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Economically-Driven CNS/ATM Enhancements

David L. Allen
Manager, CNS/ATM Airborne Projects
Boeing Commercial Airplane Group

Abstract
It is safe to say that most stakeholders feel that insufficient progress has been made in the implementation of CNS/ATM. Examination of the reasons behind this lack of progress indicate that too much attention is being placed on technologies and too little attention being paid to the real drivers. Technology may be part of a solution, but is not a driver, yet most energy seems to be spent in this area. Economics is the real driver, and very little real work is being done here. Economic analyses have been developed, but lack sufficient depth to support an investment decision. Lack of investment is the primary cause of our insufficient progress. The analysis to develop a structured business case for CNS/ATM is a non-trivial task. The CNS/ATM Focused Team (C/AFT) is an informal, airline driven group that is tasked to develop economic cases. This team has been working about two years and has made some significant progress. The data developed so far by the C/AFT Data Link Focus Group can be used as an indicator of the complexity of the business case development. This work is not complete, but represents a significant step.

1.0 Introduction

An outsider, viewing the aviation industry's efforts relative to CNS/ATM, might easily come to the conclusion that we are obsessed with technology. Industry activities are centered around technology. Much of the research and development work is centered around technology. Technical standards seem to precede the definition of the problem to be solved. Some standards seem to be in a perpetual revision cycle. We seem to grasp a technical solution, engage in multiple trials (few of which feature appropriate operational content), and then stumble when it comes to actual deployment. Even mandated changes in CNS/ATM are slow to materialize. In reality, progress is not measured by the number of accepted pages of standards or the number of successful trials but by the extent of actual deployment. By this measure, we are not making good progress.

Industry is beginning to reach consensus is on a strategic vision for CNS/ATM. Captain Russ Chew of American Airlines and the C/AFT chair provided an analysis of the U.S. domestic air transportation system and demonstrated the need for substantial capacity enhancements by the year 2005.[1] This position has been endorsed by all the airline members of C/AFT. Similarly, Europe's ATM2000+ is focused on the need for increased system capacity in the next decade for core Europe operations. The industry is moving toward consensus that the essential CNS/ATM goal is ensuring that the infrastructure will not constrain the growth of the air transportation system.

The vision developed by the ICAO Future Air Navigation System (FANS) committee was too focused on technology solutions and not enough on system objectives (i.e., increased capacity), how the operation should change to support growth, and how to establish economically viable transition steps. Lack of progress is not a result of insufficient technology. If anything, we might have too much technology (it is confusing to have multiple solutions in search of a single problem to solve). There is also not a lack of desire. All stakeholders see the need for improvements, and agree on the basic ICAO FANS concept as the appropriate strategic vision. Why haven't we been able to move forward? How do we translate the vision into technology

[1] This C/AFT Presentation is available on the C/AFT Web Page (http://www.boeing.com/commercial/caft/reference/meetings/presentations.htm) under the March 19,20, 1997, as Strategic Issues. It is downloadable as a PPT or PDF file.

choices based on economically viable transitions? The problem is a lack of a basis for investment; investment by all stakeholders. There is a gaping hole between the strategic vision and financial reality. The link between the strategic objectives and the technology selections must be based on the development of a requirement basis for the operational transitions. In too many cases, technology merchants rather than the requirements for operational enhancement and business cases drive the service providers.

The aviation industry has a good handle on the “notional” benefits associated with CNS/ATM. We know that if we implement CNS/ATM enhancements there are huge benefits. The problem is that individual stakeholders can’t understand:

- Their share of those notional benefits
- When they will receive those benefits
- At what rate will those benefits accrue
- What technologies will best repay investment with needed operational change
- What are the risks associated with each benefit
    - Which risks are out of stakeholder control

We end up with a situation in which the costs are often underestimated due to a lack of well-founded technical requirements as the basis of the technology selection and where there is a very poor understanding of the real benefits (and the risk in achieving the benefits) to offset those costs. Benefit risks are often tied to the inability of service providers to introduce new technology to an agreed-upon schedule, or to deliver operational changes that enable benefits. Also, at times the technology promoters are either uninformed or overly optimistic regarding the magnitude of the costs of the technologies. All of these factors make it difficult to establish a credible business case; in many instances, we get a failed business case.

Investment strategies are based on safety, investment analysis considering overall return on investment, and stockholder value. Risk is a significant consideration, and often a risk management or mitigation plan is needed. Safety mandates are rarely successful in “forcing” CNS/ATM investment. Most enhancements will need to “survive” a business case analysis; one which is acceptable to the decision-makers. This is going to be difficult. The decision-makers are used to investment decisions based on factors and risk they understand. The factors and risks associated with CNS/ATM enhancement implementations are not as well understood and in many cases are not known at all. There are new parameters that are outside the scope of any single stakeholder. There are new risks and uncertainties that have a very small experience base against which one can operate. Previous attempts at business case analysis have glossed over this deficiency have, in most cases, failed.

2.0 CNS/ATM Focused Team Overview

The CNS/ATM Focused Team has been struggling with the issue of how to develop the basis of these business cases for two years. The main task of this team is to “fill the hole” between the strategic vision and the financial realities. This means identification of the factors in an Operational Concept that drive the benefits and tying those benefits to CNS/ATM enhancements. This is a simple statement, but one which has significant complexity.

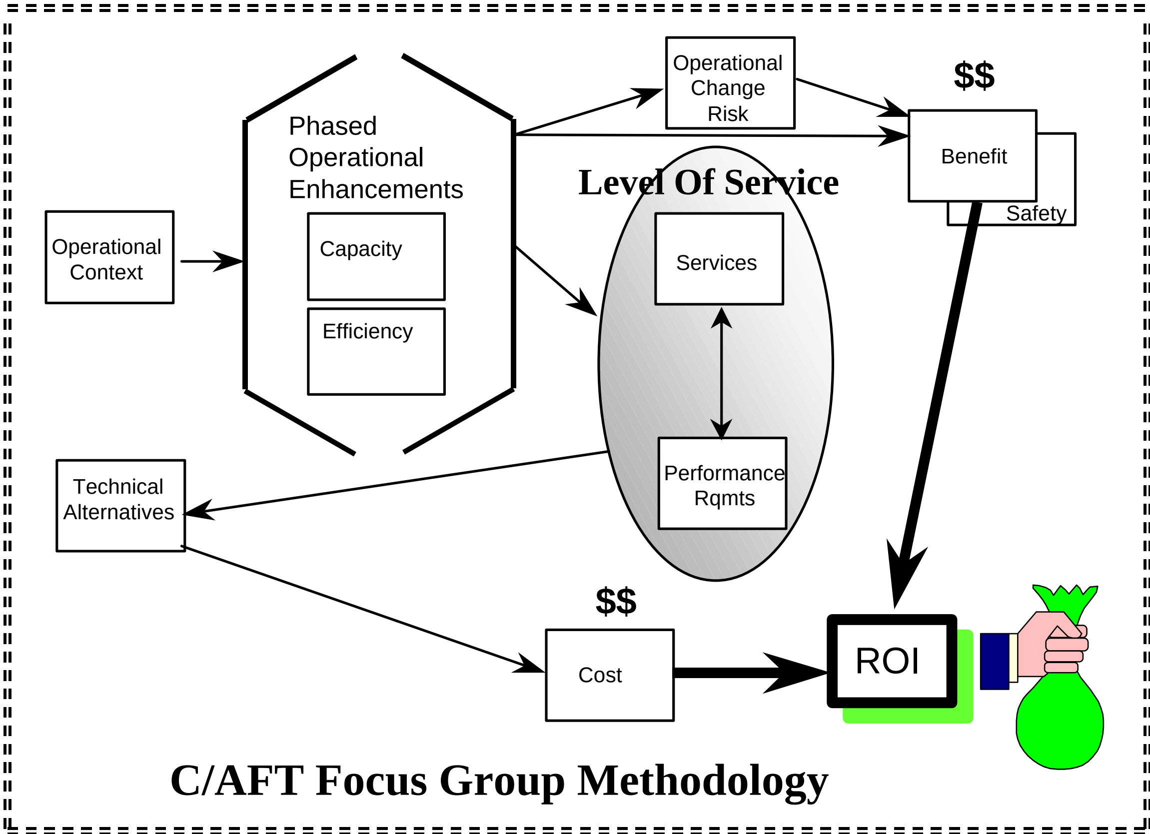

Figure 1

Figure 1 presents part of the C/AFT analysis model. We have to understand that the goal of this effort is to develop a business case; a clear understanding of the Return on Investment. That requires a credible, defensible assessment of costs and benefits. Safety is a factor, in that we require that safety be maintained or increased with each improvement, but it generally does not considered as a quantitative factor in the analysis. Where an enhancement is seen as primarily a safety issue, its incorporation is not dependent on ROI analysis.

Working back from the Cost and Benefit boxes, we consider the major impacts on Cost/Benefit. The largest benefit imaginable is usually inadequate for a business case if we can't characterize the risk associated with its implementation. There are also risks associated with Cost, often because a technical alternative is selected before the true requirements are known, leading to inadequate system performance or to excessive costs due to "gold plating".

The Operational Enhancements section of the analysis provides the Benefit mechanisms and the issues associated with the enhancements provide the basis for the Operational Change Risk. The Operational Enhancements are based on improvements to Airspace Capacity and/or Airspace Efficiency. These enhancements need to identify:

- The Operational Change which will directly lead to an economic benefit (e.g. Increased Terminal Management Area throughput)
- The Performance Factor(s) which will allow that change (e.g. increased Controller intervention capability)
- The overall system functional requirement (e.g. Data Link Communication with a specific message set)
- The broad allocation of requirements between ground and airborne implementations which enable that specific functional change.

When one looks at the full set of potential operational enhancements for a region of operation (Terminal, En-Route, etc.) and the ground and airborne enablers, it is possible to sequence those operational enhancements into a transition sequence. Many try to lump all of the enhancements into a "big bang" implementation scheme because this provides the largest benefits. However, each operational enhancement has a set of costs and risks associated with it. These risks are known with different levels of uncertainty. Lumping all of the operational enhancements together (with their associated risks) provides a package which looks pleasing (pure benefits-wise), expensive, and with risks which are generally unacceptable due to their potential impact on benefits. By replacing the "big-bang" with a sequence of transition steps which are based primarily on increasing levels of uncertainty and risk, we can provide a pathway by which we can justify some early implementation steps while working towards reducing the risks associated with later steps. While it is tempting, in theory, to try to define a single, "complete" step, the uncertainties of the business case, especially when risk is considered, make this difficult in practice.

When one has a set of Transitions, then one can look at the Levels of Service (Communication, Navigation, Surveillance, and Air Traffic Management) which are associated with each set. Again, because of the technological bent of CNS/ATM, industry tends to look at technologically based solutions rather than requirements based solutions. The C/AFT methodology identifies specific Operational Enhancements that can then be evaluated for the level of technical service that is required to gain that benefit. From these Levels of Services, functionality and associated Performance Requirements can be derived which can be used to evaluate the Technical Alternatives.

This approach forces industry to consider the implementation as a business decision. The initial transition implementations must consider the later implementation requirements. In those cases where the risks, costs, and benefits of the later implementations are well understood; the earlier implementations will probably take on higher costs to make sure that early implementations directly support later transitions. However, in those cases where the later transitions have unquantified risks (especially with regards to implementation dates), the early transitions may not give them much consideration. Most CNS/ATM stakeholders (some ATC service providers, most airlines, and all communication service providers) operate as a business. They are forced to operate in this manner and do so in other aspects of their business.

One primary input to the Operation Enhancement Analysis is the Operational Context. The Operational Context is a summary of the high level assumptions of a general Operational Concept applied to a specific airspace environment. It involves all operational assumptions necessary to complete the economic evaluation of a set of CNS/ATM transitions. No general Operational Concept can cover all of the unique characteristics of a particular environment; the operational context fills this gap by taking those unique aspects of a particular environment into account. These unique aspects will affect how a specific Operational Enhancement will be implemented, thereby affecting the Operational Change Risk, Benefits, and Level of Technical Service.

But there are other inputs into this process.

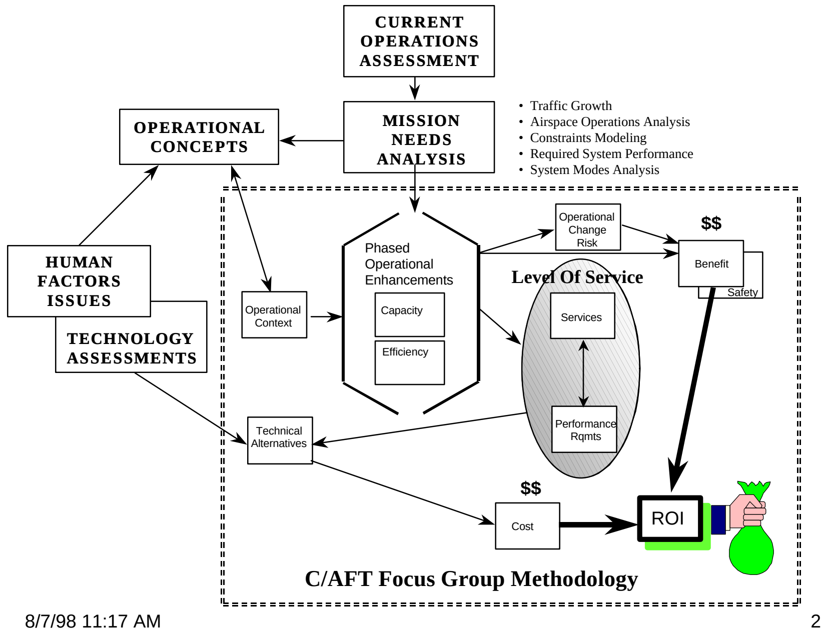

Figure 2

Figure 2 incorporates the external processes which are key to the C/AFT Focus Group Methodology. It all starts with a Current Operations Assessment. This analysis is necessary to identify the air space system constraints that are affecting Capacity and Efficiency. This leads to an identification of those factors that must change in order to increase Capacity or Efficiency and is documented in a Mission Needs Analysis. The Mission Needs Analysis identifies the end-to-end operational changes that are needed to relieve the constraints found by the Current Operations Assessment. These end-to-end operational changes defined by the Mission Needs Analysis are used to update the Operational Concept. An Operational Concept is a high level description of how an airspace is utilized and how basic ATM services will be performed. It includes a description of the Communication, Navigation, Surveillance and Air Traffic Management services and functions. It identifies who performs these functions, as well as the procedures and the assumed levels of automation in the performance of the functions. Human Factors Issues and available technologies heavily influence the Operational Concepts. The portion of the Operational Concept needed for the business case analysis, when applied to a specific airspace (with its unique traffic flows, characters, and topology) is defined as the Operational Context which is used by the C/AFT methodology.

The Mission Needs Analysis defines the high-level system needs quantitatively. An example of a Mission Needs Analysis is the American Airlines system capacity study referred to previously. This analysis, carried to the particular operating region, defines the delay cost (and potential cost avoidance) for each operational enhancement step of the economic analysis defined previously. This forms the basis of the benefits assessment against which the investment cost and risk must be compared.

It is clear from Figure 2 that the C/AFT methodology is highly dependent on the Missions Needs Analysis and Operational Concept. Unfortunately, baseline Operational Concepts are often not available and the entire Operational Concept must be developed to support the incorporation of CNS/ATM enhancements. Detailing the operational assumptions needed for the investment analysis in the Operational Context is a way to establish the investment analysis ground rules before the complete operational concept is defined.

3.0 Core C/AFT Concepts

The C/AFT Methodology has developed some core concepts that are central to the linkage between the financial business case and potential airspace CNS/ATM Enhancements.

3.1 Separation Assurance Model

Many benefits from CNS/ATM assume an ability to increase aircraft flow rates (or throughput) through a particular airspace. Throughput is determined by the separation standard in effect and a number of other factors in the real-time execution of air traffic control. However, the mechanisms by which throughput can be increased in today's radar controlled airspace are not well understood, partly due to the lack of a documented analytical foundation for current radar separation standards. The separation standards have evolved empirically with advances in radar technology to the level achieved today. Therefore, a performance baseline that would allow a justification of separation reductions based on CNS/ATM performance improvements, does not yet exist. This section presents an approach to modeling the separation assurance function conceptually, by characterizing the primary factors the function is composed of. The separation assurance function is assumed here to be made up of a sector traffic planning component and a traffic control component (strategic and tactical control). Depending on airspace design and traffic levels, these functions could be performed by one individual or a team of two to four in heavy peak periods. Regardless of the assignment to individuals, the performance elements discussed here remain the same.

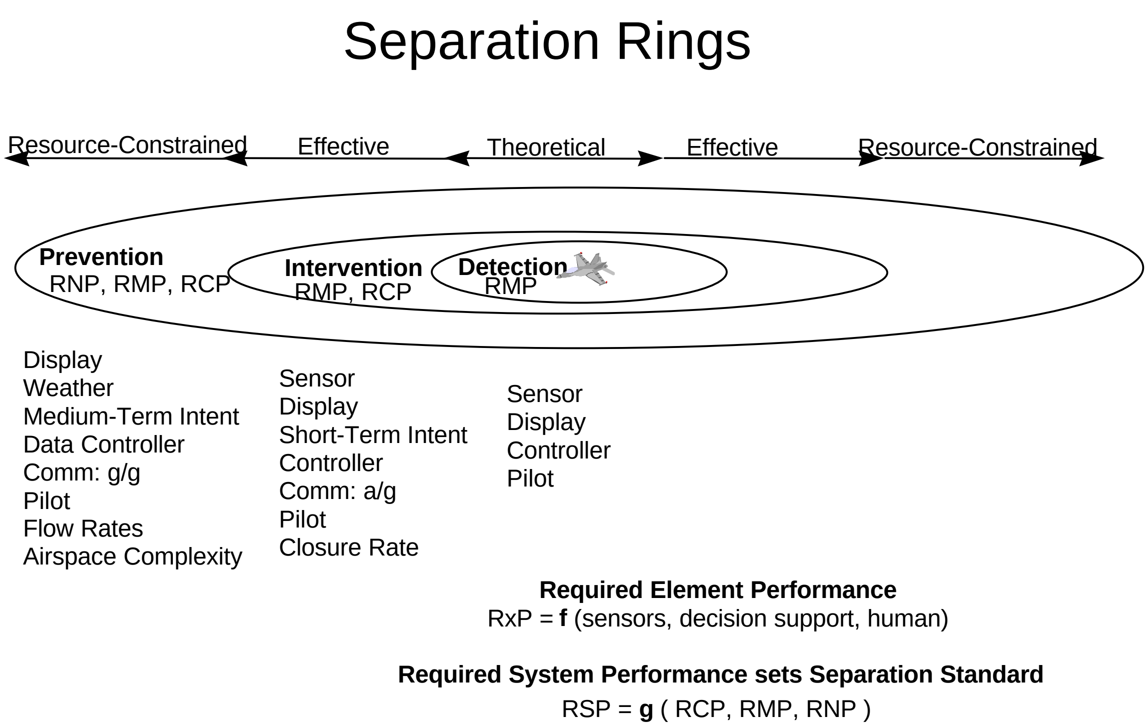

Figure 3

Figure 3 is a conceptual representation of the Separation Assurance Model. Effective traffic spacing is depicted as concentric rings or buffers in the figure, with the innermost region, termed "Detection," representing the theoretical maximum capacity based on the separation standard. The separation standard in radar controlled airspace has been established primarily as a function of radar surveillance and display system performance. Traffic spacing in busy terminal areas is usually at the separation minimum, achieved by highly structured airspace design and high controller proficiency. Significant changes to one or more of the communication, surveillance, and controller/pilot intervention performance are necessary in order to reduce separations beyond the current minimum.

The middle separation ring (Intervention) represents the additional separation required to determine that a conflict is imminent and intervene to resolve it. In a radar control environment this buffer is a function of the time from detection of intervention need, decision on resolution action, transmission of instruction to the pilot, and the pilot's response. The buffer size is also affected by traffic flow patterns (high closure rate encounters require larger control loop margins) and the speed and maneuverability of the aircraft. This buffer can potentially be reduced through the provision of better short-term aircraft intent data, data link communications, tools for conformance monitoring and short term conflict alerting.

The outermost ring (Prevention) is adjusted by the sector traffic planning function to limit tactical controller workload by preventing too many potential traffic conflicts from developing simultaneously in the sector. As workload increases, the planning controller adopts strategies to prevent the possibility of conflicts. These strategies include level-offs, holding and re-routing of aircraft away from dense airspace. These strategies must take into account the uncertainty in medium-term (20-20 minute) trajectory prediction. Their overall effect is to reduce system throughput and to increase aircraft time and fuel in the system. This buffer can potentially be reduced through air to ground sharing of medium-term intent data through data link, along with automation aids for conflict probing, conflict resolution and terminal area sequencing and spacing.

In a procedural environment, the separation minima are dictated by conflict prevention, with essentially no ability to detect and intervene due to poor performance of the communications and monitoring functions (third party voice position reports and clearances). This necessitates a large prevention buffer (and very low throughput), based purely on navigation performance, to make the likelihood of the need for intervention acceptably small.

Potential improvements in airspace throughput should be proposed in light of such a model. Specific tools and improvements to CNS/ATM can be targeted to specific factors that influence the size of the individual separation rings. In general, the performance levels required for change increase towards the center of the rings. The inner circles are probably more difficult to effect and thus involve a higher implementation risk associated with the needed CNS/ATM enhancements. The FANS 1/A CNS/ATM enhancement primarily addresses the outer ring, as it was targeted at procedurally controlled airspace that has a large Prevention buffer. Radar control airspace has a much smaller Prevention buffer and significant airspace improvements will eventually demand that the Intervention and/or Detection buffers be addressed there. While some claim that FANS 1 cannot be used in radar control airspace, a detailed analysis with validated performance requirements is needed to answer the question of which CNS/ATM elements can be used to improve airspace throughput. Until this type of study has been done, it is unknown whether FANS 1/A elements have sufficient performance to be used in this environment.

Separation reductions need to be proposed in light of this model. Specific tools and improvements to CNS/ATM can be targeted to specific factors that influence the magnitude of the individual separation rings. In general, the performance levels of change increase towards the center of the rings. The inner circles are probably more difficult to affect and have higher risk and uncertainty associated with CNS/ATM enhancements targeted at those inner rings. The FANS 1/A CNS/ATM enhancement primarily addresses the outer ring. This can be successful because this enhancement was targeted towards procedurally controlled airspace that has a large Intervention Rate buffer. Positive control airspace (radar) has a much smaller Intervention Rate buffer and significant airspace improvements will demand that the Intervention Buffer be addressed. While some have said that FANS 1 cannot be used in positive airspace, a detailed analysis with validated performance requirements is needed to answer the question of which CNS/ATM elements can be used to reduce the Intervention Buffer. Until this type of study has been done, it is unknown if FANS 1/A elements have sufficient performance to be used in this environment.

3.2 Transition Logic Diagrams

Transition Logic Diagrams will be the primary output of the C/AFT methodology. They will be used to provide a framework for the benefits analysis. This portion of the methodology is sill under development and the examples contained in this document are capturing a "work in progress". Transition Logic Diagrams have been developed, but they have not been validated to assure the sequence of operational enhancements makes sense and to assure accurate identification of the enablers, benefits, services, and performance requirements. Both the methodology and the conclusions are subject to change due to further development. The Transition Logic Diagrams and their supporting material will cover:

- Phased Operational Enhancements
- Benefit Mechanisms
- Enablers:
- Service(s) required of Primary Investment Enablers
- Performance Requirements
- Supporting Industry Studies/Trials
- Rules for Modeling Benefits

Further work on the Transitions will be done to make sure that risks (and associated mitigation strategies) are adequately covered.

Each of these will be discussed in the following paragraphs. Examples will be covered in Section 4.0

3.2.1 Phased Operational Enhancements

The Phased Operational Enhancement is the series of benefits-driven operational changes that are sequenced in terms of the increasing risk and uncertainty associated with the Benefit Mechanism. An Operational Enhancement is not described by a technology, but by the impact of the Benefit Mechanism on the operations.

3.2.2 Benefit Mechanism

The Benefit Mechanism is the specific change in the Operational Concept that allows the removal of a constraint to capacity or efficiency. In more complex transitions, there may be several Benefit Mechanisms (ground and airborne) which will often have differing levels of risk and uncertainty associated with them. While these complexities make the analysis (and sequencing) more difficult; they must be addressed. Ignoring these inter-relationships can lead to implementation of partial solutions with no resulting benefits.

3.2.3 Operational Context

The Operational Context will consist of a brief description of how the benefit mechanism will be used in a particular airspace.

3.2.4 Enablers

This is a listing of the functions required to "enable" the benefits mechanism to achieve its results. These functions will center on Communication, Navigation, Surveillance, and Air Traffic Management. At the Transition Diagram level, these enablers are described at the highest levels and are broken down in the analysis charts.

3.2.5 Services Required of Enablers

This concept is used to help describe the high level requirements needed by the Benefit Mechanism in order to reduce the specific constraint targeted by the transition element. This concept helps us keep from defining broad technical solutions and focus's analysis on the requirements of the Benefits Mechanism.

3.2.6 Performance Requirements

These performance requirements relate to the performance of the Services required by the Primary Investment Enabler. Determination of these performance requirements is based on analysis and simulation and addresses specific factors in the targeted Separation Ring.

3.2.7 Supporting Industry Studies/Trials

This section of the Transition Logic Analysis details existing studies that can be used as a resource in developing the analysis.

3.2.8 Rules for Modeling Benefits

This section of the Transition Logic Analysis lists the ground rules that are understood and will be used to develop the benefits. These do not affect the benefits mechanisms or the Primary Investment Enablers, but are key to the determination of the benefits themselves.

4.0 Example - TMA Arrival/Departure Capacity Transition

This next section will use an analysis of the Terminal Management Area (TMA) to illustrate the use of the Separation Ring Model and the Transition Logic Diagrams.[2] This evaluation is for capacity-related enhancements in a positive control environment. The airplane level transitions are based on specific changes to the "Separation Rings". The airspace level transition is temporally independent of airplane level enhancements. Figure 4 represents a graphical model of the diagram.

[2] Note: This example is drawn from work in progress. The model is neither complete nor validated. Please treat it as an example only.

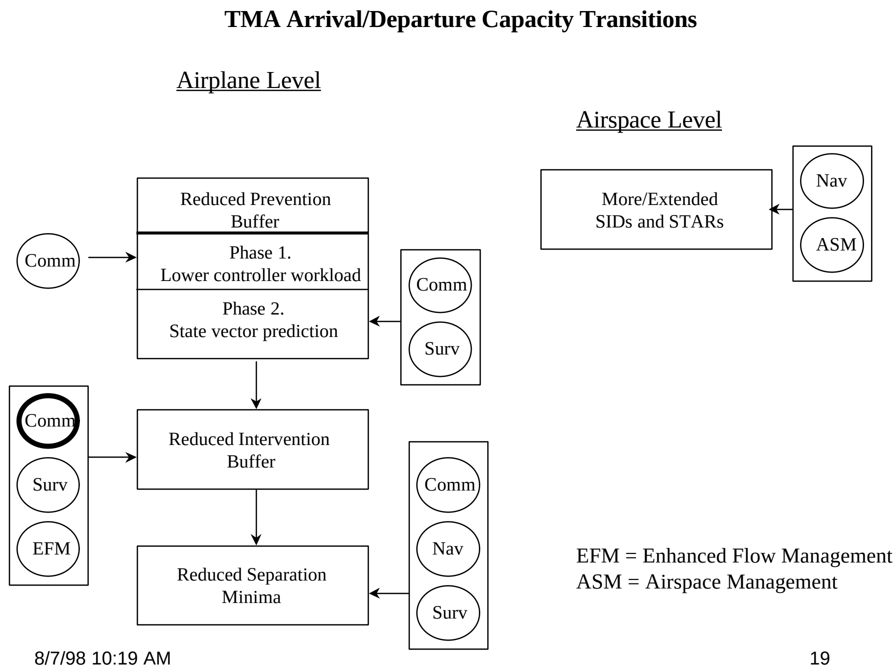

Figure 4

These transitions impact different separation regions. The first, "Increased Intervention Capability" and "More/Extended SIDs/ STARs" affect the Prevention ring by reducing tactical controller workload with regard to overhead tasks. The next transition, Reduced Intervention Rate Buffer, further reduces the Prevention Ring by providing tools for the tactical controller's main tasks (such as conflict probe) . The "Reduced Intervention buffer" transition begins to introduce changes to the control loop (aircraft controller/flight crew). Changes in this area will center around communications and surveillance, but due to the nature of the control feedback loop; they will have higher performance and integrity requirements. The final transition would be to "reduce the separation standard". This will probably entail significant changes to the Surveillance functions and if the aircraft provides surveillance data, by navigational enhancements.

The C/AFT group has been concentrating on the early transitions, so this paper will restrict coverage to the "Increased Intervention Capability" and "More/Extended SIDs and STARs" transitions.

4.1 TMA Arrival/Departure - Increased Intervention Capability

This transition is targeted at the portion of the outer ring (prevention) which corresponds to the tactical controller overhead. This is workload not directly associated with the primary tactical controller task.

The benefit mechanism associated with this transition is:

> Increased resource-constrained throughput by reducing tactical controller workload through data link transfer of clearances and communication

The following studies/trials were used to establish this mechanism:

- FAA En Route Study (DOT/FAA/CT-95/4)

- FAA Terminal/Area Study (DOT/FAA/CT-96/3)
- Eurocontrol PETAL II Trials
- FAA NAASIM analysis of effect of data link equipage rates on voice communications

The Enabler is Communication with the required communication services:

- CPDLC/CIC/Tactical Messages
  (These represent a limited part of the FANS 1/A/ATN message set.)
- CPDLC/ATC Communication Management

The analysis required to define the Communication Service performance requirements is not complete at this time and so the requirements are yet to be determined. This would be considered a risk element in that they could drive substantial requirements that are currently unknown.

The rules for modeling benefits are:

- Preferential treatment to equipped airplanes
- Benefits are stepped, with the largest benefit with the last step.
- The first step of the benefit will begin with implementation.

So, this transition is targeted at reducing tactical controller workload through the use of specific data link messages to ease constraints caused by work-load and voice channel availability associated with transfer of communication and altitude level change clearances. This will require simultaneous ground and airborne implementation of a subset of the CPDLC message set.

There is significant work needed to complete the analysis of this transition. The Performance requirements (human factors and technical data link performance) need analysis and simulation. Data exists which can be used in the benefits analysis. Validation of the Rules for Modeling Benefits is necessary for a high fidelity cost/benefit analysis. The C/AFT Data Link Focus subgroup will be continuing efforts in these areas.

4.2 TMA Arrival/Departure – More/Extended SIDs and STARs

This transition represents an airspace level modification to the TMA Arrival/Departure region. Again, the benefit mechanism is to add capacity that can be used to reduce the tactical controller workload. This change would effectively convert the region from one controlled via intervention to one controlled procedurally. The primary improvement would be the addition of RNAV capable routes. The Enablers would be Navigation and Airspace Management.

The required services for Airspace Management would be:

- Airspace Design and Route Separation Criteria
- Airspace Design
- Airspace Procedures

The required services for Navigation would be:

- Horizontal Guidance (RNP)
- Vertical Guidance (TBD)

The performance requirements for Navigation would be a horizontal performance in the range of RNP 1-0.3. Vertical Guidance performance needs further study. The level of Vertical Guidance performance will primarily drive the efficiency of the route and will affect the capacity in Instrument Meteorological Conditions (IMC).

The most work on this has been done via the NESS trials (conducted by DLH at Frankfurt). Results from these trials indicate significant potential savings with regards to efficiency, airspace capacity, and noise abatement.

The Benefits Model would assume that aircraft would be segregated by capability.

Currently, the C/AFT Navigation Focus Group has not begun work on this transition. This activity is scheduled to begin later in 1998.

5.0 Use of Transition Logic Diagrams

As stated earlier, the Transition Logic Diagrams have not been completed or validated. The purpose of this section, however, is to detail how the Transition Logic Diagrams will be used in the development of business cases.

Transition Logic Diagrams are tools that are used to create “enhancement packages”. They group the required enablers with their associated benefits. The simulation and trials tasks are crucial to “tune” the performance requirements of the enablers and to quantify the risk associated with the benefits.

Transition Logic Diagrams can be used to evaluate alternative enablers. The performance requirements for the benefit mechanism will provide the “level playing field” which will allow the alternatives to compete based on cost and risk. The applicability of an alternative enabler to future transitions can also be taken into account.

For example, the initial Airplane Level transition (Increased Intervention Capability) was packaged with a minimized set of functional requirements. The enablers will be specific communication function improvements required to support transfer-of-communication and altitude clearances. The cost associated with this effort can be estimated for both the ground and airborne implementations. The primary risk associated with the cost estimate is centered on the assumed performance requirements (both Required Communication Performance and human factors). Specific trials and/or simulations will be required to reduce this risk.

The more substantial risk is associated with the development of the benefits. The C/AFT will be working with the FAA and Eurocontrol on how we can derive quantifiable benefits through the reduction in tactical controller workload. This will probably be done based on some existing trials (Human factors aspects can be validated during operational trials if they designed to use representative controllers and situations) and estimates of impacts on representative, busy airports. The following “dollarization” model will be used in developing that benefits estimate (Figure 5).

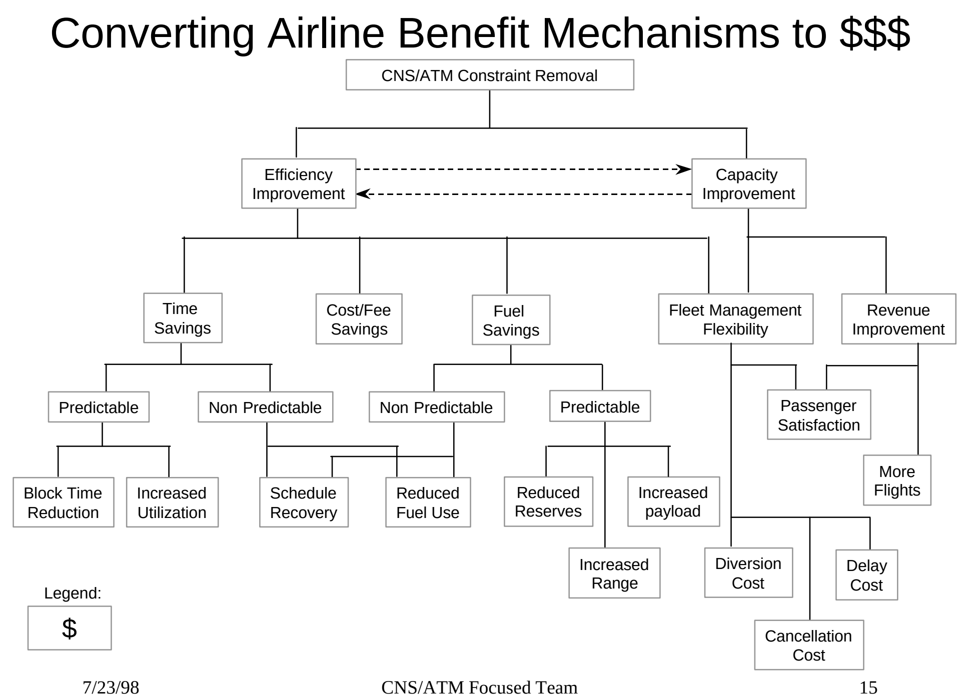

Figure 5

It is not the purpose of this paper to provide a complete explanation of this process. But basically, operational improvements must be converted into specific operational procedure changes that relate to cost savings or increased revenue. While significant work has been done on cost savings, less work has been done on the revenue enhancement side. Almost no work has been done on the financial rewards associated with fleet management flexibility or the capability to add more flights (conversely, little or no work has been done on the financial penalties associated with increasing capacity on our current air traffic management system). This work has to be done in such a way that the airlines can take their specific operations, match the operational improvements to those operations, and establish a benefit that they believe they can capture.

Again, the goal of C/AFT is to help stakeholders develop the answers to their most critical questions:

- Their share of those notional benefits
- When they will receive those benefits
- At what rate will those benefits accrue
- What technologies will best repay investment with needed operational change
- What are the risks associated with each benefit
- Which risks are out of stakeholder control

The complete Transition Logic Diagram package will help stakeholders quantify what their share of benefits will be. The risk associated with the enablers will help them establish the risk associated with the benefits and the benefit accrual rate. Because alternative enablers can be evaluated, this methodology is intended to aid in the evaluation of those alternatives (based on performance and risk). Finally, the risks associated with each benefit should be identified; allowing the stakeholder to decide which ones can be mitigated.

6.0 CNS/ATM Focused Team Scheduled Activities

The CNS/ATM Focused Team is an airline driven team. The Chairman is Captain Russ Chew of American Airlines. In addition to the other airline representation, this team also includes representatives from Airbus, Boeing, FAA, MITRE, and Eurocontrol.

The CNS/ATM Focused Team is currently split into four subgroups:

- ATS Performance Metrics
- ATS Data Link
- Advanced Navigation
- ADS-B

The purpose of the ATS Performance Metrics group was to build a library of airspace capacity/efficiency measurement tools. This would provide a common baseline of measurements for the remaining subgroups. This group has completed its work.

The work of the ATS Data Link group has been described in this paper. This subgroup is lead by Captain David Massy-Greene of QANTAS airlines

The Advanced Navigation Team is beginning to develop transitions associated with:

- Current navigation capability (RNAV)
- Existing GPS capability
- Potential GPS augmentation

This team is lead by Captain Brian Harkness of Air Canada.

The ADS-B Group is developing transitions based on augmented surveillance. Captain Claudia Gerstle of United Airlines is leading this subgroup.

All of the teams are developing information for an All-Airline meeting which is being planned for November. The meeting will be hosted by United and is tentatively scheduled for November 18, 1998.

Information on meetings and schedules is available on the C/AFT Web Page. This web page also contains the minutes and presentations from all previous meetings as well as a substantial amount of supporting documentation. All of this information is downloadable. Access to the web page is unrestricted and material is available for all. The web address is:

http://www.boeing.com/caft

Currently, participation in the working groups is limited to airlines, airspace managers, and airframe manufacturers. Organizations interested in joining will find contact information on the C/AFT web page.