

## CAMOLAND Clothing and Textile Industrial Base Wargame Report

Charles Cartier, Catherine Lea, and Eugene Saad



## Abstract

In early 2023, The Defense Logistics Agency asked CNA to design and execute a wargame to explore the vulnerabilities, bottlenecks, and limitations of the clothing and textile defense industrial base and its ability to support wartime demand for clothing and textile items during concurrent contingencies. The game brought together members from government and industry to explore vulnerabilities and possible solutions to ensure that America's warfighters are equipped for the future fight. This report documents the design of the game, the associated model, and our analytic findings from the pre-event analysis, capstone, and post-event analysis.

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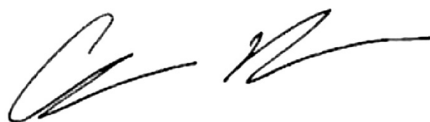
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**Approved by:**

**July 2024**



Dr. Christopher Ma  
Research Program Director  
Gaming and Integration

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# EXECUTIVE SUMMARY

The Defense Logistics Agency (DLA) Strategic Plans and Futures Directorate tasked CNA to examine the domestic clothing and textile (C&T) industrial base (IB) as part of its broader campaign of learning. In October 2023, CNA conducted the CAMOLAND wargame. The game allowed participants from government and industry to engage with and understand the challenges that the C&T IB faces during a full-scale mobilization of the US military. The wargame scenario explored overlapping contingency operations in the High North and the US Indo-Pacific Command (INDOPACOM) areas of responsibility. CNA designed the wargame to meet the following objectives:

- Identify constraints, bottlenecks, and limitations within the C&T supply chain
- Understand prioritization of material production and distribution
- Apply lessons learned from minor to moderate contingency events to large-scale conflicts
- Prioritize potential IB investments and modifications to Department of Defense (DOD) business operations

## Key insights

This wargame leveraged modeling, discussions with industry representatives, and other analytic techniques to understand how bottlenecks occur in supply chains, their implications, and mitigating options that the DLA and DOD can take. Key insights included the following:

- **Supply chains have a fundamental “speed limit” to ramping up.** Supply chain bottlenecks occur when a company runs out of staff, materials, or equipment, and production cannot increase further

until the bottleneck is addressed. Because material bottlenecks depend on companies upstream, the ramp-up time requires every company within the supply chain to ramp up (from upstream to downstream). Within the wargame, this resulted in the C&T IB being unable to meet new DLA demand for multiple turns during contingency operations. Furthermore, DLA’s stockpiles were unable to fully mitigate the wargame demand. **This would have resulted in military personnel lacking uniforms and the corresponding environmental or physical protection.**

- **In large-scale contingencies, everything becomes a bottleneck, and there is no “cure-all.”** The large-scale contingency operation explored within the wargame presented players with demands five to seven times greater than current-day orders. Industry representatives indicated that their supply chains are lean, implying that companies need to increase equipment, staff, and material orders. Within the wargame, industry players repeatedly stressed that solutions that helped one company type often did not make sense for another. **Policies supporting the IB must align with specific company needs.**
- **Delays between policy or planning and their implementation risk miscalculations.** In the wargame, government players stockpiled component parts to mitigate delinquencies. However, when the wargame pivoted from a cold- to hot-weather contingency, some of DLA’s stockpile of cold-weather components went unused. Meanwhile, stockpiled parts that could be

used across multiple uniform types could pivot to alternate products. This highlights the value of commonality in uniforms.

- **Downstream C&T supply chain vendors face a “tragedy of the commons” with their upstream providers in a large-scale contingency.** Producers upstream in the supply chain tended to be versatile (i.e., able to pivot materials to many different products). When DLA demand for all products ramped up simultaneously, companies upstream were overwhelmed with orders and had to make (often uninformed) choices about how to prioritize downstream companies. Upstream companies have little visibility on the operational importance of their products or capacity of companies downstream. In the game, this resulted with some companies starved of materials while others held excess.
- **Companies balance profit against labor stability.** Labor stability is crucial to the C&T IB, particularly for Tier 1 for-profit vendors. Volatility in labor is a cost to companies as they hire and train new staff. Industry players balanced hiring decisions against the possibility of future layoffs and did not “chase” DLA demand. Instead, industry ramped up to meet an average throughput to match DLA’s new order rate. This stopped cumulative delinquencies from increasing; however, cumulative delinquencies did not decrease until after the contingency ended. Post-conflict, players observed that the cumulative delinquencies could provide the C&T industry with a natural “soft landing” and mitigate layoffs associated with sharp drawdowns.

## Recommendations

### *Analyze the C&T supply chain and reduce known bottlenecks*

- **DLA Troop Support should perform analysis to understand industry ramp-up rates and where to apply limited resources in a surge.** This analysis should identify which companies can ramp up fastest (and slowest) in a contingency and the root causes. In the context of a ramp-up, some bottlenecks will be easier to address than others, and focus should be given to both resolving today’s bottlenecks and identifying factors that will become rate-limiting months into a conflict.
- **DLA should review current C&T stockpiles and consider identifying and stockpiling critical component parts.**<sup>1</sup> DLA’s current stockpiles for the items explored in the wargame were not sufficient to cover the delinquencies the IB accumulated as it ramped up to meet the hypothetical demand presented. However, the demand presented in this wargame, while informed, is not necessarily what DLA should target. Further analysis should comprehensively review DLA’s products and determine which items are priorities for a given contingency. Priority items should be compared against demands from multiple contingency plans to ensure a robust stockpile. For priority items without sufficient stockpiles, DLA should determine whether to stockpile the finished item or its critical components (if they represent potential bottlenecks) and consider factors

<sup>1</sup> When we refer to stockpiles in this report, we mean the acquisition and storage of excess products that DLA has purchased and maintains in third-party logistics warehouses or via vendor-managed inventory. These “stockpiles” are not associated with the Strategic Material stockpile.

such as shelf life and specific sizes. We recommend DLA focus first on single- and sole-source vendors.

- **DLA and the services should create mechanisms to communicate known and emergent priorities to the supply chain.** The government needs visibility when multiple items are competing for components or materials produced by the same vendor (with limited resources for production) and must have a process to prioritize items. DLA noted that although it tracks items for which there is competing demand, such as zippers or other single-source items, it does not currently have a way to deconflict these items within the current contract framework. This might be solved via contract modification to formalize an agreement to extend delivery times or reprioritize orders. Just as important, the government needs an internal process to determine which items from which services will be prioritized.
- **DLA and services can improve C&T IB supply chains by stabilizing current-day demand to reduce fluctuations and increasing commonality of uniform designs.** DLA indicated that its forecast of anticipated demand from the services is not always accurate, and services can change requirements. This in turn limits DLA's ability to provide stable long-term demands to the C&T IB. Industry representatives described challenges such as "cold" production lines (producing products in batches rather than continuously) and inefficiencies with modifying lines to meet different requirements from different services.

### *Create excess capacity in the C&T IB*

- **Consider investing in strategic excess to the domestic C&T IB.** The C&T IB is currently built to provide "just-in-time" logistics and therefore is unable to respond to shocks to the system. To mitigate this risk, DLA can make strategic investments to generate excesses that might benefit the C&T IB in the long term—for example, purchasing uniforms for the purpose of stockpiling them in forward prepositioned sites. DLA should study where vendors might benefit most from excesses and how much excess to provide. Moreover, DLA should study the viability of prepositioning uniforms and consider necessary storage conditions and restocking rates.
- **Consider adding strategic excess through Berry Amendment expansion.** The Berry Amendment fundamentally reflects the US government's policy decision to mitigate risks to the C&T IB from foreign supply chain disruptions in case of conflict. Whether the Berry Amendment is "good" policy or not was outside this project's scope. However, US policy-makers should be aware that wargame discussions from industry participants indicate that the C&T IB is weaker than in the past. While the information is anecdotal, players indicated that new companies are not entering the DOD C&T market; instead, companies are going out of business, and many companies have reduced commercial business or none at all and rely solely on DOD contracts.

Players discussed three ways that strengthening the Berry Amendment could make the C&T IB more robust. We recommend DLA conduct a cost-benefit analysis of each option and compare the benefits of excess capacity against any challenges with their implementation.

- 1. Strengthen Berry by expanding compliance beyond the DOD.** Currently, the Berry Amendment only covers uniform items purchased by the DOD. The Homeland Procurement Reform Act increases the requirement for the Department of Homeland Security to source uniforms and protective equipment from American manufacturers, but it also allows for items to be purchased from Canada and Mexico via trilateral trade agreements. If the Berry Amendment were expanded to include uniforms for other federal agencies, it would increase opportunities for the domestic C&T IB and would likely increase the production capacity of some current vendors. More importantly, however, expanding Berry beyond the DOD would allow vendors to shift away from non-DOD production lines in the event of a crisis.
- 2. Strengthen cost threshold requirements for Berry-compliant end-items.** Currently, the Berry amendment provides an exception for purchases at or below \$150,000. However, industry participants indicated that military exchanges circumvent this by placing many small orders below this threshold, which in aggregate exceed this threshold. Strengthening this requirement might be accomplished by lowering the cost threshold or conducting audits for compliance to incentivize the purchase of Berry-compliant over non-Berry-compliant products.

- 3. Require military exchange uniform shops to sell only Berry-compliant uniform items.** The Army and Air Force Exchange Service (AAFES) stocks some combat boots manufactured overseas. Requiring that military exchanges stock only Berry-compliant uniform items in their uniform shops increases the likelihood that servicemembers will purchase Berry-compliant uniform items. While this issue is currently limited to boots sold at AAFES exchanges, it creates the opportunity for additional non-Berry-compliant uniform items to be sold in military exchanges globally.

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# INTRODUCTION

The Defense Logistics Agency (DLA) Strategic Plans and Futures Directorate requested that CNA design and facilitate a wargame exploring the effect a full mobilization of US military forces would have on the capacity, resilience, and responsiveness of the clothing and textile (C&T) industrial base (IB) and supply chain. The C&T IB is responsible for manufacturing all US military uniforms and uniform components, including footwear, headwear, and gloves. DLA intended for the wargame to identify the vulnerabilities, bottlenecks, and limitations of the C&T IB. DLA identified the following objectives for the wargame:

- Identify constraints, bottlenecks, and limitations within the supply chain
- Understand prioritization of material production and distribution
- Apply lessons learned from minor to moderate contingency events to potential large-scale conflicts
- Prioritize potential IB investments in and modifications to Department of Defense (DOD) business operations

To prepare for the wargame, CNA worked with the DLA Analytic Center of Excellence (ACE) to develop a model that could run during the wargame and provide the agency with additional insights. The model highlighted the effects of participants' decisions on the following:

- Baseline of DLA demand for identified uniforms and boots
- Model-created "optimal" production to meet DLA demand

The model created a visualization of player decisions over time that shed light on how C&T IB partners may prioritize their decisions during a large-scale crisis.

## Wargame scope

To achieve its objectives, DLA defined the scope of the wargame as follows:

### *Timescale*

The wargame scenario covered six years (2024 to 2029) and included two separate contingencies, both of which involved preparation time and post-contingency drawdown.

### *Wargame scenario*

Within the wargame timescale, DLA asked the CNA team to include two geographically separate large-scale contingencies. The first contingency was the smaller of the two and lasted for less than a year, including deployment preparations and redeployment. This scenario occurred in northern Scandinavia, thus requiring the seven-layer extreme cold weather clothing system (ECWCS) for approximately 100,000 deploying servicemembers.

Preparations for the second contingency began three years into gameplay during redeployment from the first event. The second scenario was a large-scale contingency operation (LSCO) that required mobilization of active, reserve, and guard components, plus a force expansion, although not necessarily a draft. In this scenario, two million Americans were in uniform and required combat uniforms for deployment to temperate and tropical weather environments.

## Uniform items included in the wargame

Military uniforms range from dress and utility uniforms to protective gear. A single wargame cannot address all uniform items that DLA procures, therefore DLA asked CNA to focus on uniforms specific to the combat scenarios—namely, the ECWCS, combat utility uniforms, boots, coveralls, and special-purpose flame-resistant uniforms used by air crews.

CNA asked participants to discuss uniform manufacturing in each of the mentioned categories, but the wargame mechanics that we developed shortened the list of uniform items to combat uniforms, fire-resistant (FR) uniforms, and cold-weather (CW) gear. We used this shorter list to model the uniform manufacturing process consistently across the wargame timeframe.

## The Berry Amendment

The Berry Amendment was enacted in 1941 as part of the Fifth Supplemental National Defense Appropriations Act, which mandates that DOD-purchased clothing and textiles be sourced and manufactured in their entirety in the United States from US origin materials.<sup>2</sup> As such, it has effectively become governing legislation for the domestic C&T IB. Most civilian clothing sold in the United States is manufactured abroad, therefore military uniform manufacturing is among the only remaining US C&T production. The Berry Amendment serves multiple purposes, including protecting the domestic C&T IB to ensure domestic supply in times of national emergency and reducing reliance on foreign suppliers.

The Berry Amendment was codified by the National Defense Appropriations Act for fiscal year (FY)

2002.<sup>3</sup> Under Berry Amendment regulations, not only finished uniforms but also all components and the raw materials used to make those components must be of US origin. Because the domestic C&T industry has contracted and moved overseas since Berry Amendment adoption, fewer US businesses manufacture finished uniforms and their components. As a result, many uniform components are produced domestically by only a single manufacturer. The remaining C&T vendors that produce military uniforms are protected by the Berry Amendment, and they have become more dependent on DOD contracts to stay in business.<sup>4</sup>

As a result of the US domestic C&T industry shrinking during the latter half of the 20th century, remaining C&T vendors have become highly dependent on DOD contracts to stay in business.<sup>5</sup> Moreover, many Berry-compliant uniform component (e.g., zippers, snaps, thread) manufacturers are now the single source for those components in the US. Although uniform manufacturers, as opposed to the government, manage this part of the supply chain, the limited availability of uniform components increases the timelines necessary to manufacture uniforms.

## Outline of this report

This report contains four sections. The first provides an explanation of the wargame design choices we made to meet DLA's stated objectives. The second reconstructs gameplay with a focus on the decisions players made during each turn. The third analyzes wargame inputs and results to gain additional insights into DLA objectives. The fourth contains our insights and recommendations based on our analysis of gameplay and game data.

<sup>2</sup> Michaela D. Platzer, *Defense Primer: The Berry and Kissell Amendments*, Congressional Research Service, 2020, <https://crsreports.congress.gov/product/pdf/IF/IF10609/5>.

<sup>3</sup> Platzer, *Defense Primer: The Berry and Kissell Amendments*.

<sup>4</sup> Nanjiba Nur, "History of the American Textile Industry," *Textile Focus*, Aug. 11, 2022, <https://textilefocus.com/history-of-the-american-textile-industry/>.

<sup>5</sup> Platzer, *Defense Primer: The Berry and Kissell Amendments*.

## Scoping and assumptions

DLA requested a wargame with the following scoping constraints:

- Timescale: spanning six years (2024 to 2030), including pre- and post-contingency.
- C&T requirements: DLA requested that the wargame focus on C&T national item identification numbers (NIINs) associated with CW gear, combat uniforms, boots, coveralls, and special-purpose items (flame-resistant uniforms).
  - Based on the backgrounds of attending players and time constraints, we developed supply chain engine mechanics only for combat uniforms, FR uniforms, and CW gear.
- Contingency requirements:
  - As required by the LSCO, either a full or total mobilization of active, reserve, and guard components, comparable to a congressional declaration of national emergency.
  - A small-scale (short duration and comparatively small force) contingency operation.

As CNA designed the wargame's supply chain engine, we made further assumptions detailed in Appendix A: Supply Chain Engine Assumptions. These assumptions are based on realities of the chains and six different subject matter expert (SME) discussions that CNA held with representatives from the defense IB.<sup>6</sup>

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<sup>6</sup> CNA, discussion with representatives from Belleville Boot Company, Vibram Corporation, and the Warrior Protection and Readiness Coalition, July 18, 2023; CNA, discussion with Stephen Lamar, American Apparel & Footwear Association Government Contracts Committee (AAFA GCC), Aug. 10, 2023; CNA, discussion with Bill Ells, Vibram Corporation, and Mark Ferguson, Belleville Boot Company, Aug. 22, 2023. CNA, discussion with Brett Ayers, AAFA, Sept. 6, 2023; CNA, interview with Justin Hayes and W. L. Gore, Sept. 21, 2023; CNA, discussion with Jeffrey Niethammer, Cheryl Wright, and Humberto Zacapa, Sept. 12, 2023.

# WARGAME DESIGN

From October 16 to 20, 2023, 41 participants from the government and industry attended the wargame. Government participants included DLA Troop Support; DLA Logistics Operations; DLA Acquisition; Program Executive Office for Special Operations Forces Warrior; Project Manager Soldier Survivability; Personnel Support Center-Military Uniforms; Army Combat Capabilities Development Command; Office of the Under Secretary of Defense for Acquisition & Sustainment, and Office of the Assistant Secretary of Defense for Industrial Base Policy; and Industrial Base Resilience, Air Force Life Cycle Management Center. Service representatives included US Coast Guard-44, US Air Force, US Marine Corps (USMC) Systems Command, and US Navy Naval Supply Systems Command. The 17 industry representatives came from 11 companies representing Tier 1 and Tier 2 organizations (both for-profit and nonprofit) producing CW gear, boots, special-purpose items, and uniforms, and representing organizations such as the American Apparel & Footwear Association, the National Industries for the Blind, Federal Prison Industries (FPI), and the National Council of Textile Organizations.

During CNA's pregame research, we determined that DLA's learning demands for CAMOLAND covered distinct topic areas, and each required distinct mechanics to explore. For example, bottlenecks can be represented fundamentally as a limited flow of materials, and both government and industry can take a variety of potential mitigation actions to address these. But understanding where a specific real-world bottleneck is for an item or company and developing a tailored response to address that challenge requires discussion with that specific company and a performance analysis (e.g., supply chain models) on the datasets specific to those items.

Therefore, the wargame leveraged the following five components to get a wide-ranging understanding of the issues facing the C&T IB:

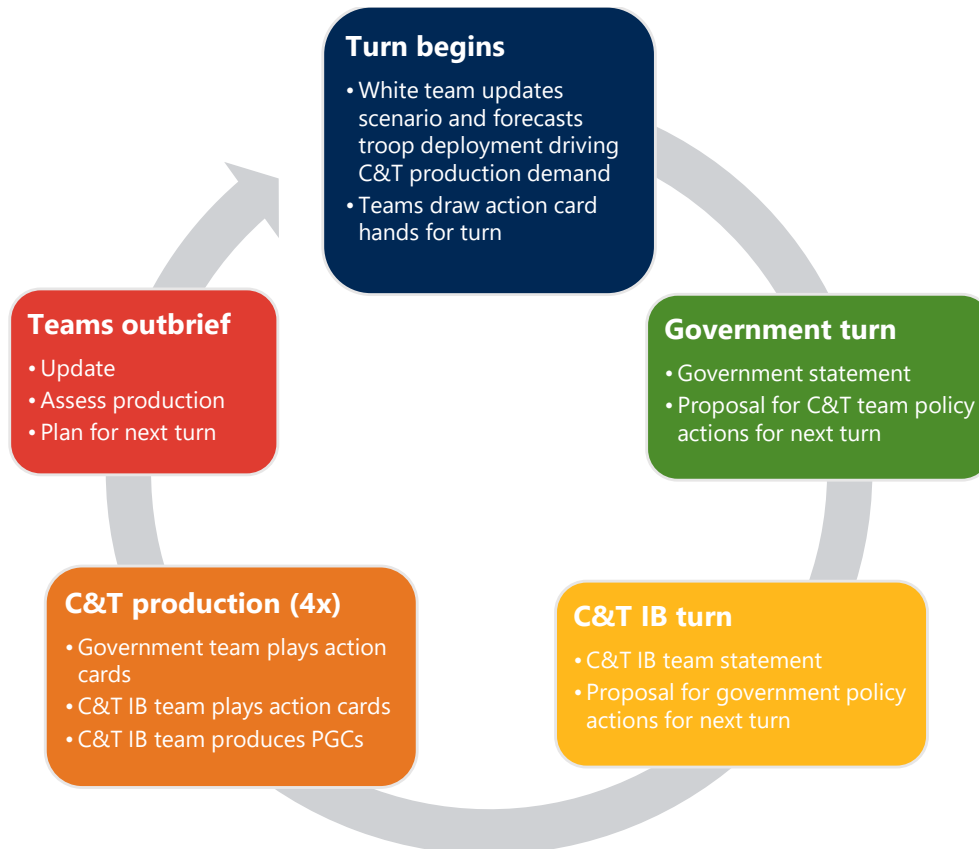
- Tailored scenarios: each scenario (and turn) was designed to explore a qualitatively different situation within the abstracted wargame supply chain. Specifically, we explored ramp-ups, ramp-downs, and steady-state operations for short- and long-term contingencies based on the best data available to us.
- Action cards: these cards represented the various levers (e.g., policy, investments, business decisions) that government and industry players might use to mitigate fundamental challenges to fluctuations in demand.
- Supply chain engine: industry representatives were asked to role-play themselves in a simplified supply chain. Although this simplified supply chain abstracted many of the complexities and nuances of specific items, it forced players to confront fundamental challenges within all supply chains.
- Government-industry breakout sessions: to better understand specific challenges within the C&T IB, subgroups of industry representatives met with government players for facilitated discussions.
- Supply chain model: as the wargame progressed, ACE modelers received data from CNA data collectors representing player decisions. The modelers were able to compare player performance against "optimal play" and provide insights on

alternative policies that players considered but ultimately did not have time to explore in the wargame or that the wargame mechanics were unable to address. This component was largely invisible to participants during the wargame and will be addressed in more detail in the analysis section.

These components were incorporated into the turn structure illustrated in Figure 1. At the start of the turn (top blue box), the White team (game control) introduced or updated the scenario and provided anticipated troop deployments that drove the C&T production demand. At the end of this stage, teams drew action cards for the upcoming turn. The action cards were played over the next two boxes (green

and yellow). Action cards represented potential policies, resource allocations, negotiations, or other activities the government and IB players might take in response to the scenario. The government and IB teams each provided a statement explaining their strategy and focus for addressing the scenario and presented the action cards under consideration for the upcoming turn (government presented seven and IB presented five). Each team also lobbied the other for specific actions that they believed would help support their efforts. The discussion over action cards ended with a subset of action cards from the government (two) and IB (three) played and adjudicated for the upcoming supply chain run (orange box).

Figure 1. CAMOLAND turn structure



Source: CNA.

With policy and other action cards in place, IB players used the supply chain engine to produce the procurement group categories (PGCs) demanded by the scenario. The target was four rounds (representing four quarters or one year of play) during game execution, but three rounds per turn was more typical. Concurrent to IB players running the supply chain engine, the government facilitated a breakout discussion with a subset of the IB players (not shown in figure). After the production phase completed, the supply chain engine facilitator held a mini hotwash of the turn, gaining additional feedback from the participants. The facilitator and IB team outbriefed an overview of key decisions and challenges in the supply chain engine to the government team.

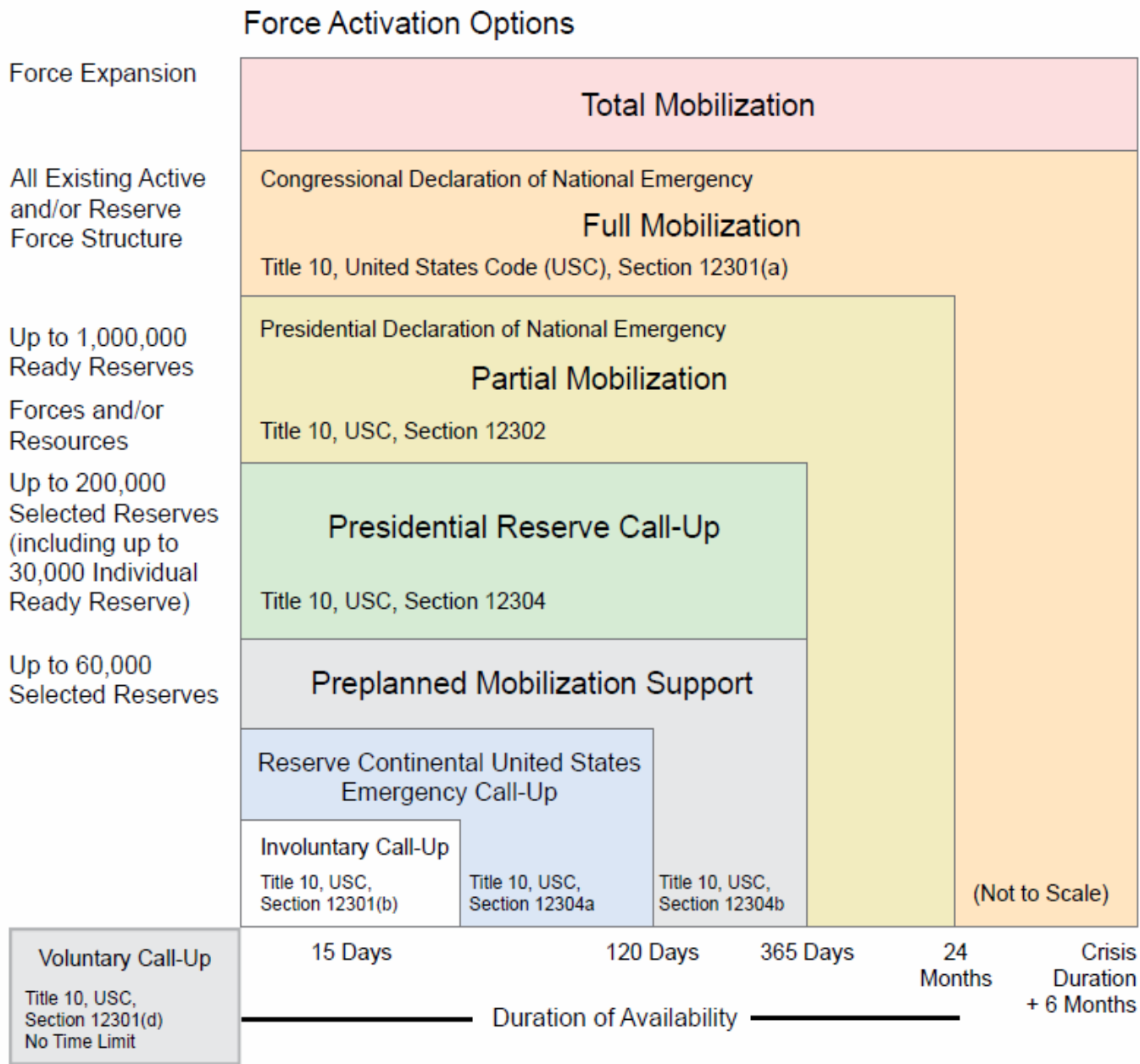
### Tailored scenarios

DLA requested that this wargame explore how the C&T IB might respond to both a smaller scale CW contingency and an LSCO in a warm-weather climate in the Pacific. Understanding what the C&T demand looks like in the context of an LSCO is not straightforward. This demand is tied to the number of reservists that are called up, which requires knowing the type of reservists (broken out by service), the inventory of reservists available, and the percent of that inventory that is available for mobilization, and accounting for policy (directives, codes, laws, etc.) related to establishing a draft. Once the total numbers available are decided, the phasing (mobilization over time) can then be decided (to

produce an instantaneous demand). Once these are determined, one can scale the C&T demand based on specific products for the demand required to deploy. Finally, additional assumptions are required to replace C&T products caused by wear and tear and to account for changing demands caused by wartime casualties.

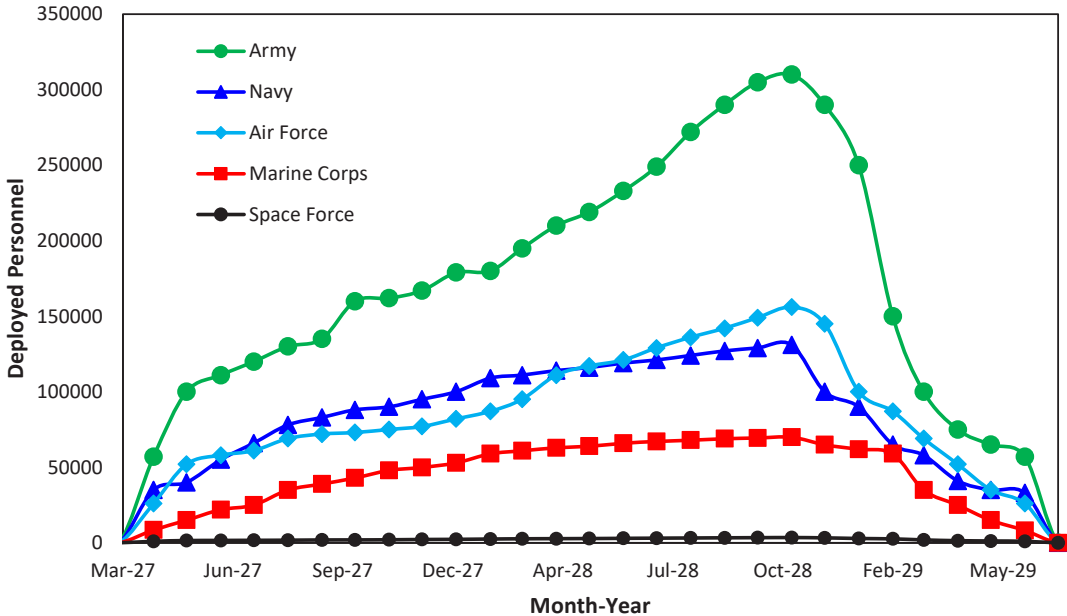
DLA requested that the wargame explore scenarios beyond partial mobilization (e.g., full or total mobilization), described in Figure 2. Full mobilization involves leveraging all existing active and reserve force structure. Both full mobilization and total mobilization are not well defined, to our knowledge, for current-day operations. Reference points are available for the potential number of personnel that were called up during the Vietnam War and World War I in Appendix C: Reserve and Draft Call-up, as well as current eligible males in the selective service based on recent US Census information. Using these numbers as references, we developed a total active force peaking at around 2 million personnel called up by month 18 of an LSCO, with an aggressive forward-force posture totaling 670,000 personnel forward deployed (following a one-third deploying, one-third training, and one-third returning rotation schedule). We took a similar approach for a relatively moderate contingency operation, assuming a peak mobilization of 300,000 personnel (with one-third deployed forward). Figure 3 and Figure 4 show these demands broken down by service.

Figure 2. Levels of mobilization



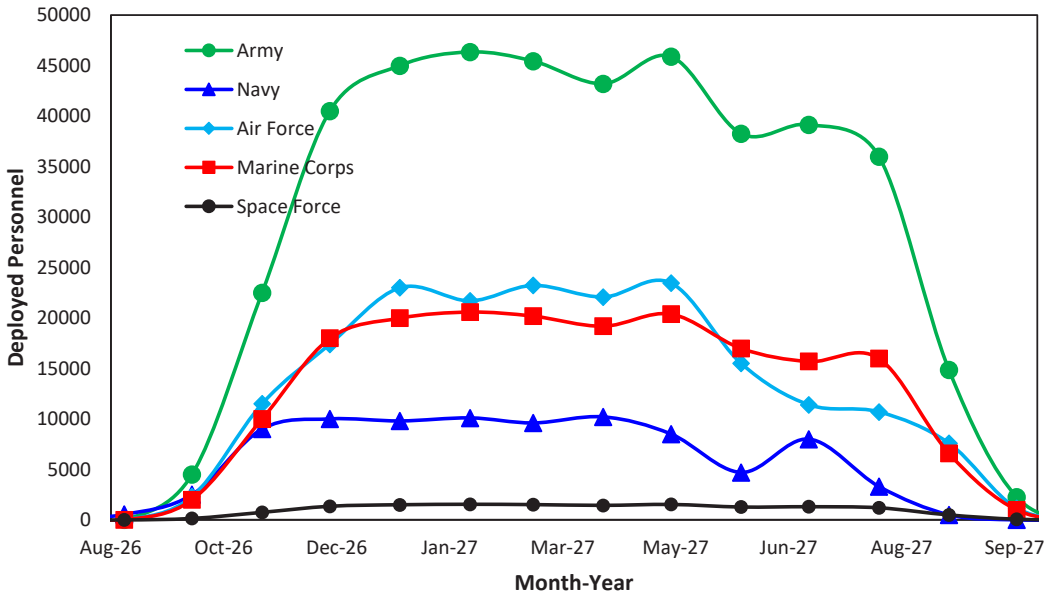
Source: Joint Publication 4-05, Oct. 23, 2018, revision of JP 4-05 dated Feb. 21, 2014. *Joint Mobilization Planning*.  
[https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp4\\_05.pdf](https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp4_05.pdf)

Figure 3. Hypothetical forward deployed personnel in full mobilization scenario



Source: CNA.

Figure 4. Hypothetical forward deployed personnel in High North scenario



Source: CNA.



From these hypothetical demands for the contingency operations, we made assumptions for how many items each person deployed with and the rate of wear and tear. We also added this to DLA's baseline demand for each item at present. For wargame purposes, we assumed that each person deployed from the Army for both contingencies would require 4 improved hot-weather combat uniform (IHWCU) coats, and every 6 months, 50 percent of them would require replacements. For the CW parka, we assumed that all deployed personnel regardless of service would need one parka, that would need to be replaced every 6 months because of wear and tear. Finally, we assumed that each marine deployed would require 2 FR uniforms, with a 50 percent replacement rate every 6 months.<sup>7</sup> We did not make any assumptions related to demand changes associated with casualties in conflict. We add the caveat that although we desired this demand to be plausible and grounded in available information, this is not a validated demand for generating requirements. In addition, we emphasize that the demand and shortfalls of specific items explored within this game are less important than the challenges the IB faced when attempting to significantly ramp up.

These contingency events include the following four qualitative phases associated with demands to the supply chain:

- **Competition:** steady-state operations and low demand. Before the conflict and ramped-up demand, the supply chain is optimized for DLA's current-day demand.

If DLA's demand is relatively steady for a long period, an efficient supply chain will be lean and not have excess equipment, staff, inventory, and facility space to minimize operating costs and maximize profit.

- **Contingency begins:** war demand ramps up. During this stage, delinquencies begin accumulating as DLA increases its demand, but the vendors have not yet increased their production capacity.
- **Mid-war:** war demand continues to ramp up or reaches a peak. If the war continues long enough, the supply chain will have increased throughput to meet a new high steady-state demand.
- **War-end:** the war ramps down, returning to pre-war competition demands. Here, the supply chain must meet the demands. Because companies can perform layoffs relatively quickly, we do not anticipate a lag in response to the shift in demand.

These phases were used to guide how game turns were designed (ideally, with the supply chain engine performing enough rounds per turn to fully explore behavior within that phase).

## Action cards

The CAMOLAND action cards provided players with a defined set of actions they could take each turn in response to the scenarios. We developed these actions based on numerous pregame discussions with government and industry representatives and intended them to represent the majority of actions

<sup>7</sup> For each of these demand assumptions, we attempted to make reasonable estimates for a highly speculative set of scenarios. Although we intended these demand estimates to be grounded in logical assumptions rather than predictive, we note that an error was pointed out to us during wargame execution. The FR coat we associated with USMC demand was in fact a Navy item. This only affects one analytic point in a later discussion—the comparison of stock on hand to wargame demand.

each could take.<sup>8</sup> The IB had a wild card option, and the government had three Defense Production Act (DPA) cards (functioning like wild cards) to cover any options we were unaware of and to allow more creative player solutions.

We made two card decks: one for government players and one for the IB. The full list of cards and descriptions are reproduced in Tables 1 and 2. Both teams had access to the other team’s deck for lobbying purposes. At the start of the turn, the government team chose seven cards, and the IB team chose five cards. These cards were the

teams’ hands for the turn. Teams were allowed to negotiate with each other on which cards to choose. During government and IB turn phases, each team recommended which cards the other team should play. At the beginning of the production phase, the government team played two cards (reflecting that it has power, but less ability to act), and the IB team played three cards (reflecting that it has less power, but more freedom to act than the government). At the end of the turn, the White team adjudicated the effects of the cards (players were allowed to argue, disagree, or propose alternate adjudication based on their expertise).

**Table 1. Government action cards**

No.	Name	Description
1	Create Warstopper program material buffer stock	Create Warstopper program material buffers to decrease lead times for raw material to support defense contracts relating to military systems with wartime requirements
2	Create buffer stock of component items	Create buffer stock arrangement of long-lead-time component parts at a vendor’s facility
3	Use DPA Title III (Tier 1)	Provide funding to expand IB capabilities (rated orders)
4	Use DPA Title III (Tier 2)	Provide funding to expand IB capabilities (delivery order (DO)-rated orders)
5	Use DPA Title III (Tier 3)	Provide funding to expand IB capabilities (unrated orders)
6	Award surge clause contracts	Increase use of surge and sustainment Defense Logistics Acquisition Directives
7	Award engineering analysis contracts	Award standalone contracts in which vendors are paid to review their own supply chain
8	Award IB maintenance contracts (IBMCS)	Prevent loss of design skills, retain institutional knowledge, prevent closure of critical production lines or divestiture of equipment, or reduce the number of vendors exiting the marketplace during times of lower demand

<sup>8</sup> CNA, discussion with representatives from Belleville Boot Company, Vibram Corporation, and the Warrior Protection and Readiness Coalition, July 18, 2023; CNA, discussion with Stephen Lamar, AAFA GCC, Aug. 10, 2023; CNA, discussion with Bill Ells and Mark Ferguson, Aug. 22, 2023; CNA, discussion with Brett Ayers, AAFA, Sept. 6, 2023; CNA, interview with Justin Hayes and W. L. Gore, Sept. 21, 2023; CNA, discussion with Jeffrey Niethammer, Cheryl Wright, and Humberto Zacapa, Sept. 12, 2023; Carolyn Shivers, email to CNA, Subject: Alternative Acquisition Strategies, 2023.

No.	Name	Description
9	Award minimum sustaining rate contracts	Prevent loss of design skills, retain institutional knowledge, prevent closure of critical production lines or divestiture of equipment, or reduce the number of vendors exiting the marketplace during times of lower demand
10	Vendor-managed inventory (VMI)	Provides access to end items, ensuring DLA can supply or resupply the services during contingency events
11	Award corporate exigency contracts	Provide access to end items, ensuring DLA can supply or resupply the services during contingency events
12	Make multiple awards for critical items or contract length	Split production requirements and awards among two or more contractors
13	Change acquisition policy to provide government-furnished equipment (GFE) and government-furnished material (GFM)	Change acquisition policy to provide GFM and GFE. GFM and GFE are types of government-furnished property provided to a contractor during a contract period of performance. For example, GFE is equipment, tooling, or test equipment provided to a contractor for use on a government contract, and GFM are consumable items expended in the production process during the life of a contract.
14	Request domestic nonavailability declaration	C&T end item or component is not produced domestically and must be procured outside the US
15	Waive a uniform standard	Waive any uniform standard
16	Store excess uniforms in government-owned or third-party logistics location	Create new storage for C&T end items
17	Award research and development (R&D) grant to IB partner	Encourage players to develop production innovations
18	Revise contract terms	Propose revisions to existing contract terms to better meet wartime demands
19	Request exception to Berry compliance	Request overseas sourcing if uniform end items or components cannot be procured domestically
20	Request revision to other government policy	Identify policy to be revised for its intended effect and any second- and third-order consequences likely to occur from its implementation
21	Request reprioritization or elimination of C&T vendor preference	Request a change to DLA vendor selection priority, especially nonprofit C&T vendors and small businesses

Source: CNA.

Table 2. Industry action cards

No.	Name	Description
1	Open a new production line	Identify the new production line and startup time
2	Purchase capital equipment	Identify the equipment you will purchase, the effect of the new equipment on the production, and the time it will take for the new equipment to come on line
3	Conduct R&D	Describe the R&D you will conduct, the time you expect it to take, and the effect you expect it to have on your production rate
4	Lease or purchase a new facility or facilities	Describe the facility or facilities
5	Reprioritize commercial business	Describe which product lines you will deprioritize and the capacity you will create for DLA-contracted C&T items
6	Increase number of shifts	Identify the new number of shifts, the new production rate, and any second-order consequences
7	Request material swap with another industry player	Identify the material you are requesting to swap and the player you are requesting to swap with. Describe the effect of the swap
8	Protest a government decision	Identify the decision you are protesting and the outcome you are seeking
9	Decline to bid on a contract	Identify the products the contract covers that you are declining to bid on and the reasons you are declining
10	Stockpile components	Identify the components you are stockpiling and the purpose of the stockpile
11	Wild card option	Allows players to create options outside of those listed above

Source: CNA.

## Supply chain engine

We designed the supply chain engine based on Jay Forrester’s Beer Distribution Game (invented during his work at MIT on system dynamics), which is regularly used as a classroom tool to teach students supply chain dynamics such as the bullwhip effect and how errors in communication and forecasting can amplify inefficiencies in supply chains.

Similar to the Beer Distribution Game, each player in the CAMOLAND supply chain engine represented a company within the supply chain and was responsible for placing orders and producing to

meet the demands of the tiers below them. Players did this in CAMOLAND by interacting with the three different game materials, displayed in Figure 5: the company card (top), order cards (bottom left), and inventory cards (bottom right). Each card had a whiteboard surface so players could write down or erase numbers as these items changed. The company card provided players with a quick reference of the rules per turn (left), pictographic rules for what they could produce (upper right), and a status of the lines used to produce materials (lower right), which gave an abstracted way to account for staff, equipment, and facility space (rolled up into one mechanic).

Figure 5. CAMOLAND game components

C1 - Tier 1 – Uniforms - C1

**Per Quarter (3 months):**

- **Place Orders**
  - Use order cards and fill out request and pass to higher tier (do not resubmit delinquent orders)
- **Use Production Line to Produce**
  - Check line is set up to produce item (token at top of line)
  - Match color of inputs to token (black is wild)
  - Use required inventory items and update. Fill in corresponding number of produced goods as delivered on supply card and on line. If overproducing, update inventory.
  - Update delinquencies (cumulative)
  - Receive \$1 per product delivered to requestor. Lose \$1 per excess staff or produced items held in inventory.
- **Receive Deliveries:**
  - Pass order cards back to originator.
  - Copy delivered column to inventory card. Erase request column, erase production mark on lines.
- **Adjust production lines (All steps optional – must do in order)**
  - **Scale Up:** Increase staff on line(s) by number in training station.
  - **Pivot:** Decrease staff on line to increase another line.
  - **Layoff:** Reduce staff on line (no penalty).
  - **Hire:** List new staff in training station (train 1 quarter before moving to line).
  - **Expand:** Start new line or switch token of line with zero staff (cannot staff this turn).
- **Turn End:** Update data collection sheet.

**Production Rules:**

+ + =

Colors must match!

+ + =

Training Station (1Q)	Line 1	Line 2	Line 3	Line 4	Line 5
# _____					
	Staff Prod.	Staff Prod.	Staff Prod.	Staff Prod.	Staff Prod.
	+40	+40	+40	+40	+40
	+20	+20	+20	+20	+20
	+10	+10	+10	+10	+10
	9	9	9	9	9
	8	8	8	8	8
	7	7	7	7	7
	6	6	6	6	6
	5	5	5	5	5
	4	4	4	4	4
	3	3	3	3	3
	2	2	2	2	2
	1	1	1	1	1

For staff over 9 mark circle and sum with below

**Production Lines:**  
Must have at least as many staff as production desired

Qtr # _____	Order		
	New Request (Current turn)	Delivered	Delinquent (Past turns)
DLA-T1-A	Requestor Name _____		

Qtr # _____	<span style="color: green; font-weight: bold;">A</span> <span style="color: red; font-weight: bold;">MC</span>		Inventory										
	    	<table style="width: 100%; height: 100%; border-collapse: collapse;"> <tr><td style="width: 50%; height: 20px;"></td><td style="width: 50%; height: 20px;"></td></tr> <tr><td style="width: 50%; height: 20px;"></td><td style="width: 50%; height: 20px;"></td></tr> <tr><td style="width: 50%; height: 20px;"></td><td style="width: 50%; height: 20px;"></td></tr> <tr><td style="width: 50%; height: 20px;"></td><td style="width: 50%; height: 20px;"></td></tr> <tr><td style="width: 50%; height: 20px;"></td><td style="width: 50%; height: 20px;"></td></tr> </table>											
T1	Company Name _____												

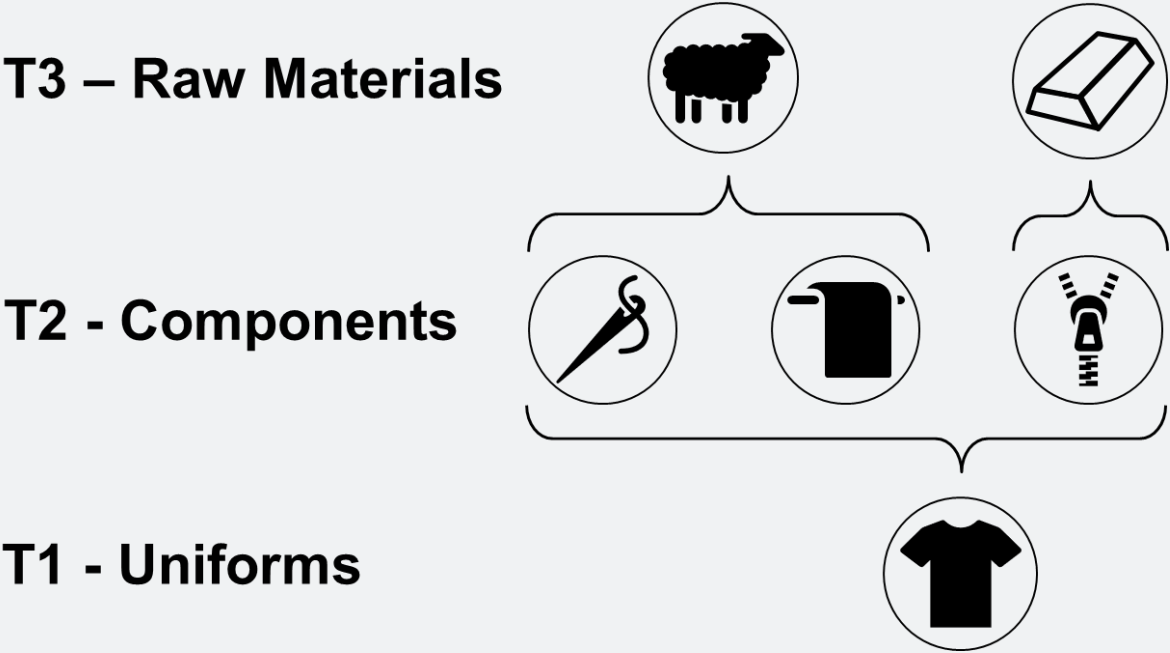
Source: CNA.

We developed simplified uniform supply chains for the game, depicted in Figure 6 and Figure 7. Figure 6 shows that an Army shirt produced in Tier 1 (represented by the t-shirt icon) was made using materials from Tier 2. From left to right, Tier 2 icons represent thread, bolts of cloth, and fasteners. In turn, Tier 2 components are produced from Tier 3 raw materials. Within the game, the sheep icon represented raw materials for thread and bolts of cloth, and a metal ingot represented raw materials for fasteners.<sup>9</sup> Materials were also color coded within

the game, with green representing materials for Army shirts and red representing USMC FR uniforms (which otherwise follow the same supply chain).

For the supply chain for CW gear displayed in Figure 7, we modified the uniform supply chain to include a process for waterproofing bolts of cloth (represented by a bolt of cloth icon with a “no-droplets” symbol overlaid). This generated an extra component tier within the game that required bolts of cloth and waterproofing chemicals as additional raw materials.

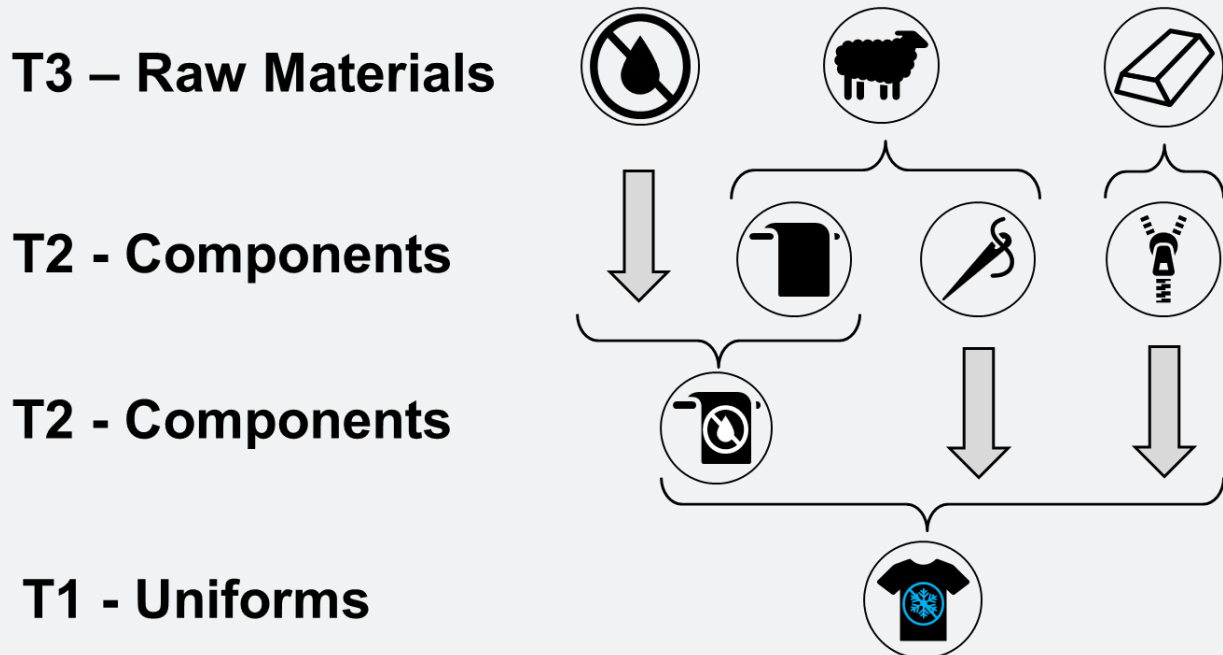
Figure 6. CAMOLAND uniform supply chain



Source: CNA.

<sup>9</sup> Here, icons were meant to represent more than just the items they depict. For example, the zipper icon represents all fastener types within the game (e.g., buttons, hook-and-loops). Similarly, the sheep icon represents not just wool but also cotton, synthetic fabrics, and specialty materials, as appropriate.

Figure 7. CAMOLAND CW uniform supply chain



Source: CNA.

Players could role-play as one of eight different companies (usually two to three players per company) that were responsible for the following products:

- DLA: responsible for storing all final products and generating demand for T1 players in accordance with the scenario demand
- Uniform Company 1: Tier 1 company responsible for producing Army shirts
- Uniform Company 2: Tier 1 company responsible for producing Army shirts and USMC FR uniforms
- CW Uniform Company: Tier 1 company responsible for producing CW gear (all services)
- Cloth and Thread Company: Tier 2 company responsible for taking sheep and generating either cloth or thread
- Fastener Company: Tier 2 company responsible for taking metal ingots and converting them to fasteners
- Waterproofing Treatment Company: Tier 2 company responsible for using waterproof chemicals to treat bolts of cloth
- Raw Materials Company: Tier 3 company responsible for producing all raw materials in-game

The players' in-game goal was to meet orders from the tiers below them each turn while minimizing delinquencies and maximizing profits. During each round of the production phase (representing three

months), the facilitator would update DLA's demand, and players would work through the steps on their player mats—placing orders and using production lines to produce, receive deliveries, adjust production lines for the next turn, and record their turns on data collection sheets before repeating. These steps are described in more detail here:

- **Place orders.** Players used order cards to fill out their material request for the next turn and pass it to a higher tier. The order cards include a running tally of delinquent orders and do not need to be resubmitted. At the end of this step, everyone had received an order.
- **Use production line to produce.** To produce an item within the game, players needed to ensure their companies met the following requirements:
  - A line must be set up to produce the item (represented by a token at the top of the line matching the supply chain icon and color); this represents the process of designing a line (the steps, order, and stages to make a shirt).
  - The color of the input materials must match the desired product (black is wild). This reflects that many materials (particularly components), once made, are only useful for producing certain items—Army camouflage patterns cannot be used for USMC shirts, for example.
  - A line must be staffed to produce the desired number of items, and sufficient materials must be available to produce the desired number of items (otherwise, whichever factor is most limiting is the max number of items that can be produced).
- If all previous requirements are met, players use (expend) required inventory items. Players fill in the corresponding number of produced goods as delivered on the supply card and supply line. Players update inventory (removing items expended and adding any unsold items) and delinquencies (if they produced more than demanded to catch up with delinquencies).
- Finally, players receive \$1 per product delivered to the requestor and lose \$1 if their staff did not produce or if they held produced items in inventory (to account for insurance and excess staff costs).
- **Receive deliveries.**
  - Once production is complete (and with facilitator permission), everyone passes order cards back to the originator.
  - All players have received an order (except raw materials) and players copy items they receive into their inventory card. Players erase items requested and received from their order cards and erase production mark on lines from this turn.
- **Adjust production lines (all steps optional—must be done in order).**<sup>10</sup> Once players have completed production, they decide how much to scale up production for the following turn. Players can make any of the following actions related to staff in their company:

<sup>10</sup> The scale-up, layoff, and hiring steps are legitimate steps companies may take. However, the details are at best only partially aligned with what we observed during our site visit to Bestwork Industries for the Blind and learned during discussions with industry representatives. Based on discussions during the site visit and subsequent discussions, hiring new personnel is complex—for Bestwork, there is a limited pool of visually impaired personnel for hire, but retention is high once staff are hired and trained. In comparison, some for-profit manufacturers described a “revolving door” of staff. The difference in timeline between hiring, scaling up, and layoffs reflects the asymmetry between the time investment to hire and train personnel and immediate loss of trained personnel during layoffs.



- **Scale up:** Increase staff on line(s) by number in training station. This represents taking staff that have been trained in the previous turn (quarter) and placing them on a line.
- **Pivot:** Decrease staff on one line to increase another line. Staff that have already been trained on a machine are relatively easy to pivot to a different product with a production step using the same machine.
- **Layoff:** Reduce staff on line (no delay). Although layoffs are not simple decisions for companies, from a timeline perspective, they can be enacted quickly with immediate effect.
- **Hire:** List new staff in training station (train one quarter before moving to line). This reflects the time required to recruit, interview, and finally hire new staff.
- **Expand:** Start new line or switch token of line with zero staff (cannot staff this turn). This accounts for the time that cost players to pivot a line to another product.
- **Turn end.** Players complete their turn by updating their data collection sheet.

At the beginning of each turn, players were presented with an updated demand table (example in Table 10). Major rows represented the expected orders players should make from one tier to another (not accounting for delinquencies on previous turns), with subcategories representing specific game items. Coloring (red, green, or colorless) reminded players they needed materials with that item. Columns provided the quantity demanded at each quarter, and subcolumns broke the demand

across companies. Players had visibility of future DLA demand for only two quarters ahead. Table 10 specifically represents what players would see at the beginning of quarter 2. Looking ahead to quarters 3 and 4, players knew the anticipated demand based on current DLA DOs issued. Note that this table does not represent forecasting typically performed in the industry. Instead, it represents a DO that has been issued six months in advance when the items are due, with quantities and sizes specified.<sup>11</sup> DLA players were requested to mirror the demand represented by the table displayed (to remain consistent with the scenario); however, all other players were free to leverage or ignore the demand chart as desired—as long as they could tie their reasoning to a real-world business decision.

<sup>11</sup> Based on our pregame research, the C&T industry does not rely on DLA forecasting of item quantities and will not start placing orders for materials to produce items until the DO has been signed and funded. The approximately three- to six-month time window between issuing the DO and the due date usually provide sufficient time for the C&T industry to order materials. This behavior seemed to be true across all industry representatives we met with.

Table 3. Wargame demand sample

	War Demand		Q1		Q2		Q3		Q4	
			UNI-C1	UNI-C2	UNI-C1	UNI-C2	UNI-C1	UNI-C2	UNI-C1	UNI-C2
Order from DLA to TIER 1	Army	Coat, IHWCU	5	4	3	3	4	4	4	3
	USMC	FR Uniform	0	0	0	0	0	0	0	1
Order from TIER 1 to TIER 2	Army	Cloth	3	3	4	4	4	3	5	4
	Army	Thread	3	3	4	4	4	3	5	4
	Army	Fasteners	3	3	4	4	4	3	5	4
	USMC	Cloth	0	0	0	0	0	1	0	0
	USMC	Thread	0	0	0	0	0	1	0	0
	USMC	Fasteners	0	0	0	0	0	1	0	0
Order from TIER 2 to TIER 3	Metal Ingot		8		8		9		6	
	Sheep		16		16		18		12	

Source: CNA.

# RECONSTRUCTION

## Action cards per turn

At the beginning of each turn, after new scenario details were revealed, both industry and government players worked through a process of choosing, lobbying, and down-selecting a sequence of actions they wanted to take over the course of the turn. These action cards represented levers that players could use to potentially mitigate the challenges of the surge in demand within the scenario.

Table 4 displays the action cards chosen at the beginning of each turn of the wargame. Tables 5 through 9 each summarize the in-game adjudications made to each of the cards played. Some cards had no in-game effect but often still reinforced the underlying wargame assumptions (such as the government's ability to place orders beyond existing contracts in wartime).

We observed that although the government players could act with more unity of action and often came to quicker decisions for choosing action cards, industry players struggled, particularly when down-selecting to three action cards. **A reoccurring comment from industry players was that different tiers and companies have different requirements and corresponding solutions—such that no one action card was a panacea for the entire supply chain.** This was based on players' real-world expertise. For example, nonprofit Tier 1 uniform manufacturers had different concerns related to staffing and hiring than for-profits. Federal Prison Industries (FPI) and AbilityOne programs were generally less concerned with turnover. Tier 2 component manufacturers (boot supply chain representatives) described the long lead times associated with acquiring new or specialized equipment as a limiting factor. Tier 3

raw materials participants expressed skepticism with the relative lack of Tier 3 production constraints in the wargame (there is a limit to how fast you can pull metal out of the ground that we lacked data to properly account for).

Notably, many action cards provided to the players were used repeatedly over the course of the wargame. For industry, the most common cards were numbers 6 and 10, "increase number of shifts" and "stockpile components," respectively. The government most frequently chose to revise contract terms to better flex to meet emerging wartime requirements. The next most common government action card was "use the DPA" (which remained in play for the remainder of the contingency once activated). Unlike the niche requirements that C&T manufacturers wrestled with, these two options broadly represented panaceas for the government. Part of this observation was potentially a game-ism (we generally scoped out contract negotiation details). However, government players emphasized the flexibility that the DPA provided them. Each side was given a wild card, which was only played once—during turn 5, the LSCO drawdown.

Similarly, many cards were not used or were rarely used during the wargame. For example, "conduct R&D" was used only during the drawdown of the final scenario. This was largely associated with incorporating lessons learned over the course of the contingencies into new processes within supply chains (rather than developing or investing in new automating equipment).

Table 4. Action card choices per turn

No.	Type	Name	T1 (Q5–Q7) Baseline	T2 (Q12–Q14) CW Turn	T3 (Q15–Q18) LSCO Start & CW End	T4 (Q19–Q20) LSCO Mid-War	T5 (Q21–Q23) LSCO End
2	Gov	Create buffer stock of component items	x				
4	Gov	Use DPA Title III (Tier 2)		x	x		
6	Gov	Award surge clause contracts					
8	Gov	Award IBMCs				x	
12	Gov	Make multiple awards for critical items or contract length		x			
18	Gov	Revise contract terms	x		x	x	x
1	Ind	Open a new production line			x	x	
2	Ind	Purchase capital equipment					
3	Ind	Conduct R&D					x
4	Ind	Lease or purchase a new facility or facilities	x				
5	Ind	Reprioritize commercial business		x			x
6	Ind	Increase number of shifts	x	x	x	x	
10	Ind	Stockpile components	x	x	x	x	
11	Ind	Wild card option—player-defined effects					x

Source: CNA.

Table 5. Turn 1 (Q5–Q7)—competition action card adjudications

No.	Type	Name	Effect	Q Start	Duration
18	Gov	Revise contract terms	Supports assumptions. No game effect. Provides Gov flexibility for surge—allowing orders beyond initial contract		
4	Ind	Lease or purchase new facility or facilities	Supports assumptions. Reduced timelines for equipment acquisition. Also provides +2 trained staff in staff pool at start of turn	Q8	1 Time
	Ind	Increase number of shifts	Supports assumptions. Reduced timelines for equipment acquisition. Also provides +2 trained staff in staff pool at start of turn	Q5	1 Time
10	Ind	Stockpile components	No cost for first four items held in inventory	Q8	1 Time
2	Gov	Create buffer stock of component Items	DLA to choose 20 items to stockpile and can distribute as needed, starting next turn. DLA chooses nine sheep—to T2 cloth and thread, seven ingots to T2 zippers, four waterproof chemicals to T2 waterproof treatment	Q13	1 Time

Source: CNA.

Table 6. Turn 2 (Q12–Q14)—CW scenario action card adjudications

No.	Type	Name	Effect	Q Start	Duration
4	Gov	Use DPA Title III (Tier 2)	Government flexibility to surge waterproof chemicals—no in-game effect		
12	Gov	Make multiple awards for critical items or contract length	Supports game assumptions—no in-game effect		
5	Ind	Reprioritize commercial business	Supports game assumptions—greater quantity of trained personnel in hiring pool available—no in-game effect	Q12	N/A
6	Ind	Increase number of shifts	Assumption support—reduced timelines for equipment acquisition (to align with wargame assumptions)—also provides +2 trained staff in staff pool at start of turn	Q12	1 time
10	Ind	Stockpile components	No cost for first four items held in inventory	Q12	Re-upped, ongoing
			+20 items—DLA choice next turn—14 zippers split between companies (7 and 7); 6 CW-treated cloth (to T1 CW)	Q16	1 time

Source: CNA.

Table 7. Turn 3 (Q15–Q18)—LSCO begins and CW ends: action card adjudications

No.	Type	Name	Effect	Q Start	Duration
4	Gov	Use DPA Title III (Tier 2)	Government flexibility to surge—no in-game effect	Q15	until LSCO ends
18	Gov	Revise contract terms	No game effect. Provides gov flexibility for surge—assumption support—allows government to surge requirements beyond initial contract		
1	Ind	Open a new production line	Assumption support—reduced timelines for equipment acquisition (to align with wargame assumptions)—also provides +2 trained staff in staff pool at start of turn	Q15	1 time
6	Ind	Increase number of shifts		Q15	1 time
10	Ind	Stockpile components	No cost for first four items held in inventory	Q15	Re-upped, ongoing
			+20 items—DLA choice next turn—four Army zippers (split even at T1), four cloth even split at T1, four needle and thread—even split at T1, one USMC zipper, remainder CW gear—unused	Q19	1 time

Source: CNA.

Table 8. Turn 4 (Q19–Q20)—LSCO mid-war action card adjudications

No.	Type	Name	Effect	Q Start	Duration
18	Gov	Revise contract terms	Assumption support. Provides Gov flexibility for surge beyond initial contract	No game effect	
10	Ind	Stockpile components	No effect—war ends next turn	Q21	1 time
8	Gov	Award IBMC	No game effect. Reinforces assumptions		
1	Ind	Open a new production line	+4 (+2 for each) staff to training at start of turn—all companies and tiers	Q15	1 time
6	Ind	Increase number of shifts			

Source: CNA.

During turn 5’s drawdown, industry players struggled to find any action cards that applied to their situations because most of them involved expanding efforts. The cards they thought might apply were “conduct R&D” and “reprioritize commercial business.” In comparison, in previous turns the DPA required the C&T IB to deprioritize commercial business. Here, players would attempt to bring that business back. Players were pessimistic about whether they could regain contracts with commercial companies after losing them. Players also discussed material swaps with each other to use extra material more efficiently on the shelves. Although this can occur in the nonprofit sector, players indicated this would be unusual for the for-profit sector (they do not have visibility of what is on each other’s shelves). Players used the wildcard option to lobby government players to allow them to extend deadlines on their delinquent supplies (as DLA began restocking its warehouses),

which allowed industry players to engineer a “soft landing” for themselves (rather than immediately implement large and painful layoffs).

## Government-industry breakout sessions

This section is intended to reconstruct and summarize the discussion points industry participants brought up during the breakout sessions. Because (as we shall see) each group has different challenges unique to either its company type or product, groups were split into the following categories:

- For-profit uniform manufacturers competitively bid against one another for uniform contracts from DLA while also competing for staff against all other commercial industries (not only C&T but all other minimum-wage jobs (e.g., fast food, retail)).



- Nonprofit uniform manufacturers are composed of AbilityOne manufacturers, primarily staffed by persons with disabilities or those who are blind and FPI manufacturers staffed by persons who are in prison. In both cases, staff turnover is low and both organizations benefit from “set-asides.”
- CW manufacturers are for-profit but for a smaller set of products with specialized materials, resulting in reduced quantity but with potentially more strict quality requirements requiring more skilled labor.
- Boot manufacturers have products that require more components (and different materials than uniforms) to assemble, resulting in different supply chains with quality control requirements varying by boot.
- Component-level manufacturers represent a tier farther upstream in the supply chain.<sup>12</sup>

### *For-profit uniform manufacturers*

**Labor challenges.** Participants noted that their ability to maintain skilled labor is and will remain one of their biggest challenges. The IB cannot keep its supply lines operational without a retainable workforce. Participants offered that one of the major suppliers of uniforms is in Puerto Rico, and this vendor needs to attract potential employees with competitive wages because other jobs currently pay more for less physically demanding work, such as working at pharmaceutical companies.

**Maintaining a healthy C&T IB.** Participants highlighted that neither DLA nor the C&T IB are ready for a wartime surge on the scale played during this game. To meet the demand of the services, participants said they would require more lead time or at least the ability to stretch out the

demand over a long period. Participants noted that to rapidly meet this spike in demand, the IB and DLA would need to order and stock components now to prepare the lines for the orders. Without DLA funds to make these preparations, the cost would have to be shouldered by the vendors, which they said is not financially viable.

**New vendors in the market.** One of the participants noted that there is no incentive for new companies to enter the market. To highlight the lack of new companies in the industry, the “youngest” organization present at the wargame had been in business for 26 years, which shows just how difficult it is to enter and remain in this IB. Participants stated that to bring in new vendors and strengthen the capabilities of the IB, DLA must find ways to incentivize commercial companies to build Berry-compliant lines. One such incentive could be the DLA stabilizing its order numbers to ensure it is viable for companies to invest the money to enter the market and ensure long-term viability in this space.

**An IB struggling to stay afloat.** Players indicated the current list of vendors in the IB is about half as long as it used to be, and the remaining vendors are about one-third as big as they once were. Participants noted that their industry must band together to ensure that their competitors stay in business. They push business to each other when one is struggling and sell inventory to each other to ensure they can keep their lines operational and their staff employed. Participants mentioned how one vendor stepped in to push a section of their uniform assembly order to a competitor to give them some business. They noted that their primary challenge is ensuring that the final cut-and-sew companies remain viable because with them, the whole IB can fulfill its orders and the rest of the supply chain receives orders.

<sup>12</sup> Our impression is that component-level manufacturers are also more likely to require specialized equipment (requiring much longer lead times) compared to acquiring cutting or sewing machines.

## *Nonprofit uniform manufacturers*

**Labor challenges.** Labor challenges for nonprofit uniform manufacturers are markedly different than those in the for-profit sector. AbilityOne vendors must maintain a 75 percent staffing level of individuals with impairments, which challenges their ability to surge. Because of these requirements, vendors require potential employees who can operate these machines to meet the criteria set forth under the AbilityOne regulations.

**Private and public vendors.** Participants in this breakout session were from private vendors in the AbilityOne category and representatives from the FPI. AbilityOne participants noted that although they do not compete with FPI for contracts, they view the set-asides to FPI as not conducive to a strong IB because FPI can afford to undercut AbilityOne costs by paying inmates significantly less when compared to other nonprofit vendors. FPI currently receives priority over AbilityOne, and this reduces the amount of work available for AbilityOne vendors. Private industry representatives argued that one way to solve this problem is to remove FPI's priority status, which would require a change in federal legislation.

**Nonprofit status.** AbilityOne vendors are designated as nonprofit organizations and therefore cannot sell their goods for a profit in the same way as for-profit vendors. These vendors sell their products with enough profit to make capital investments and maintain a rainy-day fund. Still, these profits are less than what for-profit organizations can legally achieve. This becomes particularly challenging for them when DLA asks them to execute a surge contract for which they need to be staffed or equipped.

## *Boot manufacturers*

Participants noted that one of the industry's biggest problems is that the Army and Air Force currently purchase non-Berry-compliant boots. If they were purchased through Berry, compliant vendors would increase their orders by around half a million. Industry representatives noted that this noncompliance issue is being discussed at the Secretary of Defense level and in Congress. However, studies must be commissioned to find actionable solutions to this problem. Participants were very vocal about this being a significant area of difficulty for their companies.

**Current capacity.** Representatives from the industry noted that their companies with current equipment and manpower max out at 525,000 boots per year. The scenario asked them to fill orders that would increase their production by an additional 456,000 per year, which they said would be possible only with DPA investment before a conflict requiring this scale of production. Based on participant conversations in the game, the most significant bottleneck for this IB at this tier for boot sole manufacturing is that their machines are already working at full capacity. A solution to this bottleneck would be to open new lines to meet a demand spike for this scale, but vendors do not have the capital to invest without some financial assistance from DLA as well as assurance from the government that additional orders would remain operational.

**Personal resupply.** Currently, the services issue Berry-compliant boots to incoming servicemembers. However, after this initial issuance, individuals are responsible for purchasing their boots, which do not have to be Berry-compliant. Participants noted that this is a problem for their industry because they must rely on orders for boots as servicemembers enter boot camps. Participants' preferred solution was to bring regulation to cover personal resupply, which requires senior service or congressional action.

## *CW manufacturers*

**Complexity of CW products.** CW vendors stated that the technical requirements for CW systems are more significant than those for other areas of the C&T IB. Processes such as seam-sealing and sourcing approved components require specialized skills at the prime and subprime levels, and these skills atrophy when production slows and employees work at a lower tempo. This problem is exacerbated when services require unique CW uniforms.

**Communication between DLA and subprime suppliers.** Reasons for production delays and delinquencies are often outside the scope of DLA's purview because only primes speak regularly with DLA. Participants noted that if the prime made the government aware of the circumstances behind the delay, DLA could try to find a solution. Currently, the prime is responsible for overseeing fulfillment of the contract and managing issues. Participants noted that if DLA could weigh in at the subprime level, it would be possible to deconflict back-ordering by conveying priorities.

**Single-source vendors.** As mentioned in the case of the uniform breakout group, there is a persistent problem with single-source manufacturers that provide components to the entire IB.<sup>13</sup> Examples include hook-and-loop fasteners and zippers. Participants speculated that this issue stems from the fact that items are often back-ordered for months because the volume of orders outpaces the ability of the manufacturers' production capacity. Although this may be a contributing issue, there were no participants representing these organizations with the ability to comment on whether additional challenges were at play. Participants suggested that the services authorizing the use of other fasteners would relieve some of the pressure on these single suppliers. We could not assess this claim.

**Vendor stockpiling is not a sure method.** Many components' minimum buys result in stockpiling, and other minimum buys are exhausted in production because of the need for some items to be size- or item-specific. An example is the purchase of zippers, which are sized based on the length of the product and are therefore not one-size-fits-all items like buttons or other fasteners. Some garments are made in more than 50 sizes and require different zippers or components. Stockpiling may seem like an easy solution to the problem of insufficient stock in the case of a surge; however, it does not provide an assured surge capacity in the IB.

## *Component manufacturers*

**Single-source vendors.** Component manufacturers played the role of Tier 2 vendors and highlighted the sector's challenges regarding single-source suppliers. When it comes to zippers and pattern printing, these companies are maxing out their employees' current productivity and their equipment's production capability. This equipment capacity is primarily a problem for component manufacturers of size-dependent items such as zippers or hook-and-loop, which require vendors to manufacture for specific sizes. This challenge has less of an effect on the pattern-printing vendors that make rolls of fabric that the cut-and-sew vendors can cut to whatever size they need. When producing size-specific items, participants repeatedly noted that it makes their production lines sluggish in the face of change. Discussion highlighted that in real life, a shift in demand results in either excess component materials as surplus stock or insufficient stock being available.

**Stockpiling.** In the face of the LSCO scenario in the game, participants noted that there is no way for the current IB to meet (let alone get ahead of) the demand unless the DLA or some other funding source creates

<sup>13</sup> "Single-source supplier" refers to a situation in which a company purchases a product or service from only one supplier when other suppliers may exist. "Sole-source supplier" refers to a situation in which there is only one possible supplier for a specific product or service.

and funds a stockpile of critical items. This suggestion from participants would smooth out the IB's orders in peacetime, but CNA questions whether it would meet a surge requirement. Government participants noted that FR uniform vendors requested a stockpile of Nomex because of the lack of excess production. Vendors now draw from this stockpile instead of following a just-in-time order model. Participants are aware of this stockpile and said that if they could draw from a stockpile instead of waiting for their upstream suppliers to fulfill surge orders, it would enable them to be more agile and responsive. Whether a component level stockpile is best accomplished via GFM (which DLA would purchase and make available to vendors to buy from) or via VMI, (where DLA would purchase items under a blanket purchase agreement, with the vendor responsible for monitoring, accounting for, and maintaining the stockpile), remains unclear. Participants noted that either option would be viable for them but that it would require lengthy conversations with DLA and each vendor to allow DLA to tailor the program to each vendor's unique situation.

# ANALYSIS

CNA conducted qualitative and quantitative analyses of the C&T IB both before and after wargame execution. This section outlines the results of those analyses.

## Pregame analysis

Before the wargame, we gathered data to design the wargame and develop game mechanics through interviews with government and IB SMEs. This process included discussions with Tier 1 and Tier 2 C&T IB vendors that produce the product lines we considered during the wargame (CW, uniforms, textiles, and boots).<sup>14</sup> CNA asked vendors how their supply chains respond to fluctuations in demand and about their ability to surge production on short notice. DLA Troop Support also arranged a site visit for the CNA team to Bestwork Industries for the Blind, Inc., a uniform manufacturing facility that produces utility and physical training uniforms for the DOD. We also gathered C&T data on DLA forecasts, purchase orders, orders received, and stock-on-hand values for PGCs within these product types for current production levels. CNA also incorporated themes from the National Defense Industrial Strategy to ground the game space in strategic policy and doctrine.<sup>15</sup> These data-gathering efforts exposed the CNA team to the government and industry partnerships required to procure military uniforms.

## Supply chain truths

One output from these discussions was what we referred to as the C&T “supply chain truths,” a series of statements that we understand to be near

universal across all the IB’s C&T supply chains. The supply chain truths were as follows:

- **Production of any item requires sufficient trained staff, equipment, facility space, and inventory of requisite materials.** All supply chains are limited by these factors, and whichever factor is most limiting becomes the bottleneck for that supply chain. Just one missing component can bring a supply chain to a halt. To significantly scale up a supply chain, all of these components must be scaled up proportionately.
- **Bottlenecks must be worked through in sequence, starting with raw materials.** Because a lack of (any) materials in a supply chain can immediately become a bottleneck, scaling up a supply chain must be done in a phased manner, starting with the upstream raw materials. There is no benefit in Tier 1 manufacturers hiring significantly more personnel in preparation of a surge if Tier 3 has not ramped up its production and Tier 2 has correspondingly scaled to match Tier 3’s throughput.
- **The C&T supply chains (particularly Tier 1) are lean.** Lean supply chains create efficient production lines for current-day operations; however, they are more vulnerable to shocks from a sudden increase in demand. C&T representatives (particularly Tier 1) avoid overproduction, retaining unused equipment, and overstaffing. There

<sup>14</sup> CNA, discussion with Stephen Lamar, AAFA GCC, Aug. 10, 2023; CNA, discussion with Bill Ells and Mark Ferguson, Aug. 22, 2023; CNA, discussion with representatives from Belleville Boot Company, Vibram Corporation, and the Warrior Protection and Readiness Coalition, July 18, 2023; CNA, discussion with Jeffrey Niethammer, Cheryl Wright, and Humberto Zacapa, Sept. 12, 2023; CNA, discussion with Brett Ayers, AAFA, Sept. 6, 2023; CNA, interview with Justin Hayes and W. L. Gore, Sept. 21, 2023.

<sup>15</sup> Department of Defense, *National Defense Industrial Strategy*, 2023, accessed June 2023, <https://www.businessdefense.gov/docs/ndis/2023-NDIS.pdf>.

is minimal storage of produced items because these are shipped promptly to DLA. Challenges with changing uniform requirements are attributed to this minimal storage. Specifically, if the requirements change or contracts pivot to a different company, any product made in advance of a contract is suddenly either out of compliance with the new standards or does not have a demand and cannot be sold. We note that this appears to be less true as one moves upstream in the supply chain. Although higher tiers still strive for efficient production lines, if they overproduce, they are more confident in their ability to eventually sell their product. Higher tiers (particularly sole suppliers) do not need to consider which company will receive a contract, they just need to consider the total number of anticipated contracts and produce for that. Similarly, they do not have to pivot as much to new uniform requirements. Tier 2 bolts of cloth can be dyed and treated many colors, cut to many sizes, or used whether buttons or hook-and-loop are the preferred fastener.

- **Scaling up takes more time than scaling down.** Although both scaling up and scaling down supply chains come with unique challenges, scaling down personnel (performing layoffs) can be implemented rapidly; however, the process of recruiting and hiring personnel (particularly in for-profit companies) is time-intensive. This is aggravated (sometimes severely) by long lead times to acquire new equipment.
- **Steady demand is more efficient than sporadic demand.** Fluctuating demand over the course of a year is more challenging for

C&T vendors to meet. Peak demand early in the year requires hiring additional personnel (or staff to perform overtime). In contrast, a low demand later in the year leaves hired personnel without work; however, companies struggle with whether to perform layoffs because the beginning of the following year may bring high demand again.

- **Production of goods does not begin until companies receive a DO, and delivery comes three to six months afterward.** Unlike commercial supply chains that may forecast anticipated demand, companies within the C&T IB will not take any action on DLA-provided forecasts or even on awarded contracts until DLA has provided a DO with specific quantities of each size of product. Once the DO arrives, Tier 1 companies place their orders with Tier 2 suppliers, and Tier 2 orders from Tier 3.<sup>16</sup>

### *IB surge capacity*

Before the game, CNA requested data from C&T manufacturers that produce the uniforms and footwear under consideration in the wargame. The requested data encompassed three categories: uniforms each vendor currently produces, current production rate, and surge production rate. The aim of this request was to understand the ability of the C&T IB to surge production during the crises that we developed for the wargame scenario. Although the wargame scenarios are hypothetical, the responses of C&T IB vendors provide insight into the scale and timeframe of their individual surge capacities.

The C&T vendors that responded to the data call said that they can surge production of the uniform items that they produce in response to DLA demand. However, the rates at which they could ramp up

<sup>16</sup> We believe the three- to six-month lead time allows material to move through the supply chain starting at production from Tier 3 through Tier 1.

production and the time it would take them to increase production vary markedly. In general, most vendors indicated that they could increase their production moderately within 30 days and continue to increase their production for six months to one year. Labor and component availability were most often cited as limiting factors for any production surge. The data provided by C&T manufacturers indicate that there is an opportunity to expand production in the current IB; however, the ability of individual vendors to surge their production rates within 30 days varies considerably.

## Post-game analysis

After the wargame, the CNA team analyzed the outputs of the supply chain model and reviewed data on the procurement costs associated with Berry Amendment compliance.

### *Supply chain model*

Supply chains are complex and nonintuitive processes. Although we attempted to mitigate this with player aids and facilitation, there is limited time for each turn within a wargame, and this time pressure can result in players making mathematical errors or failing to fully optimize their turns. We wanted to use a model to provide context for the wargame decisions. Specifically, how fast could players ramp up in the game within the constraints of the game rules? When players chose not to ramp up to this level, was it because of a decision or calculation error? Or was the difference in behavior intentional, with real-world reasons guiding their decisions? As we shall see, although the players made mathematical errors in the game, **large deviations between the model and the wargame occurred because of real-world challenges the industry players struggled with.**

DLA's ACE developed a supply chain model using Advana to mirror the mechanics of the supply

Although players made mathematical errors in the game, large deviations between the model and the wargame occurred because of real-world challenges the industry players struggled with.

chain engine and used a ruleset to simulate optimal play. We defined optimal play as actions required to minimize delinquencies to DLA and minimize unused production lines. We present pseudo-code (a high-level summary of the logic) for this algorithm in Appendix B. Broadly, the code records the orders, delinquencies, inventories, and production across all tiers and companies in a process mimicking the wargame mechanics and has the following functions:

1. The model uses the available information on current demand, delinquencies, and whatever future demand is available to forecast staffing requirements. Tiers 2 and 3 lack information for us to know their exact staffing requirements for future turns, so the algorithm averages previous and current demand to estimate new demand.
2. If production next quarter is expected to decrease, the model lays off staff immediately proportional to the upcoming decrease in demand.
3. When a spike in demand is introduced that a company is unable to meet, the model evenly distributes materials that the company can produce (and delinquencies for materials it cannot produce) across lower tiers so the burden is shared evenly.

4. In addition to the optimization, ACE manually modified the model to include the effect of policy decisions during the wargame, which we reconstructed in the tables displayed in the “Action cards per turn” section. Note that not all action cards could be implemented within the model. Instantaneous (one turn) changes to staffing or inventories were implemented; however, the model was not reoptimized to account for allowing buffer stock in company inventories.

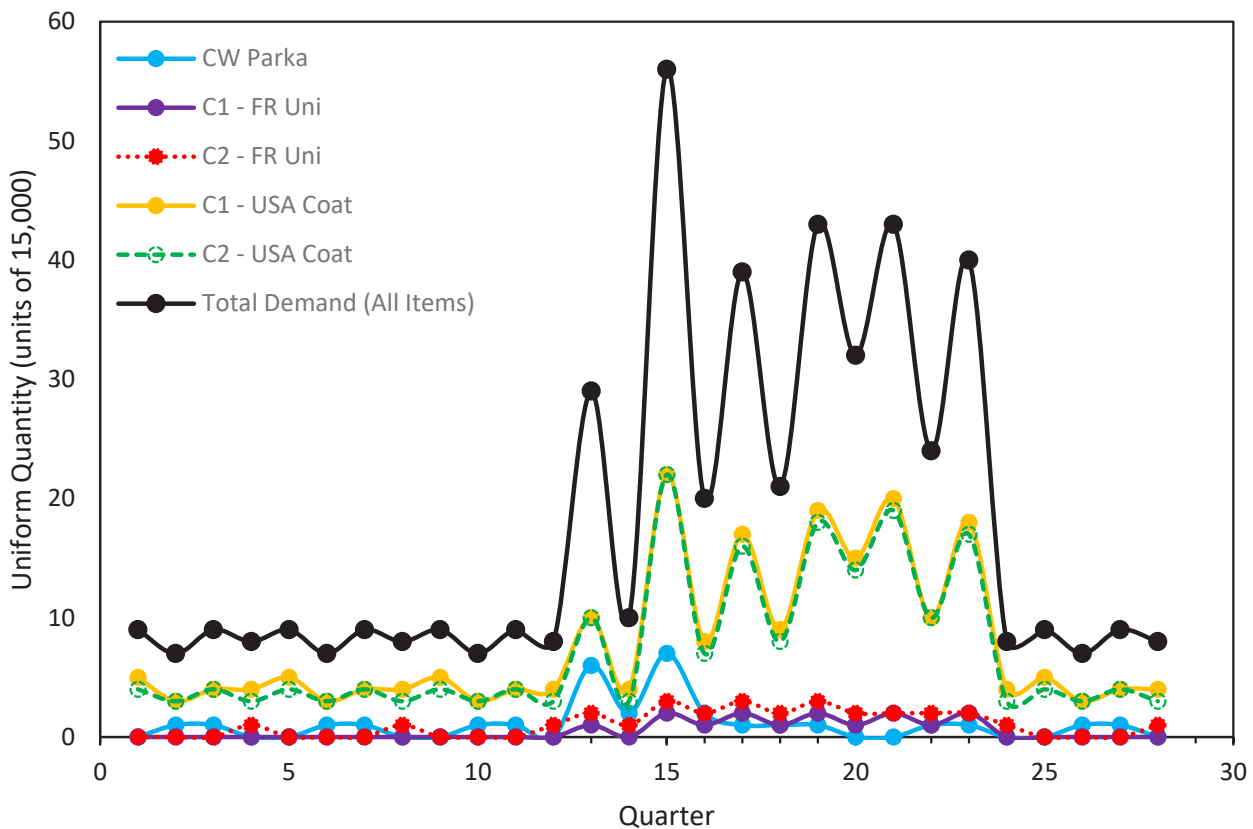
Next, we will discuss the wargame demand generated from the scenarios, review the optimized model results, and finally compare the model results to results from players within the wargame. While the following sections will present the model and

wargame results quantitatively (in figures and with calculations), the graphs and numbers presented in this section are intended to demonstrate themes and trends but not precisely quantify shortfalls.

### SCENARIO DEMAND

Figure 8 displays DLA’s demand per quarter for each product made by each company within CAMOLAND. Each game unit (e.g., an order of one CW parka or one Army uniform) represented 15,000 uniforms. As a point of reference, the daily production requirements at the Bestwork site were on the order of 500 per day (item complexity influenced the number of staff working the line but did not seem to influence the total produced per day). This scales to

Figure 8. DLA demand per quarter for each product and total demand for all products



Source: CNA.



about 30,000 items per quarter,<sup>17</sup> so a single game item represents about the quantity that a real-world line could produce in six weeks.

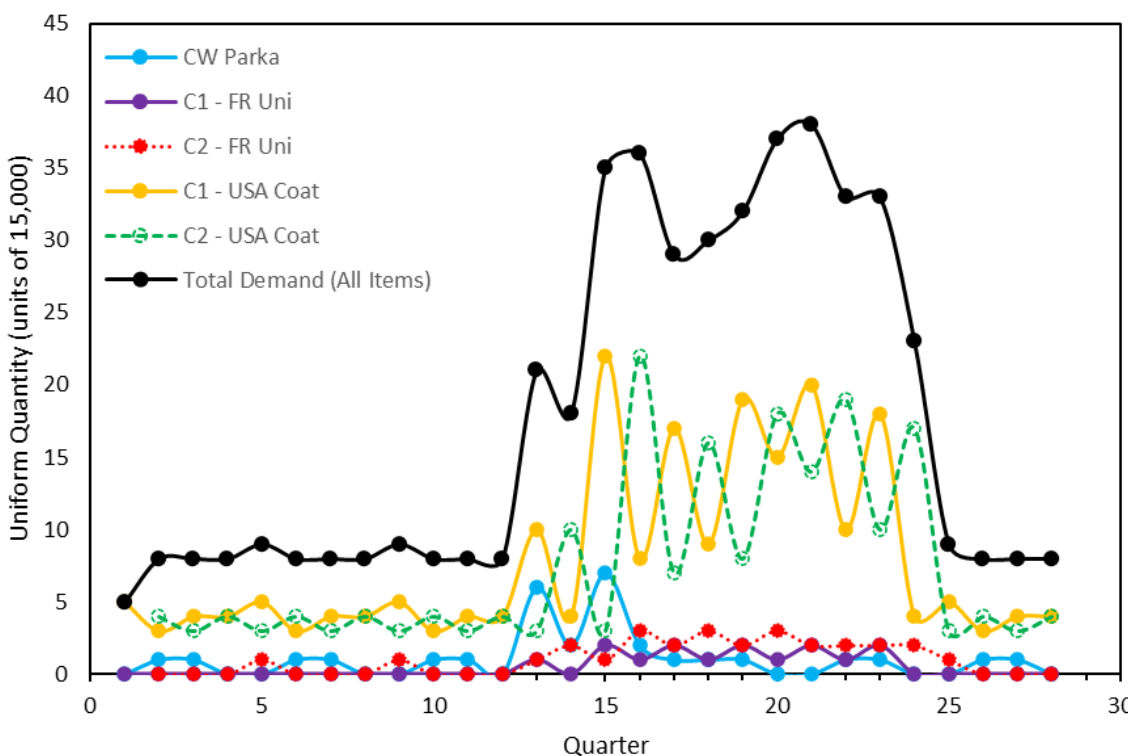
The full demand curve generated for the wargame covered seven years (28 quarters), with the first three years of the scenario and the final year (quarters 1–12 and 25–28) representing a competition or current-day baseline derived from DLA’s uniform production orders from FY 2022 and 2023.

The black line in Figure 8 displays the cumulative demand across all products per turn. The highest peak represents 56 unit orders and occurred at quarter 15 (the start of the LSCO, although the CW contingency was ongoing). Notably, because shocks were introduced to all supplies at the same time

(we assumed the war start time is when all demand surges), there was a constructive interference effect resulting in a sixfold increase in demand compared to today’s baseline. The oscillations occurred because of a wear and tear approximation in which we assumed some percentage of uniforms of personnel deployed would need to be replaced every six months.

Consider if instead the orders to Company 2 shifted left or right by one quarter (example displayed in Figure 9), DLA could achieve a destructive interference effect, dampening or spreading out the shocks to the system. This would also provide a more uniform total demand signal. The maximum peak would occur much later in the conflict, and the demand at quarter 15 would be 35 units (37 percent lower). This example illustrates how phasing demand can

Figure 9. A hypothetical “destructive interference” example to smooth demand



Source: CNA.

<sup>17</sup> Five hundred products per day x 5 days per week x 4 weeks per month x 3 months per quarter = 30,000 items per quarter. We initially planned to scale by 30,000, but this zeroed out the products with smaller production demands.

smooth shocks to the system and how important this is in the context of our supply chain truth that steady demand is more efficient than sporadic demand. High demand for multiple products simultaneously (whether in peacetime or in war) can compound to create much greater challenges for the C&T IB.

We note that offsetting the demand of one company versus another does not address the fluctuations each Tier 1 company would face; it would only address fluctuations seen at higher tiers sourcing to both companies. Mitigating the fluctuations seen in Tier 1 would require DLA to average out anticipated peaks in advance and distribute orders across vendors that are proportional to their production capacity. In either case, the services would have to accept some risk for the delay. The delay would likely occur regardless because of the demand's shock to the system.

### ACE MODEL RESULTS

Using the wargame demand as an input and modifying the model based on player action cards, ACE ran the supply chain engine model and provided outputs to CNA. To understand how demand propagates through the supply chain, we focused on the progression from metal ingots (Tier 3) to USMC and Army fasteners (Tier 2) to USMC FR uniforms, US Army uniforms, and CW parkas (Tier 1). To interpret the results more easily, we summed the total demand for fasteners and ingots at each tier. Within the model, the cumulative amount produced should be equal across all tiers. According to equation 1:

$$\begin{aligned} \text{T3 Metal Ingots} &= \text{T2 USMC Fasteners} + \text{T2 USA Fasteners} \\ &= \text{T1,C1 USA Uniforms} + \text{T1,C1,USMC Uniforms} \\ &+ \text{T1,C2 USA Uniforms} \\ &+ \text{T1,C2,USMC Uniforms} + \text{T1,CW Parkas} \end{aligned}$$

Figure 10 shows the cumulative total of produced units per tier with DLA demand per quarter (black line) for reference. We observed two notable behaviors here. First, all cumulative totals approached the

same final value (slight discrepancies are caused by DLA stockpiling and distributing extra supplies, reducing the demand). Second, supply chains had to ramp up production starting upstream and continuing downstream (see supply chain truths). The largest increase in demand was associated with the LSCO (resulting in the increased slope of the black line) beginning at quarter 15. However, the C&T IB was unable to significantly increase uniform production until quarter 20 (finally "catching up" to the accumulated delinquencies), **1.5 years into the war**. In game mechanics, this translates to the following sequence of steps:

- Q15—16 delays with communicating new demand to T3
- Q17—T3 to hire, one round for T3 to train staff and T2 to hire
- Q18—T3 to produce, T2 to train staff, and T1 to hire
- Q19—T2 to produce (using material received from T3) and T1 to staff
- Q20—T1 to produce (using material received from T2)

Although communication delays can be mitigated, the steps to ramp up tiers sequentially (steps associated with Q17 through Q20) cannot be shortened easily. Although some companies can hire and train on shorter timelines (Bestworks indicated a six-week training timeline), this is counterbalanced by real-world limits on the hiring pool and potentially much longer delays acquiring larger equipment or additional facility space (the ramp-ups resulted in a peak demand six times larger than current-day operations).

In some ways, this represents a best-case scenario (with an infinite pool of persons available for hire and no significantly long delays from equipment acquisition or new facilities). As we will see, this also represents a best-case (and unlikely) result from a decision standpoint by players. **Notably, this also**

indicates that the C&T IB would be unable to ramp up for shorter-term contingencies. The CW contingency (one-year duration) played in the wargame would have been over by the time the C&T IB could respond.

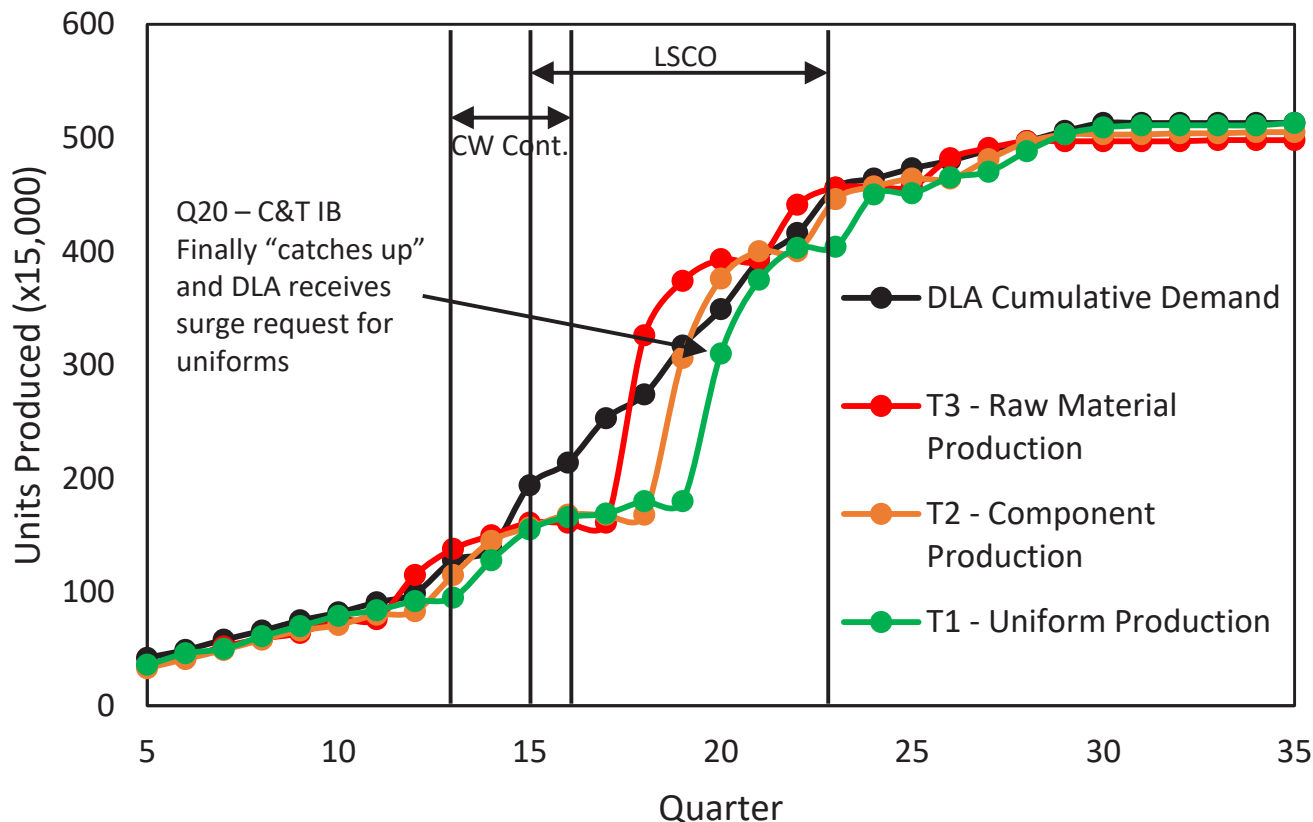
It is also notable that within the model, a crossover point occurred between cumulative produced goods and demand—this occurred as higher tiers surged to not only meet the new increased demand but also “catch up” with the accumulated delinquencies from past quarters. This behavior resulted not only in a rapid ramp-up but also a rapid ramp-down shortly afterward because the high production rate required to catch up

was not sustainable. This result is more easily shown in Figure 11, where the production pulses high for each tier sequentially, then drops to zero.

### DELINQUENCIES AND DLA STOCK ON HAND

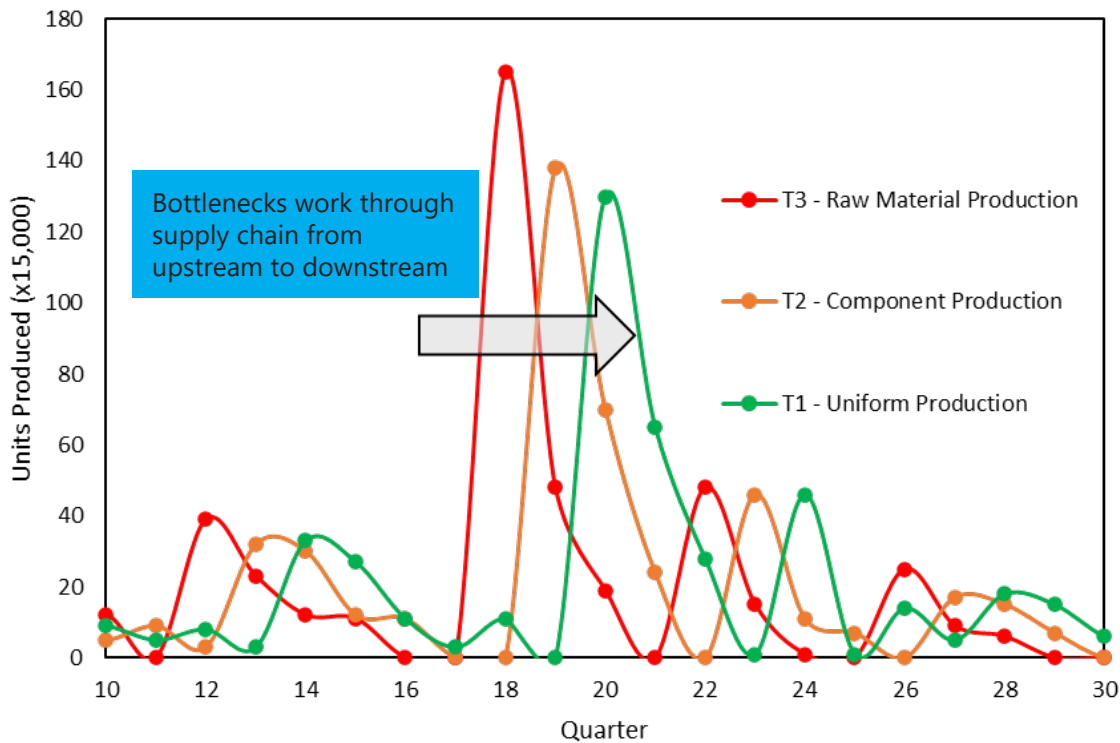
Fundamentally, there are two components to preparing for a surge: (1) ramping up a supply chain such that its new production can meet the new higher demand and (2) ensuring there is enough stock on hand (SOH) so suppliers can meet or mitigate the immediate demand while waiting for the supply chains to ramp up. Within the wargame, we did not provide industry players with DLA SOH; however, DLA

Figure 10. ACE model results of cumulative units produced per quarter per tier



Source: Raw model results from ACE. Data manipulation by CNA.

Figure 11. Production per turn per tier—model of supply chain engine



Source: Raw model results from ACE. Data manipulation by CNA.

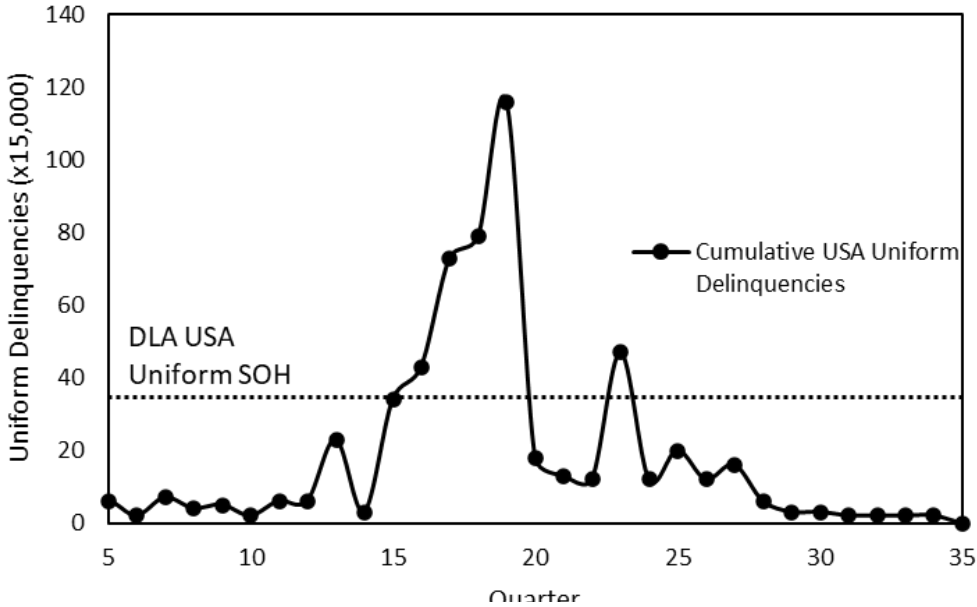
Troop Support provided current quantities for post-game comparison and analysis. Figure 12 and Figure 13 display the cumulative delinquencies for each product and provide a threshold line representing the SOH values for each of these items. In all cases, the surge for these scenarios exceeded the SOH, so DLA is not prepared to fully mitigate the shocks to the supply chains presented within this wargame. As previously mentioned, while these demands were intended to be plausible, they are not validated demands intended to generate requirements. However, in all cases, they can partially mitigate the surge. All items were chosen as representative categories for different types of products, and it is worthwhile to acknowledge the potential operational implications of a shortfall. In the case of Army uniforms, the SOH is sufficient to support the first wave of soldiers deployed, and subsequent waves of demand are associated with wear and

tear, indicating that delays with ramping up the C&T IB would manifest as soldiers muddling along with poor-quality uniforms. For the CW scenario, the lack of parkas would represent a more pressing environmental safety concern (e.g., protection from frostbite and other cold weather-related injuries). The SOH for FR uniforms was lowest relative to the in-game demand; however, the demand here assumed that all Marines were provided an FR uniform and may be unrealistic—the true demand for USMC FR uniforms requires more analysis. The lack of FR uniforms has important implications for the safety of operators.

### COMPARING THE SUPPLY CHAIN MODEL TO WARGAME RESULTS

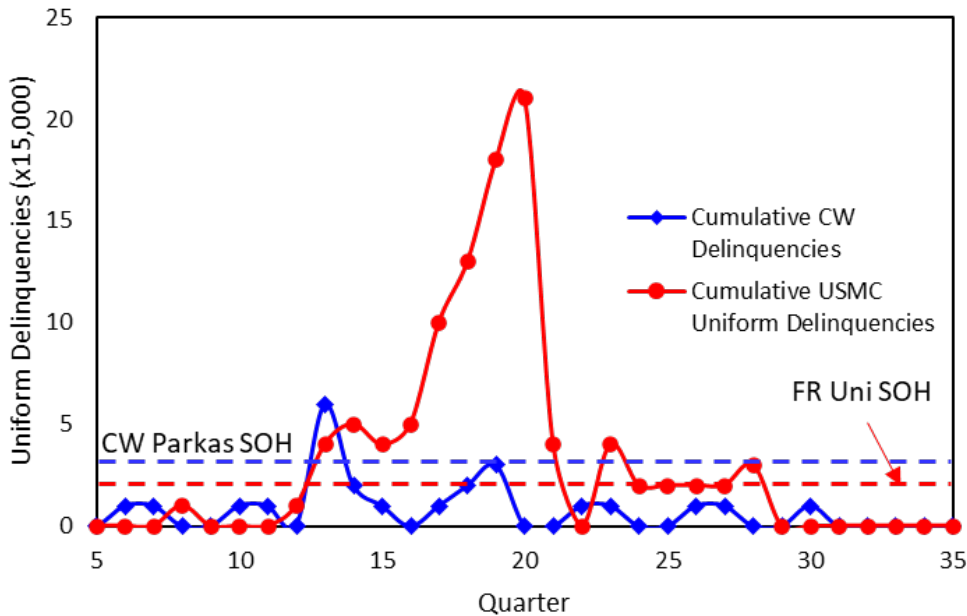
Figure 14 displays the cumulative products produced by the model and the wargame for Tier 1 and displays the cumulative DLA demand for comparison. There

Figure 12. Comparison between ACE model delinquencies and SOH for IHWCU



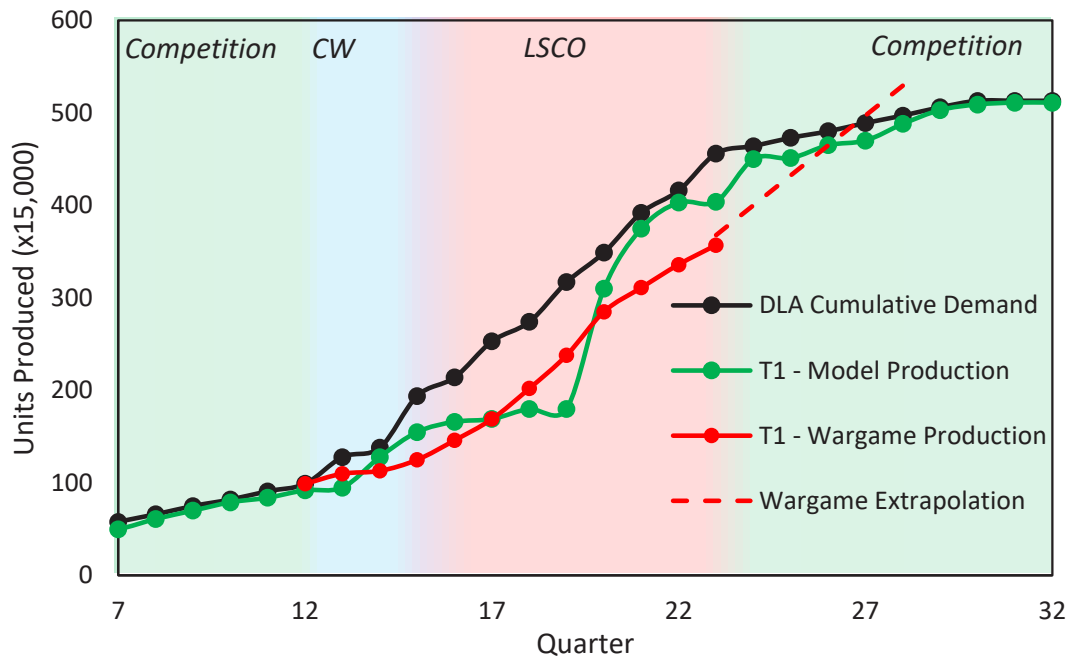
Source: Raw model results from ACE. SOH values provided by DLATS. Data manipulation by CNA.  
Note: Wargame demand was hypothetical and does not correspond to validated requirements.

Figure 13. Comparison between ACE model delinquencies and SOH for CW parkas and FR uniforms



Source: Raw model results from ACE. SOH values provided by DLATS. Data manipulation by CNA.  
Note: Wargame demand was hypothetical and does not correspond to validated requirements.

Figure 14. Comparison between ACE supply chain model and wargame results



Source: Raw model results from ACE. Wargame reconstruction and data presentation by CNA.

Note: Wargame demand was hypothetical and does not correspond to validated requirements.

T1 wargame production only reflects turns played within the wargame. Wargame demand was modified slightly in the final turns to reflect an early ramp-down due to time constraints; however, because of the accumulated delinquencies, players did not significantly deviate from their wartime production rates.

are distinct qualitative differences in behavior between the model results and those from players within the wargame. First, the new steady-state production rate within the wargame matched the slope of the new demand, but the industry never attempted to surge to catch up. During the hotwash, players indicated that this was real and intentional. Players were very reluctant within the wargame to perform layoffs and preferred to maintain a happy medium between large swings in demand.

More subtly, players were able to beat the model briefly. We attribute this to two factors: (1) players were reluctant to ramp down (i.e., perform significant layoffs) because of the expectation that more demand would eventually come and (2) players benefitted from a CW contingency operation

immediately before the LSCO (rather than starting from cold supply lines—the CW scenarios ironically helped warm supply lines up). Notably, if players were only responding to the CW scenario, this might have been a miscalculation.

The relatively stable queue of delinquencies had two unexpected (for CNA) benefits to the C&T IB. First, a stable demand (internal to the supply chain) was effectively generated for the remainder of the wargame. Although DLA’s demand fluctuated between turns, the C&T IB had such a large backlog that they no longer felt the fluctuations. Second, the backlog created a natural “soft landing” for the C&T IB after the LSCO ramped down. Specifically, DLA still needed to rebuild its safety stock after the war, but there was now a reduced urgency to produce

materials. In addition, contracts for products demanded during the war were assumed to remain in place (rather than DLA renege) for the delinquent orders. During the final phase of the wargame, C&T IB requested these timelines be extended so they would not have to immediately lay off significant numbers of staff.

### COMPARING PRIORITIES WITHIN THE WARGAME AGAINST THE MODEL

There was one final difference between the model and the wargame associated with prioritization, particularly at Tier 2 (though it is potentially applicable to higher tiers as well). Different players (or the same player at different times within the game) would prioritize how to disperse produced materials differently, with the following decision types seen within the wargame:

- 1. Spreading the damage.** Delinquent orders and limited-production materials were spread evenly across all subordinate vendors. This was the prioritization assumed within the model and as long as everyone (all companies across all tiers) did this, no major issues were seen within the supply chain.
- 2. First in, first out.** Players met orders based on when they arrived and provided as much material as they could to the vendor that first submitted its order. The remaining vendor(s) were left with delinquencies.
- 3. Playing favorites.** Players sometimes prioritized a single company or a single product. When faced with a significant surge, players indicated that they could not appease everyone but that they might be able to keep one company or one product line happy—this product was then prioritized regardless of the order in which it arrived.

These different prioritization decisions, although logical and justified by the players locally, **caused global inefficiencies downstream, particularly when different Tier 2 companies used different methods to prioritize orders.** For example, in one turn, Cloth and Thread chose to spread the damage, and Fasteners chose to use a “first in, first out” approach. The result was one company had zero fasteners and could not produce at all despite having staff and other needed materials. Meanwhile, the other company held a surplus inventory in zippers but could not use them because they still lacked staff for cloth and thread. Later in the game, Cloth and Thread and Fasteners both started playing favorites—specifically prioritizing the USMC FR uniforms because this was the only product for which they could keep the delinquencies at zero. This occurred within the game at the expense of Army uniforms (both of which depended on the same raw materials within the game). Although we do not know if these examples would play out the same in a real-world contingency, we believe that this type of challenge—different companies prioritizing differently—is at risk of occurring for any DLA products that compete for components or raw materials. **This risks the wrong products being prioritized, not by DLA or the services, but by decisions internal to the C&T IB, which may not account for operational need.**

### *The cost of Berry compliance*

The Berry Amendment, which requires DOD to procure C&T products from domestic sources, is open to criticism as both anticompetitive and higher cost. The domestic sourcing requirement ensures a domestic C&T industry in an era when most commercial garment production now occurs overseas. Government prioritization of efficiency and cost-control in procurement leads to ultra-low profit margin contracts, which has driven some US clothing and footwear manufacturers to stop producing uniform items for DOD, thus contracting

an already small IB.<sup>18</sup> Outside of DOD, other US government agencies with uniformed workforces can procure uniforms from foreign sources because they are not covered under the provisions of the Berry Amendment. Lower costs and wider selections offered by foreign manufacturers are motivations for sourcing uniform items from foreign vendors.<sup>19</sup>

Industry partners and the associations representing them argue that mandatory domestic sourcing should be expanded to include federal agencies outside DOD. Expanding the reach of the Berry Amendment in this way will increase the demand for domestic clothing, textiles, protective apparel, and footwear, thus increasing the size of and creating a more predictable demand for the domestic C&T IB. To wit, increased demand will allow C&T vendors to shift production capacity away from civilian agencies' production and toward DOD uniform production in times of national emergency—thus allowing domestic C&T IB vendors to ride out the notoriously unpredictable DOD demand.

During the wargame, players compared procurement of similar uniform items sourced from Berry- and non-Berry-compliant sources. After the wargame, DLA Troop Support provided CNA with 2018 data comparing procurement costs for similar uniform items procured by the Department of Homeland Security (DHS).<sup>20</sup> DLA Troop Support provided cost examples for DHS uniform components for which DLA pays less using domestic sources, specifically:

*Examples of items for which we pay considerably less (i.e. Boat shoe \$60.50 vs \$168.47, cold weather boots 134.72 vs 297.50, flyers gloves 25 vs 50), so please don't be concerned that Berry compliant equates to higher cost.<sup>21</sup>*

According to DLA Troop Support, the cost differential between DLA and DHS is because of the costs associated with the contract vehicle that DHS uses. This suggests that DLA Troop Support may be able to achieve economies of scale by providing procurement and inventory management functions on behalf of DHS.<sup>22</sup> The data from DLATS SMEs suggests that procurement costs may not always be higher for federal uniform items procured from domestic versus foreign sources.

<sup>18</sup> Stamen Borisson and Elizabeth Oakes, *Defense Industrial Base Assessment of the US Textile and Apparel Industry*, US Department of Commerce Office of Technology Evaluation, 2017, pp. 127–133; CNA, discussion with representatives from Belleville Boot Company, Vibram Corporation, and the Warrior Protection and Readiness Coalition, July 18, 2023.

<sup>19</sup> Valerie Bailey Grasso, *The Berry Amendment: Requiring Defense Procurement to Come From Domestic Sources*, Congressional Research Service, 2014.

<sup>20</sup> DLA Troop Support, email to CNA regarding non-Berry prices for items used by DHS, 2023.

<sup>21</sup> DLA Troop Support, email to CNA regarding non-Berry prices for items used by DHS, 2023.

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# INSIGHTS AND RECOMMENDATIONS

## Insights

### *Supply chain delays*

#### **Supply chains have a fundamental speed limit.**

The supply chain truths discuss how material bottlenecks can halt production, which depends on higher tiers (each with their own bottleneck). In these cases, DLA's SOH will determine warfighter readiness at the beginning of contingencies. When considering short-term contingencies (such as our CW scenario), the C&T IB will not be able to respond quickly enough to meet demand for rapid scenarios, while in the LSCO, the C&T IB will lag behind the wartime demand.

**Military personnel lacking uniforms.** During the LSCO explored within the wargame, the cumulative delinquencies exceeded DLA's SOH for the items explored, indicating that in a mass mobilization, the C&T IB would have to surge, and delays associated with this surge would result in military personnel lacking uniforms. In instances in which the uniform provides environmental or physical protection (e.g., frostbite, burns, injuries), this gap can be dangerous for warfighters.

### *Manufacturers prioritize labor*

**Labor stability.** Labor stability is crucial to the C&T IB, particularly with Tier 1 vendors. Volatility in labor results in additional time and investment lost in hiring and training new staff (even while attempting to ramp up). Decisions that the IB made were grounded in the idea of labor stability. A stable labor force made businesses viable, and industry representatives indicated frustration with inconsistent or fluctuating demand from DLA, which inhibits their ability to operate smoothly. Within the

game, players were deliberate about how quickly they hired people, and they actively attempted to avoid layoffs and the corresponding disruption to their businesses.

**Balancing profit and stability.** In the wargame, as DLA increased demand in support of the LSCO, the C&T IB lagged in response, causing delinquencies. Cumulative delinquencies for products did not decrease until the end of the LSCO and never actually zeroed out (which would not have occurred until more than one year after the war ended, extrapolating the wartime rate outward). This was attributed to several factors influencing player decisions. Catching up on and reducing the cumulative delinquencies during the LSCO would have required a short-term surge beyond DLA's wartime demand. To do this, players would have had to subsequently lay off staff and would have been left with unused equipment once they closed that gap. This same desire to protect staff also resulted in players not chasing the demand as it rose and fell each quarter. Instead, players targeted an average between the high and low demands from DLA. Discussions with industry participants noted that this was purposeful and reflected what they might do in real life.

### *Additional supply chain challenges*

#### **Complications with component stockpiling.**

Players cited success in DLA deciding to stockpile component parts to reduce the current number and timing of delinquencies. This can be accomplished via GFM or VMI. However, this is not a straightforward process, and within the wargame, participants noted that when they played action cards, the delay between the decision and effect in the game resulted in miscalculations regarding the stockpile size (i.e., what is in demand early in the war may not be a

high priority item later in the conflict). This resulted in some companies having a surplus of unneeded parts.

**Competing prioritization.** Within the game, players made different prioritization decisions independently of each other when handling orders and choosing where delinquencies would be created (e.g., “first in, first out” versus “spreading the damage”). This resulted in downstream tiers having a surplus of components that they could not fully use and others having a deficit of them, causing a bottleneck. These differences occurring in a simple supply chain suggest that the problem will only be magnified as more products compete for parts upstream in the supply chain.

**Everything is a bottleneck, but some bottlenecks are worse than others.** At the onset of both the CW contingency and LSCO, all tiers faced increased demand for which they were unprepared, with demand peaking five to seven times greater than competition demand. This in turn saw delinquencies pile up across all tiers because they were unable to meet the orders that had been placed by DLA and, by extension, the tiers downstream from them. In discussions, vendors said that some bottlenecks (e.g., hiring new staff) might last weeks or months; however, some specialized industrial equipment can have lead times of more than a year to acquire.

**There is no cure-all for bottlenecks.** There is no panacea for addressing C&T IB supply chain bottlenecks while leaving the demand unchanged. Different vendors had unique challenges and policy interventions vary based on their specific needs. Industry players generally struggled to down-select to the number of action cards allowed within the wargame. Frequently, industry players would comment that what one company or tier suggested did not make sense for their company or tier. We did not explore the effects of reducing the variety of items ordered from DLA.

## *IB observations*

**Natural soft landing post-conflict.** Vendors experienced sharp drawdowns in Operation Iraqi Freedom and Operation Enduring Freedom, which resulted in hesitancy by C&T IB vendors when considering surging for another conflict. This hesitation may have contributed to players not chasing the demand. Within the wargame, the accumulation of delinquencies resulted in significant backorders at the end of the LSCO. During discussion, industry players considered how DLA might extend order due dates to create a natural soft landing. A soft landing contrasts with an abrupt decrease in demand that necessitates drastic changes to an IB partner’s business, such as laying off staff or shutting down a production line.

**Service-specific uniforms with complicated components lead to manufacturing inefficiencies.** Both government and IB participants argued that some aspects of service-specific utility uniforms, such as the orientation of their pockets, slow the manufacturing process. This happens when a cut-and-sew manufacturer must switch between assembling two services’ uniforms. Differences in pocket orientation require resetting sewing equipment and, in some cases, retraining workers. Another example is variations in camouflage patterns between services, which can lead to supply chain bottlenecks given the small number of domestic vendors that print camouflage fabrics.

**A collaborative IB.** The dynamics in the C&T IB are more collaborative than competitive, particularly with the prime vendors. Players consider this collaboration a symptom of an industry struggling to remain viable. Throughout the wargame, we heard about vendors subcontracting orders from other vendors to prevent them from going delinquent or selling unused raw materials. When we raised this with some of the participants, they noted that this industry is a fraction of its former size in terms of the number of vendors currently in the IB.

## Recommendations

### *Analysis of the C&T supply chain*

**Assessment of IB ramp-up rates.** DLA troop support should perform analysis to understand how quickly companies can ramp up and understand where limited resources would be most effectively applied in a surge. Participants noted that although there may be solutions to these delinquencies, each company's structure and cash on hand dictated that no one policy would solve all the companies' (across all the tiers) problems. This analysis should identify which companies can ramp up fastest in a contingency that DLA could leverage. We anticipate that the companies that can ramp up most quickly will be the last companies to have equipment and staffing bottlenecks when demand surges, although they may still experience material bottlenecks from upstream dependencies.

**Analysis to identify components to stockpile.** DLA should consider policies to stockpile critical components throughout the supply chain. This should be paired with analysis to understand the optimal distribution of stockpiled components or uniform priorities throughout the supply chain. We recommend DLA focus first on single- and sole-source vendors for this analysis.

Analysis of uniform commonality opportunities. Commonalities among utility uniforms can increase manufacturing efficiency and reduce bottlenecks; however, uniform design is the purview of each service and is a sensitive issue. We therefore recommend that DLA conduct an analysis of the uniform commonality changes that would lead to the greatest increases in manufacturing efficiency for IB vendors. Such an analysis can help DLA and IB vendors target advocacy for uniform commonalities with the greatest potential to increase IB manufacturing efficiency.

### *Reduce known bottlenecks in supply chains*

**DLA should create a robust stockpile of critical components** available to C&T IB vendors. Stockpiling only GFM or VMI is not enough—DLA needs to reevaluate how active it should be within higher tiers of the C&T supply chain. In an industry in which there are single- or sole-source supplies and DLA establishes VMI just to make the industry run, DLA should closely examine how more government engagement could benefit companies higher in the supply chain and create greater efficiencies. We are unsure how to prioritize individual components, but people who currently prioritize materials within DLA may have established practices that can be applied to the C&T IB.

**DLA should consider modifying current and future contracts to allow vendors to follow DLA direction and fill the most in-demand orders first.**

The government needs visibility when multiple items compete for components or materials produced by the same vendor (with limited resources for production) and must have a process to prioritize items. DLA noted that although it tracks items for which there is competing demand, such as zippers or other single-source items, it does not currently have a way to deconflict these items within the current contract framework. This would in theory require a clause to excuse delinquencies or another mechanism that does not penalize vendors that are moved to a lower priority. One possible solution would be for DLA to pay for the items that were able to be delivered and then direct the vendor whose order was placed on hold to pivot their lines to another higher priority item or produce at a lower rate. An example of this was seen during the ramp-down of the CW scenario when the LSCO was ramping up. During this overlap period, the CW supply chain was competing directly with the IHWCU production for bolts of cloth. Although DLA would need to refill

its stockpile of CW parkas for future scenarios, it is possible that CW parka producers could fulfill a more pressing priority.

### **DLA and services stabilize current-day demand.**

We recommend that DLA work to establish a stable rate over time for its orders to reduce large fluctuations. DLA indicated that its demand from the services is not always accurate, and services can change requirements. This in turn limits DLA's ability to provide stable long-term demands to the C&T IB. Industry participants chose to establish a stable rate of production during the scenario contingencies rather than follow demand oscillations. Participants also noted throughout the game that when faced with inevitable delinquencies, they are willing to take on delinquencies over hiring and laying off staff rapidly because once the staff is gone, industry perceives a low likelihood that they will return (more so than what is reflected in the game mechanics).

### *Create excess capacity in the C&T IB*

**Consider investing in strategic excess to the domestic C&T IB.** The C&T IB, like any DOD supply chain, is currently built to provide "just-in-time" logistics and therefore is unable to ramp up to meet an immediate demand on the scale that these scenarios required. For example, by the time the CW parka producers were able to ramp up to begin to whittle away at their delinquencies, the scenario was already ramping down and was no longer a priority, as discussed in the previous recommendation. Therefore, we recommend that DLA invest in strategically placed excesses that might benefit the C&T IB in the long term—for example, competitive wages within vendors' markets, adjustments to contract terms, experimenting with stockpiling uniforms (potentially prepositioned in forward locations), and expansion of Title III programs to the C&T IB. DLA should study where vendors might benefit most from excesses and how much excess to provide.

**Consider adding strategic excess through expansion of the Berry Amendment.** The Berry Amendment fundamentally reflects a policy decision by the US government to mitigate risks from an inorganic C&T IB in case of conflict (if uniforms or key components are manufactured by foreign companies, how might supply disruptions from those nations influence US readiness?). The question of whether the Berry Amendment is "good" policy or not is outside the scope of this project. The strengths or weaknesses of the Berry Amendment simply reflect the extent to which US policy-makers are willing to accept risk in case of a contingency. However, US policy-makers should be aware that, based on discussions within this wargame, there are indications that the C&T IB is weaker than it has been in the past. While we have not done a market assessment to confirm this, players indicated that new companies are not entering the DOD C&T market, companies are going out of business, and many companies now have reduced or zero commercial business to support them and rely almost exclusively on DOD contracts.

Player discussion indicated three ways in which the Berry Amendment could be changed to bring about a more robust IB. While DLA does not have direct control over this, DLA may have opportunities to engage with military leadership or Congress on this issue. These opportunities are explained in detail here:

- 1. Strengthen Berry by expanding compliance beyond DOD.** Currently, the Berry Amendment covers only uniform items purchased by DOD. The Homeland Procurement Reform Act increases the requirement for DHS to source uniforms and protective equipment from American manufacturers, but it also allows for purchase of items Canada and Mexico via trilateral trade agreements. If the Berry Amendment were expanded to include uniforms for other federal agencies, it would increase opportunities for the domestic C&T IB and would likely increase the

production capacity of some current vendors. More important, however, expanding Berry beyond DOD would allow vendors to shift away from non-DOD production lines in the event of a crisis.

- 2. Strengthen cost threshold requirements for Berry-compliant end items.** Currently, the Berry amendment provides an exception for purchases at or below \$150,000. However, industry participants indicated that military exchanges circumvent this by placing many small orders below this threshold that in aggregate exceed this threshold. Strengthening this requirement might be accomplished by lowering the cost threshold or conducting audits for compliance to incentivize the purchase of Berry-compliant over non-Berry-compliant products.
- 3. Require military exchange uniform shops to sell only Berry-compliant uniform items.** The Army and Air Force Exchange Service (AAFES) stocks some combat boots manufactured overseas. Requiring that military exchanges stock only Berry-compliant uniform items in their uniform shops increases the likelihood that servicemembers will purchase Berry-compliant uniformed items. While this issue is currently limited to boots and to AAFES exchanges, it creates the opportunity for additional non-Berry-compliant uniform items to be sold in military exchanges globally.

We recommend that DLA conduct a cost-benefit analysis of each of the above potential opportunities to determine whether they would create sufficient excess capacity in the domestic C&T IB to outweigh any challenges associated with their implementation. Similarly, we recommend that DLA conduct a cost-benefit analysis of other adjustments to the Berry Amendment to create excess capacity in the C&T IB to prepare it for times of national emergency.

# APPENDIX A: SUPPLY CHAIN ENGINE ASSUMPTIONS

The supply chain engine mechanics abstracted the true complexities of real-world C&T supply chains. We made the following assumptions with the intent of simplifying processes for playability without simplifying player decisions. Notably, although players worked through simplified supply chains, they were still challenged by the decisions and processes that are only aggravated as the processes become more complex.

## Demand and timescale

- **Demand does not account for conflict dynamics.** Rates of wear and tear for equipment and the number of personnel using equipment were assumed to be constant. In reality, casualties during conflict will reduce demand, and rates of wear and tear will vary heavily based on the conflict environment and proper use of equipment. For example, some CW gear has special storage requirements to maintain its temperature rating, which personnel using the equipment may not follow.
- **Demand assumes all personnel deployed need all equipment.** This assumption ignores the possibility that services and individuals may have their own equipment that DLA does not track. We do not have data to explore how this would mitigate the demand and assume this would not account for most equipment.
- **Player turns represented three-month time windows.** This timescale was necessary to span the range of time that DLA requested.

## Process simplifications

- **Timelines to award contracts were ignored.** The timeline to award new contracts is a complex process that can take more than a year. We did not expect that industry representatives would be able to have open discussions about costing strategy with their competitors. Effectively, PGCs played within the game represent those that are already on contract and can be further extended during option years; however, increase in demand beyond that listed in surge clauses would require contract modifications or new contracts awarded, which was abstracted within the wargame.
- **Sizes (and associated complications) were ignored.** Each PGC is associated with numerous national item identification numbers (NIINs) representing specific item sizes. For example, PGC 04039 (hot-weather Army boots) have 116 associated NIINs, each of which would have an associated order. This normally introduces challenges in supply chain forecasting. For example, smaller items require less material than larger ones, and as personnel go through boot camp, sizes may change.
- **Forecasting of future demand from services was removed from play.** Pregame research indicated that the C&T IB does not trust or rely on DLA forecast information to make decisions.
- **Quality control of products to meet DLA standards was not included.**

- **All items behaved equally.** Within the wargame, the timeline to ramp up production lines for fasteners was the same as that of ingots, uniforms, bolts of cloth, etc. In reality, conversations with industry participants indicated that some items are already known bottlenecks. However, we chose to remove this restriction because it would force a chokepoint and potentially influence prioritization decisions.
- **Tier 3 (raw materials) had no requirement for input materials.**
- **Production requirements were simplified for gameplay.** For example, a boot production line (not played in the wargame) has more than 20 components, and this was reduced to five to seven components.
- **Commercial lines are not available to pivot to military lines.** The validity of this assumption varies depending upon the industry. Some companies do not have any commercial market to pivot. Those companies that did have commercial industry indicated that they would pivot to military production if legally required but also indicated a strong reluctance because players believed commercial markets would not come back after a conflict (i.e., they could do it once and then go out of business post-conflict). That said, in a wartime scenario, the US has the option to nationalize the C&T industry to increase capacity.

### Total IB capacity

- Selecting only a few products to play within the wargame abstracts the remaining IB and the products being developed on those lines. The IB can potentially pivot low-priority production lines or commercial lines to generate increased capacity. This pivot takes time to accomplish (e.g., retraining staff on new process). Since we did not cap throughput of companies in a tier effectively, hiring staff or getting equipment within the wargame could represent pivoting resources that are not reflected in the game toward products the game focused on. Whether this is feasible depends on two factors:
  - **In a conflict scenario, we assume that the majority of military products are ramping up simultaneously.** This indicates that pivoting production lines that already produce military products will only generate other delinquent lines.

### Staff, equipment, and facilities

- **Hiring, equipment acquisition, and facility size were all combined into one wargame mechanic to change product throughput.** Within the game, this represented approximately two quarters (six months). Based on discussions with industry representatives, this may overestimate the time required to hire staff (six to eight weeks to hire and to train for uniform manufacturers) but underestimates the time required to acquire equipment (short timescales for simple equipment such as sewing machines, but potentially more than a year for boot manufacturing equipment).
- **Tiers did not have a cap on maximum throughput.** Maximum throughput is determined by the limiting factor across materials, staff, equipment, and facility space. For the purposes of the game, implementing a hard cap on one of these (e.g., players can only hire three staff per turn) may have added realism, but we had

no data to support a specific rule (e.g., why three rather than one or five?). Effectively, this eliminated issues with hiring (e.g., how large is the hiring pool?).

- **Staff retention was guaranteed.** This assumption varies between for-profits and nonprofits.
- **Equipment maintenance requirements were not considered.**

## Storage and transport

- DLA SOH was not shown to players but was accounted for in post-game analysis.
- Onsite storage of inputs was not limited.
- Transit time between companies was ignored.

Some companies do not have any commercial market to pivot. Those companies that did have commercial industry indicated that they would pivot to military production if legally required but also indicated strong reluctance because players believed commercial markets would not come back after a conflict.



Source: US National Guard photograph by Staff Sergeant Gail Parnelle.



# APPENDIX B: PSEUDO-CODE FOR DLA SUPPLY CHAIN MODEL

1. Starting conditions
  - a. A company has an inventory of input materials (which may vary between services—e.g., bolts of cloth, thread, and fasteners are service-specific) or wild materials (which are used across all services—e.g., sheep and metal).
  - b. All tiers start with exactly enough materials in inventory to meet the turn's demand (reflecting an ultra-lean supply chain).
  - c. A company has production lines staffed and equipped at integer values to produce an item (e.g., an Army shirt line staffed and equipped to produce six units of Army shirts per quarter)—initial conditions are exact staffing requirements to meet the first turn's demand.
  - iv. Past delinquent orders are tracked and are accounted for during order of needed materials (treat separately from new demand).
2. Per item (for loop)
  - a. Calculate an estimated demand across all tiers before ordering.
  - b. Place orders.
    - i. Read in quarterly demand from excel sheet from DLA for an item to Tier 1 (e.g., Army pants)—this is per company (currently two Tier 1 uniform companies).
    - ii. The following two quarters of demand are also available (in accordance with a three- to six-month lead time from a DO being placed).
    - iii. Based on the following two quarters, an estimate of expected demand of items from Tier 1 to Tier 2 and Tier 2 to Tier 3 can be placed.
3. Use production line to produce and deliver.
  - a. For each tier
    - i. For each item (e.g., Army pants)
      1.  $X = \text{demand plus delinquencies}$
      2. If  $X$  is less than all Inputs (e.g., Input 1 (bolts of Army cloth) AND Input 2 (Army thread) AND Input 3 (fasteners)) and Staffing
        - a. True: Produce  $X$  (Army pants), reduce all materials in inventory by  $X$ . Set delinquencies to 0.
        - b. False: Produce minimum of (all Inputs and Staff), decrease inventory by amount produced, set delinquencies to  $X$  amount produced.
      3. If produced value is less than or equal to  $X$ , update tier inventory receiving goods or update tier inventory receiving goods with  $X$  and difference in current tier.
4. Staffing
  - a. For each tier
    - i. For each company
      1. **Estimate demand:** For each line and product
        - a. Estimate anticipated staff requirements for future deliveries.
        - b. Tier 1 has enough information to calculate this.
          - i. Desired staff next turn = delinquencies now + estimated demand next turn

- ii. Desired staff in two turns =  
delinquencies now + estimated  
delinquencies next turn +  
estimated demand following turn  
(assumes materials are available)
    - c. Tier 2 can estimate demand for next  
turn accurately; however, it will have  
to use an average over this turn and  
the next two to estimate demand  
two quarters ahead.
    - d. Tier 3 will not have an exact demand  
since its current production is to  
meet two quarters ahead—it will  
have to use an average over three  
quarters (current and next two) for  
both values.
  - 2. Scale up:** For each company
    - a. If staff in training station
      - i. If line staff has less staff than  
anticipated next turn demand,  
move staff from training to line.
      - ii. Else do nothing
  - 3. Pivot:** Model shared works across  
supply lines and companies and did  
not include pivot logic reflecting  
gameplay.
  - 4. Layoff:** For each company
    - a. IF staff > expected production next  
turn
      - i. Layoff—reduce staff to  
anticipated production
      - ii. Else do nothing
  - 5. Hire:** For each company
    - a. Hire: If estimated demand in two  
turns is less than staff now, add  
difference to training station  
(training station = training station  
plus difference for this line).
5. Advance timestep and start again

# APPENDIX C: RESERVE AND DRAFT CALL-UP

Table 10 lists the authorized end strengths for the reserves for FY 2023. This table does not include Full Time Support, Active Reserve, or the Active Guard Reserve because they are already on active duty. We were unable to find information about the Inactive Ready Reserve, so it is excluded.

The legal authority to draft citizens expired in 1973, and Congress would need to amend the Military Selective Services Act to authorize the President to induct personnel into the armed forces. Selective service only registers men 18 to 25 years old. Once a draft is implemented, a lottery is conducted, starting with 20-year-old males. If required, additional lotteries are conducted in the following order: 21-, 22-, 23-, 24-, 25-, 19-, and 18.5-year-old males. According to the Selective Service System website, the Selective Service must deliver the first inductees to the military within 193 days from the onset of a crisis and update of the law to authorize a draft.<sup>23</sup>

Table 10 shows the breakout of eligible males for the draft based on FY 2021 Census data. For additional points of reference, 1,857,304 citizens were drafted for the Vietnam war from 1964 to 1973, accounting for 25 percent of the force, and 10,110,104 citizens were drafted in World War II from 1940 to 1946, accounting for 61 percent of the force.

**Table 10. Estimate of males eligible for a draft as of FY21**

Age	Eligible Males
18.5	1,121,076
19	2,225,419
20	2,179,996
21	2,179,996
22	2,179,996
23	2,179,996
24	2,179,996
25	2,246,567

Source: "Age and Sex Composition in the United States: 2020," US Census Bureau, <https://www.census.gov/data/tables/2020/demo/age-and-sex/2020-age-sex-composition.html>.

**Table 9. FY23 Reserve end strength by service**

Services	FY23 Reserves End Strength
USMC Reserve	30,612
US Navy Reserve	46,923
US Army Reserve	160,489
Army National Guard	294,155
Air Force Reserve	63,997
Air National Guard	83,067
Total	679,243

Source: Defense Manpower Profile Report supplemented by CNA databases.

<sup>23</sup> "Return to the Draft," Selective Service System, <https://www.sss.gov/about/return-to-draft/#:~:text=Induction%20of%20First%20Draftees,updated%20to%20authorize%20a%20draft.>

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# ABBREVIATIONS

AAFA	American Apparel & Footwear Association
AAFES	Army and Air Force Exchange Service
ACE	Analytic Center of Excellence
C&T	clothing and textile
CW	cold-weather
DHS	Department of Homeland Security
DLA	Defense Logistics Agency
DLATS	Defense Logistics Agency Troops Support
DO	delivery order
DOD	Department of Defense
DOH	Department of Homeland Security
DPA	Defense Production Act
ECWCS	extreme cold weather clothing system
FPI	Federal Prison Industries
FR	fire-resistant
FY	fiscal year
GCC	Government Contracts Committee
GFE	government-furnished equipment
GFM	government-furnished material
IB	industrial base
IBMC	industrial base maintenance contract
IHWCU	improved hot-weather combat uniform
INDOPACOM	US Indo-Pacific Command
LSCO	large-scale contingency operation
NIIN	national item identification numbers
PGC	procurement group category
R&D	research and development
SOH	stock on hand
USMC	US Marine Corps
VMI	vendor-managed inventory

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## **This report was written by CNA's Operational Warfighting Division (OPS).**

OPS focuses on ensuring that US military forces are able to compete and win against the nation's most capable adversaries. The major functional components of OPS work include activities associated with generating and then employing the force. Force generation addresses how forces and commands are organized, trained, scheduled, and deployed. Force employment encompasses concepts for how capabilities are arrayed, protected, and sustained at the operational level in peacetime and conflict, in all domains, against different types of adversaries, and under varied geographic and environmental conditions.

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