Our research on EAF support options uses an employment-driven analysis framework that identifies mission resource needs and adjusts mission goals and available resources to match each other. This approach is shown in Figure 2.1. The first step is to identify mission requirements or the force packages necessary to accomplish anticipated missions (i.e., the types and numbers of aircraft, weapons, and sortie rates needed). In this case, the information is used to estimate the demand for LANTIRN support capabilities, including the equipment, personnel, and other resources such as spare parts and transportation needed to provide these capabilities. These processes are shown in the left and middle portions of Figure 2.1. We then determine the costs of each alternative and evaluate whether they meet operational requirements.

Among variables we consider are recurring costs, deployment footprint, risks, and flexibility, as shown in the right portion of the figure. If the alternatives do not meet operational needs, then this framework can be used to revise operational objectives or to develop alternative support practices or technologies to overcome constraints. Supply system issues are not addressed in this study for two major reasons. First, we had no data to indicate which test equipment components drive particular mission-capable rate degradation. Second, because mission-capable rates were reported as a monthly average, it was difficult to ascertain how long the equipment was down as a result of lack of parts or other maintenance resources. Hence, we chose to model support equipment availability across a range of possible performance levels, as discussed later. The discussion ac-
companying Figure 3.4 in Chapter Three offers insights into the risks associated with having a single string fail at an FOL.

The alternative support structure designs are defined by peacetime and wartime locations of LANTIRN aircraft intermediate maintenance assets. These locations drive the quantities of four resources: intermediate test stands and fixtures, personnel, spare parts, and transportation assets. We extend this approach to assess multiple investment options and their effects on support equipment performance and hence resource requirements.

The LANTIRN analysis begins with employment-driven resource models to determine the minimum resource levels that enable each support structure to meet the selected scenarios. After determining
the resources and composition of each structure, we evaluate that structure against both peacetime and EAF operational goals. An example of these computations is given in Appendix A.

ELEMENTS OF LANTIRN ANALYSIS

Figure 2.2 shows the basic elements of our analysis model as applied to LANTIRN employment and support structures. We used computer models (described in Appendix A) to assess the requirements for test sets, personnel, and inventory. The loop on the left side of the chart describes the system demand. Given a specific employment program, we can predict LANTIRN maintenance needs in terms of the number of pods removed from the aircraft at the flight line for back-shop repair. We modeled removals to the back shop, not those to the repair shop at the flight line. Once removed, the pods must be transported to the back shop, which may be on base or off-site. In the shop, we modeled that the pods await repair (Queue)
for no more than 20 hours\(^1\) (our imposed constraint). This value was based on inputs from the Air Force working group supporting this study because there were no data available to quantify actual in-shop queue times. The in-shop repair times that we model are based on data from Mountain Home, Elmendorf, and Moody air bases and include Bench Check Serviceable times. They are based on the Elapsed Time Indicator clock times and include powered-off repair. After repair, the pods must be transported back to the flight line (Transport in the figure), by trailer for on-base repair, or by air or truck for consolidated repair. All these processes generate demands on the system that we can measure in terms of time.

The supply side of the model, shown on the right side of Figure 2.2, depicts three major elements of supply: test sets, personnel, and inventory. Wherever possible, these are measured in terms of time (e.g., hours that personnel and test sets are available). Personnel availability depends on work schedules, productivity rates, and logistics structures. Inventory is the number of pods or LRUs that are available. In each scenario, the goal was to always have demand less than or equal to supply. We determined stockage needs by using maximum daily removal rate estimates, including lead-time variability in computing safety stock levels. We determined the number of test sets needed by using nonlinear regression methods that link equipment availability to work schedules and test set locations (an example is given in Appendix A).\(^2\)

We determined personnel needs through industrial engineering manning methodologies. Pods are heavy and must be handled by two persons. Also, laser safety regulations dictate that at least two persons be present at a test station for repair. Thus, the base direct labor requirement is two persons for every pod or fraction of a pod

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\(^1\)We base this value on multiple shop visits and interviews with both shop personnel and the Air Force working group that supported this study (including five senior maintainers). Twenty hours is the typical wait time during peacetime operations. We evaluate queue length as an outcome of our models instead of a global system variable that should be optimized. Our goal in this analysis was to assess resource requirements to ensure a certain queue length rather than the number of resources required to minimize the queue.

that arrives at a shop. We augment this number based on predicted productivity rates. Military personnel typically perform many more tasks, such as training, briefings, and equipment repair, than those tasks that pertain to their formal assignment. Air Force policy documents indicate that military personnel typically have productivity levels of about 60 percent during peacetime and 90 percent during wartime. All told, these manning requirements and productivity levels mean that, during peacetime, a shop requires three (direct labor) persons per shift for every pod expected to arrive on a given day.

In addition to these direct manning requirements, we examine indirect labor needs in calculating total labor requirements. Indirect labor includes trainees, supply people, shift supervisors, and shop chiefs. Peacetime operations at shops with two eight-hour shifts must have one supervisor per shift and one shop chief per shop. During wartime, shops have two 12-hour shifts. Trainees and supply personnel requirements range from one-half person to two persons per test set, depending on the support equipment used and the employment scenario. Upgraded equipment was assumed to require fewer trainees and supply personnel during wartime, based on inputs from the Air Force working group and the support equipment supplier.

We also considered trends in attrition of skilled personnel. Personnel attrition will have many effects on the LANTIRN support system. If personnel skill levels decrease, fault isolation time—the time needed to isolate and identify a pod problem—will increase. This in turn will increase the number of persons required to support a given demand level. Eventually, this may require additional test sets to support the same demand level. Modeling this effect is quite complex, and predicting future skill levels is even more difficult, so we assessed manning requirements simply by using the range of expected productivity levels in peace and war. The potential effect of reduced skill levels is discussed in greater detail in Appendix B.

SCENARIOS FOR ANALYSIS

We consider an illustrative range of scenarios from peacetime operations with two deployed AEF units to two coincident MTWs to examine the robustness of LANTIRN support options. We use these scenarios to determine the costs and operational benefits of LANTIRN maintenance structures that satisfy operational requirements ranging from those posed by two coincident MTWs, one MTW, and small-scale AEF deployments in boiling peacetime operations. We found that resources satisfying a two-MTW “stressing” scenario (and the halt-phase scenario), or the immediate buildup and massive employment of forces after the start of a major theater war, will satisfy the demands of other less-demanding missions. We therefore designed the alternative structures and their resources to meet the requirements of missions for the stressing scenarios as an upper bound.

The most stressing scenario that we developed involved modeling two coincident major theater wars. In this scenario, the aircraft in the first MTW, e.g., surge for a few days and then are still flying at sustain rates, when the second MTW, e.g., Northeast Asia (NEA), would begin with aircraft flying at surge rates. Figure 2.3 shows how LANTIRN-capable aircraft would deploy for coincident MTW scenarios in SWA and NEA.

We consider three elements of each scenario. The first is the number of LANTIRN-capable aircraft deployed to each theater. The second is the type of aircraft deployed—in this case either F-15E or F-16 block 40/42. The third is the day on which each squadron or wing begins surge operations.

We do not model LANTIRN resources for all aircraft depicted in Figure 2.3. Figure 2.3 shows 144 F-16s to be employed in a second MTW in NEA, but we consider the resources needed for only 104 of these. The reason for this is that we assumed that the total number of F-16s using PGMs in two MTWs is greater than the number of LANTIRN F-16s currently in USAF inventory. The 144 F-16s that we show in the second MTW are therefore augmented in our model by 40 Air National Guard F-16s with LITENING II capabilities. All other aircraft shown in Figure 2.3 play a part in our model for resource computations.
Each scenario we consider has its own planned deployment and sortie-flying program, as depicted in Figure 2.4 for four scenarios: peacetime with AEF deployment, the two-MTW stressing and halt scenarios, and extended deployments. Each flying program has three similar elements. At the left-hand side of each graph, all aircraft start by flying peacetime sortie rates. A contingency, which can range from a boiling-peacetime operation to an MTW, requires aircraft deployment followed by a programmed employment profile. We use illustrative employment profiles for all aircraft that engage in combat operations consisting of a surge period followed by sustained operations. While some aircraft are engaged in one region (shown by a black solid line and dashed line), other aircraft remain at peacetime sortie rates (shown by a dotted line). As LANTIRN-capable aircraft deploy to regions one and two, the number of non-engaged aircraft drops—thus maintaining a constant total global inventory of LANTIRN-capable aircraft. All of the scenarios we examined have aircraft responding at surge rates to a contingency in a second region while aircraft in the first region fly at sustain rates. Finally, aircraft in both regions fly at sustain rates, with aircraft not in these regions (typically in CONUS) continuing at peacetime rates.
The number of aircraft deployed to each region, as well as the timing of their program for peacetime, surge, or sustain rates, varies by the scenario considered. The extended scenario may be more representative of current planning assumptions, whereas the “halt” and “stressing” scenarios were designed to analyze the effects of greater strains on the support system. In every scenario we included non-engaged aircraft to meet unit training requirements.

Our calculations for resource requirements focus on the peak sortie-generation period for each scenario within each region. The arrowheads shown on the stressing and halt scenarios indicate approximately when the most resources are needed. Our analysis found that the resource requirements for the stressing and halt scenarios are identical; they differ only by when they occur. We therefore show results for only three scenarios—peacetime with AEF deployment,
MTW halt phase, and MTW extended—when describing differences in resources needed by scenario. Furthermore, we focus primarily on only two scenarios—peacetime with AEF and the MTW halt phase.

In addition to our scenario assumptions, we have several other assumptions for our analysis. We base our models on likely scenarios in 2008 to allow time to modify the LANTIRN support structure, as necessary. We model MTW needs for wars occurring first in Southwest Asia and then in Northeast Asia. We model both the effects of no technological improvements to the pods and support equipment as well as those of several equipment-upgrade options. Although our initial data collection showed no indications that pods are failing more frequently, we assessed the sensitivities of our analysis to increased pod failure rates through a simulation based on wartime removal rates computed from the AWOS data. We also assumed no wartime attrition of aircraft, which would place the most stressing demand on the support system.

Finally, we modeled decelerated removal rates in wartime—rates reflecting lower predicted levels of pod removal per sortie. To model the wartime decelerated removal rates, we employed methodologies similar to those used in calculating readiness spares package (RSP) requirements for avionics. These are based on a study by the Logistics Management Institute (LMI) that implies pod failures depend more on the number of sorties than on the sortie length. Our assessment of AWOS data from Aviano and Lakenheath air bases indicates significantly higher pod removal rates during wartime flying conditions (see Appendix F). Thus, support equipment resources may need to be based on removal rates other than those developed from the LMI document. We highlight these implications here to show the risks the Air Force faces if it were to attempt supporting two coincident MTWs.

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INVESTMENT OPTIONS FOR FUTURE LANTIRN SUPPORT

Because we found no data showing pod performance to be declining, we focus on possible decreases in support equipment performance. We modeled three investment options that the Precision Attack System Program Office (SPO) is considering for support equipment upgrades. These improvements are intended to prolong the operability of the current test sets through replacement of obsolete components and subsystems. They are also designed to make LANTIRN support equipment more readily deployable.

First, we considered the case of no investment, for which we modeled support equipment (SE) availability or mission-capable rate (MC) based on projections of test set degradation over time. With no equipment upgrades, we estimated the single-string MC rate at three possible levels: 90 percent (for today’s single-string MC rate) and 80 and 70 percent to assess the implication of a 10 percent incremental degradation over the next 10 years. The last two MC rate values are not forecasted numbers but a range of possible outcomes to help assess support equipment MC rate sensitivity and its effect on our results (see Appendices B and F).

Second, we analyzed the Advanced Deployment Kit (ADK) investment option. This option would entail a modular upgrade to the existing LANTIRN Mobility Shelter Set (LMSS), which would also improve pod-level repair capabilities. We calculated that pod repair time may be reduced by at most 25 percent with the ADK investment, using equipment supplier specifications and prototype test data collected from the Tulsa Air National Guard. The ADK would also improve the reliability and deployability of the support equipment. With the ADK investment, we estimate MC rates could range between 100 and 60 percent. The deployment footprint, measured in pallets, would be reduced by more than 50 percent. Most important, deployment and in-theater setup time may be reduced from more than 10 days to less than three days (assuming there is no wait time for strategic airlift). The ADK upgrade is estimated to cost about $2M per set.

Third, we analyzed the effects a Mid-Life Upgrade (MLU) option would have when used with the ADK investment to improve LRU test capability and overall support equipment performance. Again, be-
cause forecasting performance is extremely difficult given the data available, we chose a possible MC rate range (like that for the ADK option) to assess output sensitivities. Furthermore, although we found that recurring cost differences are negligible, our results show the major differences between investment (ADK or MLU) and no investment. In both the ADK and MLU options, deployed repair capability is limited to pod-level work. LRU capabilities currently within the LMSS do not deploy with the units in these options.

Figure 2.5 shows the physical configuration of the current system and the proposed upgrades. The LMSS used to test and repair pods and some LRUs is shown on the left. It is a completely self-contained system and fairly large, requiring some 5000 square feet of operating space, as the human figure indicates.

The boxes in the middle of the upper right-hand image, taken inside an LMSS, are a prototype of the ADK upgraded electronic equipment. This upgrade would be retrofit into existing slots in the LMSS (shown in gray) but could be quickly removed for deployments. The electro-
optical test stand (EOTS/BRITE) system shown below the ADK is an integral part of the ADK upgrade and operates with the electronic equipment described. This subsystem, which replaces an existing system within the LMSS, would be part of the deployment package. In addition to all of the elements of the ADK upgrade, the MLU would replace many of the obsolete systems used to repair LRUs in the LMSS.