Fast-time Modelling (*RAMS Plus*) from a Developers Viewpoint

Ian Crook
ISA Software

RAMS Plus – a 'Potted-History'

- **Developed at EEC from 1991-96 as replacement for EUROCONTROL Airspace Model**
  - **Fast-Time Discrete Event Model**
  - **Analysis of**
    - **Airspace Systems and Airport Configurations**
    - **ATC Systems**
    - **Controller Activities**
    - **Future ATC Concepts**
    - **…**
  - **Used by FAA since 1995**
  - **1995-1999 distributed only to national aviation authorities**
- **Commercially Supported Product Since January 2000 (as a community supported tool)**

RAMS Plus – a 'Potted-History'

- **Today, RAMS Plus is a stand-alone PC-Windows based ATM simulator used on 5 continents**
  - highly configurable simulation tool (MACRO -> MICRO Analysis)
  - High Quality of Operational (ATC) Realism
  - Enhanced capabilities (TMA, Runway Management, Ground Movement, Multi-sector Planner, Dynamic Workload Assignment …)
  - IS EASY TO USE (PC-Based GUI)
  - Provides a High Calibre, Cost Effective Solution for a large user base
  - Supports users rapidly and effectively in their simulation needs

RAMS Plus – a ‘Potted-History’

- **Throughout its Development RAMS Plus has been designed as a scalable and highly configurable tool**
  - Careful design of ATM classes
  - De-coupling of simulation and non-simulation facilities
  - Highly (*entirely*) data driven
  - Avoids ‘hard-coded’ ATM logic
  - Provides generic solutions to ATM modelling issues

What do you want to study?

MACRO ⟷ **MICRO**

Data View

- **Enroute Sectors**
- **Routes**
- **Airports**

Answers

- **Centre Counts**
- **Sector Counts**
- **Conflict Density**
- **Free Flight Benefits**

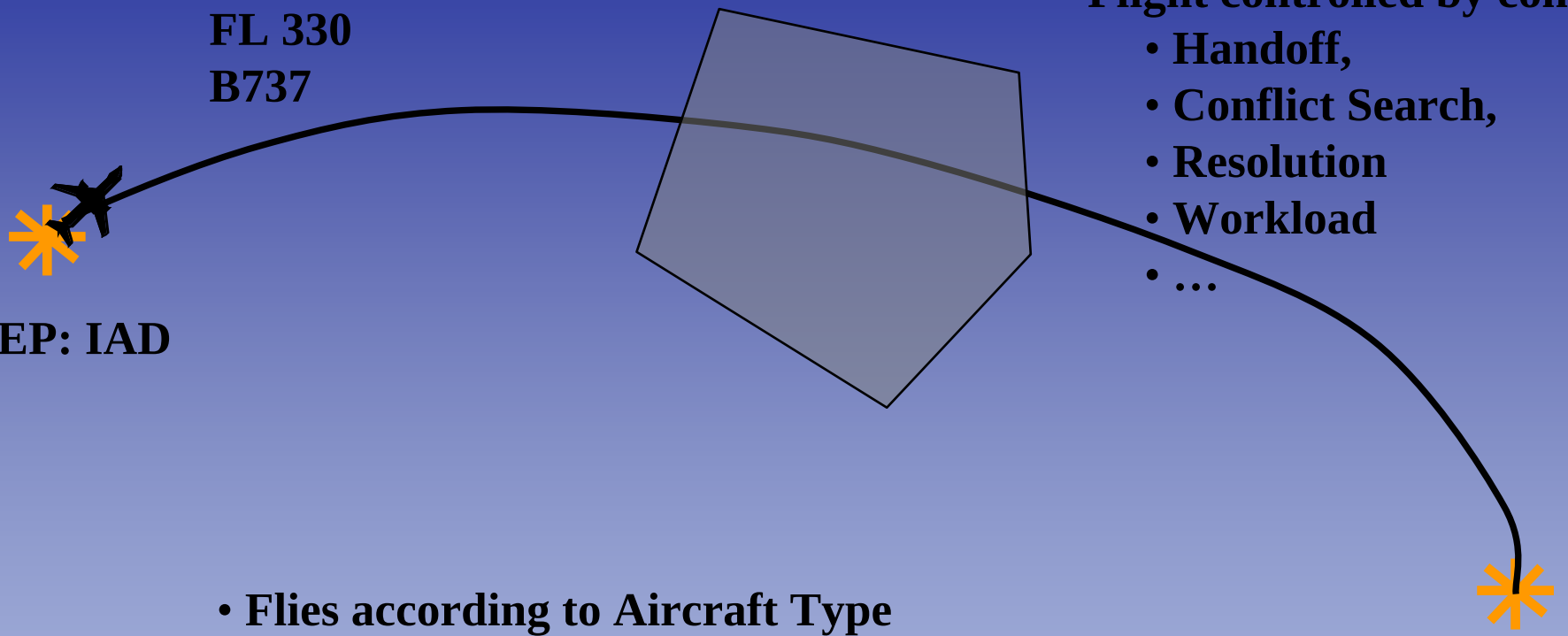
Data View

- **TMA Sectors**
- **Runways, Taxiways, Gates**
- **SIDS/STARS**
- **Holdstacks**

Answers

- **TMA Capacity**
- **Airport Capacity**
- **New approach procedures**
- **Alternate Sectorisation**

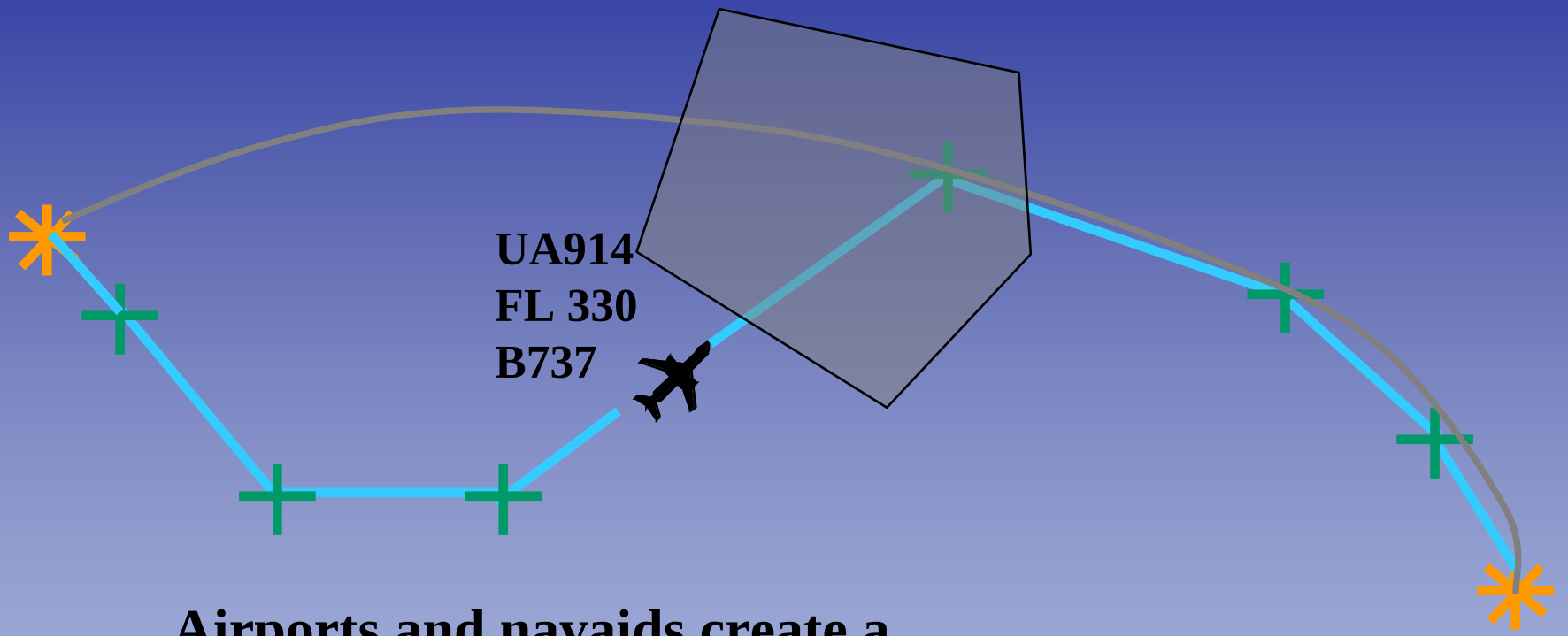
Airport – Airport



- Add a sector
- Flight controlled by controllers
  - Handoff,
  - Conflict Search,
  - Resolution
  - Workload
  - …

- Flies according to Aircraft Type
- Uses requested FL
- Follows Great Circle Route to destination
- Lands at ADES (Point)

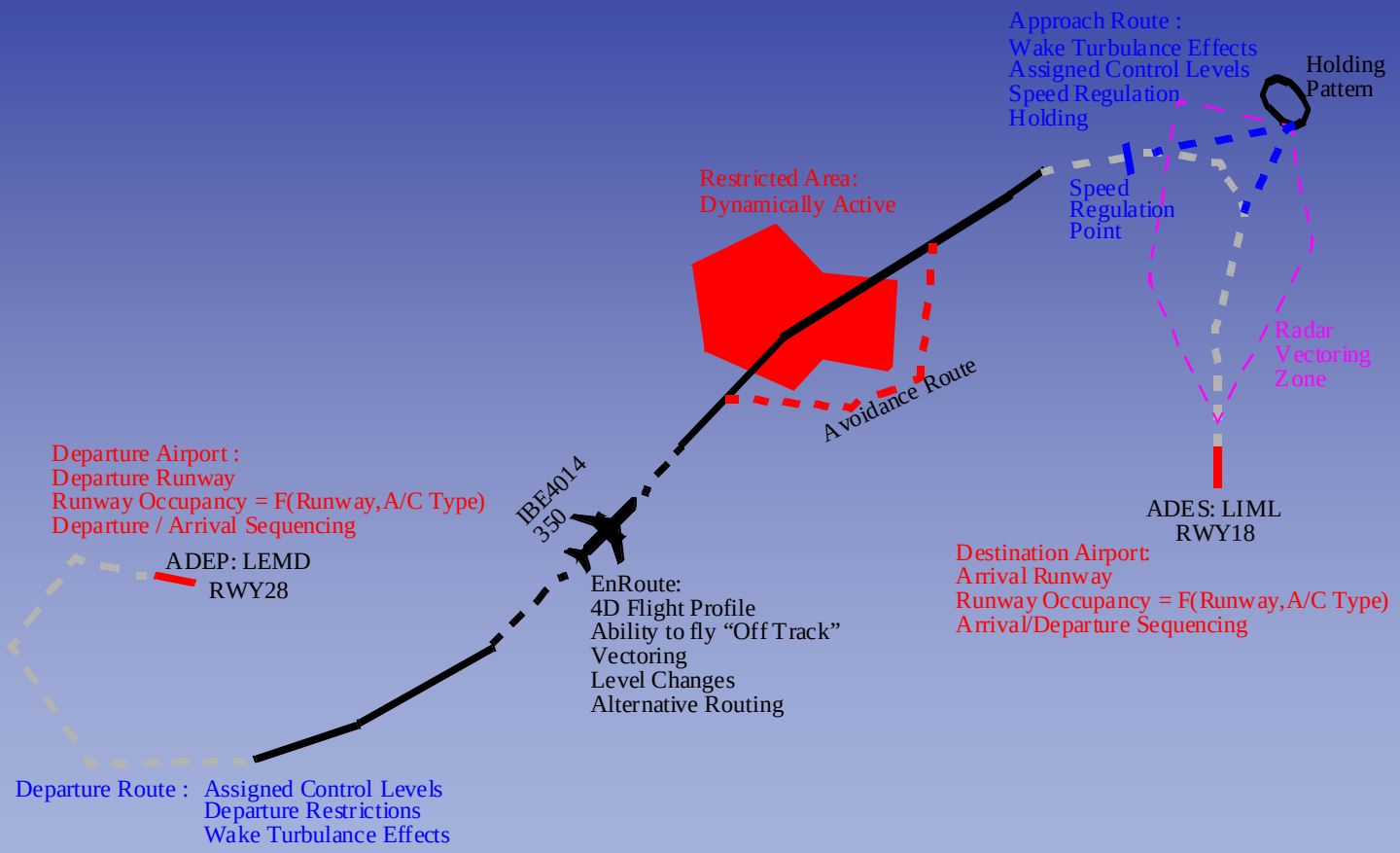
Use of CNS



Airports and navaids create a Path (route) of lat/long positions

ADES: CDG

Complex Flight Plan & ATM Features



Plan View

The operation was a success, but the patient died…

- As more features are required, the size & intricacy grows
- *1 user requirement – 25 functional requirements – 250 s/w requirements*

???can this be maintained???

The Operational Challenge…

- **Objectives**
  - Manage safely future traffic growth within a limited resources capacity
  - Reduce airspace users delays

- **Goals**
  - Support advanced operational concepts
  - Introduce advanced technology in the cockpit
  - Build airspace system modelling and simulation components to assess these conceptual approaches

… Impact on Today's Simulators

- **Airspace operations are growing more complex and demanding**
  - Difficult to anticipate new requirements in a given simulator
  - Users have different flavours to approach a particular problem
    "Example: MSP"
  - Support of gate-to-gate strategy to increase capacity and flexibility
- **Simulators developed based on the past operational needs**
  - Individual tools are required to fill the gap
  - Tools tend to create islands of functionality and data
  - Tedious to keep track of which particular tool access to which particular data
- **Much of the information your tools need is inaccessible**
  - Some simulators are already becoming semi-open systems (e.g. RAMS+)
  - Costly & frustrating challenge to integrate simulator output with your own tools

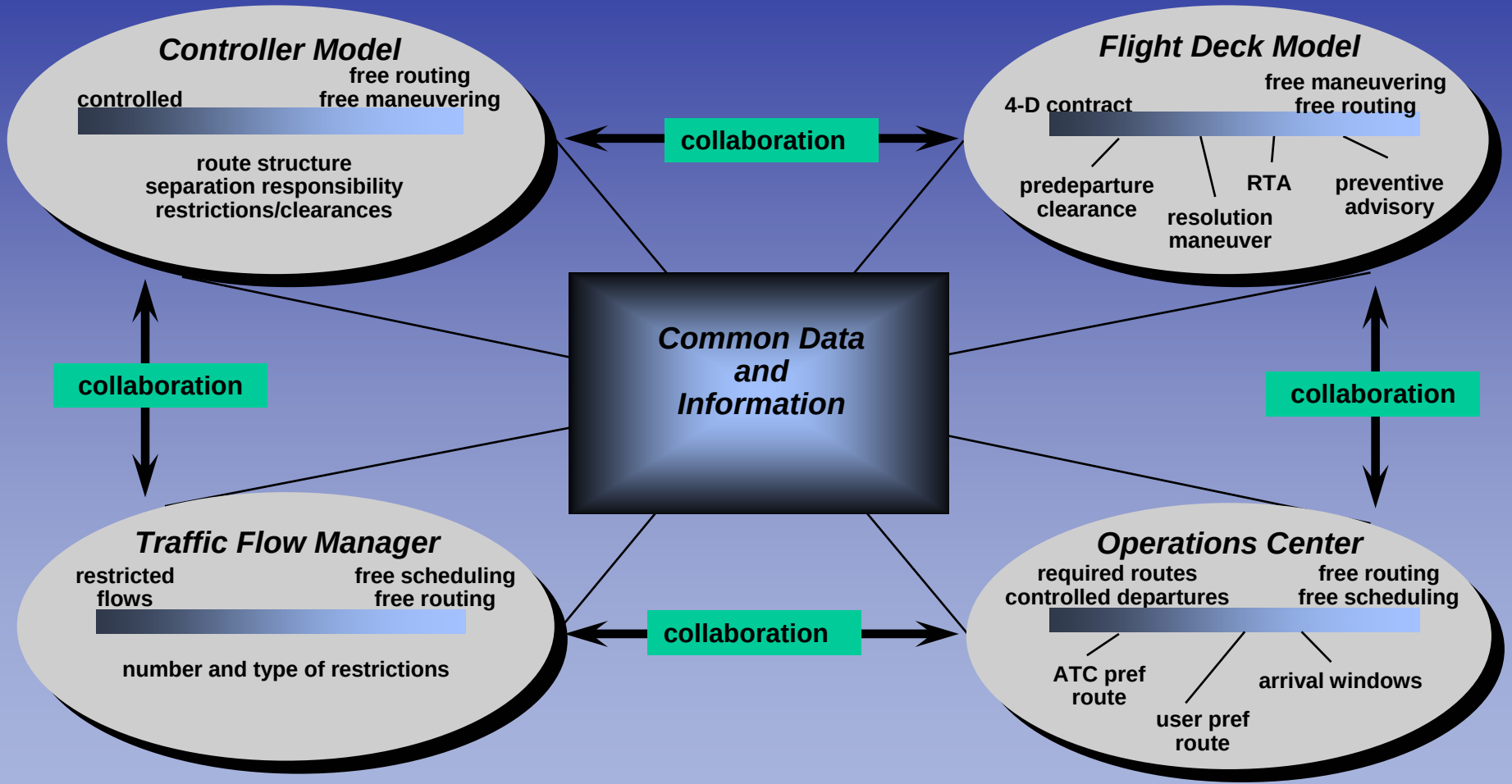
"Perfection is achieved only on the point of collapse" C.N. Parkinson

What will the next generation of simulator need?

- **Generic Simulator Engine Components**
  - Core airspace operations
  - Core airspace representation
- **CDM/DST & simulators must collaborate seamlessly**
  - Surface movement
  - Flight Deck
  - Traffic Flow Manager
  - Human behaviour
- **Able to share not only data but information**
  - Dynamic Information
  - Static Data
  - Flight information
  - Dynamic Resectorization of Airspace
- **Join forces to offer customized and comprehensive solutions**
  - Support individual user objectives
  - Complimentary and collaborative decision making based on common information availability

What will the next generation of simulators look like?

A highly-automated, collaborative environment supporting individual user objectives



Current Situation…

FAA & ISA Software has taken some giant leaps towards the next generation:

- *Information & Data sharing*
  - Implementation of the ***Common ATM Information State Space*** (CAISS)
  - Implementation of a dynamic query system to interrogate and manipulate CAISS
  - Integration of Airport Surface Movement into CAISS (A-SMIC)
- *RAMS Plus "Open Communications Interface"*
  - To allow external users and model components to interact with RAMS Plus
- *Common Information Network*
  - Strategy for Inter-Model Connectivity (SIM-C)
- *Progressively integrating tools*
  - Ready to use library to ease tools integration with CAISS
  - Third party tools as well as our own
  - Encourage others to join

"While we are postponing, life speeds by "
Seneca (3BC – 65 AD)

Current Situation…

Currently Integrated Tools
RAMS Plus
ATMOS
OPGEN
Decision Tool
MIDAS
AFDM
CAISS
MasterClock

Coming soon…
AEM
ENHANCE/INM
MM5
ACTS

MWM (in PITOT)

DST:
AMAN Tool (AENA)

R/T <> F/T Hybrid

In Summary

- **Generic simulator engine** is required to speed development and evaluation of conceptual approaches
- **ACCESSIBLE INFORMATION & COLLABORATION** are the heart of the solution to growing ATC complexity…
- Solving such problem is the key challenge for the Next Generation of Simulation tool

CASE Studies

A number of studies have been carried out using the new framework to evaluate future operational concepts…

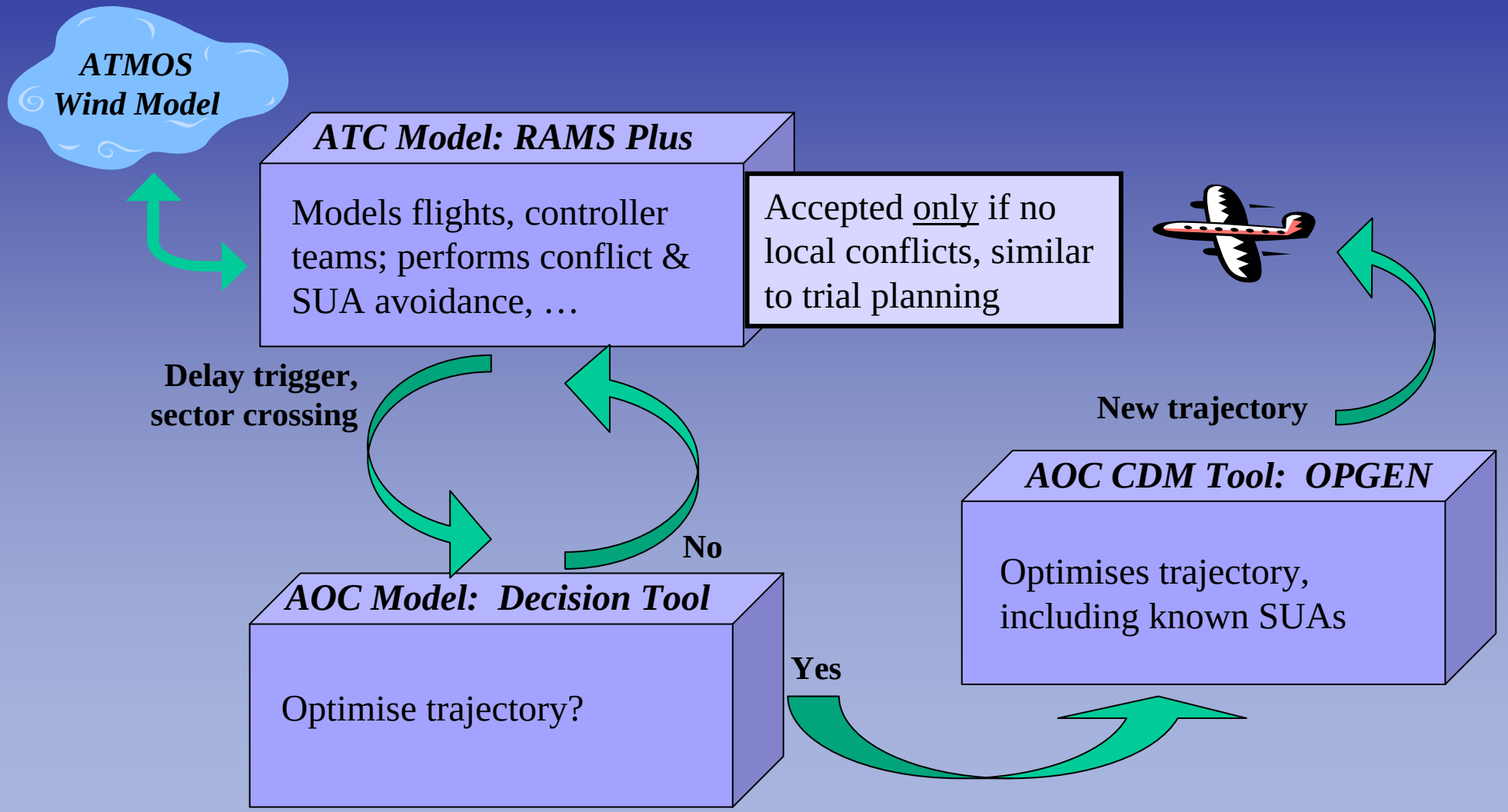
- Limited Dynamic Re-Routing (LDRR)
  - RAMS Plus (ATC Model)
  - OPGEN (AOC Business Model) *[from CSSI inc. USA]*
  - Decision Tool (AOC Decision Support Tool)
  - ATMOS (Weather Model)
- Ultra-High Airspace Analysis (Super-Sectors)
  - RAMS Plus (ATC Model)
  - MIDAS(Controller Behavioral Model) *[from SJSU, USA]*
  - CAISS (System-Wide Information Management Model)
- Free-Flight Analysis (Self Separation Assurance)
  - RAMS Plus (ATC Model)
  - AFDM (Intelligent Cockpit Model)
  - CAISS (System-Wide Information Management Model)
  - Master Clock (Simulation Time Management Model)

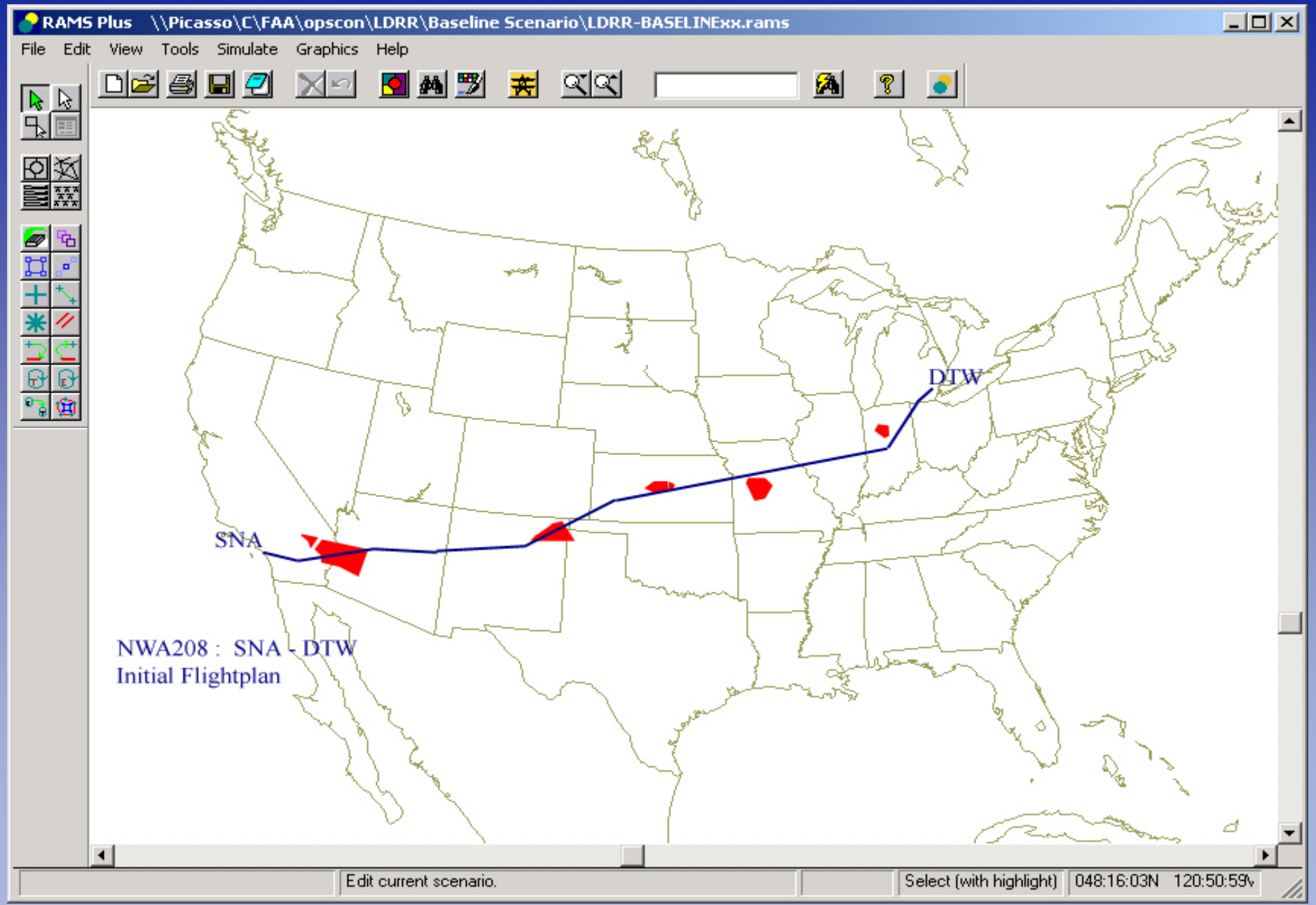
CASE STUDY : LDRR

"Increased collaboration in the ATM system will help satisfy user objectives more easily in the future"

- NAS Users (AOC) dynamically monitor the situation
- Users propose/request adaptation in accordance to their business needs
- Service provider assures system safety and efficiency
- Ground/Air based Collaborative Decision Making (CDM) support tools will further support the ATM process

LDRR Model Logic Flow

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DTW
SNA
NWA208 : SNA - DTW
Initial Flightplan
Edit current scenario.
Select (with highlight)
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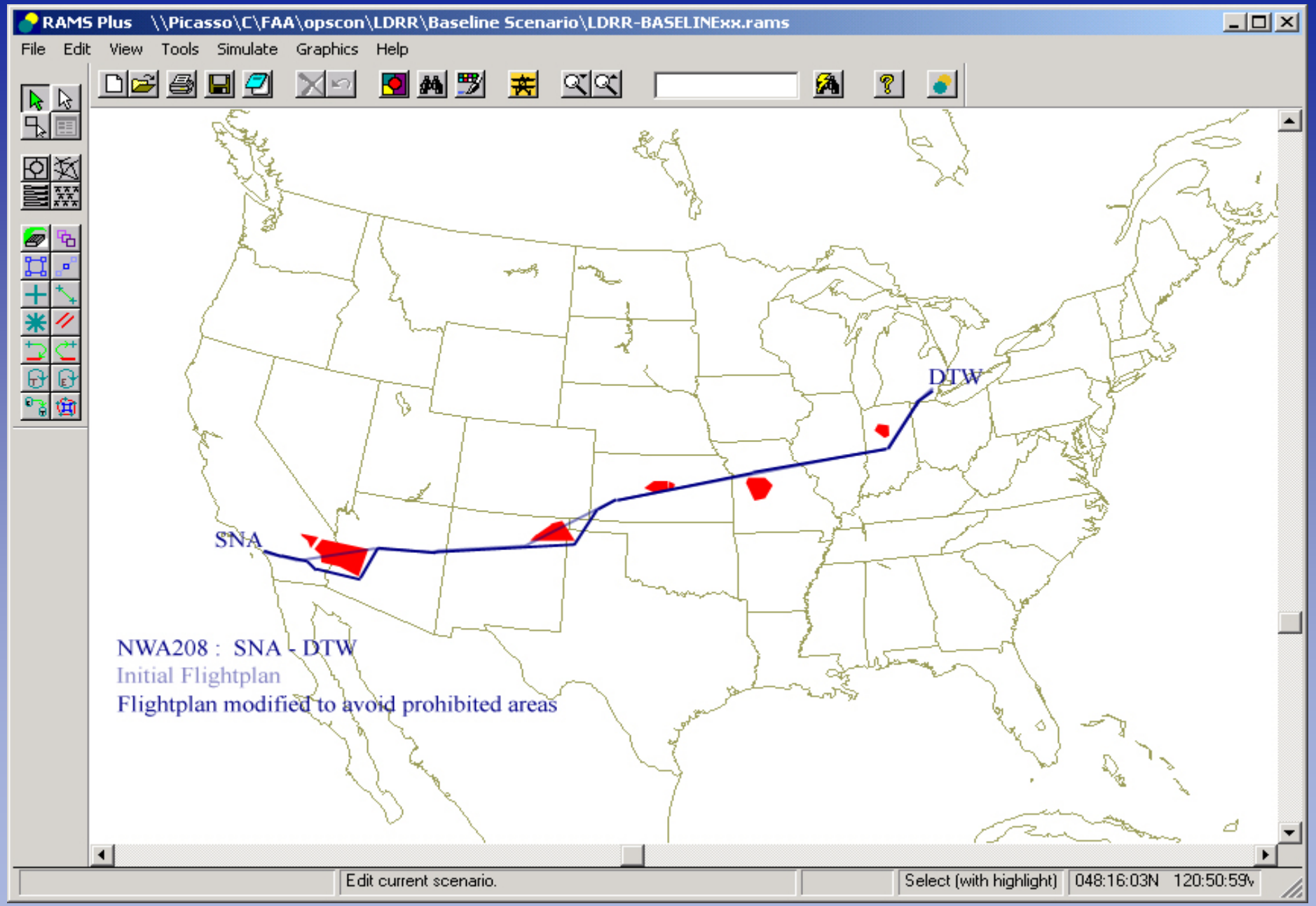
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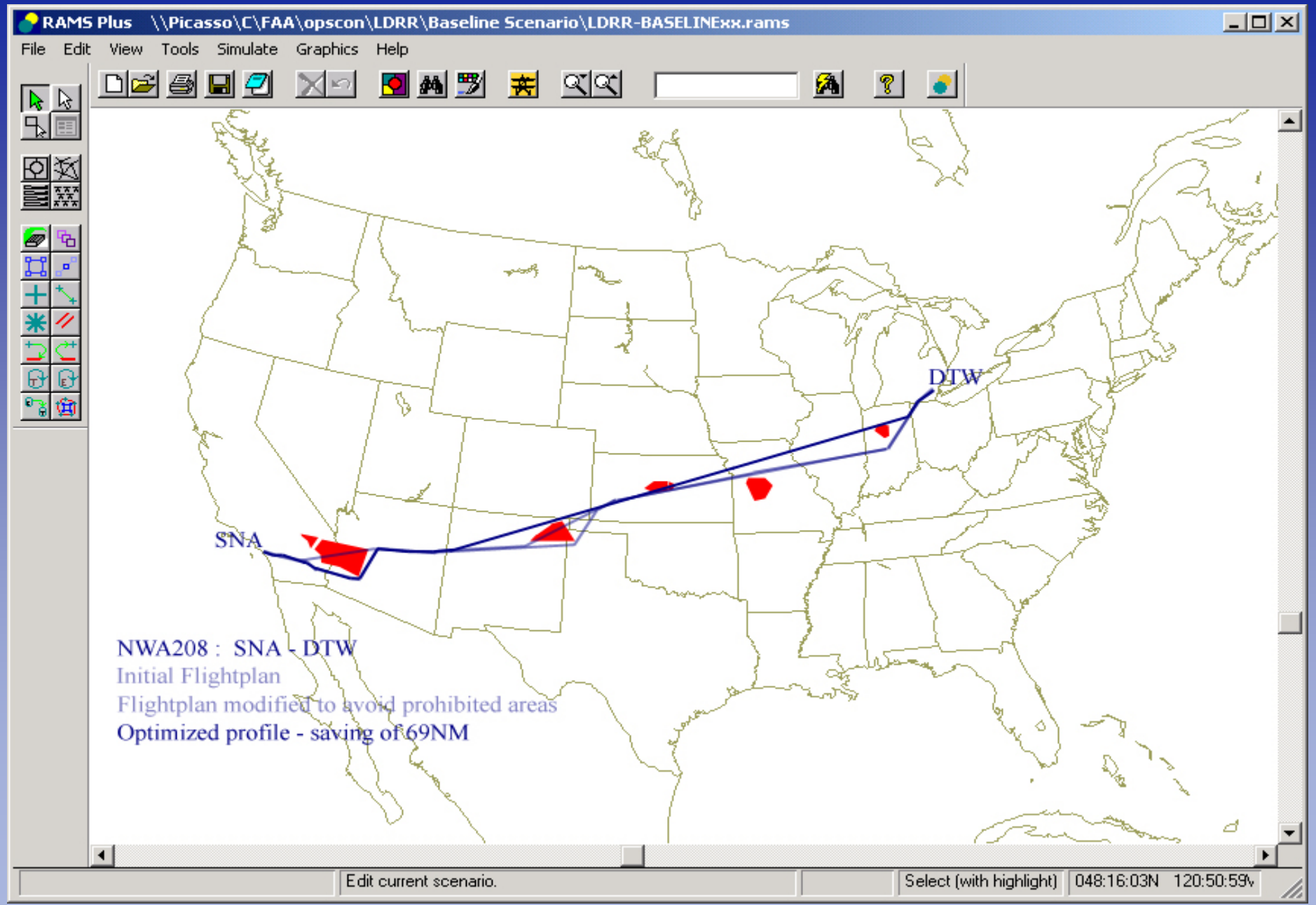
File Edit View Tools Simulate Graphics Help
DTW
SNA
NWA208 : SNA - DTW
Initial Flightplan
Flightplan modified to avoid prohibited areas
Edit current scenario.
Select (with highlight)
048:16:03N 120:50:59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File Edit View Tools Simulate Graphics Help
DTW
SNA
NWA208 : SNA - DTW
Initial Flightplan
Flightplan modified to avoid prohibited areas
Optimized profile - saving of 69NM
Edit current scenario.
Select (with highlight)
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LDRR - Key Results

“ Optimization had considerable positive benefits in a few cases (18%), but 53% of flights that requested and received re-optimized profiles ended up with higher delays (and fuel burn) than in the baseline case”

18% of optimized flights achieved good benefits
(fuel use reduced by 2.2%)
(delay reduced by 2.1%)
29% of optimized flights had no significant change (+/-0.25%)
53% of optimized flights had significant increase in penalty
(fuel use increased by 2.9%)
(delay increased by 2.5%)

LDRR - Conclusions

“ As a first step we can already see that allowing users to react to the dynamic situation in the airspace system could provide them with substantial economical benefits with no major impact on the service provide or safety in the NAS”

BUT: it is imperative to provide sufficient access to important NAS data to improve the chance of success.

What next?

Introduce CAISS into the simulation to improve common data knowledge

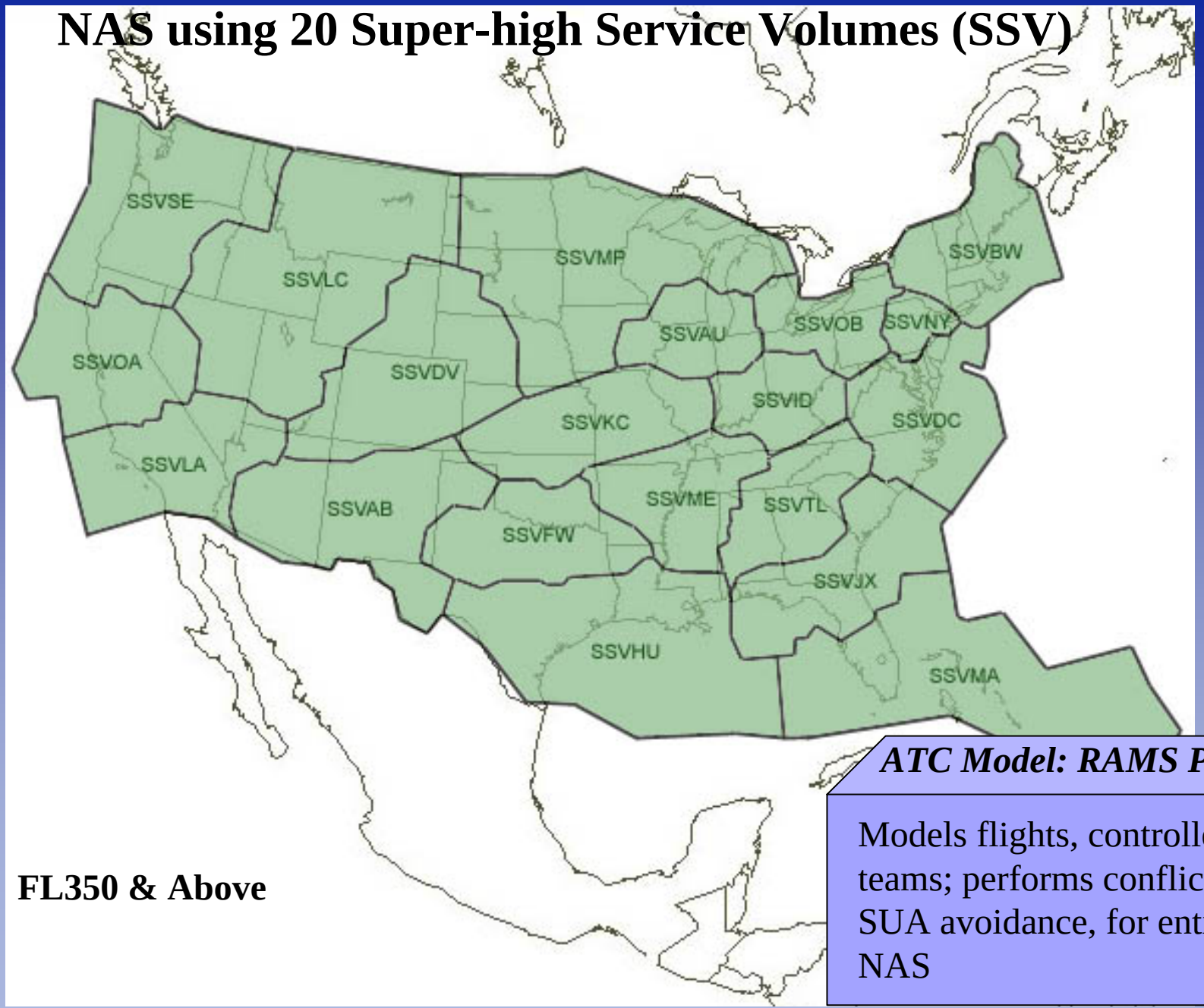
CASE STUDY : UHA

"In the future we will be able to use much larger control volumes than the present sector-based system"

- **Mid-term (2003-2007) operational concept supported by**
  - **Improved data availability**
  - **Satellite CNS capabilities**
  - **Enhanced decision making aids**

➢ **Consider using (much) larger control volumes**
  - **above a given flight level (say FL350)**

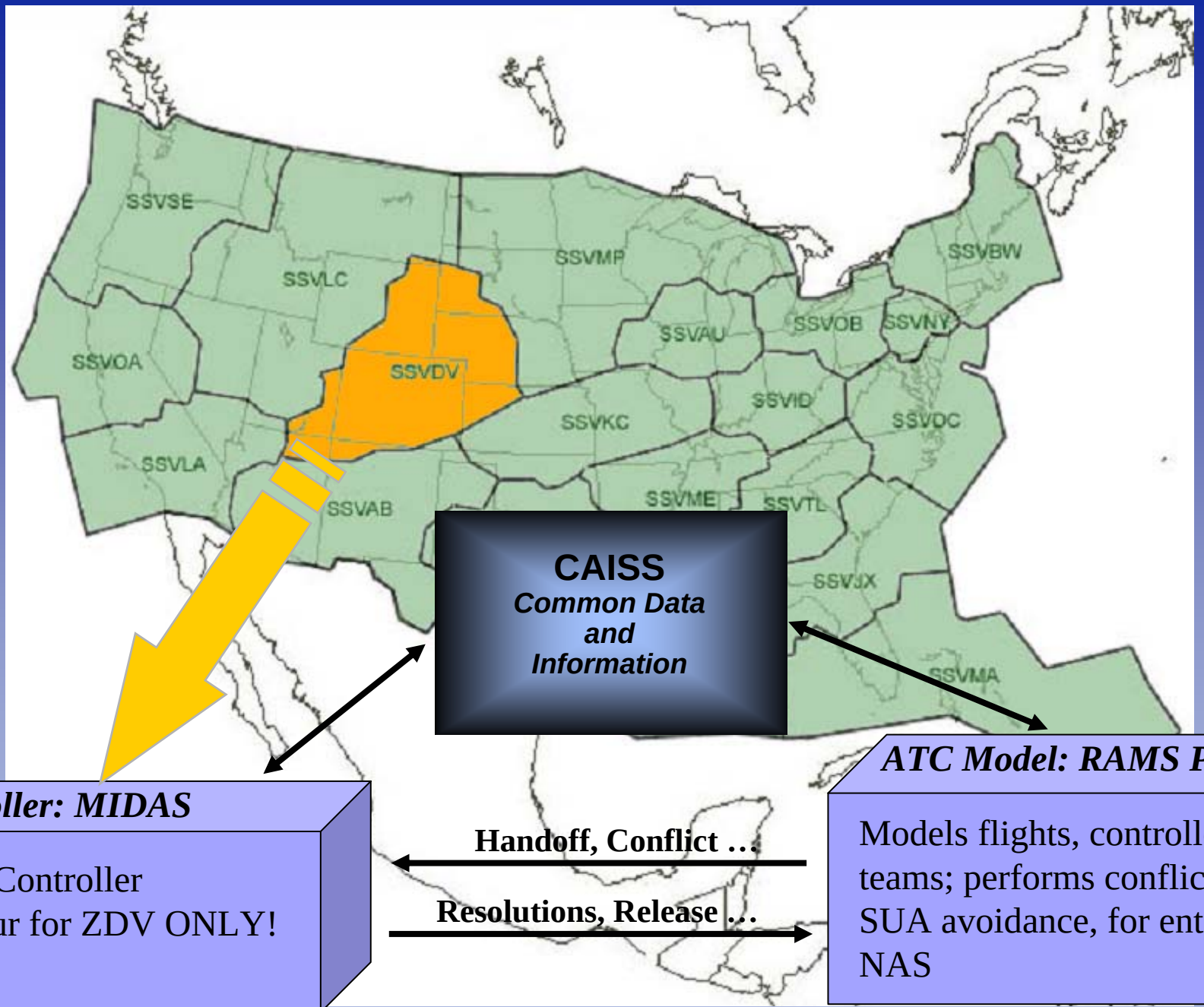
NAS using 20 Super-high Service Volumes (SSV)



FL350 & Above

ATC Model: RAMS Plus

Models flights, controller teams; performs conflict & SUA avoidance, for entire NAS



CAISS
Common Data and Information

Controller: MIDAS

Models Controller behaviour for ZDV ONLY!

Handoff, Conflict …

Resolutions, Release …

ATC Model: RAMS Plus

Models flights, controller teams; performs conflict & SUA avoidance, for entire NAS