Availability Model: Scenario Analysis and Forecasting for Force Readiness

I.   Introduction

A ready force delivers the _right people_ to the _right place_ at the right time. While simple in concept, force readiness is the final product of a long and complex sequence of time-varying processes, systems, and constraints operating at the intersection of numerous strategic processes. Readiness depends critically on the synchronization of Operations, Force Structure, and Manpower Systems, including:

- _Force Structure Development Process_ to periodically update Tables of Organization and Authorizations by skill, grade, and unit based on warfighting requirements.
- _Inventory Management processes_ to align personnel to force structure through processes such as recruiting, training, retention, promotion, and assignments.
- _Resource Constraints_ such as budget allocation, end strength caps, and overhead accounts (e.g. T2P2, P2T2, or Individual Accounts).
- _A "build from within" structure_ comprising vacancy-based promotions with fixed skill-grade flows. Shaping the force requires significant lead time; no lateral acquisitions available to fill capability gaps.
- _Force Control policies_ to shape and maintain force health through retention targets, time-in-grade/service restrictions, promotion opportunities and timing, etc.
- _Human Resource policies_ to manage career development, health, welfare, pay, benefits, etc. of individuals and their families.
- _Force Allocation and Synchronization_ processes to manage operational requirements and allocate personnel to operational formations (e.g. ships, units, platforms, etc.), over time, based on global operational tempo.

While each of these components influence readiness, the final component is where these influences are felt most. Inefficiencies anywhere in this value chain manifests as _shortfalls in qualified people available to meet operational demands_. These shortfalls are most acute at high operating tempo, right when they are most harmful to the mission. They are difficult to detect, measure, and report and correcting them takes significant coordination and lead time. The combined effect is a reactive readiness posture that detects risk _only after_ gaps begin to emerge.   When these risks are identified, the system is slow to adapt and, when it does, requires short-sighted crisis management leading to uneven distribution of burden across the force. Deploying units cannibalize returning units; some individuals deploy continuously while others rarely or never deploy. The net result is misalignment in the short-term and tendency to "hollow the force" to adapt to these emergent needs.

In contrast, proactive force management, aided by advanced analytics, makes strategic, deliberate, risk-informed decisions about readiness. Stress on the force is identified early and mitigated; Force Structure planners analyze multiple scenarios to assess relative impact to mission, budgets, and readiness; Readiness Planners evaluate varying deployment profiles to more accurately assess feasibility; Manpower planners better understand how to position inventory to support operations; sourcing solutions become more accurate with improved tools and benefitting from a force employed within its means. Achieving these lofty goals requires a paradigm shift and new tools based on state-of-the-art analytics.

This paper addresses the *Availability Problem* as a critical step toward proactive force management. Included is a discussion of concepts and challenges along with how overcoming these challenges can drive improved readiness. This paper closes by framing a solution for the way ahead by identifying key users and use cases, identifying key design themes, and documenting capability requirements.

II.   The Availability Problem

Availability is defined as being fully able to meet an operational requirement, given a time window, special billet requirements, and all other manpower constraints. A servicemember is *available* when they are deployable, not in T2P2, not fenced for special billets, not in dwell, not deployed, and so on. A key element of *availability* is time. The question is not "are you available?". Instead, the question is "are you available for requirement X departing at time Y and returning at time Z?"

In this context, the Availability Problem can be summarized as:

Constant inventory churn and shifting operational demands challenge: 1) timely identification of the total force requirement as felt by the operating forces; 2) assessment of the likelihood and impact of overextending the force; and, 3) timely and effective sourcing solutions for task-organized formations. Combined, these challenges create continual risk of misallocation of manpower resources leading to increased risk to readiness, increased costs, or both.

III.   Challenges

The central concept and central challenge of addressing the Availability Problem resides in the interplay between time, personnel statuses, permanent structure, and operational structure. The graphic below provides a simple conceptual illustration of the essential layers of the problem.
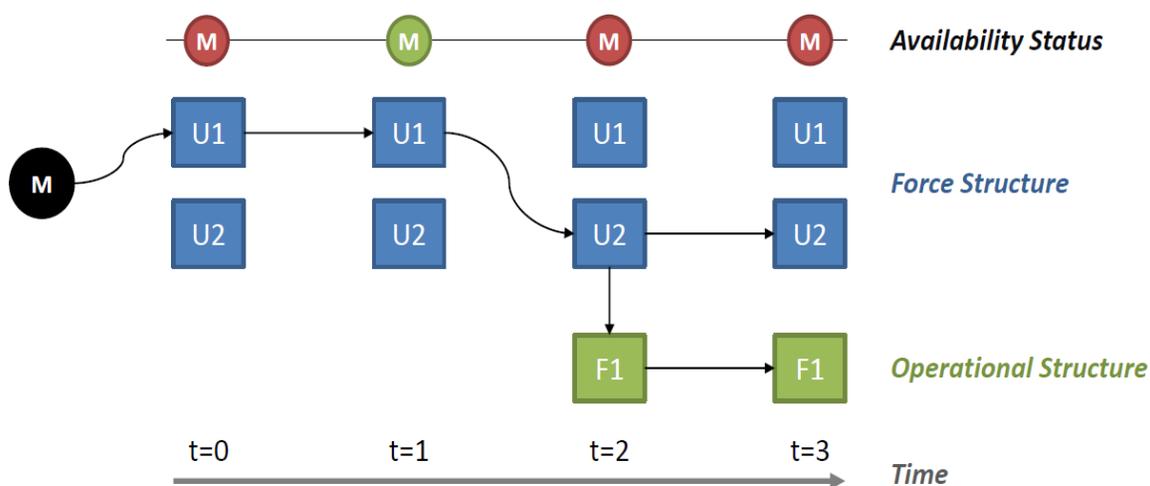
The first layer represents the individual's availability status independent of requirements. If red, servicemember M is not available at that time. The second layer is Force Structure represented by only two permanent units, U1 and U2. These are T/O units and M will be

assigned to one of these units at any given time. The third layer is Operational Structure represented by a single formation, F1. *Formation* is a generalized term to denote a deployed unit. Formations can be task-organized or may simply be a permanent unit that is deployed. The final layer is time, representing arbitrary time steps into the future.

The essential challenge here is how planners can determine from t=0 whether M can fill a requirement for F1 at t=2. Planners must know how M's availability status (represented by measures such as T2P2, dwell time, medical, legal, etc.) changes, which unit M will be assigned by then, qualifications of the billet at F1, and the duration of F1. The more accurately planners can track or estimate these factors, the closer they will be to projecting key readiness metrics and designing effective sourcing solutions.

While this simplistic example is straight forward, applying this at scale and to real-world operations presents significant challenges. The most prevalent of these is addressed in the paragraphs below.

Availability Status Projection. The status of individual servicemembers must be projected forward in time for comparison with requirements. An individual's availability status hinges on many factors, any of which could undermine accurate projection. Addressing these concerns requires complex orchestration of manpower data and, where data is lacking, advanced analytics techniques to help cover these gaps.

Dependent on Unit/Ship Assignments. Operational formations are usually sourced or adapted from existing structured units. Thus, projecting availability for a future requirement depends critically on unit assignments. Availability modeling must be tightly coupled with unit distribution plans and processes.

Changing Operational Requirements. Force deployments are affected by global contingencies and can change on short notice, making it difficult to plan for and position personnel resources to efficiently support.

Dependency on strategic-level manpower processes. As noted in the introduction, a manpower system is an enormously complex enterprise. Because readiness is the final product of that system, modeling availability requires comprehensive understanding of and tight coupling with that system. Any solution to the *Availability Problem* which is not synchronized with the larger manpower process will fail to produce meaningful results.

Data. As the figure shows, modeling availability requires aligning all data that drives the availability status of individuals, force structure, and operational structure. And, all this data must be arranged and synchronized over time while accounting for varying time cycles. For example, force structure is typically planned for bi-annual updates projected over multi-year programming and budgeting timelines. Operational structure is typically planned to update quarterly, changes often, and has a planning cycle usually less than 24 months. Manpower processes are varied operating over months, quarters, and years.

Data which reflects future personnel states greatly enhances capabilities to model availability. For example, when an individual is selected for promotion or has been assigned to a new unit, this information can be used to compare future states of individuals to future

states of requirements. Where this data is lacking, estimation techniques must be used to interpolate or estimate state changes.

Operationalizing manpower analysis requires relating unclassified personnel programming data with classified operational data. Linking such data can create complications and requires consideration for the classification levels of outputs.

IV.   Driving Improved Readiness

While the challenges are daunting, overcoming them will drive deeper readiness insight and significantly improve the quality of decision support around readiness challenges. Key impacts include:

Improved Force Utilization. Efficiently allocate personnel to units and deployed formations in a manner that balances permanent station requirements and known operational requirements. Account for and control both unit and individual dwell to distribute burden appropriately across the force. Results: Improved efficacy of on-hand inventory; distributing burdens sustains health of the force; understanding personnel utilization leads to more appropriate force employment, minimizing risk to readiness.

Improved Risk Analysis. Improved accounting of force utilization makes it possible to compare actual and planned force utilization to programmed T/O over time. This improves risk analysis in several ways. First, it enables improved gap analysis, identification of bill payer units (who is taking the brunt when the force is over extended?), and better insight on when to employ reserve units to cover gaps. Second, scenario analysis of utilization against operational demand improves impact assessments. This improves ability to accurately determine whether, and how, to support a given requirement. Improved estimates of supportability help ensure the force is employed within its mean granting numerous readiness benefits.

Improved Force Planning. Scenario analysis of varying force structure profiles against inventory disposition and anticipated operations supports improved force structure planning. Capture and analysis of operational utilization provides a strategic feedback loop which can be used to refine future force structure profiles.

Force Capacity Analysis. Quickly estimate carrying capacities of the force to determine number of concurrent operations which can be supported. This supports improved feasibility assessments, but can also assist in helping strategic planners tune force structure capacity to warfighting requirements.

Policy Analysis. Demonstrate the impact of various personnel and readiness policies on force utilization and their effects on sourcing solutions *before* risking those changes in the real world. For example: how would changing the deployment-to-dwell ratio change our ability to source personnel for operations? How does a 15-month deployment lock period reduce the operating capacity of the force?

V.   Framing the Solution

This section frames high-level requirements to meet the concepts and challenges raised in this paper.

User Stories

User	User Stories
As a Headquarters-level **Readiness Planner**, I want to be able to…	• Run scenarios against new operational requirements to assess difficulty of sourcing qualified and available personnel. • Assess the readiness impact of changes to Force Structure, Manpower, or Deployment Requirements. • Immediately identify gaps between programmed structure and utilization to inform risk assessments so I will know when accepting new requirements may overextend the force.
As an Operating Forces **Mobility Planner**, I want to be able to…	• Quickly locate available personnel who can meet current or future needs. • Make rapid, accurate risk assessments on inbound Requests for Forces (RFFs). • Rapidly assess sourcing gaps. • Develop technology-assisted sourcing solutions that will allow me to fix "knowns" and seek solutions for "unknowns". • Conduct scenario analysis between multiple sourcing solutions so I can find the best mix of solutions across a portfolio of operational requirements.
As a **Force Structure Planner**, I want to be able to…	• Immediately identify gaps between programmed structure and actual employment to plan for future requirements and assess my planning effectiveness. • Conduct scenario analysis on various force structure plans comparing with known and anticipated operational demands.
As a **Manpower Planner**, I want to be able to…	• Ensure risk and burden is distributed across the force. • Identify units that best fit operational requirements. • Improve unit distribution to support operations. • Improve Permanent Changes of Station (PCS) to support operations. • Analyze effects of manpower policies on force capacity and utilization. • Quickly identify bill payer units (units gapped due to operational needs) so I can develop mitigating strategies.

Key Design Themes

These are high-level concepts which should be used to guide solution development:

1. *Comprehensive Modeling Approach.* Because of the interdependencies among the many aspects of this problem, solution must be cognizant of all up-stream elements of the manpower process. This will require a framework which can absorb force structure,

operating structure, and manpower data and synchronize it over time, and replicate (or be informed by) all essential elements of the manpower system.

2. *Many Views.* Solution must support interrogation from perspectives of multiple users: Readiness/Operations Planners, Mobility Planners, Force Structure Planners, and Manpower Managers. Reporting modules must be tailored to needs of these different users and use cases.

3. *Time Varying.* Solution must be able to age the force and requirements to evaluate future alignment. Comparing future requirements to static force snapshots has minimal value.

4. *Human-in-the-Loop*. Must provide interactivity to work with known, fixed elements provided by users. For example, model should be able to recommend a full sourcing solution, but allow planners to override any aspect of the solution. When elements of the solution are fixed by the user, model should be able to work around fixed elements to estimate only remaining "unknowns". This process should be interactive to enable solution refinement through as many iterations as the user requires.

5. *Integrated Analytics*. To actuate the model, forecast, project future states, and perform other complex transformations the model must be based on an analytical framework and embed integrated analytical models tailored to these varying purposes.

Requirements

Develop a decision support model and analytical framework with the following capabilities:

1. Automated data pipelines to extract, integrate, and transform force structure, operational, and manpower data so they can be aligned over time.
   a. Dynamically and automatically acquire and transform historical data to suit probability-based modeling.
   b. Automatically extract and transform current state data as the starting point for aging the readiness system.

2. Implement digital representation of readiness system. Minimally:
   a. Personnel inventory to estimate future disposition with respect to occupation, rank, and unit assignment. These may be consumed as outputs of other planning models, if available, or replicated by the model.
   b. Force Structure to model permanent units/stations and all associated billets/positions over time. Requires inputs from force structure system.
   c. Operational Structure to model deployed formations and all associated billets, positions, or line numbers. Requires inputs from Global Force Management systems.

3. Implement capability to simulate future time steps to actuate changing states over time relating personnel inventory, force structure, and operational structure.
   a. Estimate and track state changes of all personnel statuses needed to construct a meaningful availability status. Requires service-level SME input.
   b. Track planned state changes of Force Structure.
   c. Track planned state changes of Operational Structure.
   d. Implement analytical capabilities to interpolate gaps in data or estimate values or parameters needed to make state changes.
   e. Ensure at least monthly time steps.

4. Design Business Intelligence and Reporting Views and Modules.
    a. *Personnel Availability* View to track all availability categories (e.g. T2P2, deployed, dep-dwell ratio, In Training, Training Support, Non-deployable (Medical), Non-deployable (Legal), Non-deployable (separating), and others as appropriate.
    b. *Unit Staffing* view to provide staffing and availability reports with measures of alignment, readiness, and operational requirements sourced or planned from each unit.
    c. *Deployment Allocation.* Allocate available personnel to deployed formations based on prioritized sourcing business rules including: skills/grade match (fuzzy match), clearance, availability status, or other specialized qualifications.
    d. *Sourcing Solutions.* Estimate sourcing solutions by providing all available matches for a given deployment billet. Must be sensitive to time of deployed requirement. Must allow user to fix known assignments.
    e. *Readiness Reporting.* Capture readiness metrics by unit, in aggregate, and over time. This includes standard fit-to-fill ratios and related readiness standards, but should add capability to view readiness with respect to planned sourcing solutions (and where they're mapped from), and how readiness changes over time given known sourcing solutions.
    f. *Force Operational Analysis.*
        • Provide capability to vary and test operational plans measuring different scenarios in terms of their impact on units, operations, sourcing, and force readiness.
        • Provide capability to compare and analyze, over time, the relationship between permanent structure, operational structure, and alignment of inventory to identify early risk signals or compare various force employment scenarios.

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