

NASA's Distributed Air/Ground Traffic Management (DAG-TM) Concept

The Distributed Air/Ground Traffic Management (DAG-TM) concept [Ref. 1] was developed for NASA's Advanced Air Transportation Technologies (AATT) Project. It embodies the vision of the AATT Project regarding far-term operations in the U.S. National Airspace System. The DAG-TM concept is a coherent set of concept elements that describe possible modes of operation within the outlines of the Free Flight concept defined by the RTCA Task Force 3 [Ref. 2]. It may be viewed as one possible approach to the potential implementation of Free Flight, progressing along the path started by the Free Flight Phase 1 activities. It is noted that aircraft-based CD&R functionality is necessary to enable several DAG-TM concept elements (outlined in a later sub-section).

The fundamental characteristics of DAG-TM have been defined in the following vision statement:

“Distributed Air/Ground Traffic Management is a National Airspace System concept in which flight deck (FD) crews, air traffic service providers (ATSP) and aeronautical operational control (AOC) facilities use distributed decision-making to enable user preferences and increase system capacity, while meeting air traffic management requirements. DAG-TM will be accomplished with a human-centered operational paradigm enabled by procedural and technological innovations. These innovations include automation aids, information sharing and Communication, Navigation, and Surveillance (CNS) / Air Traffic Management (ATM) technologies.”

Scope of DAG-TM Concept

DAG-TM is a proposed concept for gate-to-gate NAS operations beyond the year 2015. It will address dynamic NAS constraints such as bad weather, Special Use Airspace (SUA) and arrival metering/spacing. The goal of DAG-TM is to enhance user flexibility/efficiency and increase system capacity, without adversely affecting system safety or restricting user accessibility to the NAS.

The DAG-TM concept is intended to address all user classes (commercial carriers, general aviation, etc.) with an emphasis towards ensuring access to airspace resources for the entire user community. It covers all flight phases (Pre-Flight Planning, Departure, Cruise and Arrival) and operational domains in the NAS (Surface, Terminal Airspace and En route Airspace). Although other operational domains (e.g., European, oceanic, and under-developed airspace) are outside the scope of the current DAG-TM concept, research activities will give due consideration to global interoperability issues.

Formulation of DAG-TM Concept

The DAG-TM Concept was formulated as a coherent set of solutions to a series of key ATM problems (or inefficiencies) in the gate-to-gate operations of the current NAS. For each problem, one or more solutions were identified that could potentially solve the problem by utilizing distributed decision-making between the user (FD and/or AOC) and the ATSP. These solutions, known as concept elements (CEs), would potentially enable greater accommodation of user preferences and increased system capacity. A fundamental goal of the DAG-TM concept is the elimination of static restrictions, to the maximum extent possible. In this paradigm, users may plan and operate according to their preferences – as the rule rather than the exception – with deviations occurring only as dynamically necessary. Therefore, the DAG-TM concept elements were formulated to mitigate the extent and impact of dynamic NAS constraints, while maximizing the flexibility of airspace operations.

Outline of DAG-TM Concept Elements

Fig. 1 presents an overview of the DAG-TM concept elements. A special concept element for universal information access/exchange covers all ATM operations from gate to gate. This concept element is presented first, numbered “CE 0” to indicate its over-arching nature. The other concept elements are numbered “CE 1” through “CE 14.” It is noted that CEs 1 – 14 each represent a solution to a problem/inefficiency in the operations of the current NAS. Their sequence corresponds to the progression of a typical flight. The CE titles include a label that indicates the applicable operational domain and flight phase (e.g., Terminal Departure). The label “Gate-to-Gate” applies to all operational domains and all flight phases.

CE	Title	
0	Gate-to-Gate:	Information Access/Exchange for Enhanced Decision Support
1	Pre-Flight Planning:	NAS-Constraint Considerations for Schedule/Flight Optimization
2	Surface Departure:	Intelligent Routing for Efficient Pushback Times and Taxi
3	Terminal Departure:	Free Maneuvering for User-Preferred Departures
4	Terminal Departure:	Trajectory Negotiation for User-Preferred Departures
5	En route: (Departure, Cruise, Arrival)	Free Maneuvering for: (a) User-preferred Separation Assurance, and (b) User-preferred Local TFM Conformance
6	En route: (Departure, Cruise, Arrival)	Trajectory Negotiation for: (a) User-preferred Separation Assurance, and (b) User-preferred Local TFM Conformance
7	En route: (Departure, Cruise, Arrival)	Collaboration for Mitigating Local TFM Constraints due to Weather, SUA and Complexity
8	En route / Terminal Arrival:	Collaboration for User-Preferred Arrival Metering

9	Terminal Arrival:	Free Maneuvering for Weather Avoidance
10	Terminal Arrival:	Trajectory Negotiation for Weather Avoidance
11	Terminal Arrival:	Self Spacing for Merging and In-Trail Separation
12	Terminal Arrival:	Trajectory Exchange for Merging and In-Trail Separation
13	Terminal Approach:	Airborne CD&R for Closely Spaced Approaches
14	Surface Arrival:	Intelligent Routing for Efficient Active-Runway Crossings and Taxi

Fig. 1: Overview of Concept Elements

Technology Requirements for DAG-TM

The minimum equipage required to operate in a DAG-TM system will be the same as that required to operate in the current Air Traffic Control (ATC) system, in order to facilitate NAS access by all users. Users make business decisions on equipage level based on their cost/benefit assessments. Fully equipped users gain the maximum benefits due to the full range of options available to them for optimizing operations of individual aircraft and/or their entire fleet; these options include capabilities for flight autonomy, negotiation of user-preferred trajectories with the ATSP, and influencing ATSP decisions. Users who equip at an intermediate level gain significant benefits (over the current system) due to the options available to them for influencing ATSP decisions, including negotiation of user-preferred trajectories; however, they cannot conduct autonomous flight operations. This intermediate level of equipage also represents an intermediate point on the spectrum of NAS evolution towards DAG-TM. Even minimum-equipage users may gain some benefits (compared to the current system) due to the improved overall efficiency of NAS operations and greater accommodation of user-preferences by the ATSP.

A core technology requirement for DAG-TM is the enabling of universal access/exchange of information between all NAS stakeholders. Users with full or intermediate equipage utilize a suite of AOC-based and/or FD-based Decision Support Tools (DSTs) to plan and execute their operations. They also use datalink capabilities to access and exchange information, including information on the positions and velocities (and possibly intent) of other aircraft in their vicinity.

References

1. *Concept Definition for Distributed Air/Ground Traffic Management (DAG-TM) v1.0*, Advanced Air Transportation Technologies Project, National Aeronautics and Space Administration, September 1999.

2. *Final Report of RTCA Task Force 3: Free Flight Implementation*, RTCA, Inc., Washington, DC, October 26, 1995.