CTOP

• Suppose that there is en route congestion.
  – This might be caused by weather, failed navaids, unusually high demand, or any other reason.

• The two general methods of holding down en route congestion are:
  – Reroute flights.
  – Delay flights on the ground.

• The essence of CTOP is to provide a mix of reroutes and ground delays to deal with the congestion.
Relation of CTOP to Current En Route Tools

- Required reroutes can assign reroutes but not ground delays.
- An Airspace Flow Program (AFP) can assign delays but not reroutes.
- CTOP generalizes these two tools by assigning both delays and reroutes.
- CTOP tries to assign a mix of reroutes and delays that cause the capacity constraints to be met while minimizing inconvenience to the NAS users.
The CTOP Philosophy: Division of Responsibility

• When a reroute is needed, currently the FAA chooses the reroutes for each flight.

• In contrast, the CTOP philosophy is to give the NAS users as much say as possible in the reroute.
  – The FAA specifies the constraints.
  – NAS users submit their route preferences.
  – The CTOP algorithm in TFMS gives each flight its most preferred trajectory, given the constraints.
CTOP and Electronic Negotiation

• The part to focus on is the electronic negotiation, which is lacking in current reroutes.

• In contrast, GDPs make heavy use of electronic messages sent from system to system.
  – Electronic messages include the initial issuance of program, revisions, new EDCTs due to Slot Credit Subs or Adaptive Compression, airline subs.
  – This electronic data exchange allows GDPs work smoothly, and reroutes need the same.
How CTOP Works

1. The Command Center creates one or more FCAs.
2. NAS users send in trajectories they are willing to fly and indicate their preferences.
   - Trajectories are sent in what is called a Trajectory Option Set (TOS) message.
   - NAS users can send trajectories at any time, and they can send in new trajectories as conditions change and their preferences change.
   - These first two steps can happen in any order.
How CTOP Works

3. A traffic manager in the Command Center defines and issues a CTOP program.
   • Sets the CTOP parameters, e.g., capacities for each FCA for each 15-minute interval, start time, stop time.
   • Runs the CTOP algorithm to assign trajectories and delays to each flight in the FCA.
     • The essence: Each flight is given its most preferred trajectory, given the capacity constraints.
   • Inspects the modeled results, and, if necessary, modifies the CTOP parameters and re-models.
   • When satisfied, issues the CTOP program.
How CTOP Works

4. Operational personnel execute the program.
   - The ground delays are enforced with EDCTs.
   - The reroutes are enforced as in the current system, that is, the routes assigned by CTOP are treated as required reroutes.

5. NAS users lessen the impact of the CTOP program on them by responding with substitutions and additional TOSs.
How CTOP Works

6. The Command Center revises the CTOP program.
   - Manually: Changes the program parameters.
   - Automatically: Uses the set-and-hold capability.

7. The capacities can be gradually increased to end a CTOP program.

Note: In the initial release, CTOP will apply only to pre-departure flights and does not integrate weather information.
Step 1: Based on severe weather forecasts, ZKC ARTCC creates an FCA in order to begin monitoring demand.
Step 2: Customers begin sending TOSs

TOS for

RMNT: Route Minimum Notification time (required by the user to accept the given trajectory)
Customers will send TOS with priorities. CTOP will verify TMI delays on routes and respond with priority order.

**RMNT:** Route Minimum Notification time (required by the user to accept the given trajectory)
Step 3: Severe weather is developing as forecast, ATCSCC reviews demand through FCA

Demand through the ZKC FCA prior to capacity dial down

Green routes indicate flights crossing the FCA
Step 4: Weather continues to develop; ATCSCC dials down to 60% capacity

Demand through the ZKC FCA after capacity dial down to 60%

Flights with valid reroute options in their TOS get rerouted (shown in white)

Some flights get delayed (shown in yellow)
Step 5: ATCSCC dials down capacity – impact on one particular flight.
Step 6: As a constraint gets worse, further reductions can be made.
Step 7: Weather begins dissipating; ATCSCC dials up to 80% capacity

Demand through the ZKC FCA after capacity dial up to 80%

Flights begin returning to their #1 option or original route (white & yellow routes reducing and more green routes appear)

EXIT STRATEGY
Step 8: ATCSCC dials UP capacity Impact

- Initial trajectory still exists in TOS
- Current SEVEN assigned trajectory

TOS pre-dial up

Post-dial up

Flight reverts to its #1 trajectory option

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ZKC_wx

June 21, 2010
CDM Overview - Friends & Partners in Aviation Weather / Washington, D.C.
Federal Aviation Administration
Step 9: The weather dissipates further. The ATCSCC dials up the demand to 100% capacity.