Executive Summary

The CNS/ATM Focused Team (C/AFT)[1] was asked by the NEXCOM Aviation Rulemaking Committee (NARC) to develop a comparative business case analysis for 8.33/VDL2 and VDL3, as potential alternative solutions to the impending shortage of ATC VHF voice frequencies (spectrum depletion). Although the NARC was primarily concerned about the impending ATC voice spectrum depletion in the NAS, ATC datalink had to be considered at the same time, because the implicit selection of the associated datalink technology could change ATC datalink benefits.

In this evaluation, the C/AFT performed a standalone discounted cash flow analysis for each alternative. The stakeholders were identified as major airlines, regional airlines, Department of Defense (DOD), Business Aviation, and General Aviation. Unfortunately, all of the stakeholders could not be analyzed because there was not enough aircraft equipage cost data for the regional airlines, business aviation, and general aviation. Consequently, the only stakeholders analyzed were the major airlines and the Department of Defense.

The C/AFT Probabilistic Analysis Methodology

The C/AFT analysis first develops a model "Influence Diagram", which defines the interrelationship between the many factors that contribute to the total cost and benefit of each alternative. Each factor then is broken down into its data elements, which are either constants or variables for input of data into the model. Constants are used for known, quantifiable elements (such as discount rate, etc.), whereas variables are used for other elements that are difficult to quantify. Each variable is given a range: A 10 percentile estimate, a 90 percentile estimate, and a 50 percentile estimate. The 50 percentile estimates are called the "base case." For inputs that we understood well we used narrow ranges, and for those that we didn't understand as well we used broader ranges.

A probabilistic analysis is used to generate the equivalent of hundreds of discrete discounted cash flow cases. The net present value (NPV) results for all the possible outcomes are then plotted to better understand the risk for each alternative. Finally, a sensitivity analysis is generated to identify which variables have the most impact to NPV.

Analysis of Costs and Benefits

The cost analysis included capital and operating expenses of aircraft avionics equipage, FAA infrastructure, and the service providers. The FAA, DOD, MITRE, major airlines, aircraft avionics vendors, and service providers provided the input data for the model.

The benefit analysis evaluated the two alternatives by quantifying the monetary impact of reducing delays from two perspectives. First, the model computed the ability of each alternative to avoid delays related to spectrum depletion. Second, it examined how each alternative would provide ATC datalink services by enabling airspace capacity enhancements under an evolving ATC concept of operations.

OVERVIEW OF RESULTS

C/AFT examined the costs and benefits related to how the two alternatives satisfied two separate, yet interrelated, air traffic control requirements. The first requirement was to provide sufficient voice channel capacity to support near term air traffic growth under the existing ATC operating concept. The second was

[1] The CNS/ATM Focused Team is an informal industry group that uses probabilistic modeling to understand the airspace and ATC modernization programs from a business perspective. These analytical techniques are considered useful in quantifying risks associated with technical uncertainties in terms of net present value and return on investment.

to support new ATC datalink services with sufficient capacity and capabilities to enable new operational concepts to support future air traffic growth. Industry is in early stages of defining the new operational concept and, specific to this analysis, the data link Build 2 benefits, so the C/AFT estimated them at an approximate level, and used the same benefits for the two alternatives, but with different timing. In the base case scenarios, the 8.33/VDL2 alternative is expected to implement Build 2 datalink one year earlier than in the VDL3 alternative. This results in a $300M advantage for the 8.33/VDL2 alternative.

The chart below, the cumulative probability distributions, shows overall result for the major airlines' case. It plots the results of both alternatives over their full ranges of outcomes. (The y-axis is the cumulative probability: the probability that the NPV for that alternative will be less than the x-axis value, which is NPV in millions.) The mean value of all the plotted NPV results was $1962 million for the 8.33/VDL2 alternative, and $1344 million for VDL3, thus favoring the 8.33/VDL2 alternative by **$618 million**.

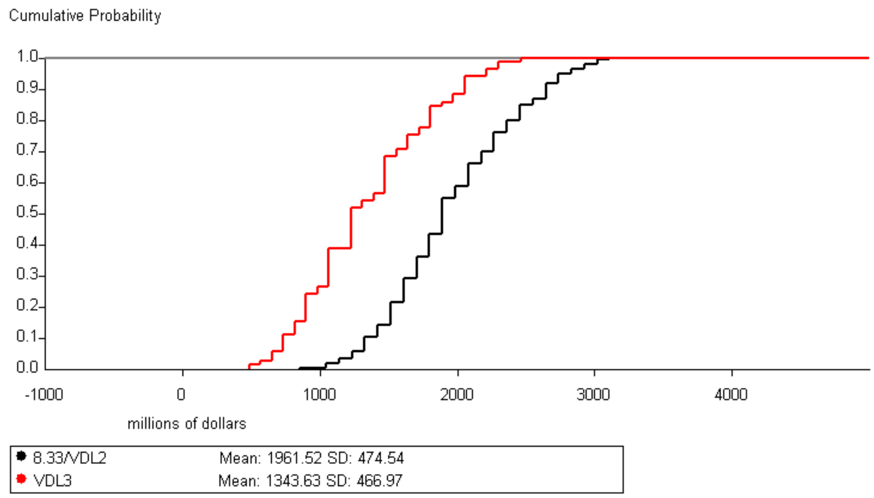

Chart 1: Cumulative Distribution of Major Airlines Net Present Value

Since no benefit difference between the two alternatives was identified for the Department of Defense, the analysis is shown only as the *cost difference between alternatives* . The mean value of all of the plotted NPV results is **$292 million** in favor of the 8.33/VDL2 alternative.

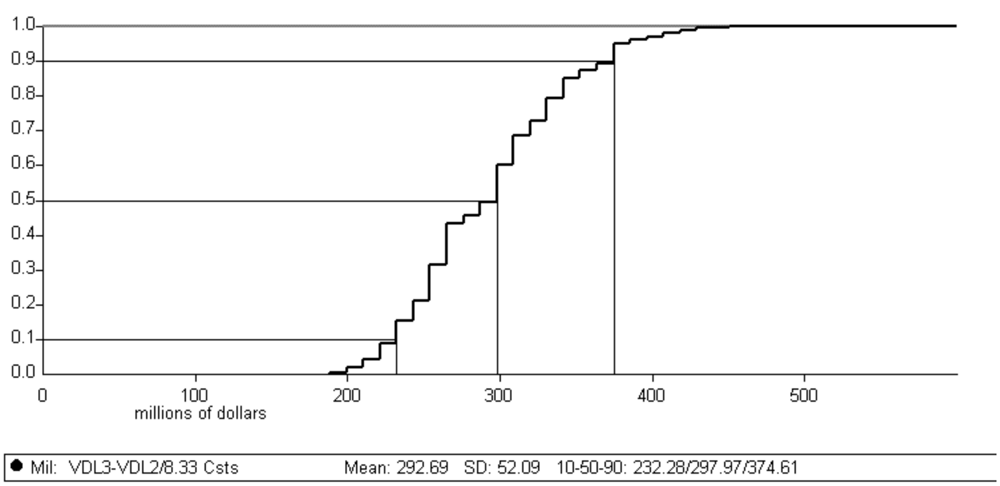

Chart 2: Cumulative Distribution of DOD Net Present Value Difference: VDL3 – 8.33/VDL2

The Major Factors

We looked at the *relative* impact that all the variables have on the result. That overall impact is best shown using a deterministic sensitivity diagram. The sensitivity diagram below quantifies how each decision-dependent variable impacts NPV in the 8.33/VDL2, major airline case. (For example, the width of the first bar indicates that the range of outcomes on Spectrum Depletion Year could result in over a billion-dollar swing in NPV.)

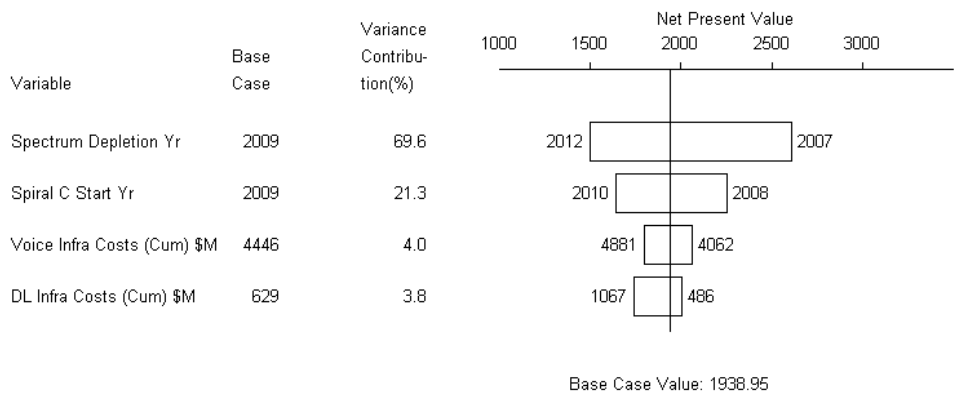

Chart 3: 8.33/VDL2 Deterministic Sensitivity

For the 8.33/VDL2 case, the sensitivity diagram identifies the four most decisive factors impacting NPV variance: the year that spectrum depletion starts, the year that Build 2 Spiral C datalink benefits start, the voice infrastructure costs, and the datalink infrastructure costs.

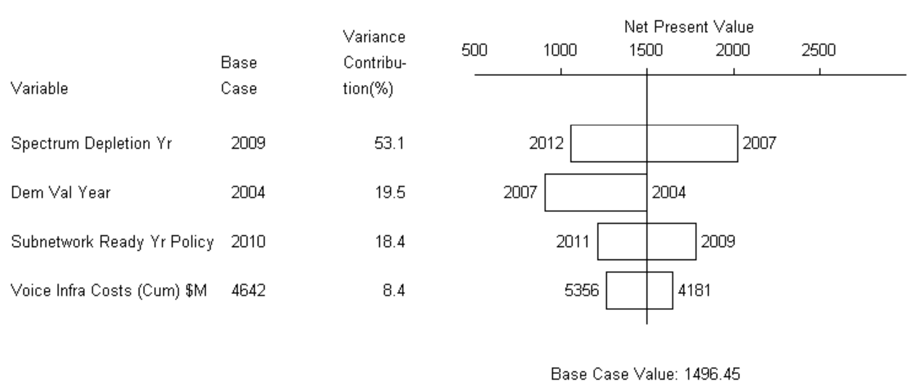

Chart 4: VDL3 Deterministic Sensitivity

For the VDL3 case, the most decisive factors are the year spectrum depletion starts, the completion year of the VDL3 demonstration and validation project, the subnetwork ready year, and the voice infrastructure costs. A delay in the "Dem Val" year will result in delays in both Build 2 datalink and spectrum relief. In the base case scenario, the "Dem Val" is completed in 2004. In the worst case, the Dem Val is slid to 2007. The possible delay in the "Dem Val" year reduces the expected value for the VDL3 case by approximately $300M.

Conclusions

The analysis suggests that the 8.33/VDL2 alternative is a better investment choice for ATC communications. This is primarily driven by the cost differences for aircraft avionics retrofit, and the earlier timing of datalink benefits from Build 2, Spirals C, D, and E. Because of the uncertainty related to ATC datalink benefits, there is a wide range on NPV. This uncertainty is due to the lack of maturity in the future ATC operating concept, and because the specific requirements for the ATC communications network are not yet fully defined. However, the values used for computing the datalink benefits for both 8.33/VDL2 and VDL3 alternatives were the same.

For the major airlines and Department of Defense, the higher avionics retrofit costs for VDL3 were a significant driver. Although cost data was not available for the regional airlines or business aviation, we would also expect higher VDL3 avionics costs, further favoring the 8.33/VDL2 alternative.

As an investment, the positive cash flows are driven by the expected ATC datalink benefits, against the costs of avionics equipage, FAA infrastructure, and delays from spectrum depletion. In comparing the 8.33/VDL2 and VDL3 alternatives, the probabilistic results show that the two alternatives have very different investment risks. The community is widely and firmly split on this matter: many believe VDL2 lacks critically important features, while others believe either technology will be adequate.

The risks of the 8.33/VDL2 alternative are based mainly on its uncertain ability to satisfy future ATC datalink requirements. These risks were not quantifiable and could not be modeled in the analysis. For the VDL3 alternative, the risks are based mainly on the uncertainties related to completing the VDL3 demonstration and validation project for voice and data. This is the gate through which aircraft equipage costs, spectrum depletion avoidance, and ATC datalink benefits must first pass. Any delays in the VDL3 implementation increases the costs from spectrum depletion and postpones ATC datalink benefits. Other delays, such as procurement or institutional risks, were not quantifiable and were not modeled in the analysis.