White Paper
The Evolution of Dual Use Applications in the Enhanced Traffic Management System (ETMS)

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Evolution of Dual Use in ETMS

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Introduction.

In the early 1970s, it was already becoming obvious that a cadre of highly trained specialists distributed around the country and using RADAR could not adequately manage air traffic. From that time until now, the aviation community has relied on a growing body of prediction, planning, optimization and management techniques known as Air Traffic Management. These techniques rely on advanced automation, and the primary system providing this automation is the Enhanced Traffic Management System or ETMS.

ETMS was first demonstrated in 1985 and deployed in 1987 and encompassed techniques and concepts developed over the previous fifteen years. The Air Traffic Control (ATC) system is primarily concerned with separating and organizing aircraft within specific regions of airspace (Sectors) including accepting and releasing aircraft to adjacent Sectors. The Traffic Management System (and the ETMS) is primarily concerned with planning the flows of aircraft and avoiding congestion in the airspace. When an air traffic controller becomes too heavily loaded (saturation), correcting the problem may actually involve taking a sector out of service and gradually repopulating it with aircraft as the ATC staff comes back up to speed. By evaluating en route and scheduled traffic, TMS can organize the traffic flow to prevent this type of incident. The ETMS rests on and uses information from the ATC automation system, and in turn vastly improves the efficiency of air transportation by better planning the way the system will be used.

Over the course of twenty years since ETMS was introduced, it has grown and evolved as the FAA has found more, varied uses for the technology. As the system incorporated more sophisticated prediction and more powerful processors, the FAA was able to use the system to monitor for potential trouble spots and even suggest tactics to manage some problems. Sophisticated prediction also permitted the system to calculate which planes should be delayed on the ground and by how much to forestall a pending congestion event. Later, similar logic combined with analysis from other FAA organizations was applied to routing projection and analysis. As these technologies grew and were applied to various TMS functions, the system began to be used for other applications never intended in the original formulation of the ETMS. As a result, the FAA's way of doing business with the airlines was completely changed.

NORAD and the ETMS.

By the late 1980s, the existence of ETMS had come to the attention of the North American Air Defense Command (NORAD). This organization had long been assigned the mission of identifying aircraft impinging on the US and Canadian boarders, and repelling invaders. This mission was executed by use of RADAR surveillance. When a RADAR echo appeared, NORAD would attempt to identify the target within fifteen minutes. If that attempt failed, fighter aircraft would be scrambled to investigate. If the target were identified as benign, the fighters would stand down. If, however, the target were hostile, well then…

NORAD had (and has) access to the ATC surveillance system (as well as their own units), and can use that to partially identify targets. Unfortunately, many perfectly benign targets were not identified, leading to numerous fighter flights with the attendant danger and expense. Because the ETMS uses numerous sources to identify the flights it will manage, it has a much more complete roster of the aircraft in flight than any other system. An interface to NORAD allowed that agency to reduce the number of fighter flights for unidentified flights significantly while providing a broader sense of what flights are en route.

Because of the related work to NORAD, both the US Customs and the US ATF agencies also utilize this NORAD ETMS feed to interdict drug traffic and other illegal traffic. Thus, a system management tool, intended merely to make the system work better, has provided a significant second use to the defense and law-enforcement community.

Aircraft Situation Display to Industry (ASDI).

As the ETMS evolved and became known within the aviation community, airline interests began to show an interest in using the unique views of air traffic provided by that system for their own operations. In particular, the Aircraft Situation Display (ASD) provided an overview that could greatly improve the management of a fleet of aircraft such as operated by airlines. In 1991, Congress passed legislation authorizing the FAA to share ASD data with airlines. The information feed, known as ASDI for Aircraft Situation Display to Industry, had sensitive information purged from it, but otherwise mirrored the information within the FAA's ETMS.

In this single move, the FAA gave the public direct access to several billions of dollars worth of advanced ATC equipment and RADAR-derived information at virtually no cost to itself. Today, not only airlines but all other manner of business dealing with aviation, including individual travelers and their contacts, can view the progress of the flights important to them. The airlines can better schedule ground crews.

Limousine services can more accurately meet customers' flights (and better manage their own motor vehicles). Individuals can monitor the flights of loved ones over the Internet.

Many more examples of the beneficial use of the ASDI exist, and new uses and benefits continue to arise ten years after the feed first became available. This "dual use," which cost virtually nothing, provided significant and in some cases totally unexpected benefits to a wide community spanning the aviation industry but in many cases affecting activities only indirectly connected to aviation.

The Collaborative Decision-Making (CDM) initiative.

By 1995, ten years after the inception of the ETMS, both the airlines and the FAA were ready to look at a new way of doing business – collaboration. Formerly, the relationship between the FAA and the direct user community was adversarial in that the FAA had to mete out access to a scarce resource (ATC) and simultaneously make sure that access and resource were safe. That meant the FAA was usually cast in a role of traffic cop combined with gate guard.

The change that became possible with ETMS was that efficient use of the airspace could begin to take on the characteristics of collaborative optimization. Conceptually, here is how such a collaborative approach works. The FAA analyzes the patterns of demand and capacity across the airspace and discerns those changes in traffic required to optimize the overall use of the airspace. By optimize, I mean maximize throughput while meeting constraints, the most critical being safety and congestion.

Once that determination is made, the overall plan can be communicated to the user community, in particular, the airlines. The airline is also optimizing its operation, but within a different set of constraints and goals. For them, the FAA's global optimization becomes another constraint, but one which they had little knowledge of before CDM. The airline, therefore, can find a solution that locally optimizes its business while meeting the FAA's constraint, but trading off various aircraft departures and routing while keeping to the numbers developed by the FAA. Finally, the various proposals by the airlines are communicated back to the FAA and, as long as the FAA's constraints are not violated, incorporated into the national flow plan.

Of course, the above is impossible without computer systems capable of handling these huge amounts of information at high speeds. The airlines added the ability to deal with large counts of active aircraft to their own, formidable, computation capability as they learned to work with the ASDI. For their part, the FAA had developed the ETMS to deal with such problems. Now, the attempt at collaboration, started in 1995, bore fruit in 1998, by effectively bringing on-line interface programs that allowed both the FAA and the airlines to share data, effectively making possible the interoperation necessary. Basically, the airline and the FAA establish policy, and their respective computers implement it.

Within a few days of the initial introduction of CDM, one major airline reported an operational cost savings (as compared to their previous operational process) in excess of $100M. This is significant, since $100M exceeded the airline's cost to implement the CDM procedures by half, thereby generating a return on investment within a week of operation. Other airlines have experienced similar benefits.

Since that time, CDM has undergone continuous improvement expanding to a system that allows smooth adaptation by the whole industry to weather and other unexpected events, and that runs optimally on a daily basis. In fact, it has changed an industry that operated as a series of adversarial cells, wasting fuel and resources and discomforting passengers, into one that efficiently interoperates in a way beneficial to all. That's not to say there are no delays, but that the resources of the system are being used cooperatively to keep delays to a minimum.

CDM is a prime example of a "dual use" of technology, because advanced information processing and computational systems, in particular the ETMS, enabled a level of cooperation that appeared to even the most senior officials to be impossible.

Conclusion.

The transportation system is woven into every aspect of what we do as Americans. Our food and supplies come to us over tremendous distances from every corner of the world. We prize our personal mobility as a basic right. Our lives are centered on daily trips that would take weeks without our modern transportation system. Even so, we take all this for granted.

Part of what makes this system so reliable and allows us to count on it and trust it with our lives is our ability to operate the transportation system in an efficient manner. Certainly, for the aviation system, the ETMS is a key element in making the system operate as smoothly as possible. That is the raison d'etre for ETMS. Yet as we have seen, by enabling the efficient operation of the aviation system, the ETMS simultaneously enables a series of additional benefits far beyond our original expectations.

This amplification effect of dual or multiple uses should be a guiding principle for new systems we would conceive of and build. A security system that impedes the functioning of the operational system it would protect is a poor choice compared to a system providing comparable security and also making the underlying operational function better. It may be that the best approach to designing a security system is to design an efficient, smoothly operating transportation system – one in which security will be achieved as a matter of course.