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

Time: 17:15z

```
Tops: 370+
GWTH: +
CONF: HIGH
CVR6: 50-75%
```

ZKC_wx

```
FCA ZKC_wx
Reason: Wx
Start: 4/30/09 20:00
End: 5/1/09 02:00
Alt: 0-600
```
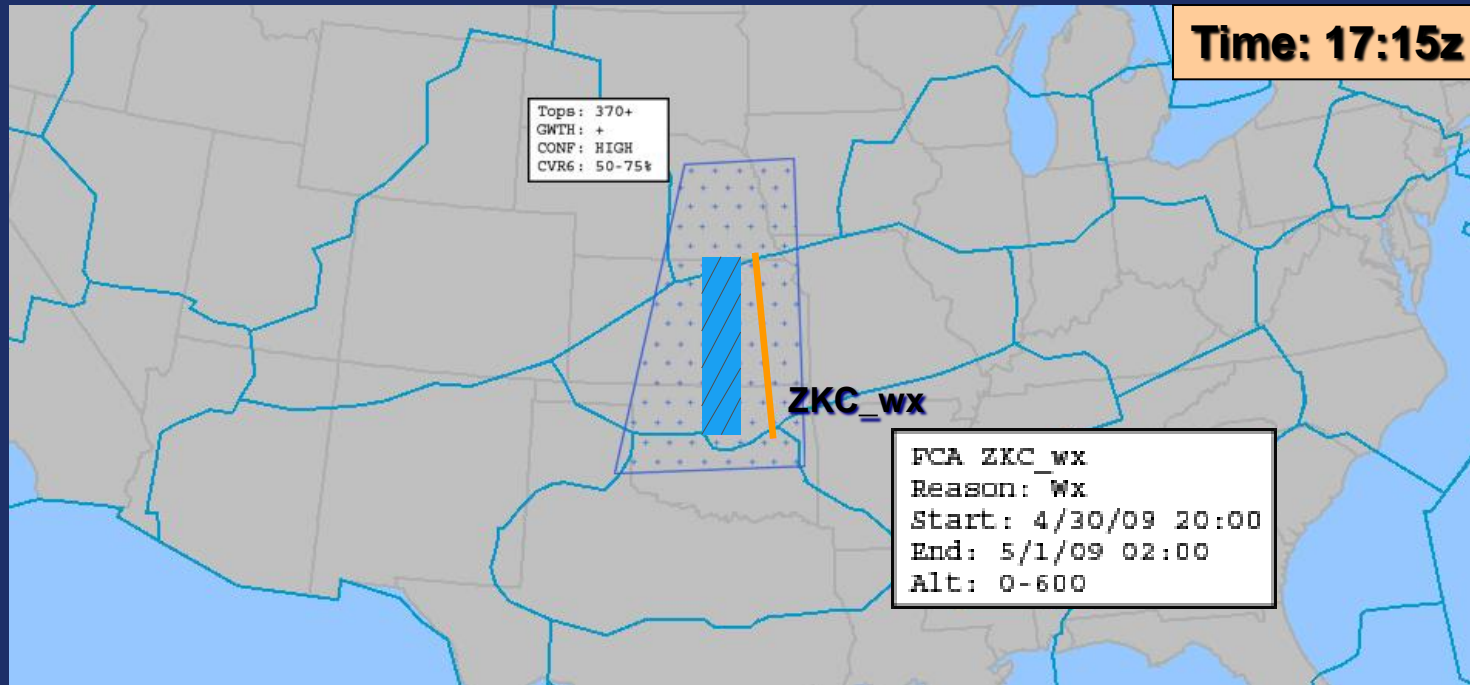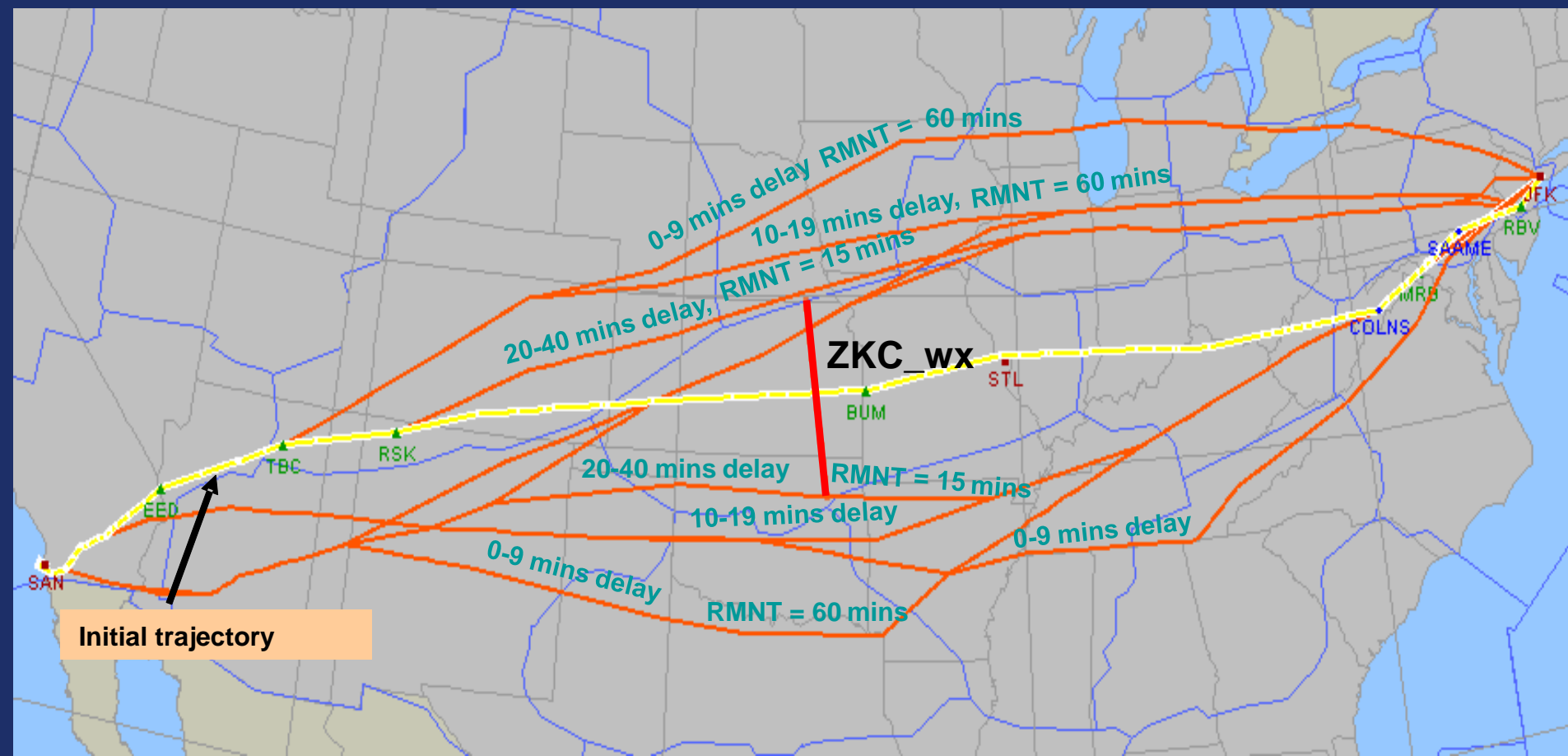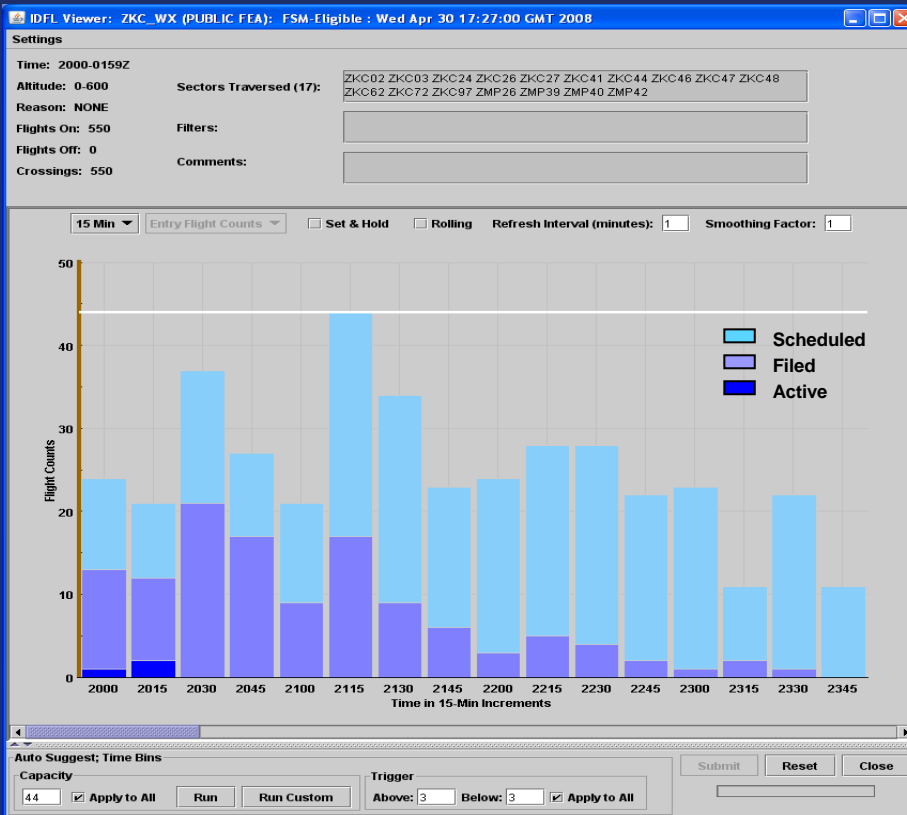
ZKC FCA + forecasted weather

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Step 2: Customers begin sending TOSs

TOS for

0-9 mins delay RMNT = 60 mins

10-19 mins delay, RMNT = 60 mins

RMNT = 15 mins

20-40 mins delay, RMNT = 15 mins

ZKC_wx

20-40 mins delay

RMNT = 15 mins

10-19 mins delay

0-9 mins delay

0-9 mins delay

RMNT = 60 mins

JFK
RBV
SAAME
MRB
COLNS
STL
BUM
RSK
TBC
EED
SAN

Initial trajectory
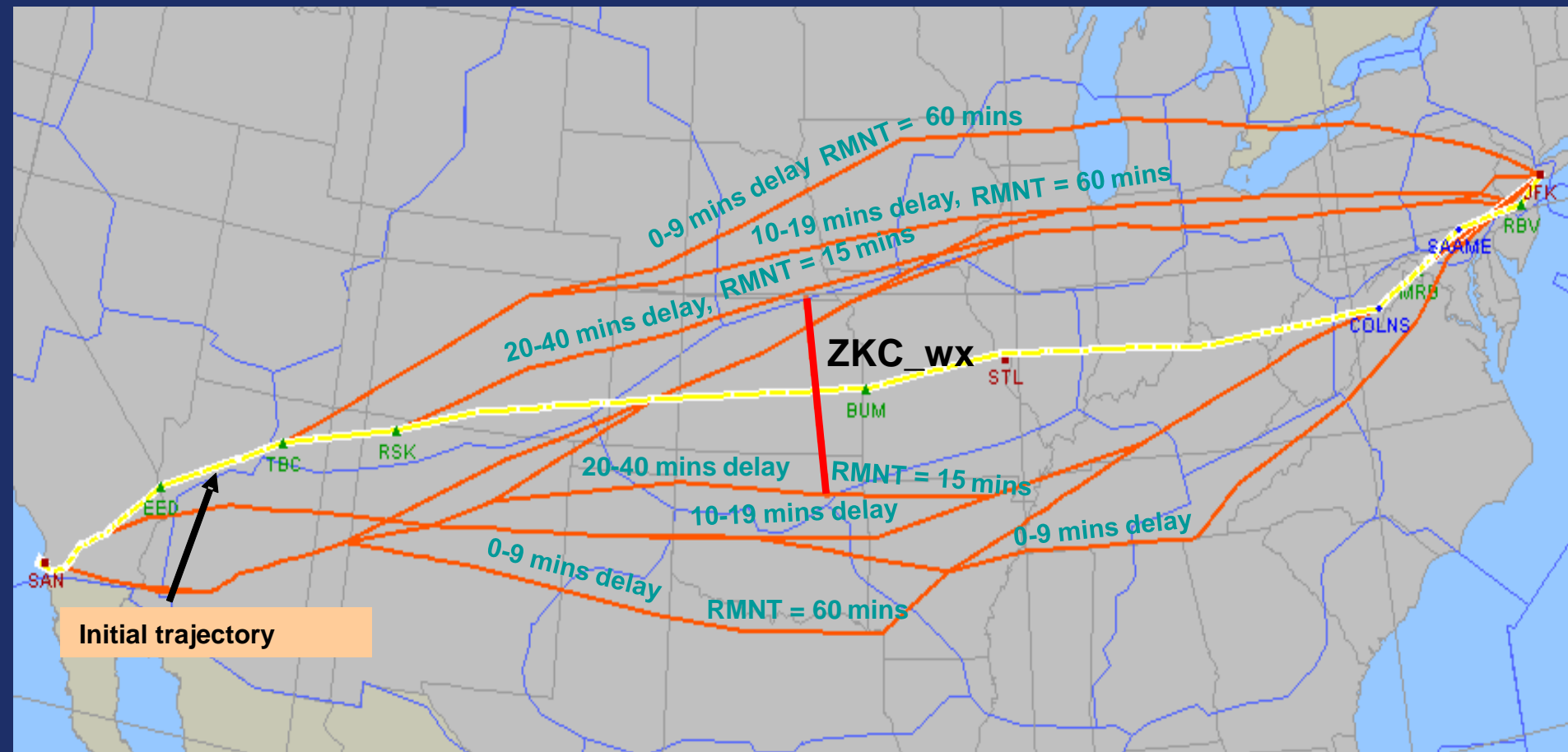
RMNT: Route Minimum Notification time (required by the user to accept the given trajectory

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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

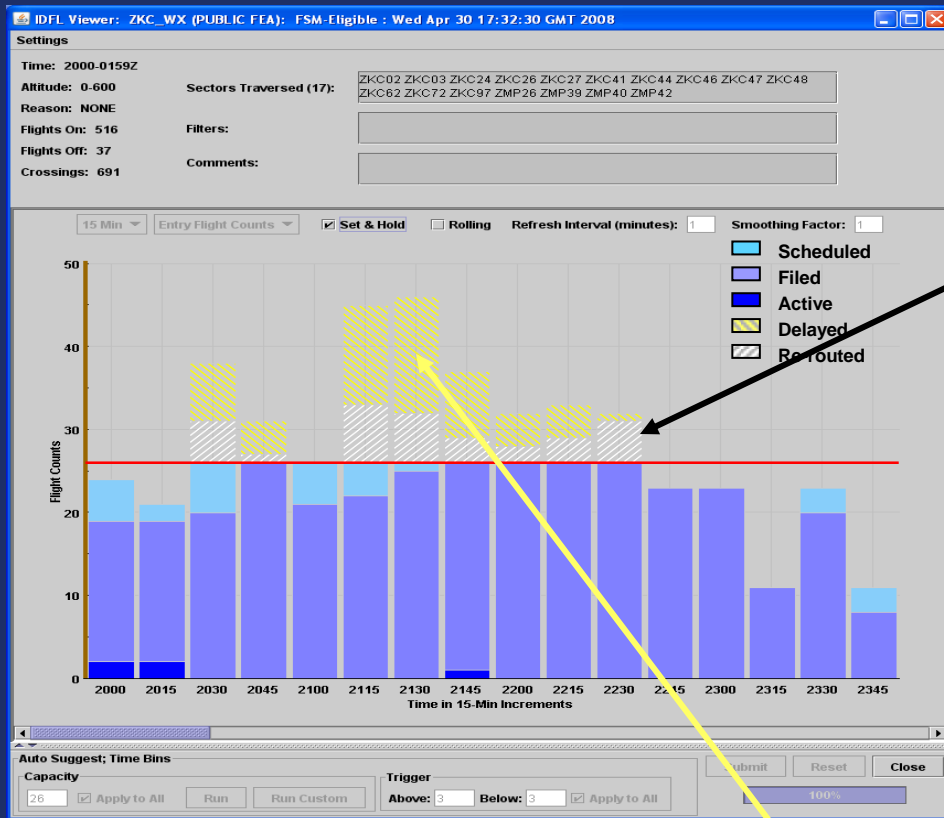# Step 3: Severe weather is developing as forecast, ATCSCC reviews demand through FCA

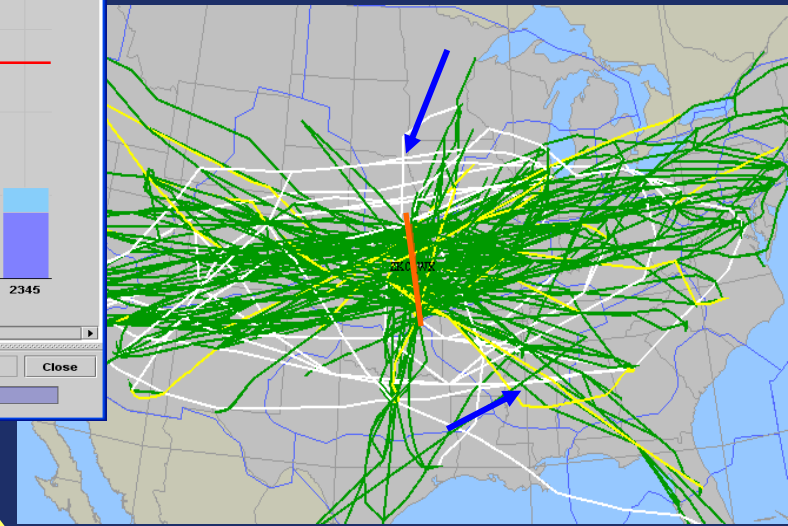
Demand through the ZKC FCA
prior to capacity dial down

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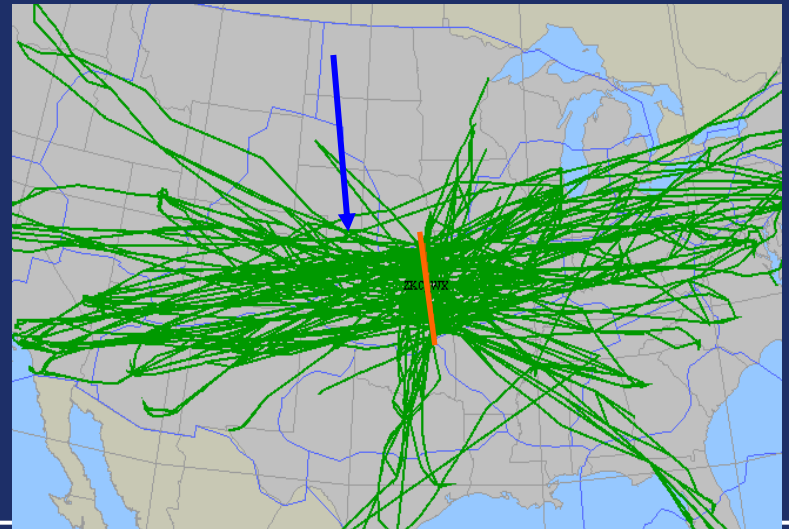
Step 4: Weather continues to develop; ATCSCC dials down to 60% capacity

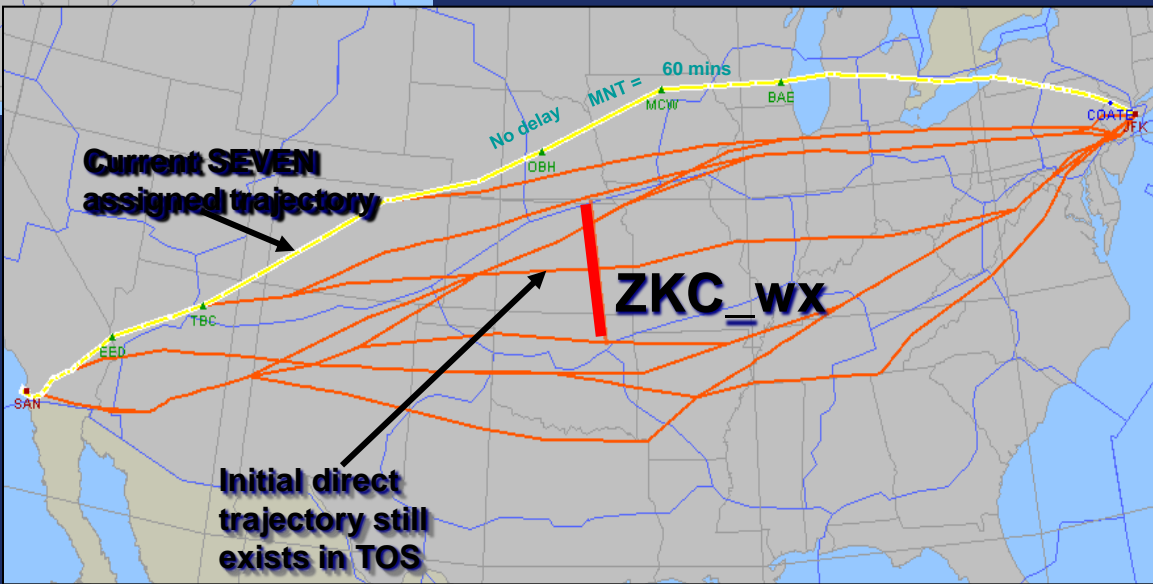Flights with valid reroute options in their TOS get rerouted (shown in white)

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

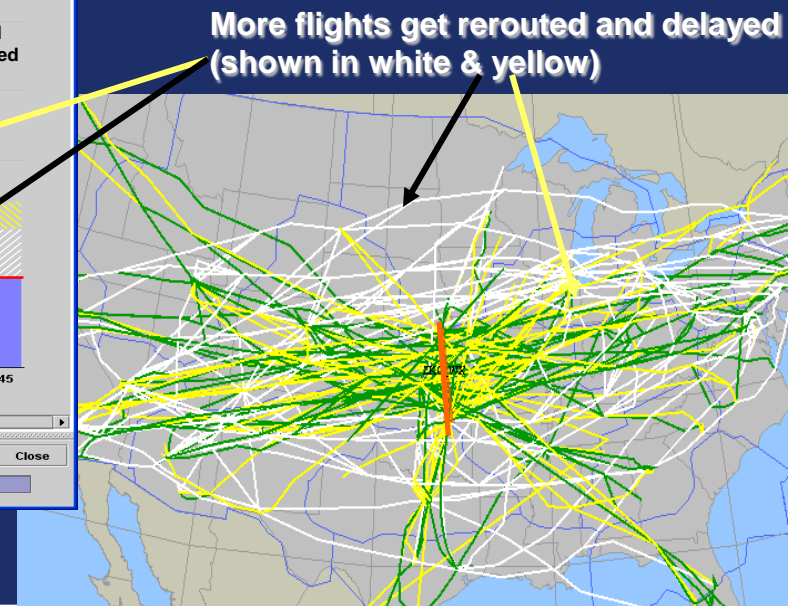Some flights get delayed (shown in yellow)

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Step 5: ATCSCC dials down capacity – impact on one particular flight.
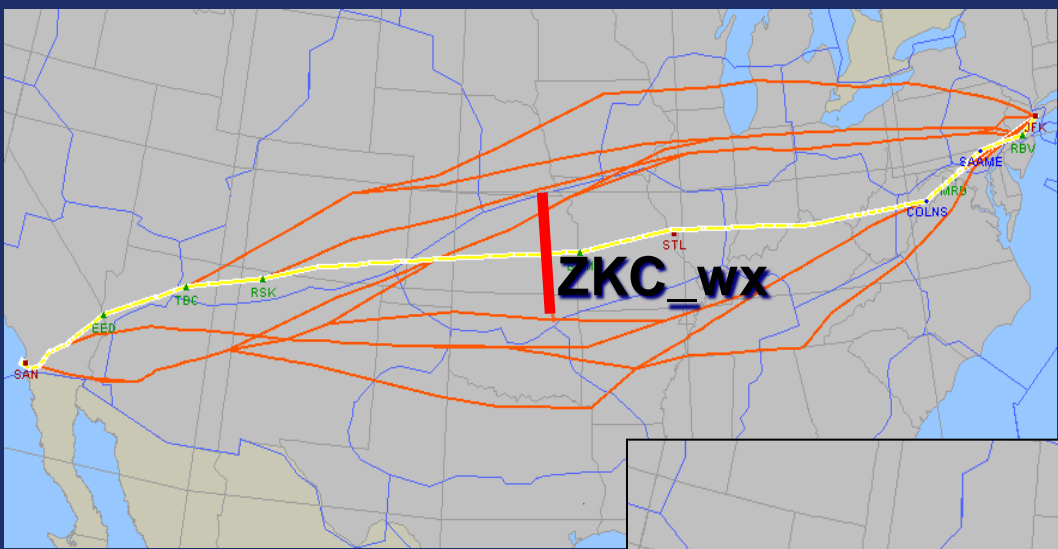
TOS Pre-dial down

Post-dial down

Current SEVEN assigned trajectory

Initial direct trajectory still exists in TOS
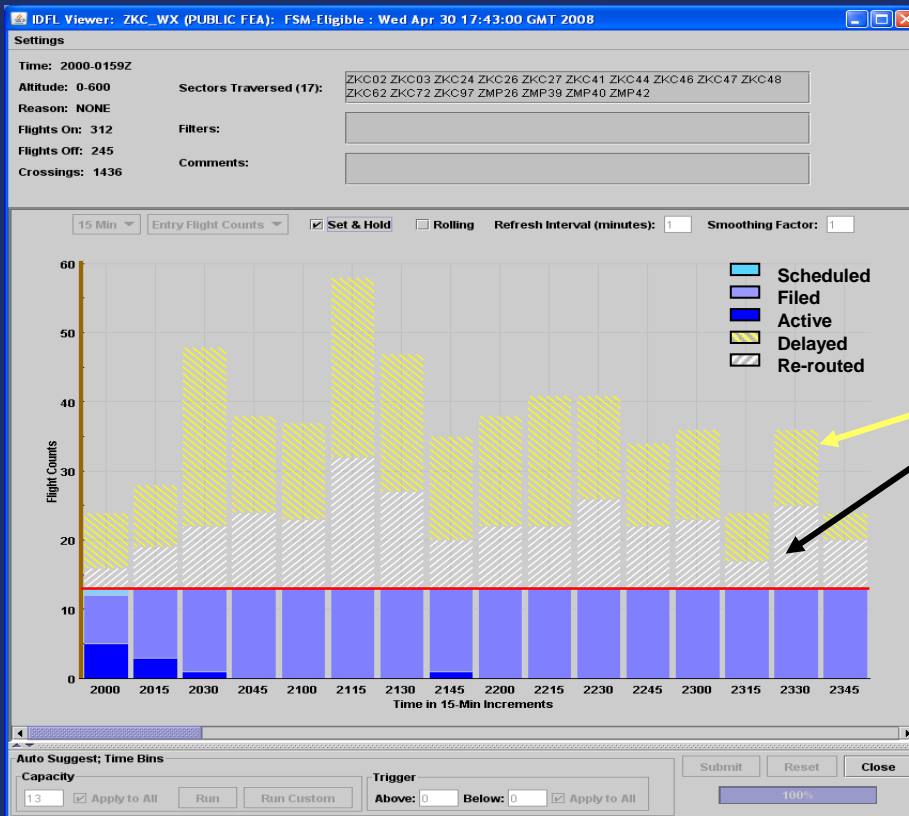
ZKC_wx

ZKC_wx

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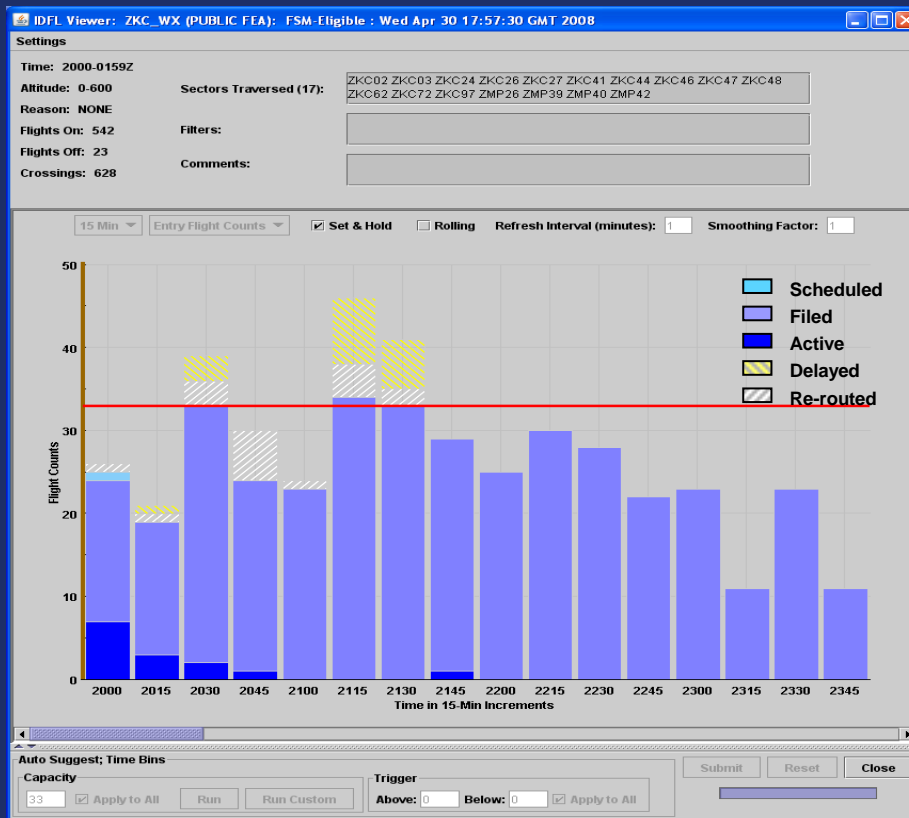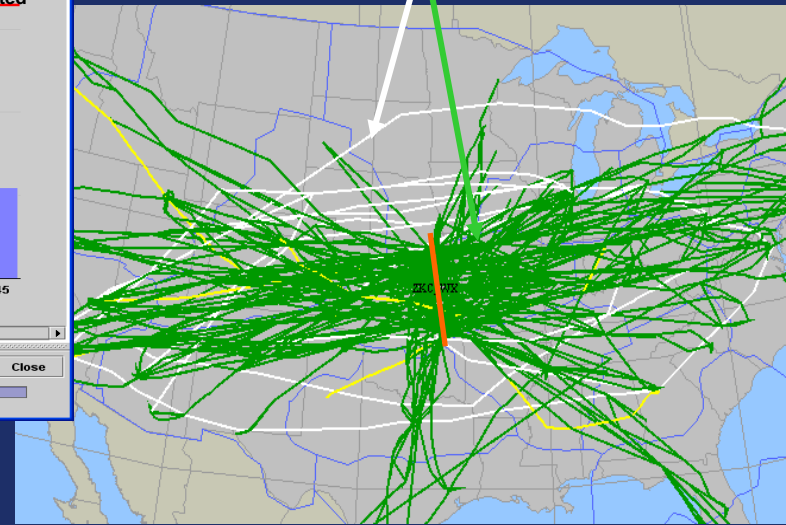# Step 6: As a constraint gets worse, further reductions can be made

More flights get rerouted and delayed (shown in white & yellow)

Step 7: Weather begins dissipating; ATCSCC dials up to 80% capacity

EXIT STRATEGY

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

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

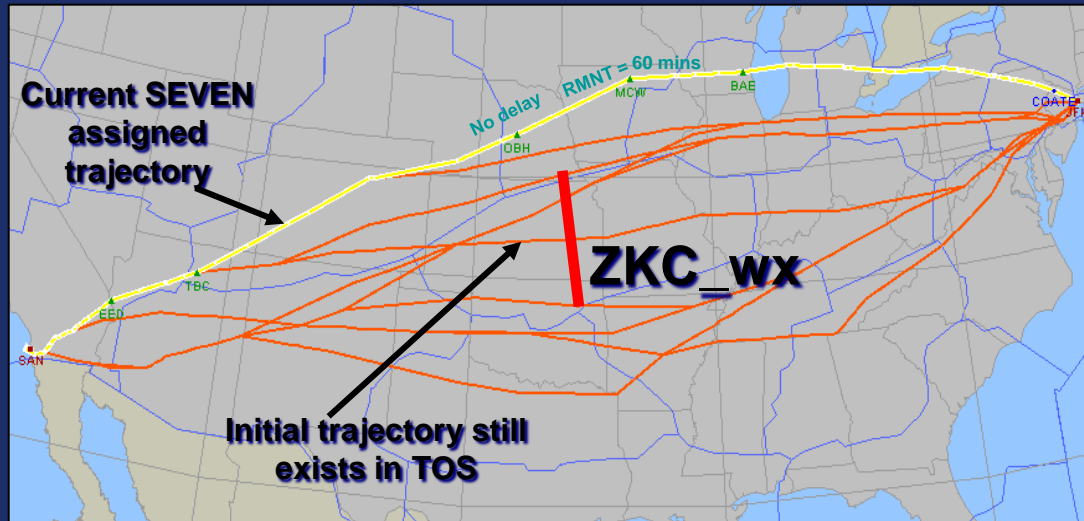# Step 8: ATCSCC dials UP capacity Impact

Current SEVEN assigned trajectory

Initial trajectory still exists in TOS

ZKC_wx

TOS pre-dial up

RMNT = 60 mins

No delay

Post-dial up

Flight reverts to its #1 trajectory option

ZKC_wx

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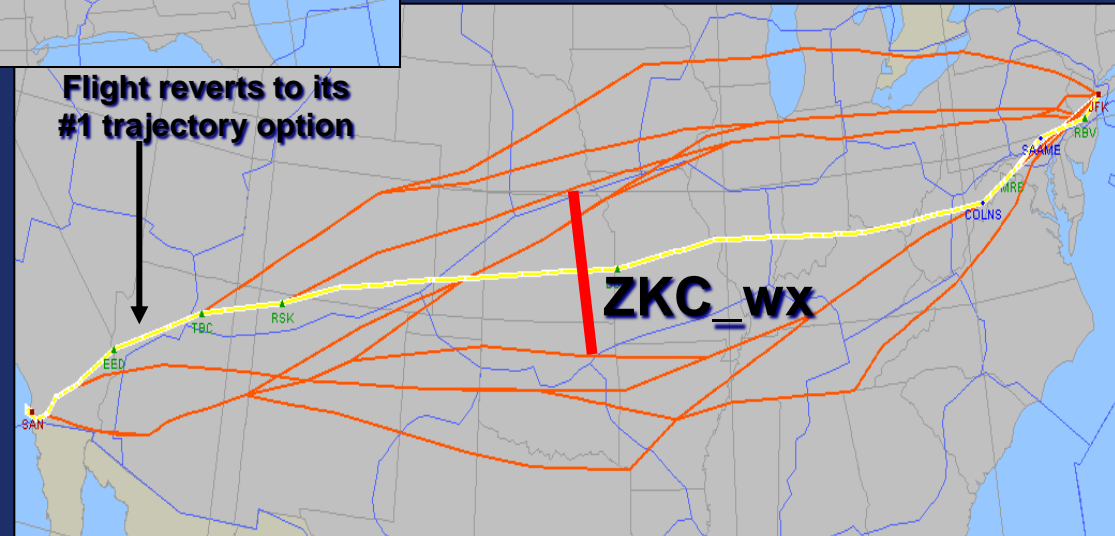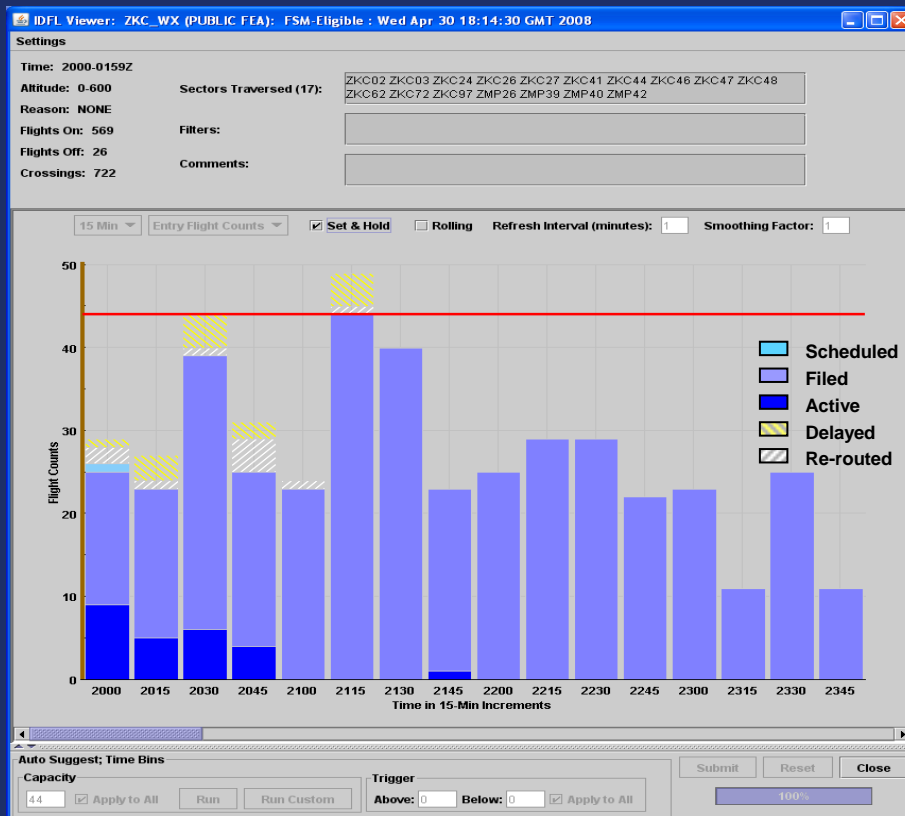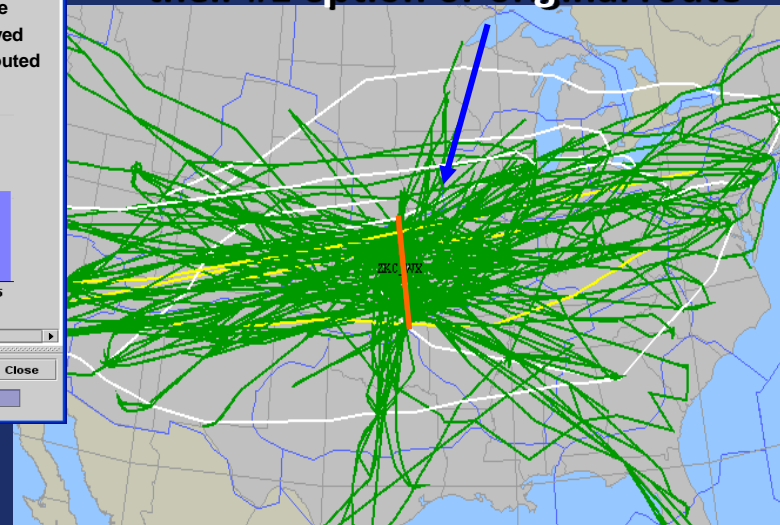17

Step 9: The weather dissipates further.
The ATCSCC dials up the demand to 100% capacity

Almost 100% flights return to their #1 option or original route

Demand through the ZKC FCA after capacity dial up to 100%

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