. ZFW TO ZNY/ZDC VIA WEST VUZ. ZHU TO ZNY/ZDC VIA
WEST MGM3.
LONG TERM PLAN
[09072000-09080000]
1. ZAU/ORD- EXPECT EXPANDED MIT, DEVIATIONS AND TACTICAL REROUTES FOR ENROUTE TRAFFIC. CDRS NORTH AND SOUTH FOR WEST DEPARTURES.

2. ZID/ZME/MEM-DEVIATION, EXPANDED MIT, POSSIBLE CAPPING.

3. ZMA-DEVIATION, EXPANDED MIT, LIMITED AIRBORNE HOLDING, TACTICAL ROUTE ADJUSTMENT, POSSIBLE LIMITED SCOPE GROUND STOP.

4. ZMP/MSP- EXPANDED MIT, DEVIATIONS AND TACTICAL REROUTES. CDRS LIKELY. EAU2 PLAYBOOK WILL BE IMPLEMENTED. POSSIBLE LIMITED SCOPE GROUND STOPS. POSSIBILTY OF LAADDR.

5. TRANSCON ROUTES- ZSE/ZLC/ZDV/ZOA TO ZBW/EWR/JFK VIA MODIFIED WEST MSS. ZLA/ZAB TO BOS/EWR/JFK/PHL VIA GAG TUL J46 ARG PXV. ZFW TO ZNY/ZDC VIA WEST VUZ. ZHU TO ZNY/ZDC VIA WEST MGM3.

NEXT PLANNING TELCON
09/07 1715- Z

NEXT TELCON PARTICIPANTS
ALL ARTCCS, N90, C90.
CDM Tools

• CDM Tools:
  – “Freeware” that is available to all CDM participants
  – Products and services available from FAA-maintained websites (internet and intranet)
  – Provide information_updates, or two-way information exchange with TFM system.

• www.fly.faa.gov
  – Products

• www.metronaviation.com/cdm
  – Products
Advisories

• In order of most recent; two week history available
Operational Information System

• Summary Page

GROUND DELAY PROGRAMS

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MISCELLANEOUS

UPCOMING PLANNING TELCON 1800Z

BOTH USERS OF AIRPORTS THAT DO NOT HAVE COMMERCIAL SERVICE SHOULD CHECK NOTAMS AND/OR AIRPORT MGMT FOR SECURITY STATUS AND OPERATIONAL AVAILABILITY.
CCSD

- CCSD (Common Constraint Situation Display) will be the primary method for the FAA to communicate dynamic information about constraints in the NAS to the users.
- CCSD can be thought of as a scaled-down, web-based version of Traffic Situation Display (TSD), which is what the air traffic controllers use to display constraints.
CCFP

Collaborative Convective Forecast Product

• Provides common situational awareness
• Basis for collaborative NAS planning, i.e. within SPT
• Collaboratively developed by airline, FAA, & NWS meteorologists
Flight Schedule Monitor (FSM)

Collaborative tool for monitoring and managing airport capacity constraint within the NAS

- Used by ATCSCC to model and implement GDPs and GSs
- Produces reports and advisories for each TFM event
- Uses ADL generated by Volpe/ETMS
- Incorporates airline-provided CDM data
- Deployed at ATCSCC FAA field facilities, and to all airline CDM participants.
Monitored Live Default View

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Optional configurations:
- Time Line
- Flight List
- Bar Graph
GDT Mode Default View
Post-Operations Evaluation Tool (POET)

- User-friendly application to query near-real-time ETMS data (60 days historical)
- Intuitive user interface for defining searches
- Interactive tables, charts, geographic displays; summary level or drill down to individual flights
- Can replay actual flight tracks
Route Management Tool (RMT)

- Centralized database of standard reroutes (CDRs, Playbooks).
- All CDM participants can access; FAA users can update reroute lists.
- Used, e.g., during severe weather events when flights must be rerouted.
- All users can quickly access and visualize implemented reroutes.
Flight Schedule Analyzer

**Real-Time**
Web-based application that permits FAA facilities and airlines to monitor GDPs as they are executing.

**Post-Analysis**
Allows for more in-depth analysis of GDPs on a next-day basis.
Questions?
The Future of CDM

• **Short-term** – enhancements to existing technology, e.g.:
  – adaptive compression
  – two-for-two slot trading

• **Functional** – fluid and evolving:
  – new workgroups develop as operational needs are identified by all CDM participants. (i.e. FCA, ICE-FM)
  – Other workgroups have become defunct.

• **Participation**:
  – GA traffic is the latest big movement – Flexjets, NetJets, “pseudo-major” carrier code
  – Down the road – microjets, SATS, UAVs
The Future of CDM

• Political/Economic:
  – CDM is ingrained in TFM culture – it can’t/won’t go away.
  – FAA classification and funding may change.
  – FAA is taking a long-term, R&D approach to TFM (JPDO); Free Flight office no longer exists.

• Operational:
  – What the customer sees/uses will evolve and improve with TFM-M.
  – Updated infrastructure to support analysis and long-term planning.
  – Will lead to more sophisticated TFM capabilities, such as quantifying and integrating impact of separate TMIs (e.g. what is additional delay impact of MIT on GDP flights?).

• Going global:
  – International interest in CDM planning and tools.
  – China, New Zealand, Japan have all expressed interest.