IDA

INSTITUTE FOR DEFENSE ANALYSES

A New Approach to Force-Mix Analysis: A Case Study Comparing Air Force Active and Reserve Forces Conducting Cyber Missions

Drew Miller
Daniel B. Levine
Stanley A. Horowitz, Project Leader

September 2013

IDA Paper P-4986
Log: H 13-000250

INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
Alexandria, Virginia 22311-1882

The Institute for Defense Analyses is a non-profit corporation that operates three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges.

About this Publication
This work was conducted by the Institute for Defense Analyses (IDA) under contract DASW01-04-C-0003, BE-7-3306, "Total Force Cost Methodology," for the Under Secretary of Defense (Personnel and Readiness). The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

Acknowledgments
Thank you to David R. Graham, Peter A. Kind, and David M. Tate for performing technical review of this document.

INSTITUTE FOR DEFENSE ANALYSES

IDA Paper P-4986

A New Approach to Force-Mix Analysis: A Case Study Comparing Air Force Active and Reserve Forces Conducting Cyber Missions

Drew Miller
Daniel B. Levine
Stanley A. Horowitz, Project Leader

Executive Summary

This paper reports an Air Force force-mix comparison of the cyber mission conducted by the Institute for Defense Analyses (IDA). It analyzes the costs and benefits of different mixes of Air Force Active Component (AC) and Reserve Component (RC) personnel used to perform Air Force cyber missions. The research was conducted for the Office of the Assistant Secretary of Defense (Reserve Affairs) and the Office of the Director, Cost Assessment and Program Evaluation (CAPE) in the Office of the Secretary of Defense (OSD). The policy question of interest is to what extent RC personnel can provide unique benefits to Air Force cyber missions.

This research is one of a number of force-mix analyses IDA is conducting for the sponsors. The other IDA reports deal with the other Services and other missions. The present report focuses on the cyber mission because of its rapid growth and because it differs in important ways from traditional military missions.

The research analyzes active-reserve mixes for cyber missions using two unique features not customarily found in force-mix analyses. The first is the use of a multi-criterion analysis that includes qualitative differences between active and reserve cyber personnel that affect their performance. The model can compare different combinations of AC and RC personnel organized into integrated or stand-alone units using 20 criteria covering a wide range, including cost, experience, currency (familiarity) with military cyber missions, readiness and response times for deployment, customer satisfaction, problems with retention, the negative impact on civilian employers when their part-time reservists leave for duty, and government limitations on the use of the reserve forces.

The reserve alternatives vary in annual terms of service and degree of AC-RC integration: Traditional Reservists serve only the required 39 days of annual duty (one weekend per month plus a two-week annual tour), and Enhanced Reservists (our definition) volunteer for additional service totaling 63 or 180 days per year (including the required 39 days). The integration options are stand-alone units; associated AC and RC units that share some equipment, missions, and personnel; and fully integrated, or blended, units, in which reserve personnel work side-by-side with active personnel.

The resource measures for many of these criteria are subjective variables scored on a 0–10 scale of values. These values, together with weights that reflect the relative importance of each criterion to the overall mission, are aggregated across criteria to

produce a total value for each alternative. The calculations are made using a multi-criterion Decision Support System (DSS) developed by RAND.[1] The inputs of the DSS can be easily changed in order to quickly produce a sensitivity ("what if") analysis showing decision makers the implications of different inputs—choices of criteria, resource measures, values, and weights. Inputs for this analysis were developed from a variety of sources, including a group of 14 Subject Matter Experts (SMEs) with long experience in active, Guard, and reserve cyber operations; surveys of military units and civilian organizations; previous analyses of cyber security; and Air Force Business Case Analyses. Many inputs are subjective judgments that should be fully disclosed and debated where there are disagreements.

Other force-mix reports have generally described forces using only a few variables—such as the number and cost of personnel—together with efficiency measures for them. Applying this approach to active-reserve analysis of cyber missions would risk failing to capture important differences and complementarities between AC and RC personnel.

This report's second unique feature is to recognize the emergence of regular, ongoing operations by the RC in peacetime. Although *reserve* has historically referred to units *in reserve* for deployment, concerned primarily with training when not deployed, reservists and active personnel assigned to missions such as Computer Network Attack (CNA) and Computer Network Defense (CND) are engaged every day in ongoing operational "mission tasks" (as opposed to education, training, and administration). The research highlights this operational use of the reserves by including, in addition to standard annual costs, a criterion that measures cost per day spent performing mission tasks. (Costs are measured by total personnel cost to the government.)

The research demonstrates the DSS methodology by analyzing the CNA mission. We were working with limited data; therefore, the results should be treated as illustrative: they suggest that the Air Force might perform this mission with higher value by using an integrated blend of active and reserve personnel. Other findings are that the Air Force might lower total personnel cost to the government by encouraging reservists to volunteer for service time beyond the required 39 days, and improve performance of both AC and RC personnel by utilizing fully integrated units in which RC personnel work side-by-side with active personnel in blended rather than stand-alone operation. This could be particularly important for RC personnel in the CNA area where operational currency is vitally important and only maintainable by continuing mission work. Caveats to the analysis results include limited data, scalability, and RegAF requirements to support the Air Reserve Component training and support pipeline.

---

[1] Richard Hillestad and Paul K. Davis, *Resource Allocation for the New Defense Strategy: The DynaRank Decision-Support System* (Santa Monica, CA: RAND Corporation, 1998).

The multi-criterion methodology can be used for analyzing other missions—including intelligence, nuclear command and control, airlift, and control of space systems—in which units are importantly distinguished by a variety of factors, and where the RC is used for mission tasks rather than as forces in reserve for wartime.

Contents

A. Introduction

This report describes research by the Institute for Defense Analyses (IDA) to evaluate the costs and benefits of alternative mixes of Air Force active and reserve units involved in cyber missions. The research was requested by the Office of the Assistant Secretary of Defense (Reserve Affairs) and the Office of the Director, Cost Assessment and Program Evaluation (CAPE) in the Office of the Secretary of Defense (OSD).

This report focuses on the cyber mission because of the growing conflict in information operations that has increased Department of Defense (DoD) interest. The policy question is to what extent Reserve Component (RC) personnel could help the Air Force conduct its cyber missions efficiently. Improving personnel capability for cyber missions is of current policy interest. General Keith Alexander, the Commander of US Cyber Command, has stated that generating the people is the biggest challenge we face to perform cyber missions.[1] A recent IBM Cybersecurity Workforce Study (CWS) observed that manning was 15–33 percent below estimated requirements.[2] And Deputy Secretary of Defense William J. Lynn III announced a program in February 2011 to better utilize the specialized cyber skills of DoD personnel who work in the civilian Information Technology (IT) area by increasing the number of Guard and Reserve units that have a dedicated cyber mission.[3]

This report employs two methodological features not customarily included in previous force-mix analyses. First, because Active Component (AC) and Reserve Component (RC) units differ in a variety of ways that affect their performance, we have employed a multi-criterion model. Second, we account for the different nature of the tasks that some reservists perform in peacetime. *Reserves* have historically functioned as forces *in reserve* for wartime, whose principal task in peacetime has therefore been training for wartime deployment. Cyber warfare, however, has become a standard, ongoing feature of international conflict in peacetime, and current reservists who work in some of the cyber missions discussed below participate in actual cyber operations, or *mission tasks*, as opposed to education, training, and administration. We account for this difference by measuring the personnel cost to the government per day assigned to mission tasks.

---

1 Jason Miller, "Workforce is DoD's Biggest Cyber Challenge," September 24, 2010, accessed December, 4, 2010, http://www.federalnewsradio.com/?nid=35&sid=2061303.

2 IBM, Ryan Farr, Brian Gwinner, Department of Defense Cybersecurity Workforce Study on behalf of Defense Information Assurance Program Office, Mr. George Bieber, March 10, 2011.

3 William J. Lynn, III, Remarks on Cyber at the RSA Conference, San Francisco, California, February 15, 2011.

Section B describes the methodology used in our research. Section C describes the resource measures and values of the various criteria. Section D illustrates the multi-criterion methodology by comparing the performance of two mixes of AC and RC units in carrying out the Computer Network Attack (CNA) mission. Much of the discussion in the paper, however, concerns cyber missions in general. Section E summarizes the findings of the analysis. Appendix A provides additional information on the relevance of civilian skills to military cyber missions and the added benefit if RC units are fully integrated with active units.

B. Methodology

This section begins with the overall approach of the analysis followed by a discussion of caveats. These are followed by subsections describing the cyber missions, the Air Force's active and reserve units and personnel that perform these missions, and how the performance of these units is evaluated. The evaluation subsection describes the criteria, the sources of inputs, and the process for aggregating the performance of all the criteria into a single measure.

1. Overall Approach

As mentioned above, this analysis employs two methodological features not customarily included in previous force-mix analyses. First, because AC and RC units differ in a variety of ways that affect their performance, we have employed a multi-dimensional approach, using over 20 criteria, that describes the ability of these units to perform missions. These criteria span a wide field of view including cost, experience, currency (familiarity) with military cyber missions, readiness and response times for deployment, problems with retention, the negative impact on civilian employers when their part-time reservists leave for duty, and government limitations on the use of the reserves. The capability of personnel to perform cyber missions is measured by the satisfaction of the customers who employ them.

Previous force-mix analyses have generally taken a narrower focus, describing forces by only a few variables such as the number and cost of personnel, along with efficiency measures for them. Restricting analysis to only a few variables permits use of a cost-effectiveness methodology that has the appeal of producing a single order of preference among the alternatives. Applying that approach to active-reserve analysis, however, would risk failing to capture the many important differences and complementarities between AC and RC personnel.

The multi-criterion approach we have employed can be used to produce a sensitivity ("what if") analysis, showing decision makers the implications of different choices of inputs. (E. S. Quade, one of the early developers of military operations research, has written: "In an analysis aimed at policy-making, an investigation of the

relevance of the many factors and contingencies affecting the decision is likely to be more useful than any narrow optimization achieved by sophisticated analytical techniques."[4])

The reserve alternatives vary in terms of service and degree of AC-RC integration: Traditional Reservists (TR) serve only the required 39 days of annual duty (one weekend per month plus a two-week annual tour), and Enhanced Reservists (ER) (our definition) volunteer for additional service totaling 63 or 180 days per year (including the required 39 days). The integration options are stand-alone AC or RC units; associated AC and RC units that share some equipment, missions, and personnel; and fully integrated, or blended, units, in which reserve personnel work side-by-side with active personnel.

Since the resource measures for many of the criteria are subjective variables, the alternatives were scored against these criteria on a 0–10 scale of values. These values, together with weights that reflect the relative importance of the criteria to cyber operations, are aggregated across criteria to produce a total value for each alternative. The calculations are made using a multi-criterion Decision Support System (DSS) developed by RAND.[5] The inputs—choice of criteria and their resource measures, values, and weights—were all determined using a variety of sources, including a group of 14 Subject Matter Experts (SMEs) with long experience in active, Guard, and Reserve cyber operations; surveys of military units and civilian organizations; previous studies of cyber security; and Air Force Business Case Analyses (BCAs).

The report's second unique feature is recognition of the emergence of ongoing use of reserve forces in peacetime. Whereas *reserve* has historically referred to units that are *in reserve* for deployment, and therefore concerned primarily with training when not deployed, reservists and active personnel assigned to missions such as CNA and Computer Network Defense (CND) are engaged during peacetime in operations, or *mission tasks* (as opposed to education, training, and administration). (The Combat Communications mission, by contrast, does largely involve training for wartime deployment.) The research accounts for this new operational focus of the reserve by including, in addition to standard annual costs, a criterion that measures cost per day spent performing mission tasks.

This research demonstrates the DSS methodology by analyzing the CNA mission. While we were working with limited data, the illustrative results show that the Air Force might be able to perform this mission with higher value by using blended integrated units and in one iteration, a reserve-heavy mix of active and reserve units. Other illustrative

---

[4] E. S. Quade and Wayne I. Boucher, eds., *Systems Analysis and Policy Planning: Applications in Defense* (Santa Monica, CA: RAND Corporation, 1968).

[5] Richard Hillestad and Paul K. Davis, *Resource Allocation for the New Defense Strategy: The DynaRank Decision-Support System* (Santa Monica, CA: RAND Corporation, 1998).

findings are that the Air Force might lower total personnel cost to the government by encouraging reservists to volunteer for service time beyond the required 39 days, and by adopting fully integrated units in which RC personnel work side-by-side with active personnel in blended rather than stand-alone operation.

The unique features of this analysis can be applied in other research. The multi-criterion methodology can be used to analyze force-mix questions of other missions—including intelligence, nuclear command and control, airlift, and control of space systems—in which units are importantly distinguished by a variety of factors, and in which the RC is used for mission tasks rather than as forces in reserve for wartime. For applications to field combat, criteria describing rotational availability and costs would be added.

2. Caveats

The reader should understand that the resource and value inputs analyzed in this paper are judgment calls. We attempted to provide a valid analysis by obtaining these inputs from the best sources of cyber information we could find—SMEs, BCAs, and previous studies of cyber information. However, the reader is free to use the DSS model to generate the implications of other inputs they might prefer to use.

Also, in some cases the precision of the assessment is limited by the nature of the rating scale that was used to elicit SME opinions[6] and by some ambiguity in the questions to which the SMEs were asked to respond. It would also have been preferable to be able to iterate with the SMEs, asking additional questions and clarifying certain responses. These qualitative results are best used as indicators of which AC-RC mixes are likely candidates for further analysis.

The CNA mission is the most demanding of the cyber missions areas in terms of complexity, need for currency in operations, and highest level clearances.

Scalability must be further evaluated. The CAN mission analysis addresses one iteration of a reserve-heavy blend. Feasibility of recruiting, clearing to sensitive levels, and sustaining at scale is critical. If sustainable, the long-term continuity and strategic surge capability of greater reliance on the Air Reserve Component (ARC) may be appealing.

---

[6] In particular, some characteristics, like currency and quality, were rated on scales where 10 indicated reservists were 100 percent better than active personnel (or twice as good) and 0 indicated they were 100 percent worse (or of no value at all). There was no way to indicate that reservists were more than twice as good. This limitation of the comparative scale in one direction but not in the other is unappealing and makes it less likely that the same results would have been achieved had the scale been defined the other way around (in terms of active performance relative to reserve performance).

Nine of the 20 criteria in the CNA Mission analysis were rated equally across the board for all categories. Further evaluation in subsequent iterations is merited.

Additional manpower may be required in RegAF units to maintain the recruiting, training, and support pipeline for active and reserve personnel.

3. Cyber Missions

There is a wide, changing variety of Air Force cyber missions. Combat Communications is a "traditional" reserve mission, in which reservists principally train in peacetime to be deployed to set up network and communications systems in wartime. CNA and CND are non-traditional, in that reserve personnel may perform mission tasks during peacetime. In rating the relative fitness of AC and RC cyber warriors for cyber work, our SMEs differentiated between eight different cyber missions.

4. AC and RC Units and Personnel

Table 1 lists the Air Force cyber units. These are *types* of units, although particular units are occasionally mentioned. Regular Air Force (RegAF) personnel are those who are serving a tour of two years or more of full-time service. Active, Guard, and Reserve (AGR) members and Air Reserve Technicians (ARTs) are full-time reservists, having signed up for at least 180 days of duty per year.

Table 1. Air Force AC and RC Units

Type of Unit	Definition
Active Component	
RegAF	Regular Air Force
Reserve Component, Full-time	
AGR	Air Guard and Reserve
ART	Air Reserve Technician
Reserve Component, Part-time	
ANG	Air National Guard
AFR	Air Force Reserve
Variations of Service for Part-time Reserves	
TR	Traditional Reserve; serves 39 days per year
ER 63 days	Enhanced Reserve; serves 63 days per year
ER 180 days	Enhanced Reserve; serves 180 days per year
Variations of Integration of RC with AC Units	
Stand-alone	Independent operation
Associate	Some sharing of assets and tasks with AC
Fully Integrated, or blended	Work side-by-side on same tasks with AC

Air National Guard (ANG) and Air Force Reserve (AFR) members are part-time reservists whose service varies by duration and extent of integration. Variations in duration include TRs, who serve only the required 39 days per year (one "drill weekend" per month and a two-week tour per year), and ERs, our term for personnel who have volunteered for service beyond the 39 days. For analysis, we have chosen total ER service times (including the required 39 days) of 63 and 180 days. Strictly speaking, the labels TR and ER refer to individuals, not units, since an ANG or AFR unit can contain both TR and ER personnel. For simplicity, we will use TR and ER to refer to units, and assume that they are composed primarily of TR and ER personnel, respectively.

The three variations in integration are: stand-alone units, which operate independently; associate units, which share some responsibility with active units for physical assets and some mission assignments; and fully integrated or blended units, in which reserve personnel fully share assets and workspace with RegAF personnel, and work is organized so that all work side-by-side on the same cyber missions. We did not analyze "Air Reserve Component (ARC) Associate" units, a relatively new type of unit comprising two integrated RC units such as an ANG and an AFR.

Although the 180-day ER unit was chosen for analysis, it might not appeal to many reservists because of (1) the difficulty of pursuing two equal-sized occupational careers, (2) separation from family, and (3) probable resistance of civilian employers to half-year disruptions. The 63-day ER program would probably be more attractive, and there is current policy interest in encouraging reservists to volunteer for this option.

5. Evaluation Methodology

a. Performance Criteria

We evaluated cyber units by the criteria shown in Table 2, a three-level hierarchy of resource measures discussed in detail in Section C. A single Aggregate Performance is calculated by the process described in subsection c, starting on page 10. It involves aggregating the performance of the individual criteria from right to left, starting with the inputs for the "basic" criteria: the low-level criteria and those mid-level criteria lacking low-level subcomponents. For example, Workforce experience and several other criteria determine Quality, which together with Integration & civilian skills leads to Capability. Input data for variables such as Number of personnel and their Readiness for mobilization are aggregated to determine Quantity and Availability.

Table 2. Performance Criteria

	High-level Criteria	Mid-level Criteria	Low-level Criteria
Aggregate Performance	Capability	Quality	Workforce Experience
			SME Experience
			Currency
			Customer Quality
		Integration & Civilian Skills	
	Quantity and Availability	Number of Personnel Available for Peacetime Missions	
		Number of Personnel Available for Wartime Surge	
		Readiness & Response Time for Mobilization	
	Personnel Costs	Cost per Year	
		Cost per Workday	
		Cost per Day on Mission Tasks	
		Cost per 20 Years ($M)	
	Limiting Factors	ARC Retention	
		RegAF Recruiting and Training Pipeline	
		Government ANG Restrictions	
		Public Support	
		Employer Impact	Small Company Key Employees
			Large Company
			Small Government

The costs are per-person personnel costs to the government based on detailed data for annual hours of service, DoD Composite pay rates, and other personnel factors. The analysis focuses on personnel cost because it is more sensitive to the different AC and RC units than the other budget categories (Research, Development, Test & Evaluation (RDT&E), Military Construction, Procurement, and Operations and Maintenance (O&M)).

Personnel Costs are measured by four mid-level criteria. Cost per year is relevant for overall budgeting. Cost per workday distinguishes between the different number of workdays per year for the various active, traditional, and enhanced reserve personnel we have defined. Cost per day on mission tasks reflects the variation in the percentage of time that is spent on actual mission tasks for the various active and reserve personnel, as well as their degree of reserve integration. As mentioned earlier, this measure is

especially appropriate for cyber missions such as CNA and CND, in which personnel perform operational mission tasks in peacetime.

Limiting Factors include problems with ARC retention and possible negative Employer Impact when part-time reservists leave for duty. Aggregate Performance is aggregated from the four high-level criteria.

Note that the criteria in Table 2 do not include a detailed measure of effectiveness—how well the units perform the narrowly-defined technical demands of the cyber missions. Measuring this was beyond the scope of this paper. Effectiveness is described to some extent, however, by the Customer Quality Survey, which reports how cyber units have assessed the work of their active and reserve personnel.

The performance of AC or RC units is analyzed by assigning a resource measure, value, and weight that reflect the relative importance of each criterion. The resource measures and associated value scale for each criterion are shown in Section C, and the weights for the CNA mission are shown in Section D. For the Workforce experience criterion, for example, the resource measure is the average number of years the unit's personnel have been working on cyber tasks, either military or civilian, and the associated value scale is shown in Table 3. The information in Section D uses a resource measure of 5 years based on survey results, an associated value of 10 from Table 3, and a weight of 2 for the CNA mission.

Table 3. Years of Cyber Work Experience vs. Value

Years of Experience	Value
5.0+	10
4.5	9.9
4.0	9.7
3.5	9.5
3.0	9
2.5	8
2.0	7
1.5	6
1.0	4
0.5	2

The resource measures are converted to values because the analysis employs many quantitative and qualitative criteria in order to capture the various differences between the

different AC and RC units, and there is no way to add up their resource measures.[7] The values derived from the resource measures, however, can be combined with the weights and aggregated, as shown in subsection c below.

b. Sources of Inputs

The information presented in this paper, including the numerical inputs for the CNA mission analysis was developed by the research group with the help of many outside sources of cyber information. Table 4 lists these sources and the criteria for which they were used.

Table 4. Data Sources and Their Corresponding Data

Data Source	Applicable Criteria and Data Areas
Work session of 14 SMEs with long experience in active, Guard, and Reserve cyber units. The session, held at IDA, provided historical experience.	• Experience (Workforce and SME) • Currency • Integration & Civilian Skills • Readiness & Response Time • ARC Retention • RegAF Training and Recruiting Pipeline
Interviews and surveys with personnel at approximately 30 RegAF, ANG, and AFR units; the Air Staff; and the U.S. Cyber Command.	• Currency • Cost (percentage of time spent on cyber mission tasks) • ARC Retention • Government and ANG Restrictions • Public Support • Employer Impact • Numbers of FTE (Full-Time Equivalents) and Cyber Warriors
IBM Cyber Workforce Study (CWS) rating of the importance of Workforce and SME experience, a critical factor for cyber work.	• Value scale for experience (developed with the assistance of the author of the IBM study, who also participated in SME rating sessions)
Defense Manpower Data Center (DMDC)	• Data in Table 20, Reservists' Satisfaction with Work and Likelihood to Remain, Air Force vs. Other Services.
Personnel cost data • OSD Controller and Air Force (AFI 65-503) tables • Air Force Business Case Analyses • Reserve Forces Policy Board study • Air Force FMCC	• Officer and Enlisted Costs • Costs of Training & Certification and Security Clearance • Extra Base Facilities inputs

[7] Richard J. Hillestad and Paul K. Davis, *Resource Allocation for the New Defense Strategy: The DynaRank Decision-Support System*, MR-996-OSD (Santa Monica, CA: RAND Corporation, 1998).

c. Aggregation Process

Table 5 illustrates the aggregation process using the inputs for Capability, one of the high-level criteria, from the research discussed in Section D. The values and weights for the four "basic" (or low-level) criteria are combined in the weighted sum shown in Equation (1) to obtain the value for Quality, which is then combined with the input value and weight for Integration & Civilian Skills in the weighted sum shown in Equation (2) to obtain the value for Capability.[8] A similar process is used for the other three high-level criteria, and the four high-level criteria are then aggregated with their weights to obtain the Aggregate Performance (an aggregate "value").

Table 5. Illustration of Aggregation Process

High-level Criteria	Name	**Capability**				
	Weight	3				
	Measure	6.8				
Mid-level Criteria	Name	**Quality**				**Integration & Civilian Skills**
	Weight	3				1
	Value	7.3				5
Low-level Criteria	Name	**Workforce Experience**	**SME Experience**	**Currency**	**Customer Quality**	
	Weight	2	1	2	1	
	Value	8	7	8	5	

$$Value\ of\ Quality\ = \frac{8\times2+7\times1+8\times2+5\times1}{2+1+2+1} = 7.3 \quad (1)$$

$$Value\ of\ Capability\ = \frac{7.3\times3+5.0\times1}{3+1} = 6.8 \quad (2)$$

C. Description of Criteria

This section discusses the resource measures of the "basic" criteria used to evaluate each of the four high-level criteria. (The "basic" criteria are the low-level criteria and the mid-level criteria that have no low-level components.) The discussion of each criterion begins with the table linking the resource measures and values.

[8] Dividing the weights by their sum in the denominator converts them to percentages that sum to 1.0.

1. Capability

Capability describes the experience and currency of the workforce and SMEs, and the degree to which survey respondents in the military cyber units—the customers of their services—assess their quality.

a. Workforce and SME Experience

The research group constructed Table 6, which relates years of experience to value for Workforce and SME Experience, from information contained in the 2011 IBM CWS. The CWS did not differentiate between active and reserve personnel, nor did it vary the assignment of values to performance measures by mission.

The CWS judged that Workforce and SME Experience were major determinants of the effectiveness of active and reserve cyber units and the number of Full-Time Equivalent (FTE) personnel needed to perform cyber missions. Experience was regarded as the most important factor in 36 percent of cyber tasks and second most important in 24 percent of the cyber tasks that CWS analyzed.[9] The study stated that "personnel turnover has a devastating impact to the security posture of a network," and that "[a] common theme from the sites visited was that it is not the number of personnel performing a task that is important, but the knowledge and ability of the personnel."

Table 6. Years of Cyber Work Experience vs. Value

Years of Experience	Value
5.0+	10
4.5	9.9
4.0	9.7
3.5	9.5
3.0	9
2.5	8
2.0	7
1.5	6
1.0	4
0.5	2

[9] IBM, Ryan Farr, Brian Gwinner, Department of Defense Cybersecurity Workforce Study on behalf of Defense Information Assurance Program Office, Mr. George Bieber, March 10, 2011.

b. Currency

Currency (Table 7) describes how familiar or "current" a cyber warrior has become with the equipment, technology, and threats of the mission. Additional analysis might quantify currency by defining it by the time since last training. Currency is especially important because of the rapidly changing nature of these missions in recent times. The changes are far more frequent than for many historical tasks such as aircraft maintenance, in which the platforms and practices change slowly over time.

The rapidity of changes in the cyber mission leads to a need for more frequent and intensive training to maintain currency. Senior personnel at the 315th Network Warfare Squadron (NWS) reported that cyber warriors assigned to the CNA mission who are gone from work even a few weeks need training to get back up to speed. Alan Paller, Research Director of the SysAdmin, Audit, Networking, and Security (SANS) Institute stated that workers need refresher training every few weeks to keep up with the dramatic increases in the sophistication of cyber attacks.[10] Finally, a Cyber BCA prepared by AFR states that it takes a month to become current in cyber technology, so ARC personnel who serve for only 60 days at a time provide low benefit. Their high turnover rate, moreover, imposes a need to provide initial training for more personnel per year to maintain a given billet.[11]

Table 7. Currency

Compared with Active Component	Value
100% higher	10
50% higher	9
25% higher	8
10% higher	7
Slightly higher	6
Same	5
Slightly lower	4
10% lower	3
25% lower	2
50% lower	1
100% lower	0

[10] Brittany Ballenstedt, "Wired Workplace: Expert Flags Flaw in Cyber Workforce Plan," *Nextgov*, August 15, 2011, http://www.nextgov.com/cio-briefing/wired-workplace/2011/08/expert-flags-flaw-in-cyber-workforce-plan/54777/.

[11] Business Case Analysis, "Total Force Integration, 24th Air Force, 624th Operations Center Air Force Space Command (AFSPC)/Reserve Associate Unit (RAU), Air Force Reserve Command, Lackland Air Force Base, TX," Air Force Space Command A8, January 2011.

c. Customer Assessments of Quality of Cyber Personnel

The value scale of customer assessments in Table 8 was based on the survey shown in Table 9 that was sent to a limited number of senior officers and civilian members of cyber units—the customers of cyber personnel—to rate their satisfaction with the quality of work of their RegAF and ARC cyber personnel. A relatively small number of respondents reported differences between AC and RC personnel. (An RC quality of 100 percent lower than the AC represents an unrealistic Quality of zero.)

Table 8. Customer Assessments of Quality

Compared with Active Component	Value
100% higher	10
50% higher	9
25% higher	8
10% higher	7
Slightly higher	6
Same	5
Slightly lower	4
10% lower	3
25% lower	2
50% lower	1
100% lower	0

Table 9. Survey of User Satisfaction

Do you notice any difference in work quality for Regular Air Force (RegAF: Active Component, AC) versus Air Reserve Component (ARC: ANG, AFR) personnel?
1. If there is an AC-ARC difference in work quality, please estimate in percent terms the degree to which the AC or ARC personnel's work product is better.
2. Have you experienced any problems with getting work done due to non-availability of personnel in AC or ARC units? (if so, please describe briefly and indicate the units, reasons for difficulties)
3. Are there times when civilian IT work skills are more valuable in this work than the standard military cyber warrior skills? (if so, please give some examples)
4. Would you prefer having more AC or ARC personnel supporting your needs?

d. Integration & Civilian Skills

The resource measures and value scale are shown in Table 10. Integrating reserve with active units increases the ability of part-time reservists to apply to military cyber missions the high technical skills they may have gained through advanced technical education and on-the-job training (OJT) in civilian occupations.

The contribution of part-time reservists to Air Force cyber missions depends on the answers to two questions: (a) Are the cyber skills that the reservists learn in their civilian occupations applicable to their military missions, and (b) Are these skills currently in short supply in the active Air Force?

Table 10. Integration and Civilian Skills

Relevance of Civilian Skills	Value
Vital	10
	9
Major value	8
	7
Negligible value	6
No impact	5
Minor harm	4
	3
Significant harm	2
	1
Catastrophic bad impact	0

The research team posed these questions in a survey to cyber service customers and the SMEs who worked with the team. The results, reported in Table 11 and Table 12, suggest that the answer to both questions is a qualified yes. The first column of figures in Table 11 indicates that over 50 percent of ARC cyber warriors have relevant skills for the CND and Exploitation missions. Civilian skills show substantial but declining relevance to the other missions, falling finally to a low of 23 percent for Combat Communications, which involves peacetime training for wartime deployment.

The second column of figures in Table 11 bears on the second question by assigning high value to bringing civilian skills into military performance of the CND, CNA, and Exploitation missions. Responses to the survey questions in Table 12 provide some additional confirmation on both questions by indicating that 88 percent of the SMEs have observed that cyber reserve units have added value to RegAF units several times or more per year.

Appendix A contains additional evidence that part-time reservists do bring in skills from their civilian jobs that are relevant to Air Force cyber missions and that the Air Force does not already have in abundance.

Table 11. Integration Survey

Mission	What percentage of ARC cyber warriors have valuable and relevant civilian work skills and experience?	How valuable is bringing in these civilian skills and knowledge?
CND	58%	8.6
Exploitation/Analysis	54%	8.3
Network and Base Operations	47%	6.5
Red Team Inspections	43%	6.9
CNA	34%	8.1
IO	27%	6.5
Combat Communications	23%	5.1

Table 12. Does the ARC Add Value to the RegAF?

Are you aware of ARC civilian cyber skills and knowledge adding value to RegAF units or other Cyber Customers?	
Never seen this	0%
Occasionally, less than once per ARC man-year	13%
Often, several times per ARC man-year	50%
Constantly, every month of ARC member cyber/IO service	38%

2. Quantity and Availability

Force quantity and availability is a high-level criterion that measures the number of personnel and their levels of readiness and response time required for wartime mobilization. The number of personnel required includes both those needed for current operations and the much larger force of cyber warriors needed for full wartime mobilization.

a. Number of Personnel Available for Peacetime Missions and Wartime Surge

Table 13 shows a value scale for both measures of force levels: the percentage change since FY 2011 of the number of personnel employed in ongoing peacetime cyber operations such as CND and CNA, and the number that in peacetime would be involved in training for wartime surge such as for Combat Communications. We were unable to obtain reliable data on the current size of the cyber workforce and their distribution across the various cyber missions for the research discussed in Section D: DoD is in the process of developing definitions of cyber tasks, manpower, and policy for the cyber

workforce, and the Air Force is making changes to Air Force Specialty Codes (AFSCs) and evaluating the number of personnel who are in retraining and transitioning to different occupations.[12]

A recent Air Force briefing did, however, offer the following rough estimates of the cyber workforce: 3,500 RegAF, 900 government civilians, 900 contractors, and 11,000 Guard and Reserve. This estimate probably does not include units such as the RegAF 55th Combat Communications Group at Offutt Air Force Base (AFB), which falls under the Air Combat Command. Most ARC cyber warriors are assigned to the 689th Wing Combat Communications mission, which planners assume would require a large number of personnel for wartime.[13] Most of the discussion in this report is devoted to pressing needs for personnel for ongoing peacetime cyber operations such as CNA, CND, Network Operations, and IO. The analysis in Section D, however, assumes more cyber personnel would be needed in wartime. Equal weights are assigned to peacetime and wartime needs.

Table 13. Number of Personnel in Peacetime and Wartime Surge

Compared with FY 2011 Baseline	Value
50% higher	10
25% higher	9
15% higher	8
10% higher	7
5% higher	6
Same	5
5% lower	4
10% lower	3
15% lower	2
25% lower	1
50% lower	0

[12] For example, someone who works on a cyber project at the individual machine level, not part of the Global Information Grid (GIG), might be assigned to an Air Combat Command unit supporting a Combatant Command (COCOM), and not part of the 24th Air Force, which manages the Air Force (AF) cyber workforce. And the 24th Air Force falls under Air Force Space Command, which adds to the confusion.

[13] Col. Kevin Wooton, CC 67th Network Warfare Wing, mission briefing presented at Armed Forces Communications and Electronics Association (AFCEA) Cyber Conference, San Antonio, TX, January 2012.

b. Readiness and Response Time

Table 14 lists the values for the two criteria of Readiness and Response Time for wartime mobilization.

Table 14. Readiness and Response Time

Compared with Active Component		
Readiness	**Response Time**	**Value**
100% higher	30 days faster	10
50% higher	10 days faster	9
25% higher	5 days faster	8
10% higher	2 days faster	7
Slightly higher	Slightly faster	6
Same	Same	5
Slightly lower	Slightly slower	4
10% lower	2 days slower	3
25% lower	5 days slower	2
50% lower	10 days slower	1
100% lower	30 days slower	0

3. Personnel Costs

a. Introduction

Table 15 is the value scale for the costs; Table 16 and Table 17 derive the four personnel cost criteria listed in Table 2: total annual cost, cost per workday, cost per day on mission tasks, and 20-year cost. (The illustrative results in Section D use somewhat different cost criteria from an earlier analysis.) Table 16 is for officers and Table 17 for enlisted personnel. A graphical analysis of the criteria follows the explanation of the calculations in the tables. The analysis focuses on per-person personnel costs to the government, since active and reserve units have similar needs for RDT&E, Military Construction, Procurement, and O&M resources.[14]

[14] A DoD management decision in 2011 (Directive-Type Memo 09-007) established a new policy that defense officials be aware of the full costs of manpower and consider the full costs to not just the DoD but the entire Federal government when developing national security policies and making program commitments.

Table 15. Personnel Cost

Compared with FY 2011 Baseline	Value
50% lower	10
25% lower	9
15% lower	8
10% lower	7
5% lower	6
Same	5
5% higher	4
10% higher	3
15% higher	2
25% higher	1
50% higher	0

b. Cost Components

1) Annual Pay

It is convenient to think of total workdays as being of two types, depending on the pay rate:

- Required days – varying numbers of days depending on whether the personnel are full-time or part-time, and
- Military Personnel Appropriation (MPA) days – the time beyond the required 39 days that reservists may volunteer to serve in response to needs of active units and Combatant Commanders.

Required days are reimbursed at the Composite pay rate explained below. Full-time personnel, both active (RegAF) and reserve (AGR and ART) serve 275 required days per year. This accounts for weekends off, 10 federal holidays and 30 days of paid vacation.[15] Composite pay is approximately $600–650 per required day. Required days for part-time reservists are 39 days per year: 24 days for one drill weekend per month plus 15 days for a two-week annual tour. Although they are reimbursed at the Composite pay rate, they are allowed to charge two days for each drill weekend day, bringing their pay up to approximately $1,000 per day. TRs are those who serve only the required 39 days.

[15] Jennifer Buck, "The Cost of the Reserves," Chapter 10 in *The New Guard and Reserve*, ed. John D. Winkler and Barbara A. Bicksler (San Ramon, CA: Falcon Books, 2008), 180.

For MPA days, current daily pay is approximately $400. We have selected 24 and 99 MPA days for analysis, yielding 63 and 138 workdays in total including the required 39 days. The additional 24 MPA days per year might consist of an extra weekend per month, and the 99 MPA days assumes the reservist would sign up for a total obligation of 180 days but would work only 138 days assuming he would be granted time off for weekends, leave days, and travel. (Air Force reservists do not normally deploy in peacetime, are not likely to convert their families to military health care, and do not qualify for the extra retirement benefits earned by Army reservists who deploy to Iraq and Afghanistan for extended periods.)

Annual pay in Table 16 and Table 17 is the sum of pay for required and MPA workdays. The Air Force Annual Composite pay rates, which are published in Air Force Instruction 65-503, are patterned after DoD Composite rates.[16] We used O-4 rates for officers and E-4 rates for enlisted personnel. (Some BCAs use E-5s and O-3s, but the differences are not significant.) The Composite rates are the sum of base pay, military-specific allowances (e.g., basic allowances for housing and subsistence, incentive and special pay, and miscellaneous pay), and accruals for retired pay and health care. They also cover Permanent Change of Station (PCS) expenses for active personnel only; reserve personnel receive PCS costs only for unusual circumstances such as relocation of a reserve unit to a different base.

[16] The cost factor tables have been migrated to the Air Force Portal (AFP) that requires an AFP account that can be obtained using a Common Access Card (CAC). The Air Force Composite rates are based on OSD Comptroller estimates, "FY 2012 DoD Military Personnel Composite Standard Pay and Reimbursement Rates," April 2011, which are available on the Internet.

Table 16. Officer Personnel Costs

	Full-time			TR		ER 63 Days		ER 180 Days	
	RegAF	**AGR**	**ART**	**ANG**	**AFR**	**ANG**	**AFR**	**ANG**	**AFR**
Annual Days of Service									
Obligation days	275	275	275	39	39	63	63	180	180
Workdays	275	275	275	39	39	63	63	138	138
Required days	275	275	275	39	39	39	39	39	39
MPA days						24	24	99	99
Annual Cost Components									
Annual pay:									
Composite pay per year	$166,559	$178,766	$174,842	$38,575	$40,988	$38,575	$40,988	$38,575	$40,988
MPA days per year						24	24	99	99
MPA cost per day				$401	$401	$401	$401	$401	$401
MPA cost per year						$9,624	$9,624	$39,699	$39,699
Total pay per year	**$166,559**	**178,766**	**174,842**	**$38,575**	**$40,988**	**$48,199**	**$50,612**	**$78,274**	**$80,687**
Cyber Training and Certification	$13,000	$13,000	$13,000	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000
Security Clearances	$1,050	$1,050	$1,050	$750	$750	$750	$750	$750	$750
Pre-Medicare Retiree Health Costs	$16,366	$16,366	$16,366	$3,117	$3,117	$3,117	$3,117	$3,117	$3,117
Extra base facilities	$2,000								
Percentage of Time Spent on Mission Tasks									
Stand Alone unit	70%	50%	50%	25%	25%	35%	35%	50%	50%
Associate		60%	60%	30%	30%	50%	50%	60%	60%
Fully Integrated		70%	70%	35%	35%	65%	65%	70%	70%
Criteria									
Cost per year	$198,975	$209,182	$205,258	$50,442	$52,855	$60,066	$62,479	$90,141	$92,554
Cost per workday	$724	$761	$746	$1,293	$1,355	$953	$992	$653	$671
Cost per day on mission tasks:									
Stand Alone unit	$1,034	$1,521	$1,493	$5,174	$5,421	$2,724	$2,834	$1,306	$1,341
Associate unit		$1,268	$1,244	$4,311	$4,518	$1,907	$1,984	$1,089	$1,118
Fully Integrated unit		$1,087	$1,066	$3,695	$3,872	$1,467	$1,526	$933	$958
Cost per 20 years ($M)	$4.0	$4.2	$4.1	$1.2	$1.2	$1.3	$1.4	$1.8	$1.9

Table 17. Enlisted Personnel Costs

	Full-time			TR		ER 63 Days		ER 180 Days	
	RegAF	**AGR**	**ART**	**ANG**	**AFR**	**ANG**	**AFR**	**ANF**	**AFR**
Annual Days of Service									
Obligation days	275	275	275	39	39	63	63	180	180
Workdays	275	275	275	39	39	63	63	138	138
Required days	275	275	275	39	39	39	39	39	39
MPA days						24	24	99	99
Annual Cost Components									
Annual pay:									
Composite pay per year	$65,526	$101,001	$98,737	$14,126	$17,027	$14,126	$17,027	$14,126	$17,027
MPA pay per year									
MPA days per year						24	24	99	99
MPA cost per day				$205	$205	$205	$205	$205	$205
MPA cost per year						$4,920	$4,920	20295	20295
Total pay per year	**$65,526**	**$101,001**	**$98,737**	**$14,126**	**$17,027**	**$19,046**	**$21,947**	**$34,421**	**$37,322**
Cyber Training and Certification	$11,000	$11,000	$11,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Security Clearances	$1,050	$1,050	$1,050	$750	$750	$750	$750	$750	$750
Pre-Medicare Retiree Health Costs	$18,704	$18,704	$18,704	$3,117	$3,117	$3,117	$3,117	$3,117	$3,117
Extra base facilities	$2,000								
Percentage of Time Spent on Mission Tasks									
Stand Alone unit	70%	50%	50%	25%	25%	35%	35%	50%	50%
Associate		60%	60%	30%	30%	50%	50%	60%	60%
Fully Integrated		70%	70%	35%	35%	65%	65%	70%	70%
Criteria									
Cost per year	$98,280	$131,755	$129,491	$22,993	$25,894	$27,913	$30,814	$43,288	$46,189
Cost per workday	$357	$479	$471	$590	$664	$443	$489	$314	$335
Cost per day on mission tasks:									
Stand Alone unit	$511	$958	$942	$2,358	$2,656	$1,266	$1,398	$627	$669
Associate unit		$799	$785	$1,965	$2,213	$886	$978	$523	$558
Fully Integrated unit		$684	$673	$1,685	$1,897	$682	$753	$448	$478
Cost per 20 years ($M)	$2.0	$2.6	$2.6	$0.5	$0.6	$0.6	$0.7	$0.9	$0.9

2) Cyber Training and Certification Costs

The Training and Certification costs in Table 16 and Table 17 are annualized figures from a recent BCA[17] covering:

1. Initial skills (residential training to attain an AFSC, or Air Force Specialty Code);
2. Skills progression (residential training to maintain or increase skill level); and
3. Periodic renewal of the special software, IA training, and certifications required for cyber workers.

The costs for enlisted personnel in Table 17 are much smaller than the average annual cost of $35,543 in FY 2011, which includes basic training and AFSC specialty training. ARC training costs (but not total costs to the government) are therefore reduced by recruiting trained cyber warriors from the RegAF and retaining them for long periods of time.

3) Cost of Security Clearances

The annualized cost of $1,050 is calculated from an initial $7,000 plus one five-year renewal of $3,500 during an assumed 10-year lifetime. These figures are from a recent Cyber BCA, which assumed that 70 percent of all cyber AFSC costs were for computer personnel (and the remainder for intelligence personnel).[18] Annualized costs are higher for RegAF personnel because their more frequent turnover leads to more initial payments per year per billet.

4) Pre-Medicare Retiree Health Costs

This allowance covers health care for retirees and dependents before they reach age 65, when they are covered by Medicare. The annual costs in the table are derived from recent Reserve Forces Policy Board estimates of total costs for 21 years for AC officers (and dependents), 24 years for AC enlisted personnel, and just four years for RC personnel who do not become eligible for retirement benefits until age 60.[19]

---

[17] Business Case Analysis, 24th Air Force, 624th Operations Center (AFSPC).

[18] Ibid.

[19] Col Robert Preiss, staff officer assigned to the Reserve Forces Policy Board, in draft briefing "Identifying 'Fully Burdened' and 'Life Cycle' Costs of Active & Reserve Component Personnel," May 30, 2012.

5) Cost of Extra Base Facilities for RegAF Personnel

We included $2,000 per year that was recently estimated by AF Financial Management personnel to cover several RegAF personnel costs that are not included in the Composite pay rates:[20]

1. Government-furnished quarters and mess charges for subsistence on military bases;
2. Morale, Welfare and Recreation (MWR) expenses for full-time and base resident personnel; and
3. Child day-care service.

While reservists often use mess halls when on duty, they are not normally provided with government quarters or base family housing. Unless these expenses are covered implicitly in reserve pay rates, the government would therefore save money by replacing RC with AC personnel, but further research would be needed to estimate the amount. We have ignored annual disability benefits paid by the Department of Veterans Affairs (VA) because of the lack of reliable data.

c. Percentage of Time Spent on Mission Tasks

As mentioned earlier, cyber personnel assigned to missions including CNA and CND spend most of their time on mission tasks, rather than training for wartime deployment. The percentages of time spent on mission tasks were estimated using information obtained in interviews with SMEs and cyber units. Those interviews reported that the percentage of time that units spent on mission tasks were generally higher for units with higher number of annual workdays and higher degrees of integration. Consider, for example, the ANG or AFR ER unit that works 63 days per year and is fully integrated. The 65 percent of time spent on mission tasks in Table 16 is consistent with the experience of the AFR 622nd Cyber unit assigned to Information Operations at Langley AFB. That unit works two or three weekends per month, is blended with RegAF personnel at the 83rd Network Operations Squadron (NOS), and reported that it averages 60 percent of total time on cyber mission operations. (The percentages are the same for officers and enlisted personnel.)

d. Four Cost Criteria and Graphical Analysis

The four cost criteria shown in Table 2 and listed at the bottom of Table 16 and Table 17 are calculated as follows:

1. **Cost per year** is the sum of the five annual cost components.
2. **Cost per workday** is total annual cost divided by total workdays.

---

[20] Secretary of AF FMCC data pulls and cost calculations provided to IDA, July 2012.

3. **Cost per day on mission tasks** is the total annual cost divided by the effective number of days spent on mission tasks, where the latter is found by multiplying total workdays by the percentage of time on workdays that is spent on mission tasks. For example, the cost per workday for ANG TR personnel in associate units is \$50,442/(39×30%) = \$4,311. As mentioned earlier, the cost per mission hour is not an appropriate criterion for the Combat Communications mission, whose principle peacetime mission is training for future wartime deployment rather than performing current cyber missions. One AFR Combat Communications unit we surveyed reported that it spends just 5 percent of its time providing cyber IO services when not deployed.
4. **Cost per 20 years** is 20 times the annual cost for full-time personnel (RegAF, AGR, and ATF). The 20-year cost for TRs and 63-day ERs assumes that they will serve for 16 years of peacetime and as 180-day ER personnel for 4 wartime years. For example, the 20-year cost for ANG TRs is:

$$(16\times\$50,442) + (4\times\$90,141) = \$1.2 \text{ million.}$$

Figure 1 through Figure 4 graph the four costs. As Figure 1 shows, full-time personnel—whether active or reserve—have virtually the same total cost, as expected. Part-time ANG and AFR personnel with the same service time (obligation or workdays) also cost almost the same, but with increasing costs for longer service. The costs rise, however, much less than in proportion to the service times. ANG ER 180 Day personnel serve approximately 4.6 times as long as ANG TR personnel (180/39), although their cost is only 1.8 times as much (\$90,576/\$51,431). The reason is that while all reservists receive the same Composite pay for the required 39 hours (approximately \$1,000 per day, including the extra pay for drill weekends), they receive only \$400 for MPA days (the days beyond the required days). The non-linearity is also illustrated by Figure 2, which indicates decreasing cost per workday with longer service times. (The graph does not distinguish between the figures for the ANG and AFR because, as Figure 4 shows, the costs depend almost completely on the service time.)

Figure 3 compares the costs per day spent on mission tasks as a function of both length of service and degree of integration. The costs fall substantially with rising degree of integration and service time. The 20-year costs in Figure 4 show the same behavior.

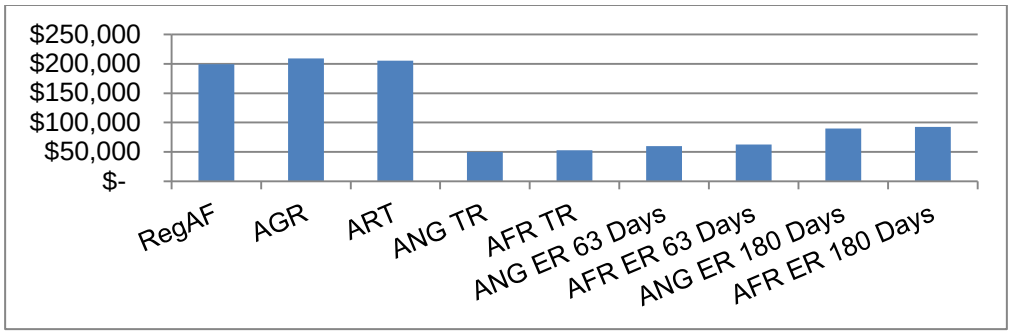

Figure 1. Total Cost per Year

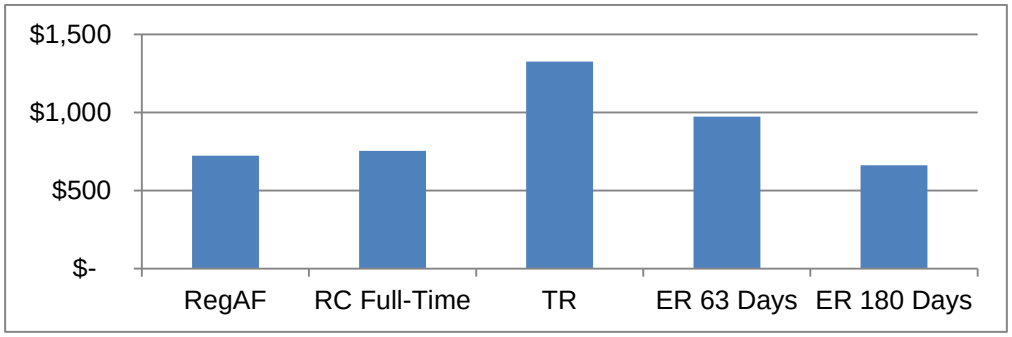

Figure 2. Cost per Workday

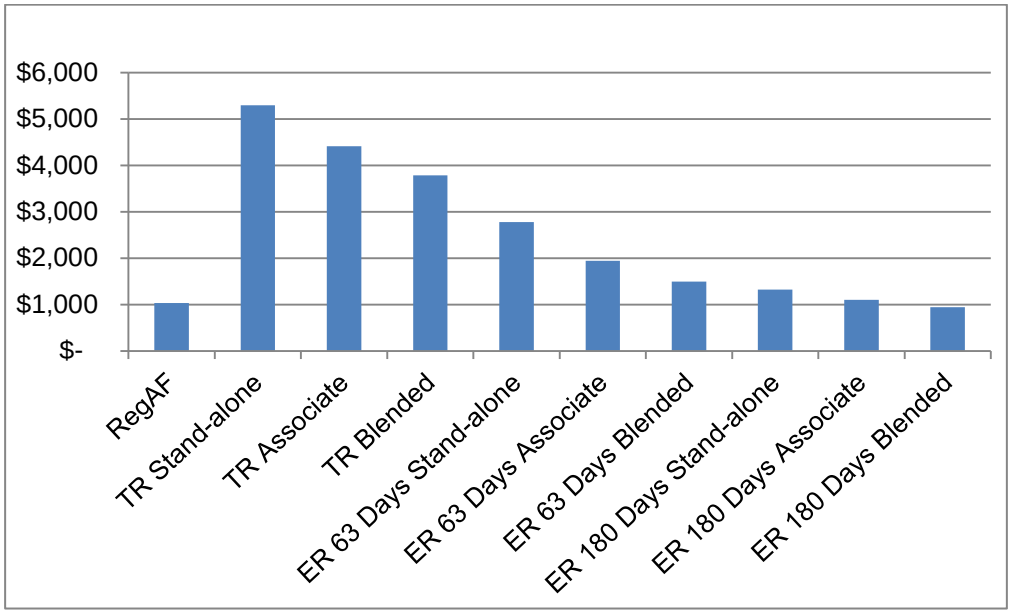

Figure 3. Cost per Day on Mission Tasks

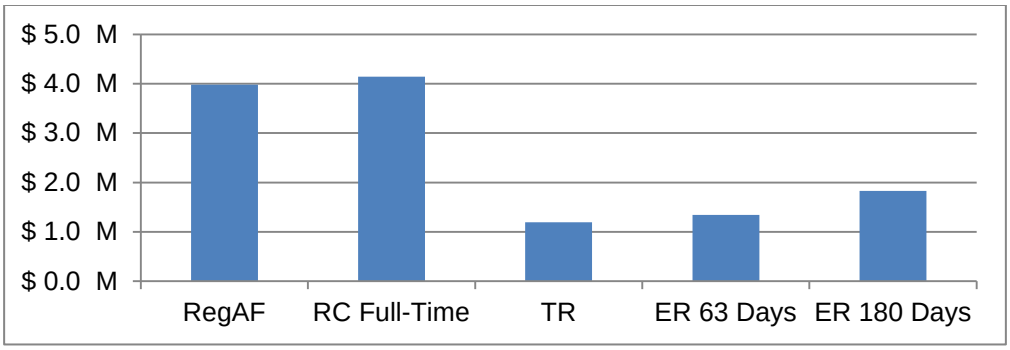

Figure 4. 20-Year Costs

4. Possible "Limiting Factors" on the Use of the Air Force Reserve Component

This section considers the constraints or "limiting factors" on the use of the RC that were mentioned in Table 2. They concern retention problems, the need to maintain the AC recruiting and training pipeline, government restrictions on the use of reserve funds for operational missions, the potential diminution of public support, and the possible negative impact on employers when reservists have to leave for service.

a. ARC Retention

Table 18 shows the value of retention as a function of manpower level expressed as a percentage of the FY 2011 baseline. Retention is an issue because of the possibility that pressing reservists for "voluntary" service for long periods of time might lead to significant attrition. Spending substantial parts of the year in two careers might be stressful, civilian employers might resent the disruption when the reservist leaves for long periods of military service, and some reservists would regret the longer time away from family. There is apparently no problem at present in the ARC. One of our surveys for this report found that for the peacetime cyber missions (i.e., other than Combat Communications), only 5 percent of reservists thought that they would need to deploy or serve long periods far from their home stations in the future to perform their missions. The percentage was 92 percent for Combat Communications.

Table 18. Retention

Compared with FY 2011 Baseline	Value
50% higher	10
25% higher	9
15% higher	8
10% higher	7
5% higher	6
Same	5
5% lower	4
10% lower	3
15% lower	2
25% lower	1
50% lower	0

The view of the SMEs who worked with the IDA research team was mixed. Some thought that ARC cyber warriors were generally eager for more work, while others thought that most cyber reservists would prefer the current TR status because of high civilian IT pay. ARC members themselves, however, were generally accepting of additional service. In a survey for the 2011 Quadrennial Review of Military Compensation (QRMC), reservists were asked how they would respond to a six-month tour of duty for the IO and Network Operations mission every three years in addition to the 39 days currently required. Their responses, shown in Table 19, indicated that 77 percent of ARC personnel would be willing, although 37 percent might do so grudgingly. A much larger 94 percent of reservists assigned to Combat Communications would be willing.[21] This might be due to the fact that many of these people might lack the higher paying IT skills, and have self-selected for Combat Communications despite (or *because* of) the greater likelihood of mobilization and deployment.

[21] IDA surveys and research supporting the QRMC, December 2010–February 2011.

Table 19. Results of IDA Cyber Unit Survey

Willingness to be mobilized for a 6-month tour of duty every 3 years, either at a home station or deployed		
	Information Operations and Network Operations	**Combat Communications**
Would be glad to do it	40%	72%
Would not like it, but would serve if asked	37%	22%
Will quit rather than have to serve this schedule frequently	23%	6%

Figures from a Defense Manpower Data Center (DMDC) survey, listed in Table 20 and graphed in Figure 5, indicate that Air Force reserves (ANG and USAFR) are more satisfied and likely to remain than the reserves of the other Services: a greater percentage of their personnel exhibit the positive features such as satisfaction and likelihood to remain, and a lower percentage of personnel exhibit the negative factors such as military stress. (The other four RC organizations are the Army National Guard (ARNG), US Army Reserve (USAR), US Navy Reserve (USNR), and US Marine Corp Reserve (USMCR.) This might be partly due to the policy of voluntary deployments for the ARC, versus frequent involuntary mobilizations as in the Army and Marines.[22]

[22] DMDC 2009 Status of Forces Survey, Leading Indicators Briefing, March 2010; Drew Miller, "Air Force Reserve Component (ARC) interest in serving as an operational reserve and contracting for more frequent deployments," Informal paper based on IDA QRMC work, Institute for Defense Analyses, July 2011.

Table 20. Reservists' Satisfaction with Work and Likelihood to Remain, Air Force vs. Other Services (Entries are percentages of personnel)

	Reserve Component Unit					
	ARC					
	ANG	AFR	ARNG	USAR	USNR	USMCR
Positive factors						
Like to stay	84	82	71	69	79	52
Family favorability of participation	84	82	77	72	78	71
Coworker favorability of participation	73	71	74	73	73	76
Spouse/significant other favorability of participation	80	76	68	65	70	58
Supervisor favorability of participation	69	68	66	62	66	70
Satisfied with military way of life	84	82	76	74	79	69
The type of work you do in your military job	86	81	76	72	74	68
The quality of your coworkers in your unit	77	77	67	66	74	70
The quality of your supervisor in your unit	72	73	68	66	74	67
Your total compensation	77	77	70	64	71	52
Your opportunities for promotion in your unit	55	55	45	59	59	50
Personally well prepared	84	82	78	73	75	78
Well prepared because of training	79	77	69	66	66	72
Unit well prepared	86	81	64	58	70	70
Negative factors						
Time away decreased desire to stay	5	6	11	9	7	11
More military stress than usual	29	30	32	31	29	28
More personal stress than usual	34	32	39	42	38	42

Source: DMDC 2009 Status of Forces Survey, Leading Indicators Briefing, March 2010.

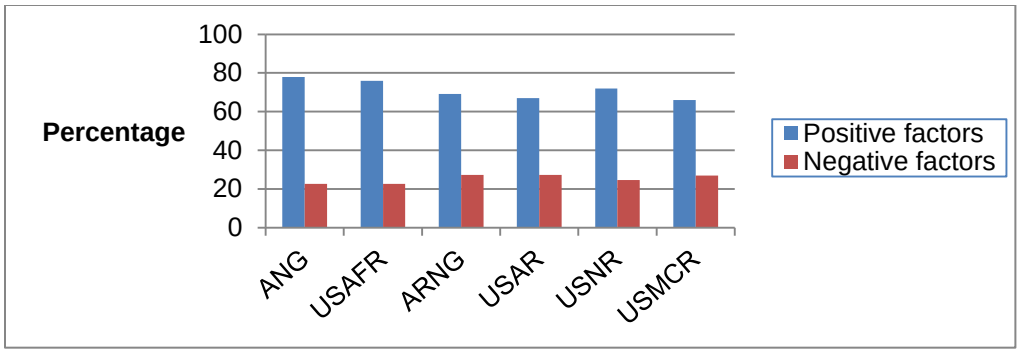

Figure 5. RC Work Satisfaction and Likelihood to Stay in Service

b. RegAF Recruiting and Training Pipeline

Table 21 shows the value scale for the health of the recruiting and training pipeline. An IDA survey indicated that there were no major constraints on the Air Force's ability to manage a voluntary cyber workforce for peacetime missions. The respondents did mention, however, that the Air Force might require additional manpower in RegAF units to maintain the recruiting, training, and support pipeline for active and reserve personnel. The RC provides a lot of overhead services in addition to mission tasks.

Table 21. Recruiting and Training Pipeline

Health of the Pipeline	Value
Vital	10
	9
Major Value	8
	7
Negligible Value	6
No Impact	5
Minor Harm	4
	3
Significant Harm	2
	1
Catastrophic Bad Impact	0

c. Government ANG Restrictions and Public Support

Table 22 describes the value assigned to the degree to which government restrictions and public support are favorable to the way the ANG is managed at present. Although many RC TR units try to perform cyber mission tasks during their drill weekends and annual tours, there is a potential problem in that legal restrictions require

that training funds be spent primarily on training. This is not normally a barrier, however, since there is general agreement that spending time on operational missions does provide good training. IDA interviews confirm that many ARC units regularly perform operational missions on drill and annual tour days because it accomplishes more useful work and provides good training.[23]

Table 22. Government Restrictions and Public Support

Acceptance of ANG		
Government Restrictions	**Public Support**	**Value**
Enthusiastic support		10
		9
Very supportive		8
		7
Pleased		6
Neutral		5
Concerns		4
	Widespread discontent	3
Restricts deployments		2
	Public Protests	1
Bans deployment		0

d. Employer Impact on Small Companies, Large Companies, and Small Government Offices

Table 23 describes the impact on civilian firms when their reserve employees are absent for 60 days per year or six months every three years. There are separate metrics for small companies, large companies, and small government offices.

[23] Some legal opinions and AF staff policies address this. Contact dmiller@ida.org if copies of these documents are desired.

Table 23. Employer Impact

Impact	Value
Very positive (savings in cost, improvements in operations)	10
Minor positive	9
No impact	8
Very minor (no loss in sales or revenues, minor disruptions)	7
	6
Major loss (3–5% loss in sales or increase in costs)	5
Very large loss (>5% loss in sales or increase in costs)	4
	3
	2
	1
Firm fails, out of business because of loss of key RC employees	0

D. Applying the DSS Model to the Computer Network Attack (CNA) Mission

Table 24 analyzes two cases in which a combination of RegAF, ANG TR, and ANG ER 63 Day personnel perform the CNA mission. This analysis illustrates applying this methodology to compare AC-RC force mix; it is not a complete analysis or recommendation. We think it is suggestive, not definitive. The two cases differ in both force composition and type of integration. Case 1 (the first three columns of data) involves current forces in stand-alone operation. Case 2 involves a reserve-heavy mix in a fully integrated, or blended, operation. The number of RegAF personnel falls from 2,000 to 1,000 and the number of ANG ER 63 Day personnel increases from 10 to 671 on active duty drawn from a pool of 3,500. A key assumption is that using 671 more experienced ARC cyber warriors, on long tours of duty, many with outside civilian cyber skills that adds to their capability, allows for replacement of 1,000 AC personnel who have less expertise, and improve the learning and ramp up speed for the 1,000 AC personnel still in the integrated unit, raising their capability. These two alternatives are roughly equal in cost and number of personnel for day-to-day peacetime operations, but Case 2 provides much more cyber manpower for surge operation. Using the scale we developed, the higher number of surge personnel scored 10 versus 5. Scales and scoring standards can and should be questioned and adjusted. All these assumptions and ratings need to be laid out explicitly in the DSS, with other analysts and organizations given an opportunity to challenge them and suggest different assessments for consideration.

The figures in the table are the values for the “basic” criteria: the low-level and those mid-level criteria that are not aggregated from low-level criteria. Colors indicate relative score. The red numbers next to the criteria are the weights.

Table 24. Case Comparison: The CNA Mission

Criteria				Case 1: Current Composition, Stand-Alone Operation			Case 2: Reserve-Heavy Composition, Blended Operation		
High-Level	Mid-Level		Low-Level	RegAF	ANG TR	ANG ER 63 Days	RegAF	ANG TR	ANG ER 63 Days
Capability 3	Quality 3		Workforce Experience 2	8	10	10	8	10	10
			SME Experience 1	7	9	10	7	9	10
			Currency 2	8	4	6	8	5	7
			Customer Quality Survey 1	5	5	5	5	5	5
	Integration & Civilian Skills 1			5	7	8	6	8	9
Quantity & Availability 3	Steady State 3		No. of FTE	*2,000*	*16*	*10*	*1,000*	*16*	*671*
			Value 1	5	5	5	5	5	5
	Strategic Depth 1		No. of Cyber Warriors	*2,000*	*150*	*50*	*1,000*	*150*	*3,500*
			Value 1	5	5	5	10	10	10
	Readiness & Response Time 0.5			7	5	6	7	5	6
Costs 3	Steady State Per Manday 2		Cost/Day ($)	*$724*	*$1,293*	*$953*	*$724*	*$1,293*	*$953*
			Value 1	5	0	1	5	0	1
	Steady State Per Hour of Mission Tasks 3		Cost/Hour ($)	*$129*	*$647*	*$341*	*$129*	*$462*	*$183*
			Value 1	5	0	1	5	0	1
	Strategic Surge Cost Per Manday 1		Cost/Day ($)	*$724*	*$584*	*$584*	*$724*	*$584*	*$584*
			Value 1	5	8	8	5	8	8
Limiting Factors 1	ARC Retention 3			5	5	5	5	5	5
	RegAF Train/Recruit Pipeline 3			5	5	5	5	5	5
	Gov't ANG Restrictions 0			7	7	7	7	7	7
	Public Support 1			6	6	6	6	6	6
	Employer Impact 1		Small Co. Key Empl. 1	5	5	5	5	5	5
			Large Co. 1	5	5	5	5	5	5
			Small Gov't 1	5	5	5	5	5	5

Note: "0-1" figures in red text are weights and "0-1" table entries (black text in red cells) are values.

The Aggregate Value for each of the six cyber units is calculated as described in Section B: weighted sums of the criteria values are calculated from the basic criteria to

the high-level criteria, and then across the high-level criteria to obtain the Aggregate Value. The results, shown in Table 24, indicate that Case 2—a reserve-heavy blended unit, has 9 percent higher Aggregate Value using the weightings and ratings shown. For roughly the same total cost, a blended unit with a higher percentage of RC personnel—and a large part of them serving longer tours of reserve duty—can provide better day-to-day operational capability due to transferring more of the civilian skills of the RC to the AC and getting more value out of the RC members serving in a more operationally integrated unit. This more reserve-heavy force also scores higher because of the larger total number of members available for strategic surge. Some measures, like customer quality survey, are left neutral because there was no data, and limiting factors were not assessed to be relevant in this case since this would likely be just one such reservist-heavy unit (at least at first), recruited from volunteers.

Table 25. Aggregate Values of Case Comparison

Type of Units	RegAF	ANG TR	ANG ER 63 Days	Average
Case 1: Current Composition, Stand-Alone Operation	5.6	4.5	5.1	5.1
Case 2: Reserve-Heavy Composition, Blended Operation Fewer RegAF personnel, More ARC personnel	6.0	5.0	5.5	5.5
Increase	7.3%	10.7%	9.6%	9.1%

In using this model, it is essential to lay out assumptions and ratings and encourage questioning of the results and presentation of differing points of view so decision-makers can see disagreements and decide what rating scores and weights to use. Oftentimes disagreement on a variety of scores and weights will still not change the option that rates highest. There will be many additional issues to factor in for particular cases of interest. For example, in this case, the administration, morale, and command and control issues of blended units would need to be considered.

E. Summary

This report has shown how the DSS can be used to help planners evaluate different active-reserve force mixes. The analysis is unique in many respects: it uses a fairly large number of evaluation criteria to account for the many differences between active and reserve units, including factors like currency and experience, where there may be substantial differences between AC and RC personnel. This approach also accounts for the extent to which RC personnel and cyber units can add value in performing day-to-day

mission tasks in peacetime, as opposed to just considering their peacetime training to be valuable work in wartime.

Some initial insights from applying the model in an illustrative analysis are that the Air Force might perform the CNA mission more cost-effectively by (a) attracting reservists to volunteer for service times beyond the current 39 days for monthly drill weekends and a two-week annual tour, and (b) integrating reserve and active units in blended operations where reservists work side-by-side with active personnel in mission work all their active time, not just when mobilized for duty after a crisis occurs.

This new methodology for comparing AC and RC forces, explicitly considering the relative costs and value of the operational employment of the RC in peacetime, should yield better decisions on the best force mix. It is a very flexible methodology that can be modified and applied to many other career fields and unit types in both the Air Force and other Services.

Appendix A.
Additional Material on Integration and Civilian Skills

This appendix supplements the information on Integration & Civilian Skills in the main body of the paper. It discusses the technical level of civilian cyber skills, their relevance to military cyber missions, and the operational benefits of applying those skills to the military cyber mission through integrating RC and AC units. The information was obtained from several sources: the research team; the group of SMEs who worked with the research team; interviews with other RegAF, guard, and reserve officers; and Business Case Analyses (BCAs) conducted by Air Force units.

Many part-time reservists with civilian jobs in private cyber firms have received advanced training in information technology through their graduate education and OJT. The careers of most RegAF officers do not include this training. Years of experience is an additional benefit. A recent BCA by the 33rd Network Warfare Squadron (NWS) reported that Air Force RC personnel average seven years of experience compared to three years for RegAF officers.[1]

There is evidence that the Air Force values this added training and experience. A BCA by the Air Force 624th Operations Center (OC) stated that cyber units staffed by only full-time RegAF personnel suffer a loss in capability because they do not tap the IT expertise and advanced experience of part-time reservists.[2] It promotes the idea of obtaining this expertise through integrating AC and RC personnel in blended units.

Part-time cyber reservists offer the Air Force another benefit, in that when units need skills not already in abundance, ARC personnel can easily acquire them through their contact with private firms. Even missions such as CNA, Cyber Command, and the National Security Agency benefit by substantial use of experts from universities, Federally Funded Research and Development Centers, and private companies.

Part-time reservists offer an attractive way for the Air Force to obtain personnel with advanced cyber training. Many people with advanced skills in information technology can command high salaries at private firms and are unwilling to accept

---

1 Business Case Analysis, "Total Force Integration – 33rd Network Warfare Squadron (NWS)," Lackland AFB, TX, 33rd Network Warfare Squadron, May 2011.

2 Business Case Analysis, 24th Air Force, 624th Operations Center (AFSPC).

employment as full-time reservists at government pay rates, but some are willing to serve as part-time reservists.

Integrating RC and AC cyber units is a way to better utilize the advanced training of part-time reservists. As discussed in the text, RegAF and reserve units can be more or less integrated. Stand-alone units operate independently, associate units involve some sharing of equipment and joint operations, and reserve personnel in fully integrated or blended units work side-by-side with active personnel on a regular basis. (The Individual Mobilization Augmentee program, where reservists work directly in AC organizations, is fully integrated.)

The benefits of integration depend on the mission. Stand-alone reserve tanker units, for example, all have full capability to conduct independent air refueling operations. Cyber missions, however, require closer personnel coordination, which increases the benefits of integration. Integrated units save money by allowing personnel to share equipment and other resources. Additionally, when the RC serves as a duty station for RegAF airmen who retire or need to leave full-time work for personal reasons, their expertise can be retained.[3]

Collocation in associate and blended units also gives highly trained part-time reservists a greater opportunity to pass those skills to AC personnel in current cyber operations in missions such as CNA and CND. An example of a blended operation is the ANG 273 IO Squadron, which works with the RegAF 23 Information Operations Squadron (IOS) and 346th Test Squadron in evaluating tests and tactics for the CNA and CND missions. The ANG unit has 23 percent full-time personnel (four AGR and four ART along with 40 Traditional Guardsmen) with seven years of experience on average. It provides the blended unit with long-term continuity while the RegAF partners maintain equipment and facilities, in addition to working with the reservists on cyber tasks. Another example is the Nebraska ANG that is fully integrated with the 55th Wing (RegAF) at Offutt AFB near Omaha, Nebraska. The Guardsmen run the training operation, where their experience and longevity are of particular benefit.

As shown in the main body of the paper, the higher the degree of integration, the more time personnel are able to spend in mission tasks, instead of education, training, and administration. Whereas personnel in stand-alone traditional reserve ARC cyber units spend 25 percent of their time on useful work, personnel in blended units spend up to 60 percent.

Integration is beneficial even for the Combat Communication mission in which personnel spend most of their time maintaining readiness and training for wartime

---

[3] Col. Drew Miller, USAFR, HQ USAF A8FX, Program Evaluation of Nebraska ANG Support to 55th Wing, October 2006.

deployment rather than peacetime day-to-day cyber tasks. An example is the 55th Combat Communications Squadron (CBCS) AFR which is co-located with RegAF Combat Communication units such as the 689th Combat Communications Wing (CCW) and 5th Combat Communications Group (CCG) at Robins AFB in Georgia. The 55th CBCS has deployed an average of 94 days annually over the past 5 years and spent just 5 percent of their non-deployed time on day-to-day cyber and IO operations. Nevertheless, they have helped to train and season less experienced RegAF personnel by virtue of their average of 12 years of experience in cyber Combat Communications. As a general matter, blended units provide much better training of the reserve and active personnel.[4]

Not all features of integration are positive, however. Although associate units were popular and their number was growing quickly a decade ago, their growth rate has slowed in recent years partly because of little willingness to move personnel and change budgets between the AC and RC.[5] Some blended units have also had problems. The 116th ACW was one of the first fully integrated wings. It was established in 2002 and operated the E-8C Joint Surveillance Target Attack Radar System with manning of 1,300 RegAF and 1,100 ANG. During 2003–2008, it maintained a high operating tempo, participated in continuous deployment related to the Global War On Terror, and won three Outstanding Unit awards for the most heavily mobilized unit in the ANG. It later separated, however, into an associate unit with separate RegAF and AC units sharing the aircraft, due largely to commander disagreements.[6]

Associate and blended units have suffered from several morale issues. ARC personnel lose their identity as reservists and, therefore, recognition for their work as reservists, when they serve, for example, with mixed crews on RegAF aircraft flying RegAF missions. And because the ARC has no flag officer billets, some senior officers resent being always subordinate to a RegAF commander without the opportunity to rotate into top leadership positions.

But a major finding of IDA's QRMC work is that blended units are appealing because ARC personnel and ANG leadership are eager for more work. The recent Comprehensive Review of the Reserve Component recommends blended units in Recommendation 10f: Increasing the level of integration of Active and Reserve forces into "blended units" to include ones that are predominantly filled from the Active Component as well as others that are predominantly filled by the Reserve Component.

---

4 BGen Donald A. Haught, Col Dennis Grunstad II, LtCol Eric "Otter" Mayheu, "Beyond "Two Aircraft in Theater," PowerPoint Briefing, 153rd Airlift Wing (ANG), 2010; Col Drew Miller, A8X, "Program Evaluation of Nebraska ANG Support to 55th Wing," October 2006.

5 IDA interviews.

6 IDA surveys/interviews.

Illustrations

Figures

Tables

Abbreviations

AC	Active Component
ACW	Air Control Wing
AF	Air Force
AFB	Air Force Base
AFCEA	Armed Forces Communications and Electronics Association
AFP	Air Force Portal
AFR	Air Force Reserve
AFRC	Air Force Reserve Command
AFSC	Air Force Specialty Code
AFSPC	Air Force Space Command
AFSPC	Air Force Space Command
AGR	Active, Guard, and Reserve
ANG	Air National Guard
ARC	Air Reserve Component
ARNG	Army National Guard
ART	Air Reserve Technician
BCA	Business Case Analysis
C2	Command and Control
CAC	Common Access Card
CAPE	Cost Assessment and Program Evaluation
CBCS	Combat Communications Squadron
CCG	Combat Communications Group
CCW	Combat Communications Wing
CNA	Computer Network Attack
CND	Computer Network Defense
COCOM	Combatant Command
CWS	Cyber Workforce Study
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DSS	Decision Support System
ER	Enhanced Reservist

FMCC	Force Movement Control Center
FTE	Full-Time Equivalent
GIG	Global Information Grid
IA	Information Assurance
IDA	Institute for Defense Analyses
IO	Information Operations
IOS	Information Operations Squadron
IT	Information Technology
MPA	Military Personnel Appropriation
MWR	Morale, Welfare, and Recreation
NetOps	Network Operations (computer networks)
NOS	Network Operations Squadron
NOSC	Network Operations and Security Center
NWS	Network Warfare Squadron
NWW	Network Warfare Wing
O&M	Operations and Maintenance
OC	Operations Center
OJT	On-the-Job Training
OSD	Office of the Secretary of Defense
PCS	Permanent Change of Station
QRMC	Quadrennial Review of Military Compensation
RAU	Reserve Associate Unit
RC	Reserve Component
RDT&E	Research, Development, Test & Evaluation
RegAF	Regular Air Force (Active Component)
SANS	SysAdmin, Audit, Networking, and Security
SME	Subject Matter Expert
TR	Traditional Reservist
US	United States
USAR	US Army Reserve
USMCR	US Marine Corp Reserve
USNR	US Navy Reserve
VA	Veterans Affairs

References

33rd Network Warfare Squadron, Lackland AFB, TX.

Air Force Audit Agency. "Implementing Combat Air Forces Total Force Integration." Audit Report. October 21, 2010.

Air Force Instruction 90-1001. "Total Force Integration." AF/A8X, May 29, 2007.

Albrecht, Mark J. "Labor Substitution in the Military Environment: Implications for Enlisted Force Management." R-2330-MRAL. Santa Monica, CA: RAND Corporation, 1979.

Assistant Secretary of Defense for Reserve Affairs. "Reserve Components of the Armed Forces." Revised September 2005.

Assistant Secretary of Defense for Reserve Affairs. "Managing the Reserve Components as an Operational Force." October 2008.

Ballenstedt, Brittany. "Building Cyber Warriors." *Government Executive*. Aug 15, 2011.

Buck, Jennifer. "The Cost of the Reserves." In *The New Guard and Reserve*, edited by John D. Winkler and Barbara A. Bicksler, Chapter 10. San Ramon, CA: Falcon Books, 2008.

Business Case Analysis. "Total Force Integration – 33rd Network Warfare Squadron (NWS)."

Business Case Analysis. "Total Force Integration, 24th Air Force, 624th Operations Center (AFSPC)/Reserve Associate Unit (RAU), Air Force Reserve Command, Lackland Air Force Base, Texas." Air Force Space Command A8. January 2011.

Chandler, Gen Carrol H., Vice Chief of Staff, USAF. "Readiness of the United States Air Force." Presentation to the Senate Armed Services Subcommittee on Readiness and Management Support. April 14, 2010.

Commission on the National Guard and Reserves. "Transforming the National Guard and Reserves into a 21st Century Operational Force." Final Report to Congress and the Secretary of Defense. January 31, 2008.

Currier, Maj Ralph, USAF. "Total Force Integration So Far." Air Command and Staff College report. April 2008.

Cyber Subject Matter Experts from the RegAF, ANG, AFR, retired AF personnel working in IT industry, IT industry and FFRDC experts familiar with DoD cyber workforce.

Dahlman, Carl J., Robert Kerchner, and David E.Thaler. *Setting Requirements for Maintenance Manpower in the U.S. Air Force*. MR-1436-AF. Santa Monica, CA: RAND Corporation, 2002.

Defense Science Board, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. "Defense Science Board Task Force on Human Resources Strategy." Report. 2000.

DMDC 2009 Status of Forces Survey. Leading Indicators Briefing. March 2010.

DoD Directive 8140.v36 (Draft), Cyber Workforce Management. January 2012.

DoD Directive Type Memo, Lifetime Personnel Costs, 09-007. Incorporating Change 3. September 3, 2011.

Everstine, Brian. "Air Guard Chief: Budget dispute damages retention; House, Senate panels side with Guard." *Air Force Times*. June 2012.

Fagan, Col Vince, HQ USAF. "Total Force Integration." PowerPoint Briefing. February 1, 2009.

Fontaine, Scott. "New USAF Cyber Unit Grapples with Data Overload." *Air Force Times*. November 15, 2010, 14.

Government Accountability Office. "Cybersecurity Human Capital Initiatives Need Better Planning and Coordination." November 2011.

Haught, BGen Donald A., Col Dennis Grunstad II, and LtCol Eric "Otter" Mayheu. "Beyond Two Aircraft in Theater." PowerPoint Briefing, 153rd Airlift Wing (ANG). 2010.

Haverstock, Col Cathy, SAF/MRR, Coordination Comments on DoD Reserve Component Roles and Missions Study Final Report. December 2010.

Hillestad, Richard and Paul K. Davis. *Resource Allocation for the New Defense Strategy: The DynaRank Decision-Support System*. Santa Monica, CA: RAND Corporation, 1998.

IBM, Ryan Farr, Brian Gwinner. Department of Defense Cybersecurity Workforce Study. On behalf of Defense Information Assurance Program Office, Mr. George Bieber. March 10, 2011.

Johnson, LtCol Bruce, A8XF. "The AC/RC Symbiotic Relationship: Ensuring the Viability and Sustainability of the Total Force" (Draft). January 25, 2012.

Joyner, Bo. Air Force Reserve Command. "Total Force Integration: Reserve and active duty join forces in the New Mexico desert to take on F-22 mission." May 18, 2010.

Lundy, Harry J., Air Combat Command Public Affairs. "Total Force Integration is key to current and future success." May 21, 2010.

Matwey, Benjamin. "Information Operations Unit Stood Up." *The DANG Truth*, Delaware ANG Newspaper. July 2005.

Mikkelson, LtCol Kathleen R., USAFR. "The Continuum of Service: Benefits, Obstacles and the Future." Report for Air War College. February 15, 2008.

Miles, Donna. "Official Urges Reserve Component Funding, Predictability." *American Forces Press Service*. May 12, 2010.

Miller, Col Drew, USAFR, HQ USAF A8FX. Program Evaluation of Nebraska ANG Support to 55th Wing, Oct 2006.

Miller, Drew. "Air Force Reserve Component (ARC) Interest in Serving as an Operational Reserve and Contracting for More Frequent Deployments." Informal Paper based on IDA QRMC work. Alexandria, VA: Institute for Defense Analyses, July 2011.

Miller, Jason. "Workforce is DoD's Biggest Cyber Challenge." September 24, 2010. Accessed December, 4, 2010. http://www.federalnewsradio.com/?nid=35&sid=2061303.

Mintzberg, Henry. *The Rise and Fall of Strategic Planning*. New York: Free Press, 1994.

Office of the Vice Chairman of the Joint Chiefs of Staff and Office of Assistant Secretary of Defense for Reserve Affairs. "Comprehensive Review of the Future Role of the Reserve Component, Volume I Executive Summary & Main Report." January 28, 2011.

Oliver, Steven A. Cost and Valuation of Air Force Aircraft Maintenance Personnel.

Preiss, Col Robert. "Identifying 'Fully Burdened' and 'Life Cycle' Costs of Active & Reserve Component Personnel." draft briefing. May 30, 2012.

Quade, E. S. and Wayne I. Boucher, eds. *Systems Analysis and Policy Planning: Applications in Defense*. Santa Monica, CA: RAND Corporation, 1968.

Quester, Brian. "Total Force Integration Summit in Wyoming Teaches Lessons Learned." Wyoming National Guard. May 12, 2010.

Lynn, William J., III. Remarks on Cyber at the RSA Conference, San Francisco, California, February 15, 2011.

Study. Maxwell AFB Gunter Annex, AL: Air Force Logistics Management Agency, August 2001.

Stultz, LTG Jack C., Chief, Army Reserve, and Commanding General. "Army Reserve 2020 Vision and Strategy." US Army Reserve Command. February 2, 2011.

Tan, Michelle. "Force Management is more than a numbers game." *Air Force Times*. October 23, 2010.

Truesdell, John C., Dep Asst Sec of Air Force for Reserve Affairs. "Changes Needed to Transform National Guard and Reserves to Sustainable Operational Force." Presentation to the Commission on the National Guard and Reserves, Washington DC, April 12, 2007.

U.S. Air Force Reserve Command. *USAF Reserve Handbook*. 2011.

Walker, David M. "Fiscal, Security, and Human Capital Challenges should be considered in Developing a Revised Business Model for the Reserve Component." Testimony before the Commission on the National Guard and Reserves. GAO-07-984. June 20, 2007.

Wooton, Col Kevin, CC 67th NWW. PowerPoint mission briefing presented at Armed Forces Communications and Electronics Association Cyber Conference. San Antonio, TX, January 2012.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
xx-09-2013	Final	

4. TITLE AND SUBTITLE

A New Approach to Force-Mix Analysis: A Comparison of Air Force Active and Reserve Forces Conducting Cyber Missions

5a. CONTRACT NUMBER

DASW01-04-C-0003

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Miller, Drew
Levine, Daniel, B.
Horowitz, Stanley, A.

5d. PROJECT NUMBER

5e. TASK NUMBER

BE-7-3306

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NUMBER

IDA Paper P-4986

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of the Assistant Secretary of Defense for Reserve Affairs
1500 Defense Pentagon, Room 2E592
Washington, DC 20301-1500

10. SPONSOR/MONITOR'S ACRONYM(S)

OASD/RA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This paper demonstrates a new approach to active-reserve force mix analysis, in which the alternatives are described by a variety of cost and performance criteria. It was developed to analyze staffing for Air Force cyber missions. Alternatives are quantitatively evaluated with respect to each of the criteria. The measures for the various criteria are translated into 0–10 values, which are then aggregated into a final value by a weighted sum using input weights of each criterion's relative importance. The procedure is illustrated by a comparison of different mixes of Air Force active and reserve personnel for performing the Computer Network Attack mission. While the illustrative research is not conclusive, it suggests that the Department of Defense might achieve greater overall value by encouraging reservists to volunteer for more than the normal 39 days (one weekend per month and a two-week tour per year) and integrating active and reserve units into "blended" units where all cyber warriors work side-by-side. These actions would (a) increase the reservists' currency (familiarity) with the fast-changing technology of modern peacetime cyber missions (where "reserves" no longer means "held in reserve" for wartime), (b) make greater use of the advanced education and training that many reservists acquire in their civilian occupations, and (c) lower RC hourly costs by adding in more workdays at less than drill pay rates and increasing percent of time performing useful work.

15. SUBJECT TERMS

cyber, force-mix, RC (Reserve Component), guard, reserve, reservist, multi-criterion methodology, fully integrated units, blended units, DSS (Decision Support System), CNA (Computer Network Attack), CND (Computer Network Defense), mission tasks, cyber security, workforce, CWS, Air Force

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Carson, Trey
Unclassified	Unclassified	Unclassified	Same as Report	53	19b. TELEPHONE NUMBER *(Include area code)* (703) 693-8115

Reset

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18