Using Work-Centered Support System Technology to Enhance Command and Control

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Overview

- Leveraging Data & Information
- C2 Environment
- WCSS Technology
- WCSS-GWM Technology Demonstration
- Conclusions

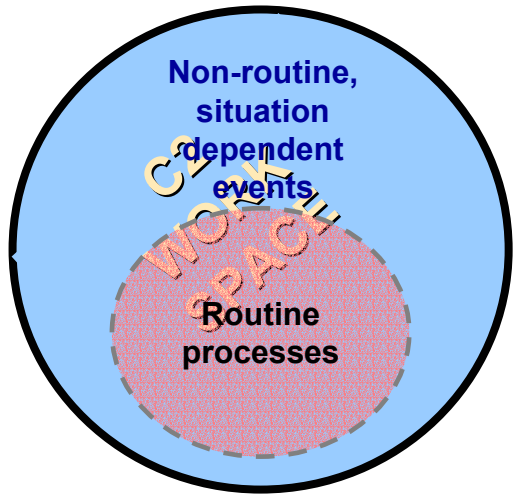
Leveraging Data & Information

- A ***key leverage point*** for enhancing operational efficiency and effectiveness
- NCW and similar concepts promise increased data/information access
- Increased data/info a ***"two-edged sword"***
  - More information, automation can aid work performance
  - BUT, data and information overload an increasing problem
    - "***Information Fatigue***"
    - "***Automation Surprise***"
    - "***Information Overload***"

  - AND, human cognitive abilities unchanged
- Challenge: ***Leverage increased access to data/information while managing overload, surprise***

C2 Environment

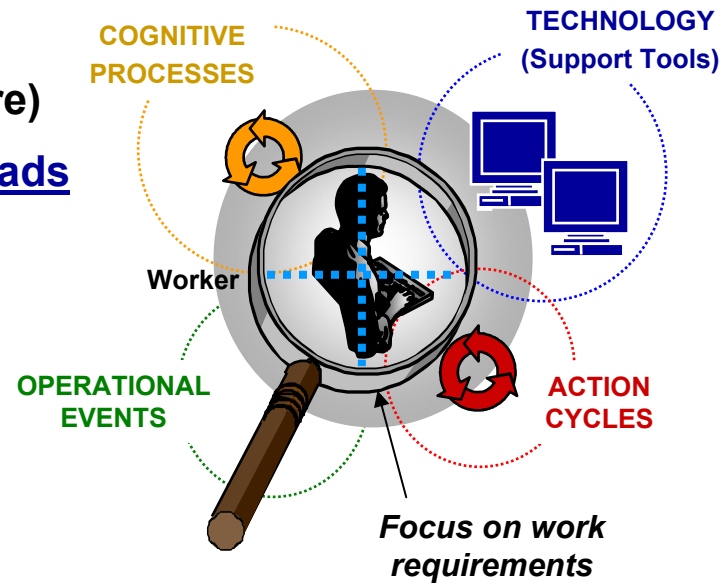
- Dynamic
- Time critical
- Often “too much data, too little information”
- Increasingly complex
  - New weapon systems, more complex socio-political environment
- General classes of activities:
  - Routine
  - Non-routine
    - User adaptation, problem solving required



- How do you efficiently support both types of activities given the constraints/environment listed?
- Common solution has been to make all info/data, functionality available; group with similar data, functionality
  - With increasing amounts of information, user can spend more time managing/finding/retrieving/fusing the IT than performing work

Work-Centered Support System Technology

- New human-computer interface technology
- Stand-alone NC application (plugs into middleware)
- Single user interface supports selected work threads
- Uses:
  - Cognitive work & task analyses
  - Cognitive-based design techniques
  - Intelligent agents

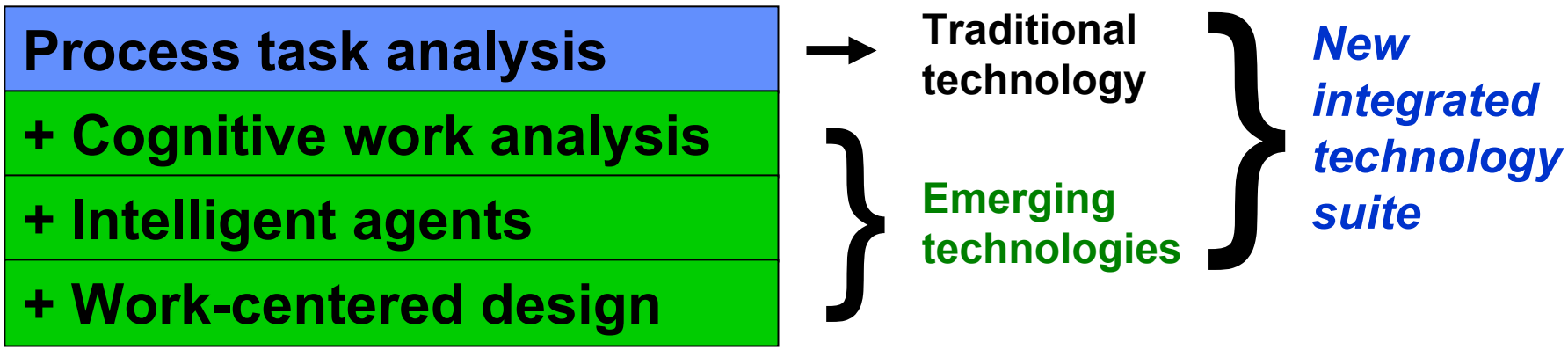


- Provides:
  - Cognitively compatible, "actionable" frames/displays
  - Rapid user adaptation to unanticipated events
  - Agents to automatically monitor, retrieve & fuse information
  - ➢ *User remains focused on "core" work activities, NOT "overhead" activities of data monitoring, retrieval & fusion*

- Benefits:
  - Proactive problem identification
  - Better, faster decisions/work actions
  - Reduced training and operating costs

WCSS Components

Work-Centered Support System =



WCSS Components

Work-Centered Support System =

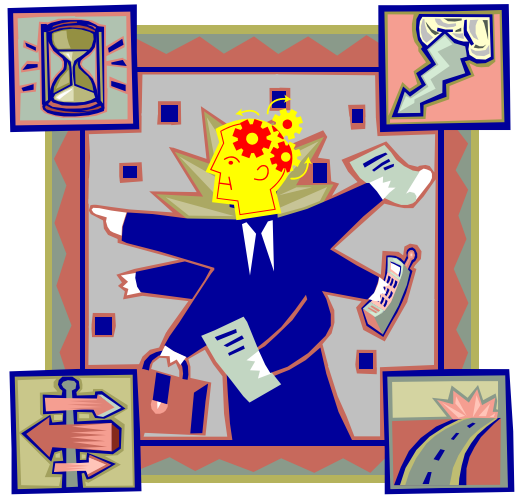
Process task analysis
+ Cognitive work analysis
+ Intelligent agents
+ Work-centered design

- ***Traditional <u>physical and information</u> processing analysis***

WCSS Components

Work-Centered Support System =

- **Process task analysis**
- **+ *Cognitive work analysis***
- **+ Intelligent agents**
- **+ Work-centered design**



- **Analysis of *mental* work and *flexible* problem solving**
- **Analysis of *dynamic* work behavior**
- **Captures *expert* problem solving and work requirements**

WCSS Components

Work-Centered Support System =

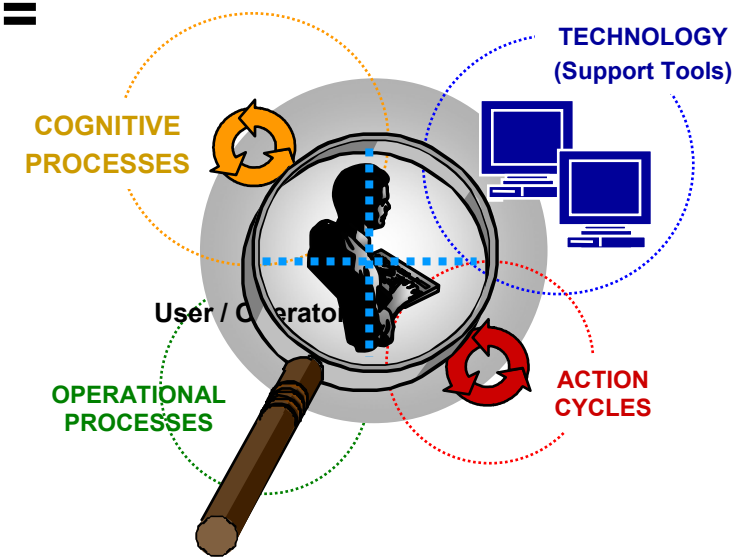
- **Process task analysis**
- **+ Cognitive work analysis**
- **+ *Intelligent agents***
- **+ Work-centered design**

- ***Perform tasks* for the user**
- ***Provide "24/7" enhanced situation awareness* and *proactive problem identification***
- ***Reduce workload* for user**
- ***Provide flexibility* to rapidly adapt to new work patterns and unanticipated operational events**

WCSS Components

Work-Centered Support System =

Process task analysis
+ Cognitive work analysis
+ Intelligent agents
+ *Work-centered design*



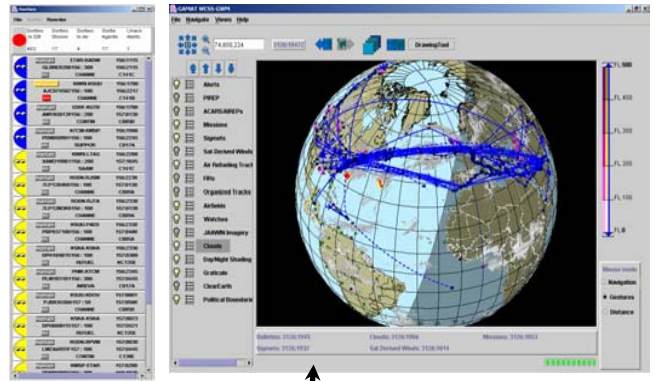
Provides:

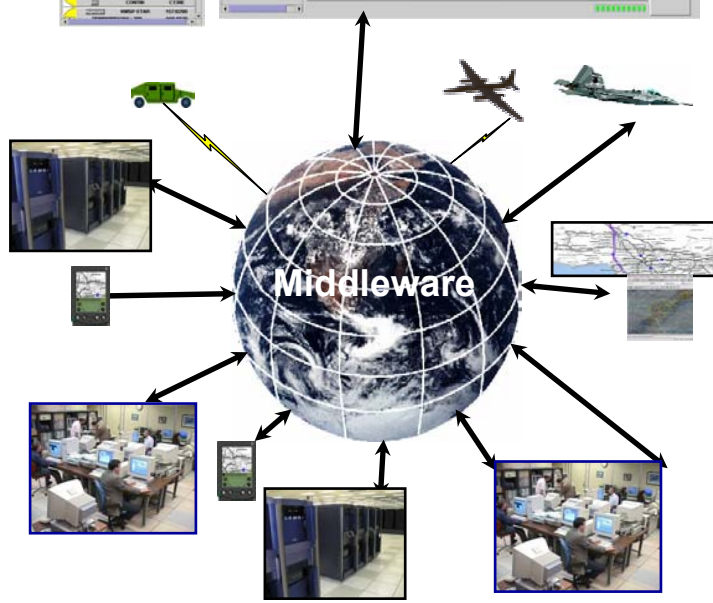
- ***"Actionable"/"Decision Quality" information***
- ***Context tailored support for work problems***
- ***Flexibility to rapidly adapt to new work patterns, unanticipated operational events and all expertise levels***
- ***Single user interface supporting selected work threads***

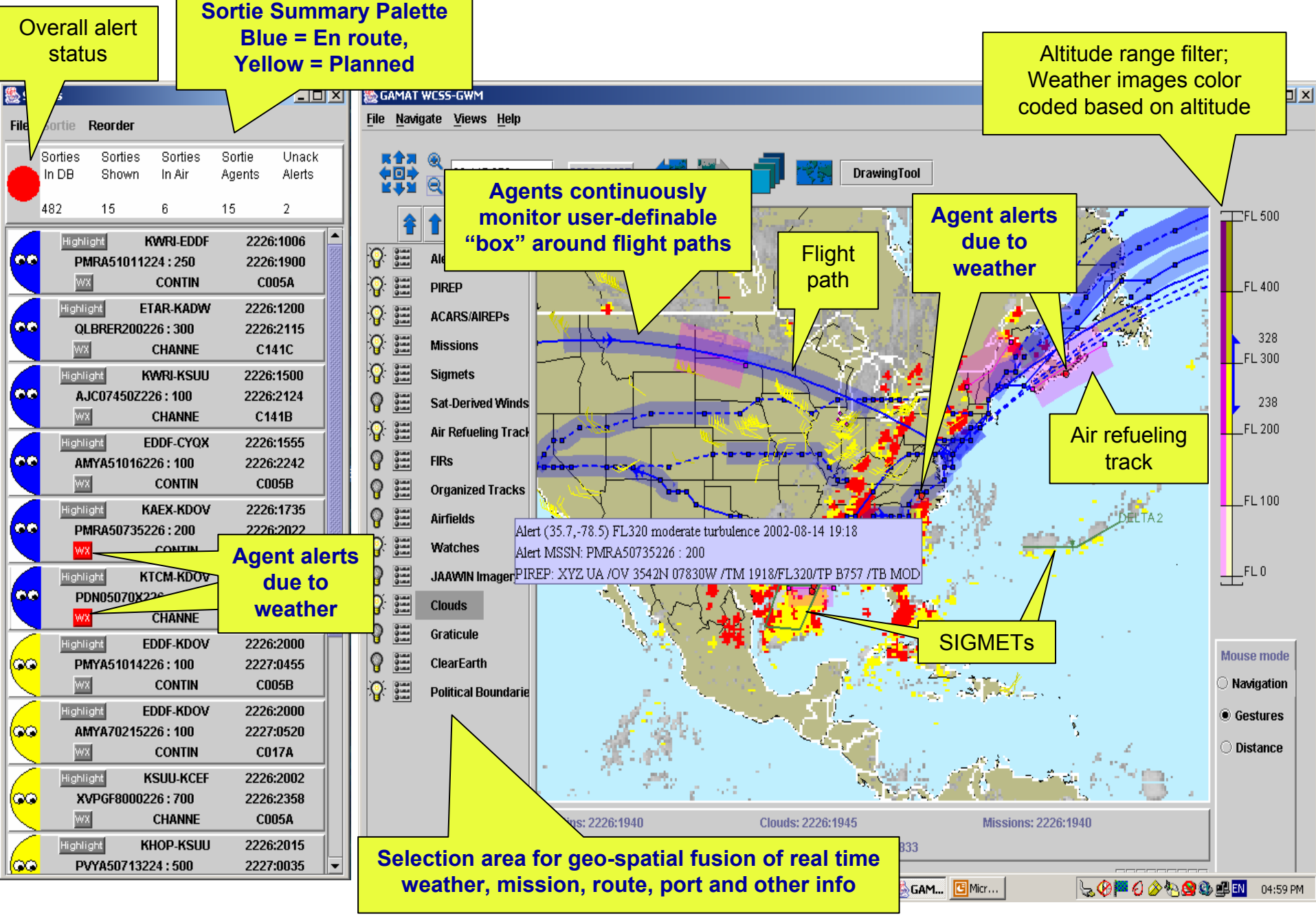
Work-Centered Support System for Global Weather Management (WCSS-GWM)

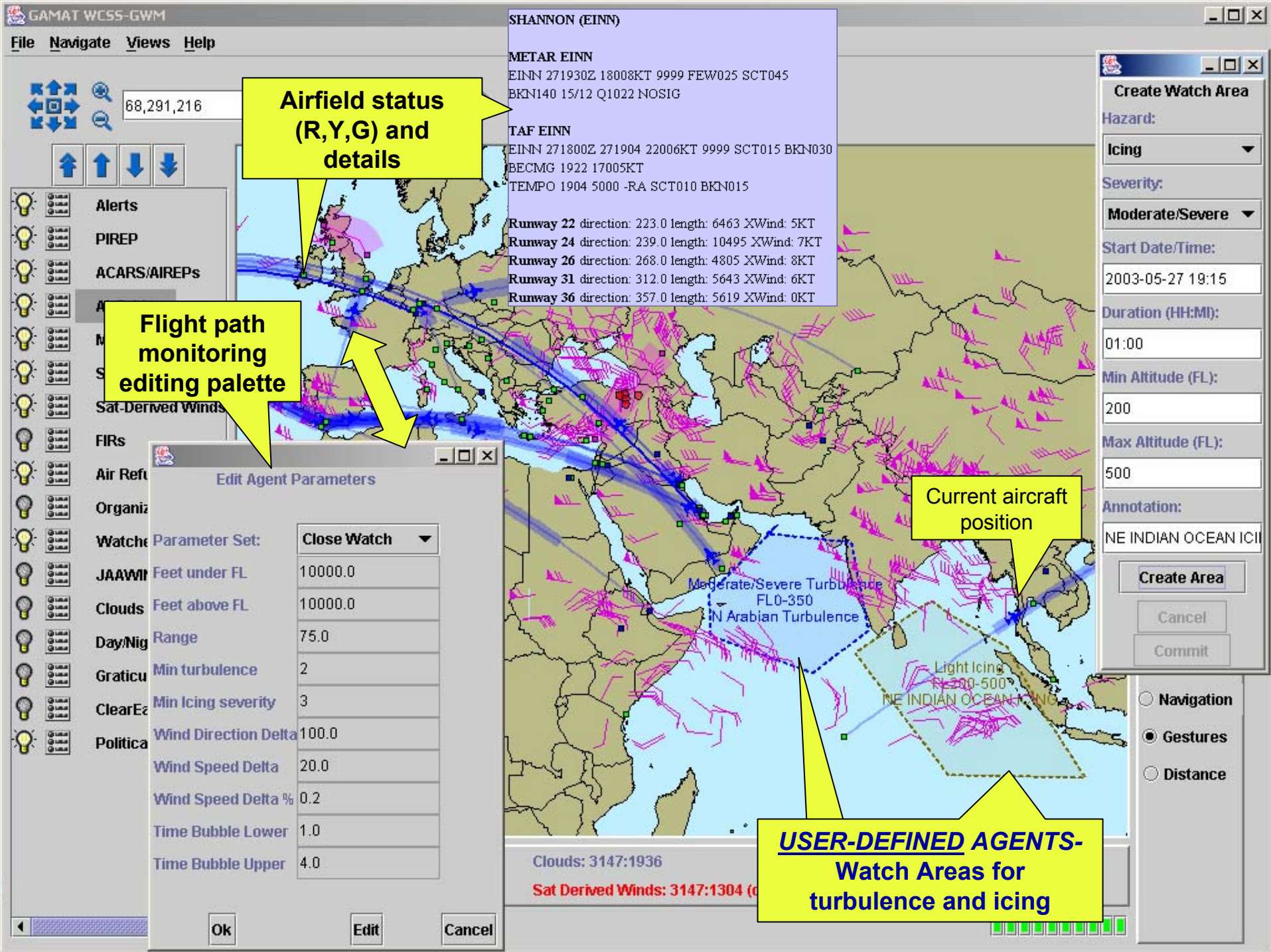
- **Goal: Minimize weather impacts on planned and en route AF missions**
- **Fuses weather and flight path info**
- **Provides:**
  - **Global monitoring, Situation Awareness**
  - **Proactive problem identification**
  - **Rapid problem resolution**
- **Demonstration of WCSS tech**
- **Preliminary performance results uniformly positive**

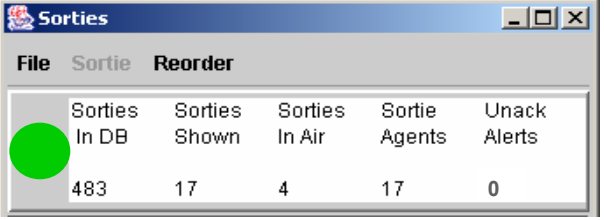
WCSS-GWM Client






Overall alert status
Sortie Summary Palette Blue = En route, Yellow = Planned
Altitude range filter; Weather images color coded based on altitude
Agents continuously monitor user-definable "box" around flight paths
Flight path
Agent alerts due to weather
Air refueling track
Agent alerts due to weather
SIGMETs
Selection area for geo-spatial fusion of real time weather, mission, route, port and other info
GAMAT WCSS-GWM
File Navigate Views Help
DrawingTool
Sorties In DB
Sorties Shown
Sorties In Air
Sortie Agents
Unack Alerts
482 15 6 15 2
Alert (35.7,-78.5) FL320 moderate turbulence 2002-08-14 19:18
Alert MSSN: PMRA50735226 : 200
PIREP: XYZ UA /OV 3542N 07830W /TM 1918/FL320/TP B757 /TB MOD
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
Watches
JAAWIN Imagery
Clouds
Graticule
ClearEarth
Political Boundaries
FL 500
FL 400
328
FL 300
238
FL 200
FL 100
FL 0
Mouse mode
Navigation
Gestures
Distance
Clouds: 2226:1945
Missions: 2226:1940
04:59 PM


GAMAT WCSS-GWM
File Navigate Views Help
68,291,216
Airfield status (R,Y,G) and details
SHANNON (EINN)
METAR EINN
EINN 271930Z 18008KT 9999 FEW025 SCT045
BKN140 15/12 Q1022 NOSIG
TAF EINN
EINN 271800Z 271904 22006KT 9999 SCT015 BKN030
BECMG 1922 17005KT
TEMPO 1904 5000 -RA SCT010 BKN015
Runway 22 direction: 223.0 length: 6463 XWind: 5KT
Runway 24 direction: 239.0 length: 10495 XWind: 7KT
Runway 26 direction: 268.0 length: 4805 XWind: 8KT
Runway 31 direction: 312.0 length: 5643 XWind: 6KT
Runway 36 direction: 357.0 length: 5619 XWind: 0KT
Flight path monitoring editing palette
Alerts
PIREP
ACARS/AIREPs
Sat-Derived Winds
FIRs
Edit Agent Parameters
Parameter Set: Close Watch
Feet under FL 10000.0
Feet above FL 10000.0
Range 75.0
Min turbulence 2
Min Icing severity 3
Wind Direction Delta 100.0
Wind Speed Delta 20.0
Wind Speed Delta % 0.2
Time Bubble Lower 1.0
Time Bubble Upper 4.0
Ok
Edit
Cancel
Create Watch Area
Hazard: Icing
Severity: Moderate/Severe
Start Date/Time: 2003-05-27 19:15
Duration (HH:MI): 01:00
Min Altitude (FL): 200
Max Altitude (FL): 500
Annotation: NE INDIAN OCEAN ICI
Create Area
Cancel
Commit
Current aircraft position
Moderate/Severe Turbulence
FL0-350
N Arabian Turbulence
Light Icing
FL200-500
NE INDIAN OCEAN ICING
Navigation
Gestures
Distance
Clouds: 3147:1936
Sat Derived Winds: 3147:1304
USER-DEFINED AGENTS-
Watch Areas for turbulence and icing

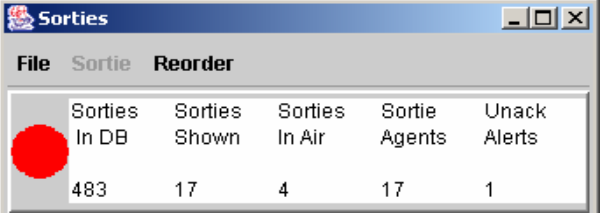


- **Sortie Summary Palette**

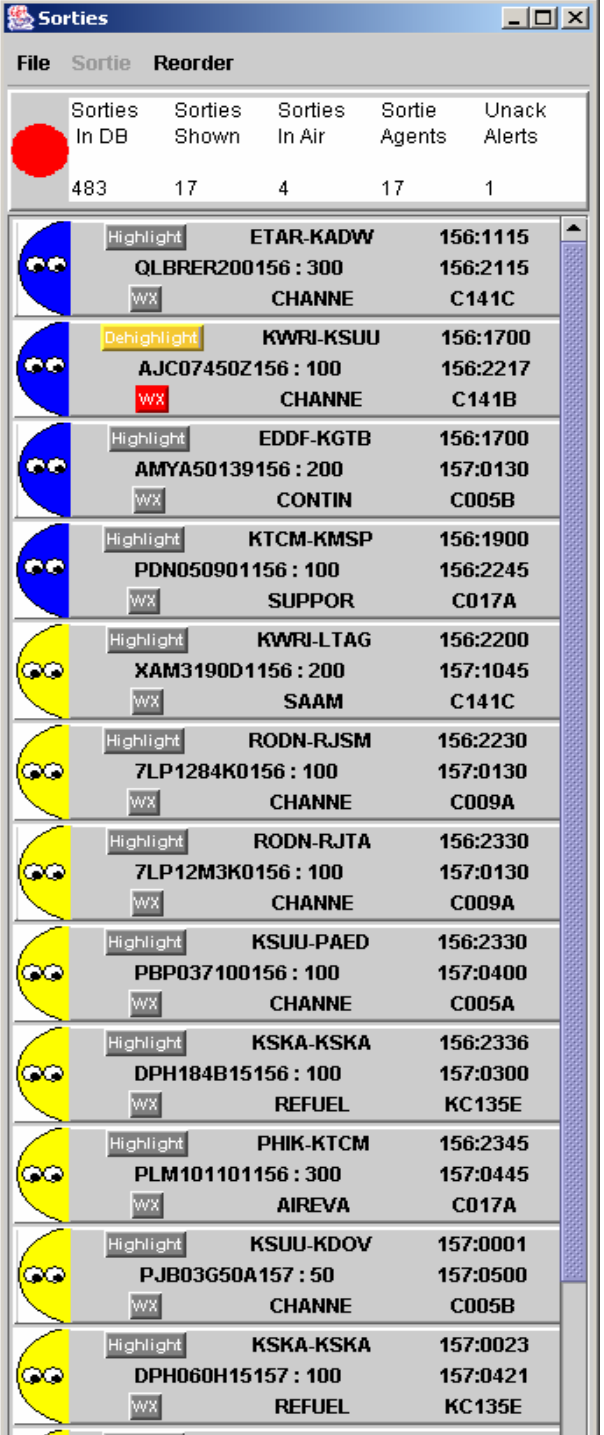
  - Allows management by exception

  - Provides relevant Situation Awareness tailored to individual user and/or team work needs

- ***Could reside on desktop, PDA, in cockpit...***

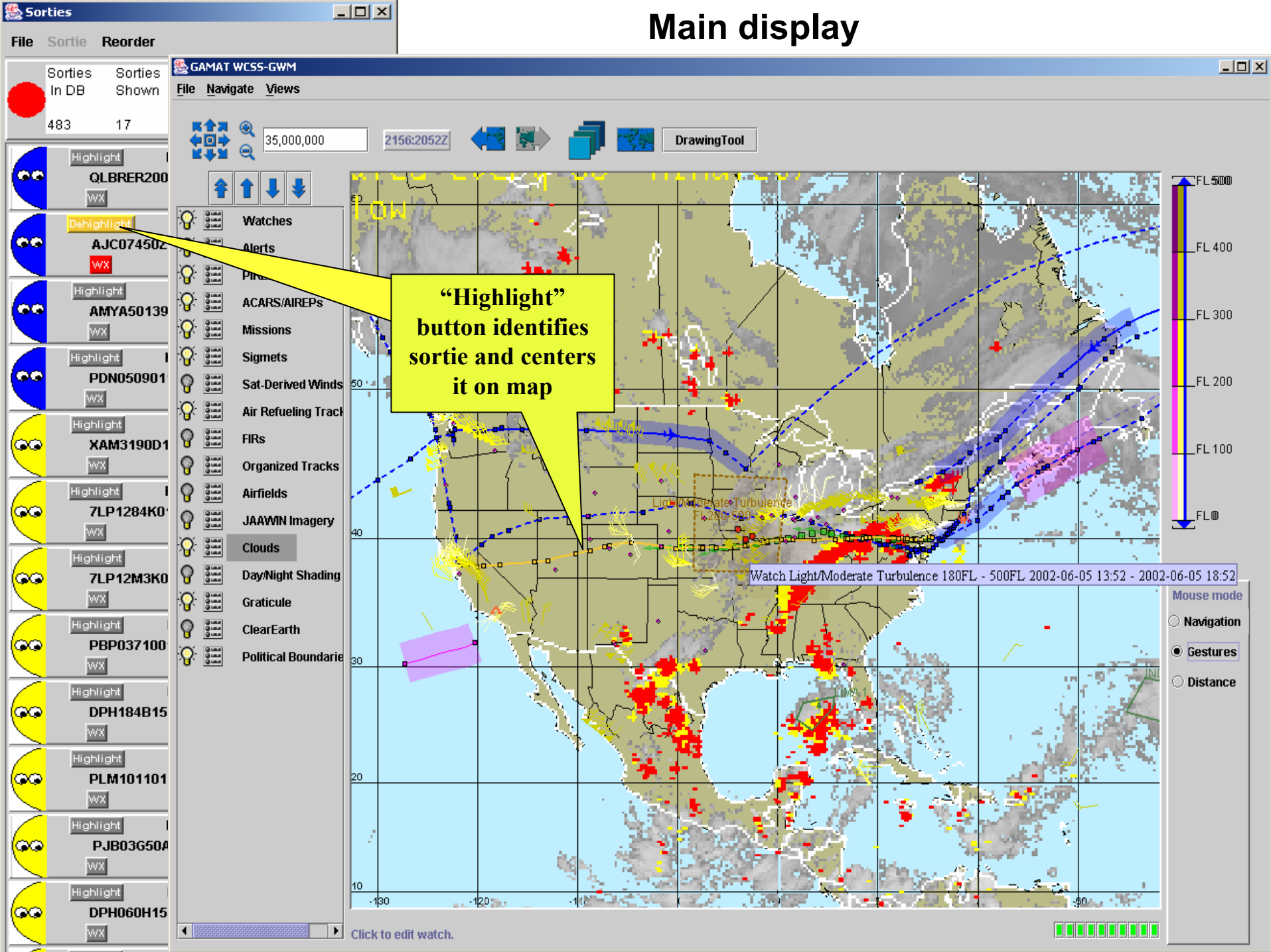


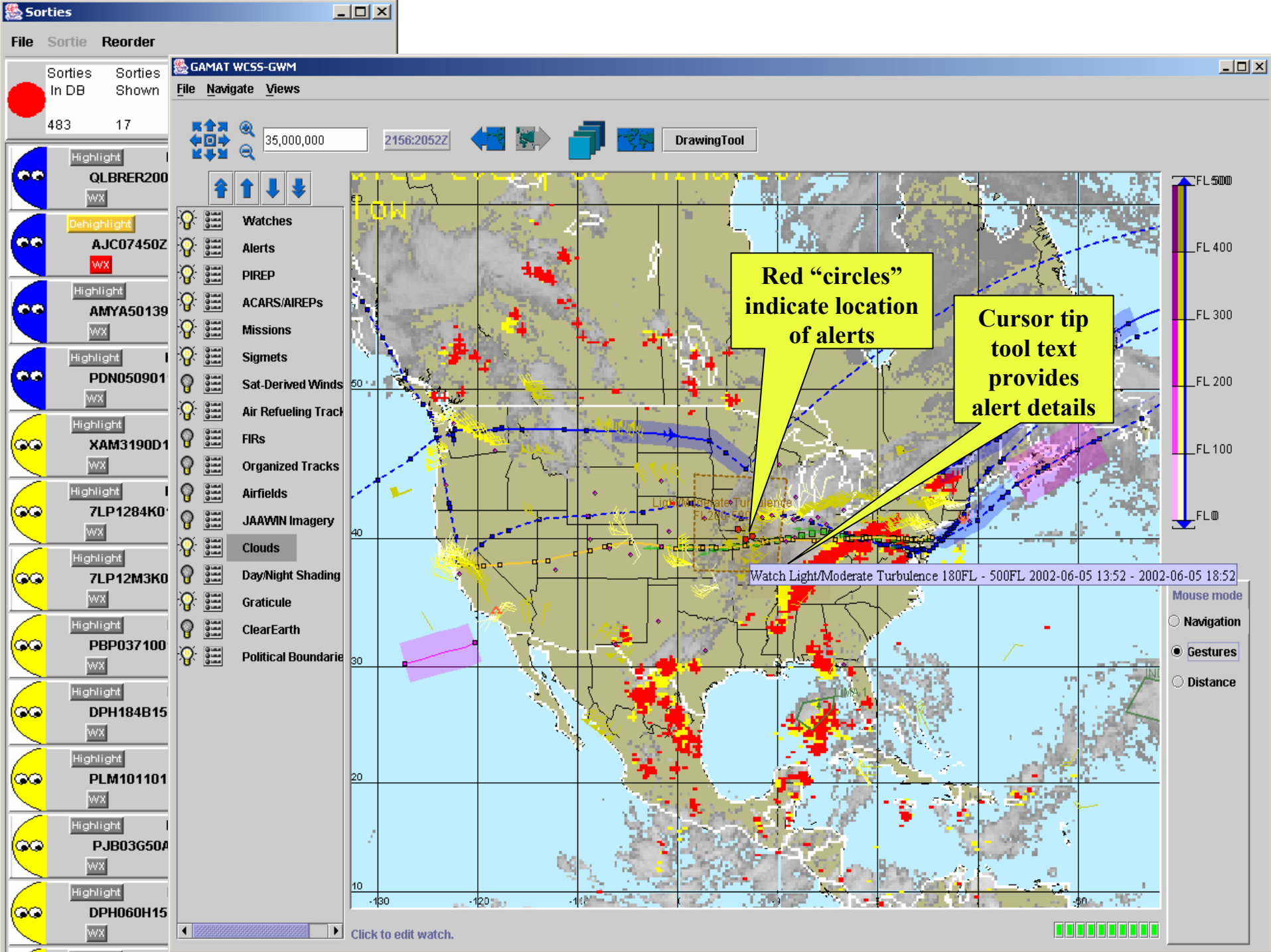
- **Master summary status turns red when agents detect potential problem**

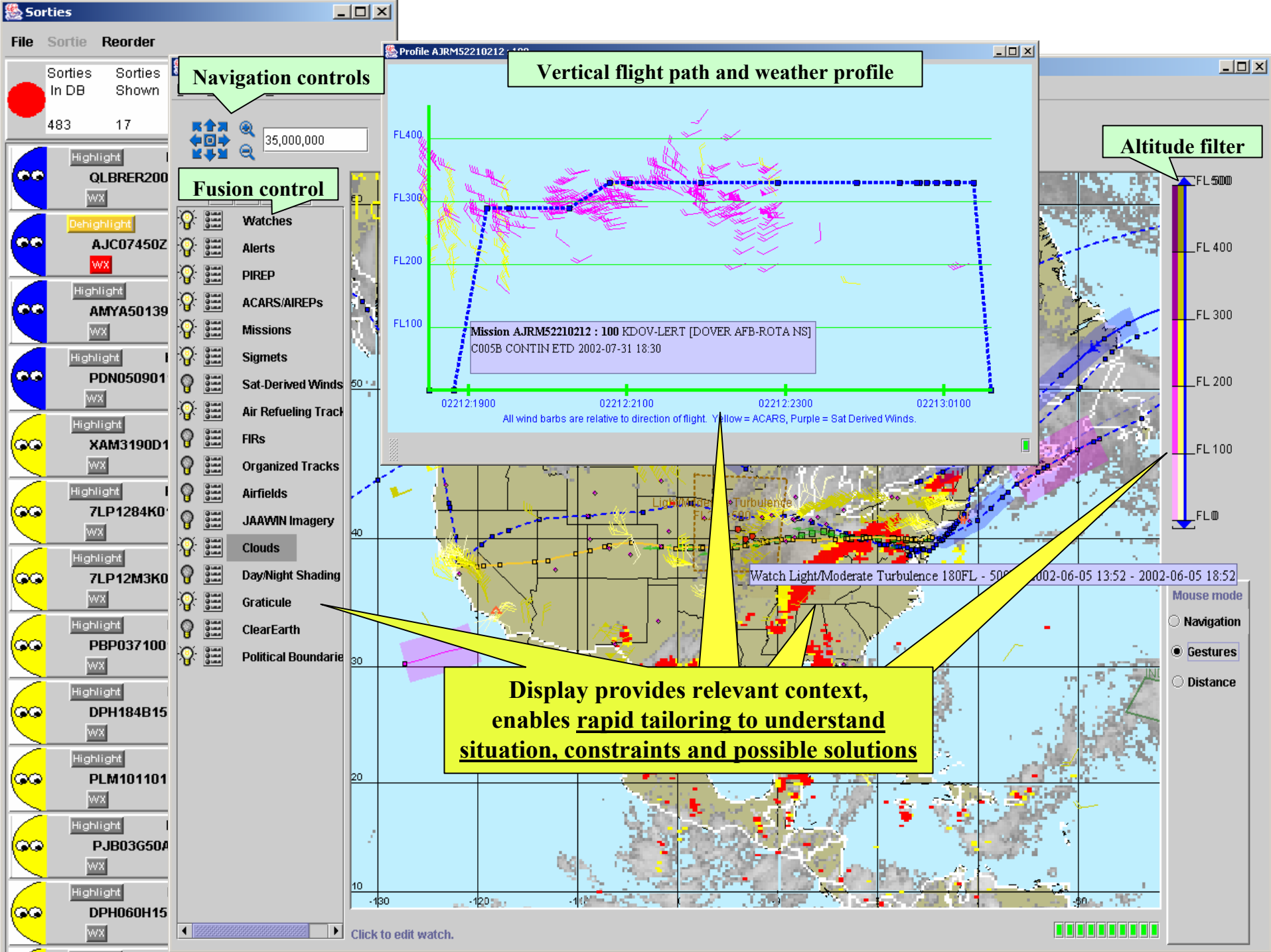


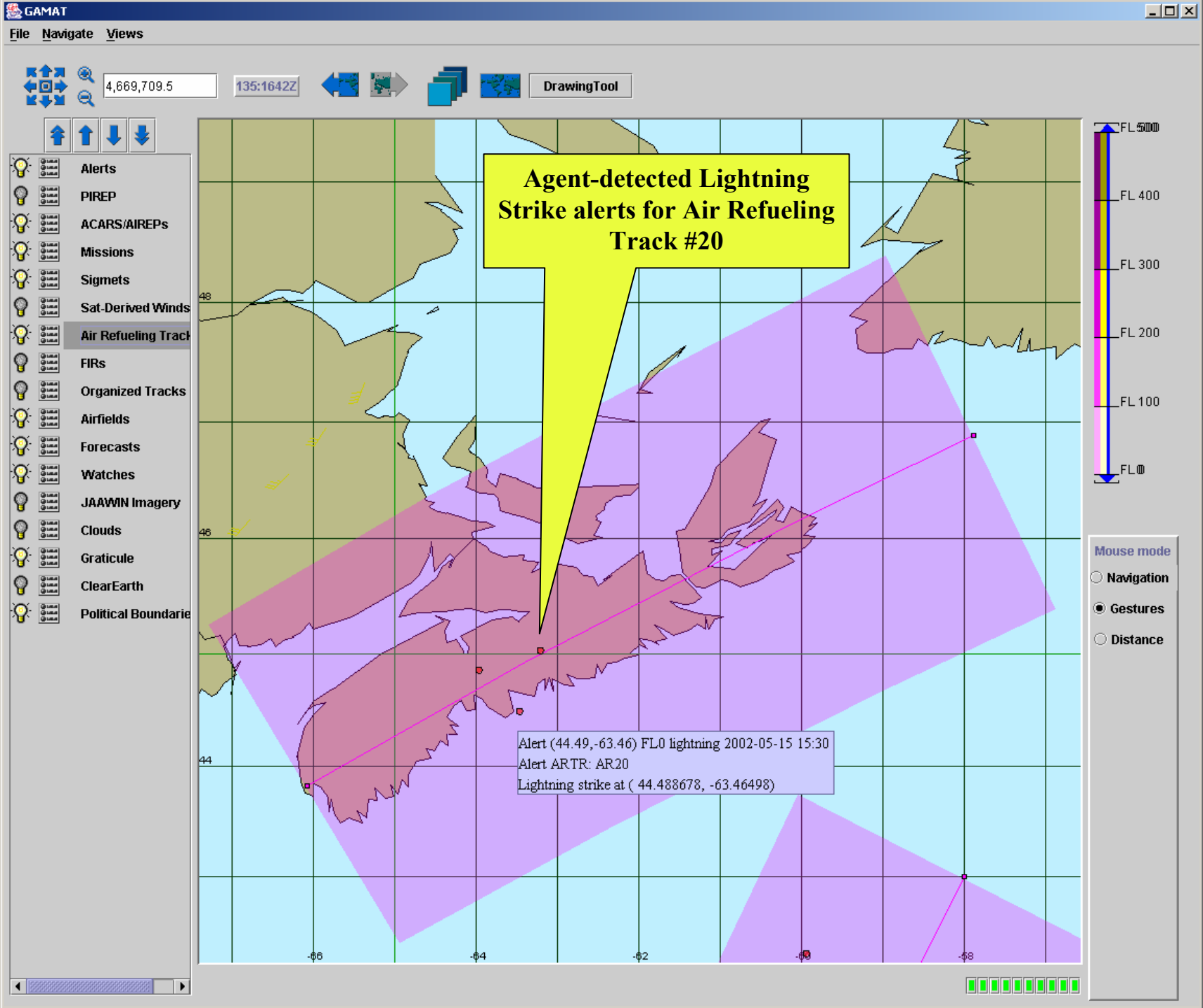
- **User expands Sortie Summary Palette to determine which sortie(s) require review**
- **“WX” indicator turns red to ID mission with alert**

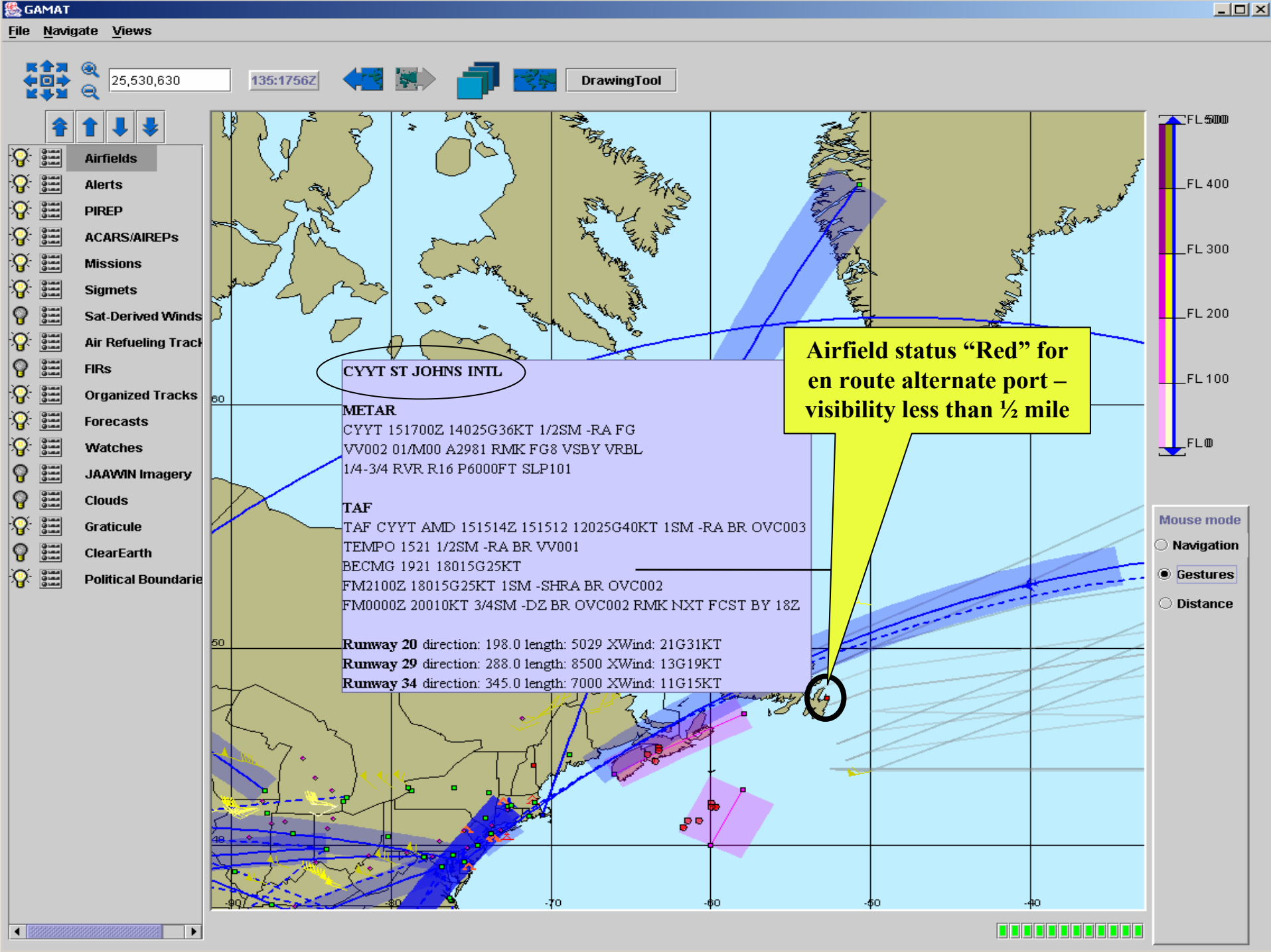
Main display

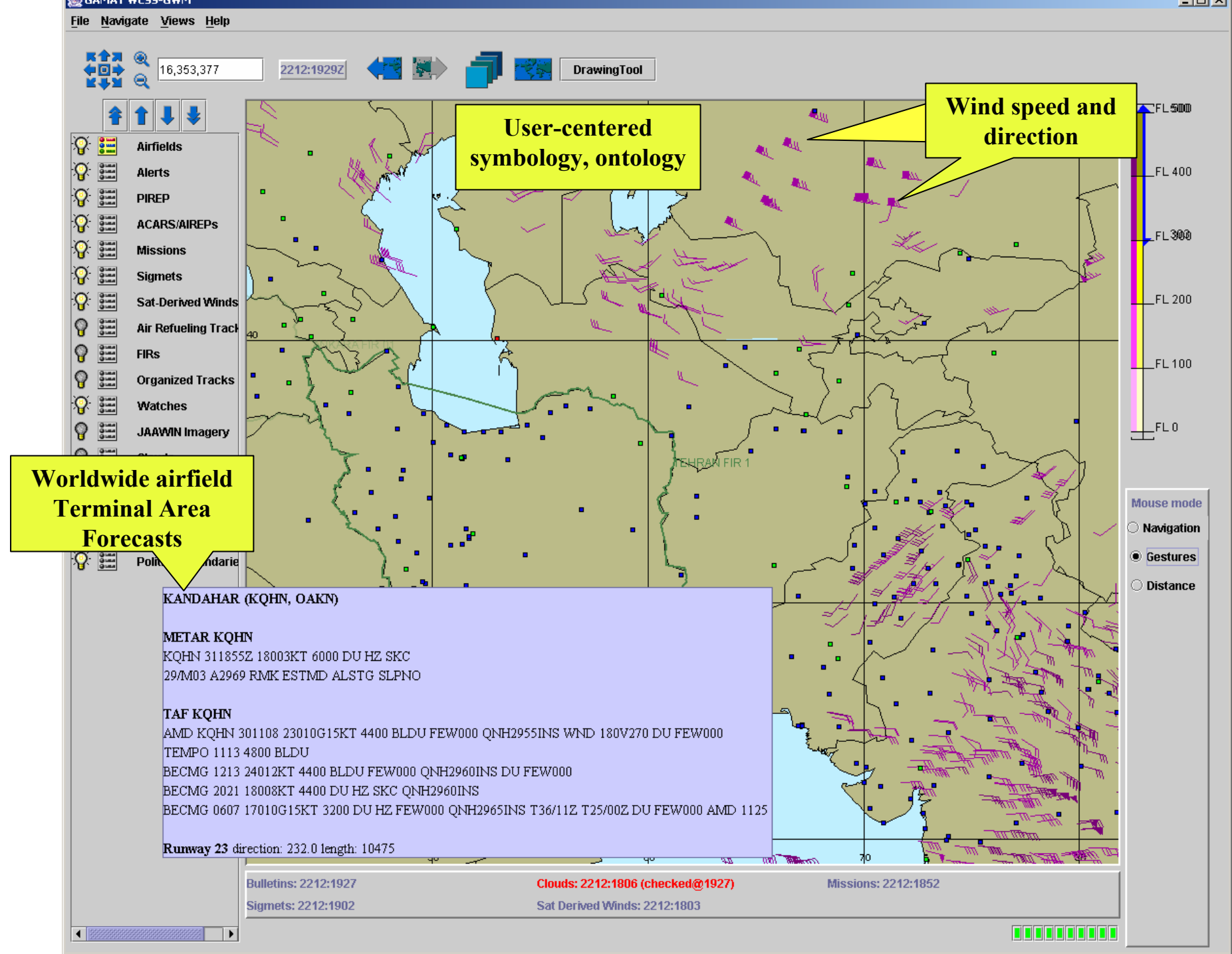


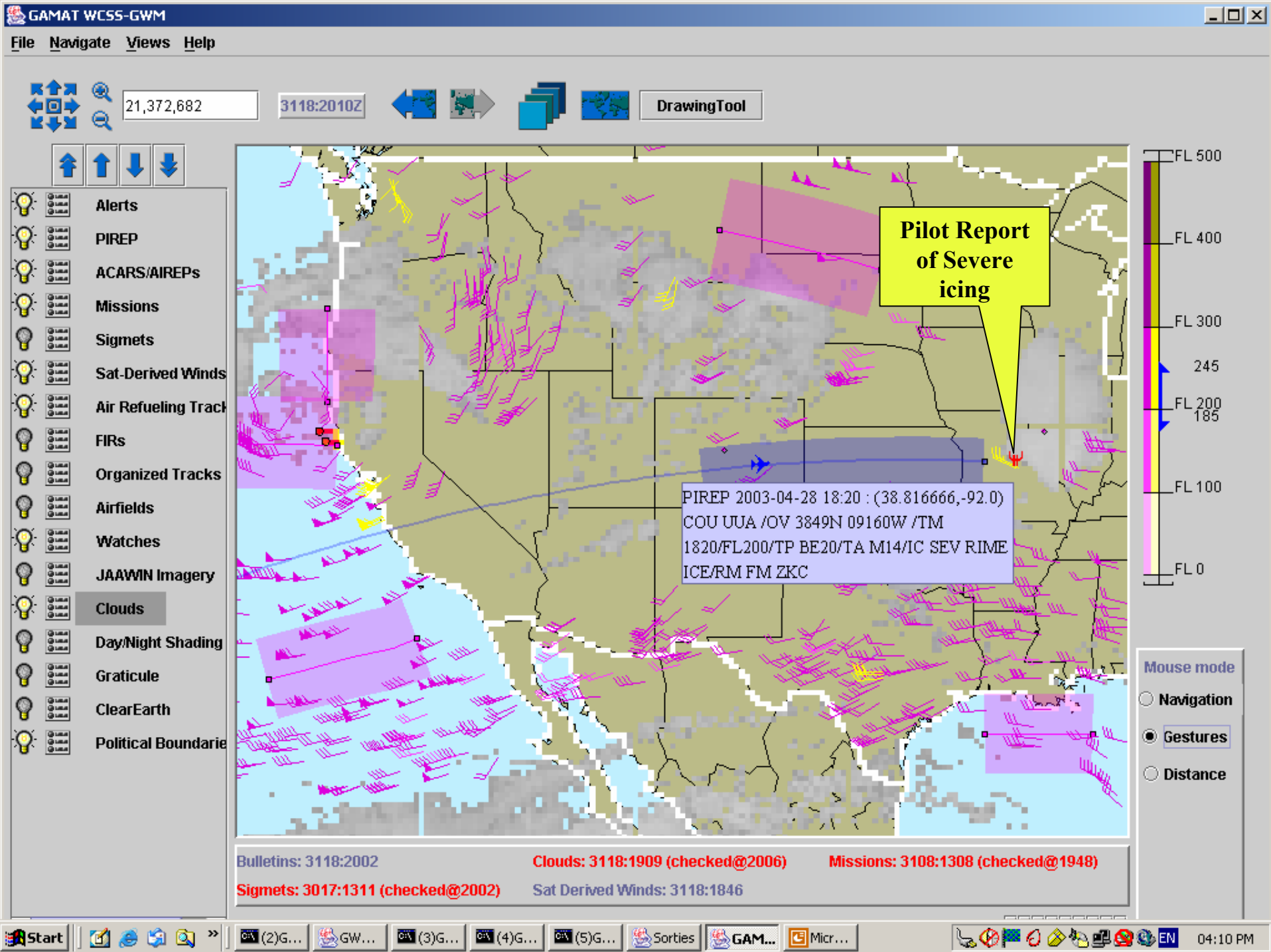

Sorties
File Sortie Reorder
Sorties In DB 483
Sorties Shown 17
GAMAT WCSS-GWM
File Navigate Views
35,000,000
2156:2052Z
DrawingTool
Watches
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
JAAWIN Imagery
Clouds
Day/Night Shading
Graticule
ClearEarth
Political Boundarie
Red "circles" indicate location of alerts
Cursor tip tool text provides alert details
Watch Light/Moderate Turbulence 180FL - 500FL 2002-06-05 13:52 - 2002-06-05 18:52
FL 500
FL 400
FL 300
FL 200
FL 100
Mouse mode
Navigation
Gestures
Distance
Click to edit watch.

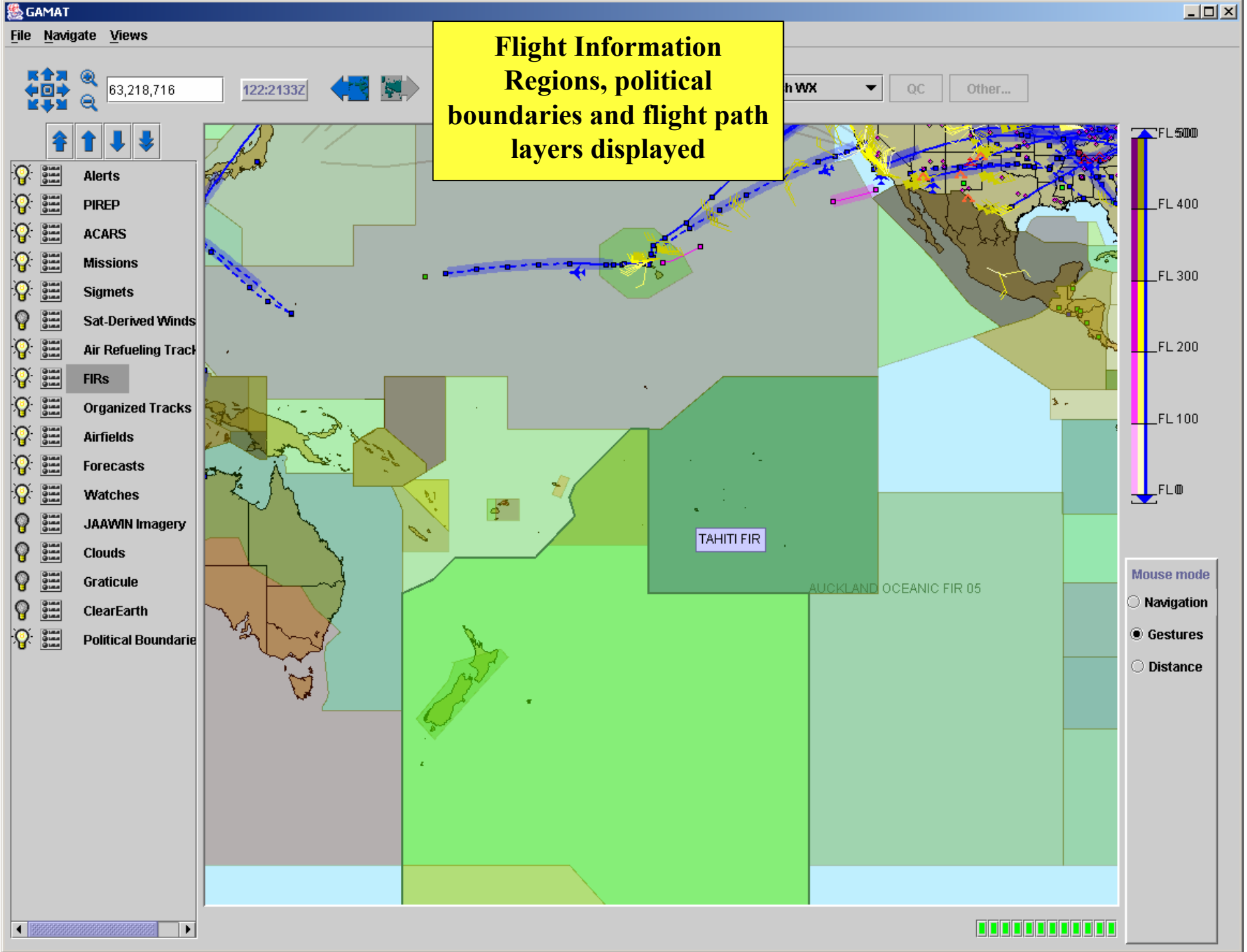

Sorties
File
Sortie
Reorder
Sorties In DB
Sorties Shown
483
17
Navigation controls
35,000,000
Fusion control
Watches
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
JAAWIN Imagery
Clouds
Day/Night Shading
Graticule
ClearEarth
Political Boundarie
Profile AJRM52210212
Vertical flight path and weather profile
FL400
FL300
FL200
FL100
Mission AJRM52210212 : 100 KDOV-LERT [DOVER AFB-ROTA NS]
C005B CONTIN ETD 2002-07-31 18:30
02212:1900
02212:2100
02212:2300
02213:0100
All wind barbs are relative to direction of flight. Yellow = ACARS, Purple = Sat Derived Winds.
Altitude filter
FL 500
FL 400
FL 300
FL 200
FL 100
Watch Light/Moderate Turbulence 180FL - 50
002-06-05 13:52 - 2002-06-05 18:52
Mouse mode
Navigation
Gestures
Distance
Display provides relevant context,
enables rapid tailoring to understand
situation, constraints and possible solutions
Click to edit watch.

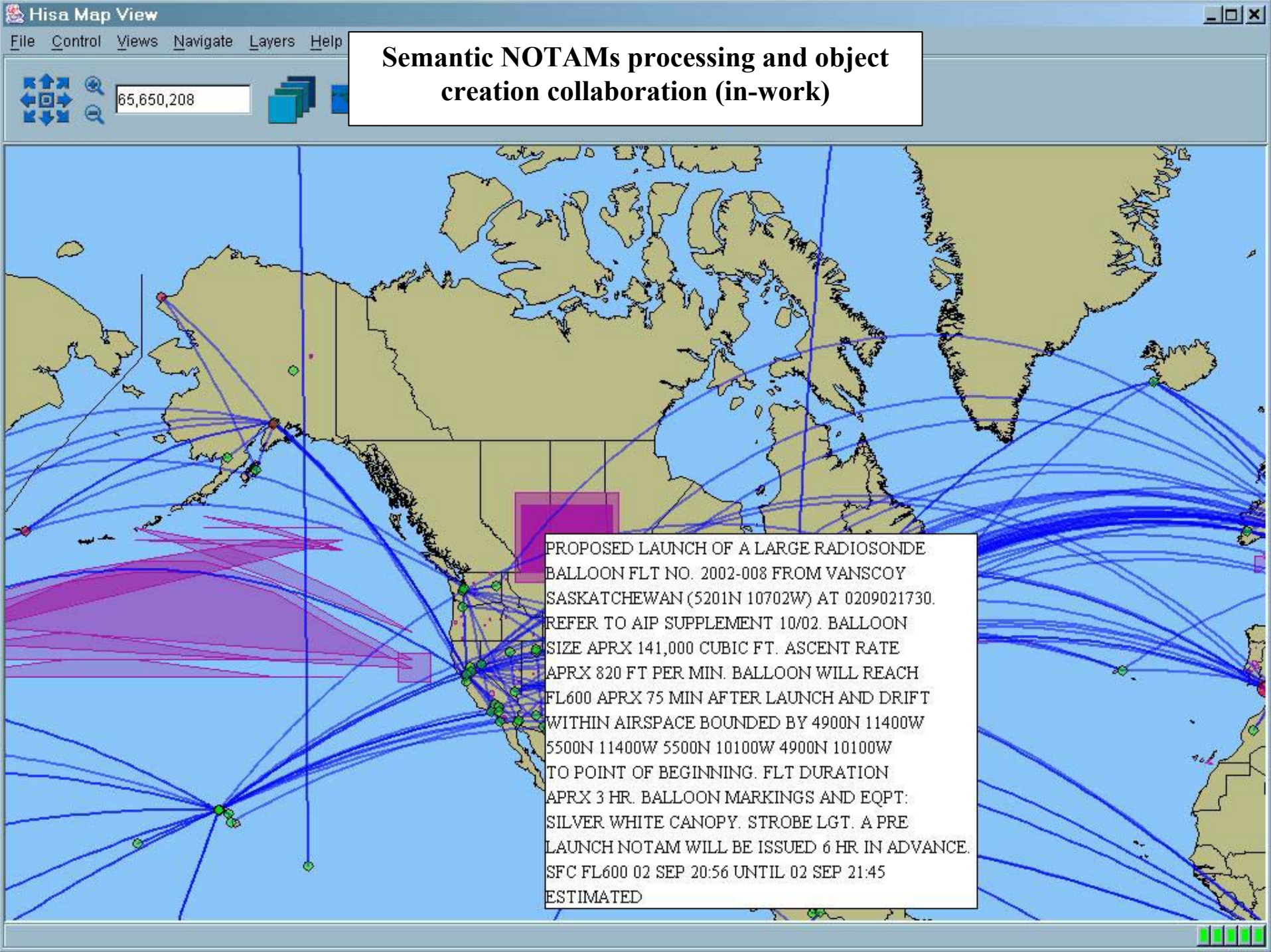

GAMAT
File Navigate Views
4,669,709.5
135:1642Z
DrawingTool
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
Forecasts
Watches
JAAWIN Imagery
Clouds
Graticule
ClearEarth
Political Boundarie
Agent-detected Lightning Strike alerts for Air Refueling Track #20
Alert (44.49,-63.46) FL0 lightning 2002-05-15 15:30
Alert ARTR: AR20
Lightning strike at (44.488678, -63.46498)
FL 400
FL 300
FL 200
FL 100
Mouse mode
Navigation
Gestures
Distance


GAMAT
File
Navigate
Views
25,530,630
135:1756Z
DrawingTool
Airfields
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Forecasts
Watches
JAAWIN Imagery
Clouds
Graticule
ClearEarth
Political Boundarie
CYYT ST JOHNS INTL
METAR
CYYT 151700Z 14025G36KT 1/2SM -RA FG
VV002 01/M00 A2981 RMK FG8 VSBY VRBL
1/4-3/4 RVR R16 P6000FT SLP101
TAF
TAF CYYT AMD 151514Z 151512 12025G40KT 1SM -RA BR OVC003
TEMPO 1521 1/2SM -RA BR VV001
BECMG 1921 18015G25KT
FM2100Z 18015G25KT 1SM -SHRA BR OVC002
FM0000Z 20010KT 3/4SM -DZ BR OVC002 RMK NXT FCST BY 18Z
Runway 20 direction: 198.0 length: 5029 XWind: 21G31KT
Runway 29 direction: 288.0 length: 8500 XWind: 13G19KT
Runway 34 direction: 345.0 length: 7000 XWind: 11G15KT
Airfield status “Red” for en route alternate port – visibility less than ½ mile
FL 500
FL 400
FL 300
FL 200
FL 100
FL 0
Mouse mode
Navigation
Gestures
Distance


File Navigate Views Help
16,353,377
2212:1929Z
DrawingTool
User-centered symbology, ontology
Wind speed and direction
Airfields
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Watches
JAAWIN Imagery
FL 500
FL 400
FL 300
FL 200
FL 100
FL 0
Mouse mode
Navigation
Gestures
Distance
Worldwide airfield Terminal Area Forecasts
KANDAHAR (KQHN, OAKN)
METAR KQHN
KQHN 311855Z 18003KT 6000 DU HZ SKC
29/M03 A2969 RMK ESTMD ALSTG SLPNO
TAF KQHN
AMD KQHN 301108 23010G15KT 4400 BLDU FEW000 QNH2955INS WND 180V270 DU FEW000
TEMPO 1113 4800 BLDU
BECMG 1213 24012KT 4400 BLDU FEW000 QNH2960INS DU FEW000
BECMG 2021 18008KT 4400 DU HZ SKC QNH2960INS
BECMG 0607 17010G15KT 3200 DU HZ FEW000 QNH2965INS T36/11Z T25/00Z DU FEW000 AMD 1125
Runway 23 direction: 232.0 length: 10475
Bulletins: 2212:1927
Clouds: 2212:1806 (checked@1927)
Missions: 2212:1852
Sigmets: 2212:1902
Sat Derived Winds: 2212:1803


GAMAT WCSS-GWM
File
Navigate
Views
Help
21,372,682
3118:2010Z
DrawingTool
Alerts
PIREP
ACARS/AIREPs
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
Watches
JAAWIN Imagery
Clouds
Day/Night Shading
Graticule
ClearEarth
Political Boundarie
Pilot Report of Severe icing
PIREP 2003-04-28 18:20 : (38.816666,-92.0)
COU UUA /OV 3849N 09160W /TM
1820/FL200/TP BE20/TA M14/IC SEV RIME
ICE/RM FM ZKC
FL 500
FL 400
FL 300
245
FL 200
185
FL 100
FL 0
Mouse mode
Navigation
Gestures
Distance
Bulletins: 3118:2002
Clouds: 3118:1909 (checked@2006)
Missions: 3108:1308 (checked@1948)
Sigmets: 3017:1311 (checked@2002)
Sat Derived Winds: 3118:1846
Start
(2)G...
GW...
(3)G...
(4)G...
(5)G...
Sorties
GAM...
Micr...
EN
04:10 PM


GAMAT
File
Navigate
Views
Flight Information Regions, political boundaries and flight path layers displayed
63,218,716
122:2133Z
QC
Other...
Alerts
PIREP
ACARS
Missions
Sigmets
Sat-Derived Winds
Air Refueling Track
FIRs
Organized Tracks
Airfields
Forecasts
Watches
JAAWIN Imagery
Clouds
Graticule
ClearEarth
Political Boundarie
TAHITI FIR
AUCKLAND OCEANIC FIR 05
FL 500
FL 400
FL 300
FL 200
FL 100
FL 0
Mouse mode
Navigation
Gestures
Distance


Hisa Map View
File Control Views Navigate Layers Help
65,650,208
Semantic NOTAMs processing and object creation collaboration (in-work)
PROPOSED LAUNCH OF A LARGE RADIOSONDE BALLOON FLT NO. 2002-008 FROM VANSCOY SASKATCHEWAN (5201N 10702W) AT 0209021730. REFER TO AIP SUPPLEMENT 10/02. BALLOON SIZE APRX 141,000 CUBIC FT. ASCENT RATE APRX 820 FT PER MIN. BALLOON WILL REACH FL600 APRX 75 MIN AFTER LAUNCH AND DRIFT WITHIN AIRSPACE BOUNDED BY 4900N 11400W 5500N 11400W 5500N 10100W 4900N 10100W TO POINT OF BEGINNING. FLT DURATION APRX 3 HR. BALLOON MARKINGS AND EQPT: SILVER WHITE CANOPY. STROBE LGT. A PRE LAUNCH NOTAM WILL BE ISSUED 6 HR IN ADVANCE. SFC FL600 02 SEP 20:56 UNTIL 02 SEP 21:45 ESTIMATED

WCSS-GWM Performance Testing

- Preliminary evaluation conducted using Likert scale on beta version
- 30 minutes of training, followed by scenario-based use
- Results:
  - Usability performance: 23 of 27 items usable with no additional training
  - Overall usefulness (to target user) rating: Mean = 4.94/5.0; lowest rating = 4.75
  - Organizational (AMC) effectiveness rating: Mean = 4.8/5.0; lowest rating = 4.6

Conclusions

- The human computer interface is becoming decoupled from application programs
- Offers the opportunity to create a new class of job aid or decision support tool
  - A stand-alone application
  - Plugs into the digital nervous system or information grid
  - Uses intelligent agents to find, format, fuse, and present information
  - Uses cognitively compatible displays focused on supporting work
- Work-Centered Support System technology
  - Offers one solution set for/has a goal of:
    - Leveraging increases in information access
    - While minimizing potential negative consequences
  - Has shown positive results
  - More work needed/research issues abound

Questions? Comments?