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Contingency Contractor Optimization
Phase 3 Extension, Analyst Tutorial - Contingency Contractor Optimization Tool Prototype

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Analyst Tutorial
Contingency Contractor Optimization Tool Prototype

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Abstract

This tutorial walks the user through analysis examples using the Contingency Contractor Optimization Tool Prototype. The examples are designed to showcase key capabilities of the tool. The main goal of this tutorial is to provide examples of how to use the tool to perform analyses to those users acting in the analyst role. All examples and locations used in the prototype are fictional, but are intended to be realistic. Users reading this manual are expected to have a basic understanding and familiarity with the Contingency Contractor Optimization Tool Prototype.

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NOMENCLATURE

AFB	Air Force Base
CCOT-P	Contingency Contractor Optimization Tool Prototype
DoD	Department of Defense
FTE	Full Time Equivalent
LN	Local National Contractor
MCO	Major Combat Operation
Non-CAAF	Non-Contractors Authorized to Accompany the Forces
TCN	Third-Country National Contractor
TPFDD	Time-Phased Force & Deployment Data
U.S.	United States

1. INTRODUCTION

This tutorial walks the user through analysis examples using the Contingency Contractor Optimization Tool Prototype. The examples are designed to showcase key capabilities of the tool. The main goal of this tutorial is to provide examples of how to use the tool to perform analyses to those users acting in the analyst role. All examples and locations used in the prototype are fictional, but are intended to be realistic. Users reading this manual are expected to have a basic understanding and familiarity with the Contingency Contractor Optimization Tool Prototype.

1.1. Analysis Quick Tips

Here is a list of items to check when looking for the cause of cost increases/decreases.

1. **Check the duration of the mission scenario phases.** Mission scenarios that last longer will cost more, since personnel must be employed longer. (*Analysis Inputs: Manpower Availability & Phase Durations*)
2. **Check the length of mission scenario overlap.** Mission scenario overlap causes a competition for resources. Once military and DoD civilian availability is exceeded, contractors must be hired to fulfill the remaining demand. (*Analysis Inputs: Manpower Availability & Phase Durations*)
3. **Check the policies and manpower business rules.** Policies or manpower business rules that prevent the use of contractors, especially low cost TCN and LN contractors, may drive up the cost if U.S. contractors are the only option. If no contractors are allowed, then the entire workforce demand falls on the military and DoD civilian personnel, and overages (staff shortfalls) may occur. (*Analysis Inputs: Policies & Guidance*)
4. **Check the operational risk settings.** Higher risk settings reduce the number of contractors that are allowed to be included in the manpower mix. When few contractors are allowed, the remaining workforce demand falls on the military and DoD civilians, and overages (staff shortfalls) may occur. (*Analysis Inputs: Risk in Non-Military Personnel*)
5. **Check the personnel requirements.** Each mission scenario has different personnel requirements, which will impact resource demands.
    - Manpower requirements on the *Manpower Availability & Phase Durations* page:
        i. The "Graph: Total Personnel Requirements by Scenario" shows the requirements based on the TPFDD-like data set.
        ii. The "Graph: Required vs Available Personnel by Capability" shows (by capability) personnel requirements versus military availability.
    - Additional support needs on the *Manpower Requirements & Substitutions* page:
        i. The Capability Requirements table shows the TPFDD-only personnel requirements by base and capability.
        ii. The Additional Support Needs table shows additional support needs by base. These additional needs are added to the TPFDD personnel requirements (total requirements = TPFDD requirements + additional support needs). This aggregated value can be seen in the *Assignments* graph under the *Analysis Results* tab.

6. **Check the manpower availability.** Insufficient personnel availability for a given capability and personnel group can lead to overages (staff shortfalls) and/or the use of a more expensive personnel group. Resource availability impacts the ability to meet personnel requirements. (*Analysis Inputs: Manpower Availability & Phase Durations*)

2. ANALYSIS OF PRUSSIA AND NEW GRANADA WARS

The analyses in this section all examine the occurrence of two wars, Prussia and New Granada. There are two major questions in this analysis section:

1. What is the impact of mission scenario overlap?
2. What is the impact of increasing the phase 3 duration?

New Granada is a major combat operation (MCO), has two bases, and will last 84 weeks (21 months). Its peak personnel requirement is 63,512 FTEs* in operational phase 5.

Prussia is a much larger, but shorter, MCO. There are two versions of the Prussia mission scenario in the prototype. "Prussia – Developed" assumes that the U.S. will have access to existing bases in the Prussia region. "Prussia – Austere" assumes that the U.S. will not have access to existing bases and will therefore have to stand up its own bases. Since these two situations have different force requirements due to existing versus austere base conditions, two different mission scenarios were created.

"Prussia – Developed" has two bases and will last 48 weeks (12 months). Its peak personnel requirement is 77,529 FTEs in phase 5.

"Prussia – Austere" has three bases and will last 60 weeks (15 months). Its peak personnel requirement is 77,530 FTEs in phase 5. This scenario's phases 1 and 2 are longer to accommodate the creation of bases.

*FTE requirements by phase for each mission scenario can be viewed on the *Manpower Requirements* page in the View Requirements by Phase table. Select the mission scenario from the dropdown menu. This table only displays the personnel requirements imported from a TPFDD-like data set and does not include values from the Additional Support Needs table.

2.1. Baseline Analysis

Create a baseline analysis with no overlap between the two mission scenarios. This analysis assumes that the U.S. will have access to existing bases in the Prussia region, so the "Prussia – Developed" scenario is used. No overlap is a good baseline for analysis because no overlapping mission scenarios mean zero competition for resources (Figure 1). Therefore, it is easier to see the impacts of overlapping mission scenarios and of increasing phase durations.

All mission scenarios and data are notional.

1. Login as Analyst.
2. Find Baseline 3 "FY 2012 Q1 Baseline" in the Analysis Manager.
3. Click "Start New Analysis."

Scenario Selection:

4. Take note of the analysis ID number. You will need this number later to locate this analysis.

5. Set the title to “New Granada & Prussia Baseline”.
6. Set the description to “Baseline analysis with no mission overlap”.
7. Set the Analysis Type to “Normal”.
8. Add mission scenarios “New Granada” and “Prussia – Developed”.
9. Click “Continue”.

Budget & Costs:

10. Check the “No budget constraints” box.
11. Set the costs for 3rd-Country National (TCN) and Local Nation (LN) contractors. These should be:
    a. New Granada
        i. TCN: $68
        ii. LN: $44
    b. Prussia – Developed
        i. TCN: $68
        ii. LN: $36
12. Click “Continue”.

Manpower Substitutions:

13. Set the substitution values for TCN and LN. These should be:
    a. New Granada
        i. TCN: 85%
        ii. LN: 70%
    b. Prussia – Developed
        i. TCN: 85%
        ii. LN: 75%
14. Click “Continue”.

Manpower Requirements:

15. Set the planning factors under Additional Support Needs (last table on the page). Select each base from the dropdown menu to view the planning factors. These should be:

Iberia AFB - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	5%	0%	80%	5%	0%	0%	10%	20%

Ft. Nasrid - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	0%	0%	90%	0%	0%	0%	12%	15%

Carroll AFB - Prussia - Developed (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	10%	0%	0%	30%	5%	0%	0%	5%	20%

Ft. Hope - Prussia - Developed (War)

Scenarios	Force Support	Battles… Awareness	Force Application	Logistics	Comm… and Control	Net-Centric	Protect…	Building Partnerships	Corpor… Mgmt & Spt
Planning Factors	15%	5%	0%	20%	5%	0%	0%	5%	10%

16. Click "Continue".

Manpower Availability & Phase Durations:

17. Set the values for Manpower Availability. These should be:
    a. No contractor limits (Set Contractor Limits is <u>not</u> checked).

	Military – Active	**Military – Reserve**	**DoD Civilians**	**JCA Totals**
Force Support	350	100	50	500
Battlespace Awareness	2000	500	100	2,600
Force Application	50000	50000	0	100,000
Logistics	10000	7500	900	18,400
Command and Control	500	500	100	1,100
Net-Centric	500	400	75	975
Protection	10000	5000	0	15,000
Building Partnerships	500	0	50	550
Corporate Mgmt & Spt	750	250	100	1,100
	74,600	64,250	1,375	140,225

18. Set the start dates and phase durations to:

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-01-06	2019	4	12	12	12	12	32
Prussia - Developed	2018-01-07	2018	4	4	4	8	8	20

19. Click "Save Changes".

20. Click on “Graph: Total Personnel Requirements by Scenario”. A window will open.
21. Personnel Requirements by Scenario graph should look like Figure 1. It can take a while to load.
    a. Note: “Save Changes” needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    b. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

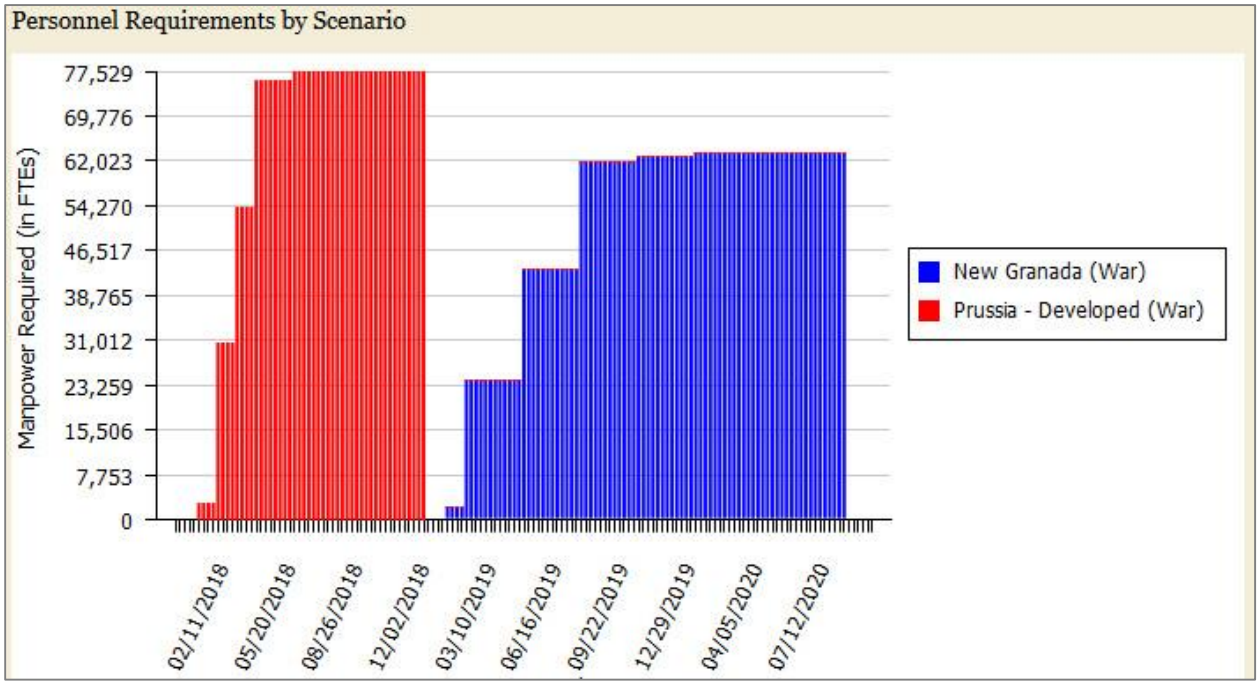


Figure 1. Prussia and New Granada baseline analysis: *Personnel Requirements by Scenario*.

22. Click “Continue”.

Policies & Guidance:

23. Set the following policies:
    a. New Granada:
        i. Iberia AFB: add “No Non-CAAF contractors”
        ii. Ft Nasrid: add “No Non-CAAF contractors”
    b. Prussia – Developed:
        i. Carroll AFB: add “U.S. Personnel Only”
        ii. Ft. Hope: add “U.S. Personnel Only”
24. Click “Continue”.

Risk in Using Non-Military Personnel:

25. Set the risk values.

Mission Scenario	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
New Granada						
Iberia AFB	Medium	Medium	Medium	Medium	Medium	Low
Ft. Nasrid	Medium	Medium	High	High	Medium	Low
Prussia – Developed						
Carroll AFB	Medium	Medium	High	High	Medium	Low
Ft. Hope	Low	Medium	Medium	High	Low	Low

26. Click "Continue: Run Analysis".
27. Click "Run Analysis".

Baseline Analysis Results

Go to the *Manpower Mix* graph under the *Analysis Results* tab. This pie chart shows us that the majority of the manpower mix includes U.S. personnel. Select "Prussia – Developed" in the scenario dropdown. Note that no LN or TCN Contractors are included in the manpower mix. LN may not appear in the legend since both scenarios excluded their use. Select "New Granada" in the scenario dropdown. Note that many TCN Contractors are included in the manpower mix, but no LN Contractors. This makes sense since the selected policies prevented the use of TCN and LN contractors in Prussia (U.S. Personnel Only) and prevented the use of LN contractors in New Granada (No Non-CAAF contractors).

To help us remember which mission scenario occurs first, go to *Assignments by Scenario*. Here we see that Prussia occurs first.

Go to the *Assignments* graph. Set the personnel group menu to "Military – Active", and click through all of the capabilities. You will notice that most of the capabilities are maxed out for the first mission (Prussia) when comparing the max chart values to the Manpower Availability table (below). The second mission (Granada) maxes out Battlespace Awareness, Logistics and Net-Centric. The "Military – Reserve" is maxed out for Battlespace Awareness across both mission scenarios and maxes out for Force Support, Logistics, and Net-Centric during Prussia. Since no LN or TCN Contractors can be used for Prussia, it makes sense that it is heavily reliant on military forces to fulfill the required FTEs.

Table 1. Manpower Availability table. JCAs that hit their max limit in the results are highlighted in green.

	Military – Active	**Military – Reserve**	**DoD Civilians**
Force Support	**350**	**100**	50
Battlespace Awareness	**2000**	**500**	**100**
Force Application	**50000**	50000	0
Logistics	**10000**	**7500**	**900**

Command and Control	500	500	100
Net-Centric	**500**	**400**	75
Protection	10000	5000	0
Building Partnerships	**500**	0	50
Corporate Mgmt & Spt	750	250	100

Go to the *Assignments by Personnel Group*. Set the capability and mission scenario menus to "All". The majority of the requirements are fulfilled by the active and reserve military due to the restrictive policies. Since New Granada allows the use of TCN contractors, those contractors are used instead of U.S. contractors due to their lower FTE cost.

Go to the *Assignments by Capability*. Set the personnel group menu to "Military – Active". This graph shows that the majority of Military - Active are used for Force Application and Logistics. They also fulfill Battlespace Awareness and Protection requirements. Going back to *Policies & Guidance* under the *Analysis Inputs* main tab, the Manpower Business Rules table at the bottom of the page shows usage rules for each personnel group. Force Application can only be performed by the military. Battlespace Awareness cannot by performed by LN or TCN Contractors. Protection cannot be performed by LN Contractors.

Based on the results above, there is an expectation of problems with fulfilling all of the FTE requirements if the missions overlap.

The rest of the analyses to be created will be branches (children) of this baseline analysis. They all use the same parameters as this baseline, with minor modifications. They all examine the occurrence of two wars, Prussia and New Granada, with varying levels of mission scenario overlap and differing phase durations.

2.2. Analysis of Mission Scenario Overlap

These four analyses examine situations where Prussia and New Granada now overlap.

2.2.1. What happens if Prussia and New Granada overlap by 16 weeks?

This analysis will use the same parameters as the baseline analysis, except that Prussia and New Granada overlap by 16 weeks (August-November 2018). This will cause a competition for resources (Figure 2).

All mission scenarios and data are notional.

1. Find your baseline analysis (created in section 2.1. Baseline Analysis) in the Analysis Manager.
2. Click the "Branch" button in the same row as the baseline analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: 16 weeks overlap".
5. Set the description to "Analysis where the two missions overlap by 16 weeks".
6. Click "Continue".
7. Go to tab **Manpower Availability & Phase Durations**.
8. Under Phase Durations, change the start date New Granada:
    a. 2018-08-19
9. Click "Save Changes".
10. Click on "Graph: Total Personnel Requirements by Scenario". A window will open.
11. Personnel Requirements by Scenario graph should look like Figure 2. It can take a while to load.
    a. Note: "Save Changes" needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    a. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

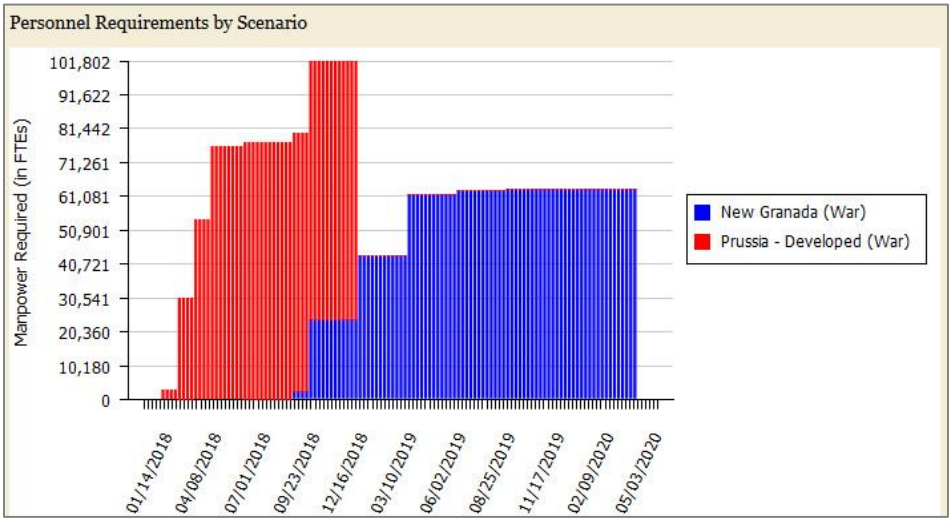


Figure 2. 16 weeks overlap analysis: Personnel Requirements by Scenario.

12. Click "Continue".
13. Go to tab **Risk in Using Non-Military Personnel**.
14. Click "Continue: Run Analysis".
15. Click "Run Analysis".

16 Weeks Overlap Analysis Results

The goal of this analysis is to discover the impact of mission overlap. First, let's compare this analysis to the baseline analysis. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select your baseline analysis. You may need to use the baseline analysis ID number to find it in the dropdown menu. You can compare the manpower mixes side by side. The pie charts don't look very different, but for the overlap analysis, 3% of the FTE requirements are now being fulfilled by Military – Reserve instead of Military – Active.

The use costs table at the bottom of the page shows that for the 16 week overlap:

- less Military – Active were used
- more Military – Reserve were used
- more U.S. contractors were hired

The 16 week overlap causes a $220.2M cost increase. The majority of that cost is due to the increased use of U.S. contractors.

Where is the Military – Reserve/Active swap occurring? What kind of work are the U.S. contractors performing? Select "New Granada" in dropdown menus 3 and 4, then select "Prussia – Developed" in both menus. We can see that the swap is occurring for both scenarios. Set both menus back to "All".

Next, let's investigate which capabilities are most impacted. By clicking through the capabilities, we see the following changes:

- Battlespace Awareness: 9% Military – Active replaced by U.S. Contractors.
- Force Application: 4% Military – Active replaced by Military – Reserve.
- Logistics: 1% Military – Active replaced by U.S. Contractors.
- Building Partnerships – 2% Military – Active replaced by DoD Civilians and U.S. Contractors.

To help us remember which mission scenario occurs first and when the overlap occurs, go to *Assignments by Scenario*. Here we see that Prussia occurs first. Clicking through a few capabilities, we see the overlap occurs August-November 2018.

Go to the *Assignments by Capability* graph. Select "U.S. Contractors" in the menu. They are mainly used for Battlespace Awareness and Logistics in Prussia (policy dictates that TCN and LN contractors can't be used), with their numbers peaking during the overlap weeks. Select "3rd-Country Contractors" in the menu. They are mainly used for Logistics in New Granada (LN can't be used, and U.S. contractors are more expensive). This makes sense since the *Assignments*

graph shows that active and reserve military are fully utilized for Battlespace Awareness and Logistics across both mission scenarios.

We previously expected problems with fulfilling FTE requirements with an overlap. This analysis reveals that there is a strain on military resources with an overlap and that contractors are required to fill the gap.

2.2.2. What happens if no contractors are used?

The increased cost in the 16 week overlap analysis is due to hiring U.S. contractors to backfill Battlespace Awareness and Logistics work because there aren't enough military to fulfill the entire demand. U.S. contractors cost nearly twice as much as military personnel (see the *Budgets & Costs* page under the *Analysis Inputs* tab). Two ways to analyze this issue is (1) to restrict the use of contractors to see the magnitude of the shortfall and (2) to increase the number (availability) of military FTEs. This analysis will address the first idea. The subsequent analysis (section 2.2.3. Will increasing military availability help to reduce the total costs?) will deal with the second.

This analysis will use the same parameters as the 16 week overlap analysis, except that the policy of "No Contractors" will be applied to all bases.

All mission scenarios and data are notional.

1. Find your 16 week overlap analysis (created in section 2.2.1. What happens if Prussia and New Granada overlap by 16 weeks?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: 16 weeks overlap, no contractors".
5. Set the description to "Analysis of 16 week overlap where all bases have the policy "No Contractors"."
6. Click "Continue".
7. Go to tab **Policies & Guidance**.
8. Set the policies:
    a. New Granada
        i. Iberia AFB: add "No Contractors"
        ii. Ft. Nasrid: add "No Contractors"
    b. Prussia – Developed
        i. Carroll AFB: add "No Contractors"
        ii. Ft. Hope: add "No Contractors"
9. All bases should now have two policies.
10. Click "Continue".
11. Go to tab **Risk in Using Non-Military Personnel**.
12. Click "Continue: Run Analysis".
13. Click "Run Analysis".

16 Weeks Overlap, No Contractors Analysis Results

The goal of this analysis is to discover the magnitude of overages (shortfalls) caused by restricting the use of all contractor groups. The *Manpower Mix* chart shows only Military – Active, Military – Reserve and DoD civilians, which is expected since we excluded the use of any contractors. By excluding contractors, we know that there will be shortfalls in meeting all of the FTE requirements.

Go to *Assignments*, which shows overages (shortfalls) if they exist. An overage is an inability to meet demand (staff shortfall). Even though it is not possible to meet the demand, the model tries to identify the cheapest personnel group as if it were possible. The model will always assign the overage to the cheapest personnel group that is allowed to complete the work. In this model run, the Military Active is cheapest of the allowable personnel groups. No contractors can be used for Prussia – Austere, and policies, manpower business rules and risk levels limit the number of contractors that can be used for New Granada. Select "Military-Active" for the personnel group menu. Clicking through the capabilities, we see that overages occur for:

- Force Support
- Battlespace Awareness
- Logistics
- Net-centric
- Building Partnerships

Mouse over the bar chart to view the magnitude of the overages.

Overages occur during the overlap period (August-November 2018), but overages also occur outside of this period. This means that even if the scenarios do not overlap, overages will occur because there is not sufficient DoD staff availability to meet the FTE requirements. Thus, the DoD manpower availability must be increased to meet the demand (analysis in section 2.2.3. Will increasing military availability help to reduce the total costs?), or contractors have to be used.

2.2.3. Will increasing military availability help to reduce the total costs?

The increased cost in the 16 week overlap analysis is due to hiring U.S. contractors to backfill Battlespace Awareness and Logistics work because there aren't enough military to fulfill the entire demand. U.S. contractors cost nearly twice as much as military personnel (see the *Budgets & Costs* page under the *Analysis Inputs* tab). Will increasing the military availability for those two capabilities reduce the need for U.S. contractors, thus reducing the total cost?

This analysis will use the same parameters as the 16 week overlap analysis, except that Active and Reserve Military sizes have been increased for Battlespace Awareness and Logistics (Table 2).

All mission scenarios and data are notional.

1. Find your 16 week overlap analysis (created in section 2.2.1. What happens if Prussia and New Granada overlap by 16 weeks?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: 16 weeks overlap, larger military".
5. Set the description to "Analysis of 16 week overlap where Military is increased by 2,000 FTE in Battlespace Awareness and 4,000 FTE in Logistics".
6. Click "Continue".
7. Go to tab **Manpower Availability & Phase Durations**.
8. In the Manpower Availability table, change the following values:
    a. Battlespace Awareness
        i. Military – Active: 3,500
        ii. Military – Reserve: 1,000
    b. Logistics
        i. Military – Active: 12,000
        ii. Military – Reserve: 9,500

Table 2. Personnel Availability Comparison

16 week Overlap, Larger Military	**16 week Overlap (Comparison)**
Active Military/Battlespace Awareness: 3,500	Active Military/Battlespace Awareness: 2,000
Reserve Military/Battlespace Awareness: 1,000	Reserve Military/Battlespace Awareness: 500
Active Military/Logistics: 12,000	Active Military/Logistics: 10,000
Reserve Military/Logistics: 9,500	Reserve Military/Logistics: 7,500

9. Click "Continue".
10. Go to tab **Risk in Using Non-Military Personnel**.
11. Click "Continue: Run Analysis".
12. Click "Run Analysis".

16 Weeks Overlap, Larger Military Analysis Results

The goal of this analysis was to reduce the use of U.S. Contractors by increasing the availability of active and reserve military. First, let's compare the results of this analysis to the original 16 week overlap analysis. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select the original 16 week overlap analysis (you may need to use the analysis ID number). The use costs table shows a significant decrease in spending on U.S. contractors. Overall, increasing military size decreases the cost by $344M. Also note that the use of Military-Reserve and DoD Civilians decrease in favor of using the lower cost Military-Active.

In the "Select a Model to Compare" menu, select the baseline analysis with no overlap (you may need to use the analysis ID number). By increasing military size for Battlespace Awareness and Logistics, the manpower mix with 16 week overlap almost looks like the manpower mix with no overlap. The 16 week overlap originally increased costs by $220.2M (versus no overlap). Since less U.S. Contractors are needed to backfill for military availability, this analysis decreases costs by $123.8M compared to the no overlap baseline.

Table 3. Comparison of Total Cost for Mission Overlap Analyses

Analysis	Total Cost
Baseline – No mission overlap	$19.2B
16 week mission overlap	$19.4B
16 week mission overlap, larger military	$19.1B

Go to *Assignments by Personnel Group*. Select "Battlespace Awareness" in the capability menu. The graph shows that the majority of this work is fulfilled by the military, with only a very small number of U.S. contractors used during the overlap period (August-November 2018). The graph for Logistics is similar.

Go to *Assignments by Capability*. Select "U.S. Contractors" in the personnel group menu. The graph clearly shows that U.S. contractors are mostly needed during the overlap period. Select "3rd-Country Contractors" from the menu. This graph shows that TCN are needed in New Granada to fulfill Logistics, Net-Centric, Protection and Building Partnership requirements.

2.2.4. What is the impact of relaxing policies?

What if increasing military availability is not possible? Instead of increasing military size, what if the policies are changed so that more TCN and LN contractors could be used? Based on the input FTE costs, TCN and LN contractors are significantly cheaper than U.S. Contractors.

This analysis will use the same parameters as the 16 week overlap analysis, except that the policies have been relaxed. Prussia is now allowed to use TCN contractors (instead of using only U.S. personnel), but LN contractors are excluded. New Granada can now use all personnel groups (instead of excluding non-CAAF contractors).

All mission scenarios and data are notional.

1. Find your 16 week overlap analysis (created in section 2.2.1. What happens if Prussia and New Granada overlap by 16 weeks?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: 16 weeks overlap, relaxed policies".
5. Set the description to "Analysis of 16 week overlap where policies for using TCN and LN contractors are relaxed".
6. Click "Continue".
7. Go to tab **Policies & Guidance**.
8. Remove all existing policies from the mission scenarios and their bases.
9. Set the following policies:
    a. New Granada:
        i. Iberia AFB: Remove "No Non-CAAF contractors"
        ii. Ft. Nasrid: Remove "No Non-CAAF contractors"
    b. Prussia - Developed:
        i. Carroll AFB: Add "No Non-CAAF Contractors"
        ii. Carroll AFB: Remove "U.S. Personnel only"
        iii. Ft. Hope: Add "No Non-CAAF Contractors"
        iv. Ft. Hope: Remove "U.S. Personnel only"
10. Click "Continue".
11. Go to tab **Risk in Using Non-Military Personnel**.
12. Click "Continue: Run Analysis".
13. Click "Run Analysis".

16 weeks Overlap, Policies Relaxed Analysis Results

The goal of this analysis is to discover the impacts of allowing the use of more contractors. First, let's compare this analysis to the 16 week overlap analysis. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select the 16 week overlap analysis (you may need to use the analysis ID number). The manpower mix pie chart shows that more LN contractors are being used instead of TCN and U.S. Contractors. LN contractors are the cheapest personnel group (see the *Budgets & Costs* page under the *Analysis Inputs* tab).

The use cost table shows that all personnel group usage is reduced in favor of using LN contractors. Relaxing the policies to allow LN contractors reduces the total cost by $1.2B.

In the “Select a Model to Compare” menu, select the 16 week overlap, larger military analysis (you may need to use the analysis ID number). The use cost table shows a $877M savings over increasing military size.

Go to *Assignments by Capability*. Select “U.S. Contractors” in the menu. Since LN contractors still can’t be used in Prussia, U.S. contractors are used to backfill Battlespace Awareness work. Select “3rd-Country Contractors” in the menu. TCN contractors are mostly used to backfill Logistics work in Prussia. Select “Local Nation Contractors” in the menu. LN contractors are mostly used to backfill Logistics work in New Granada.

2.2.5. What are the impacts of (1) not having access to existing bases and (2) a longer mission scenario which causes a 28 week overlap?

The prior runs have assumed that the U.S. will be able to use existing bases in the Prussia region. What if that is not the case? This analysis assumes that the U.S. will not have access to existing bases in the region. New bases will have to be created, so the "Prussia – Austere" scenario is used. Phases 1 and 2 for "Prussia – Austere" are longer to accommodate the creation of bases. This causes "Prussia –Austere" scenario to have a longer duration than "Prussia – Developed," which causes the longer 28 week overlap, (August 2018 - February 2019) with New Granada (Figure 3).

This analysis is a branch of the 16 week overlap analysis, except the "Prussia – Austere" scenario replaces "Prussia – Developed". Remember that the policies prevent LN contractors from being used for either mission scenario.

All mission scenarios and data are notional.

1. Find your 16 week overlap analysis (created in section 2.2.1. What happens if Prussia and New Granada overlap by 16 weeks?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: 28 weeks overlap, Prussia Austere".
5. Set the description to "Analysis where Prussia - Austere is used instead of Prussia - Developed, which leads to a 28 week overlap with New Granada.".
6. Click "Continue".
7. Go to tab **Manpower Availability & Phase Durations**.
8. Under Phase Durations, set the following values:

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-08-19	2019	4	12	12	12	12	32
Prussia - Austere	2018-01-07	2018	4	8	12	8	8	20

9. Click "Save Changes".

10. Click on “Graph: Total Personnel Requirements by Scenario”. A window will open.
11. Personnel Requirements by Scenario graph should look like Figure 3. It can take a while to load.
    a. Note: “Save Changes” needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    b. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

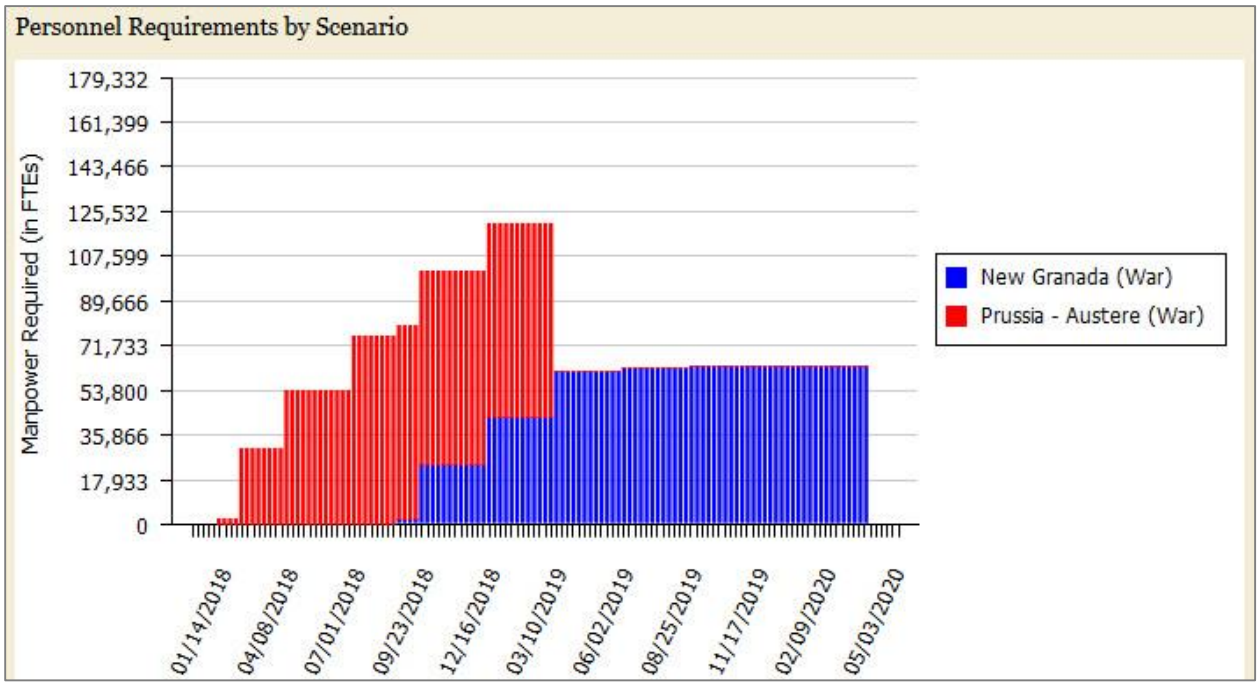


Figure 3. 28 weeks overlap analysis: Personnel Requirements by Scenario.

12. Click “Continue”.
13. Go to **tab Policies & Guidance**.
14. Set the following policies to each of the bases:
    a. Prussia - Austere:
        i. Tazir AFB: add “U.S. Personnel Only”
        ii. Ft. Mitchell: add “U.S. Personnel Only”
        iii. Ft. Hope: add “U.S. Personnel Only”
15. Click “Continue”.

16. Go to tab **Risk in Using Non-Military Personnel**.
17. Set the following values:

Mission Scenario	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
New Granada						
Iberia AFB	Medium	Medium	Medium	Medium	Medium	Low
Ft. Nasrid	Medium	Medium	High	High	Medium	Low
Prussia – Austere						
Tazir AFB	Low	High	High	Extreme	Medium	Low
Ft. Mitchell	Low	Extreme	High	Extreme	Medium	Low
Ft. Hope	Low	High	Medium	Medium	Medium	Low

18. Click "Continue: Run Analysis".
19. Click "Run Analysis".

28 weeks Overlap Analysis Results

First, let's compare this analysis to the baseline analysis. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select your baseline analysis. You may need to use the baseline analysis ID number. The manpower mix shows an increased reliance on U.S. contractors and the Military - Reserve. The use costs table shows increased spending for these two personnel groups. The 28 week overlap and use of austere bases costs an additional $3.9B. The 16 week overlap only cost $220.2M more than the baseline analysis. What is driving the exponential cost increase?

In the "Select a Model to Compare" menu, select the 16 week overlap analysis. The use cost table shows major increases in hiring for U.S. contractors (2/3 of the cost increase) and Military – Reserve (1/3 of the cost increase)

Go to the *Analysis Inputs* tab, and then go to the *Manpower Availability & Phase Durations* page. Click "Graph: Total Personnel Requirements by Scenario" at the top of the page. Compare this graph (Figure 3) to the one from the 16 weeks overlap (Figure 2). "Prussia – Austere" requires personnel for 12 more weeks than "Prussia – Developed" and overlaps with New Granada for 12 extra weeks. Instead of 16 weeks of overlap, the two mission scenarios now have 28 weeks of resource competition (the 16 weeks overlap peaks at ~100,000, and the 28 weeks overlap peaks at ~120,000). With the cap on military availability - even after exhausting the available pool of Military – Reserve - more contractors will need to be hired, and they will need to be hired for a longer period. Since TCN and LN cannot be used in Prussia, U.S. contractors must be hired. Since U.S. contractors are the most expensive personnel group, this is causing an exponential cost increase.

Where are the contractors being used? Go to the *Assignments by Capability* graph under the *Analysis Results* tab. Select "U.S. Contractors" from the menu. They are used to backfill Logistics and some Battlespace Awareness during the 28 week overlap. Select "3rd-Country Contractors" from the menu. TCN can't be used in Prussia, but they can be used to backfill Logistics in New Granada. This is similar to how the 16 week overlap is staffed.

Go to the *Assignments* graph. Select "Military – Active" and "Battlespace Awareness" in the menus. The 2,000 active military FTEs are fully utilized across both mission scenarios. In September 2018, there is a slight overage of 27 FTEs. Mouse over the bar chart to view values. The model will always assign the overage to the cheapest personnel group that is allowed to complete the work. In this model run, the Military Active is cheapest of the allowable personnel groups.

Select "Logistics". Military - Active is maxed out for most of both mission scenarios at 10,000 FTEs. There are large overages in June-August 2018 (10,577 FTEs) and September 2018 (1,673 FTEs). The June-August Logistics overages are surprising since they occur before the overlap period.

Go to the *Assignments by Scenario* graph. Select Prussia from the scenario menu. June-August 2018 occur during the Prussia scenario. Next, go to the *Manpower Requirements* page under the *Analysis Inputs* tab. In the "Additional Support Needs" table, view the tables for each of the bases for "Prussia – Austere". Two of the bases (Tazir AFB and Ft. Mitchell) have extremely large planning factors for Logistics, which makes sense for austere bases that need to be built up. These large support "plus ups" are driving up the Logistics requirements. However, this would lead one to expect overages for most phases of the Prussia scenario, not just at the beginning of the mission scenario.

Go to the *Risk in Using Non-Military Personnel* page. Under "Prussia – Austere", Tazir AFB and Ft. Mitchell have phase 2 and 3 set to High or Extreme. High means only 25% of the workforce is allowed to be non-military. Extreme means none of the workforce is allowed to be non-military. This explains the overages in June-August. The model is forced to use military personnel for 75% of the work during these 12 weeks, and there simply aren't enough personnel available to fulfill the demand. Hence, there are overages in June-September for Logistics and for Battlespace Awareness.

To resolve the overages, the availability of active and reserve military must be increased or the risk in using non-military personnel levels must be reduced to allow for the increased use of DoD Civilians and U.S. Contractors.

2.3. Analysis of Phase Uncertainty

These two analyses examine the impact of varying the duration of phase 3 for Prussia. These analyses assume that the U.S. will have access to existing bases in the Prussia region, so the "Prussia – Developed" scenario is used.

2.3.1. What if Prussia's phase 3 duration is 28 weeks?

The baseline analysis represents the minimum phase 3 duration case (8 weeks). This analysis looks at the maximum phase 3 duration case (28 weeks). In the baseline analysis, the mission scenarios do not overlap. In this analysis, the mission scenarios will overlap by about 16 weeks.

All mission scenarios and data are notional.

1. Find your baseline analysis (created in section 2.1. Baseline Analysis) in the Analysis Manager.
2. Click the "Branch" button in the same row as the baseline analysis.
3. **Scenario Selection** tab: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: Phase 3 28 weeks".
5. Set the description to "Analysis where Prussia's phase 3 is 28 weeks."
6. Under Analysis Type, select "Normal".
7. Click "Continue".
8. Go to tab **Manpower Availability & Phase Durations**.
9. Set Prussia's phase 3 duration to 28 weeks.

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-01-06	2019	4	12	12	12	12	32
Prussia - Developed	2018-01-07	2018	4	4	4	28	8	20

10. Click "Save Changes".

11. Click on "Graph: Total Personnel Requirements by Scenario". A window will open.
12. Personnel Requirements by Scenario graph should look like Figure 4. Personnel Requirements by Scenario graph should look like Figure 3. It can take a while to load.
    a. Note: "Save Changes" needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    b. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

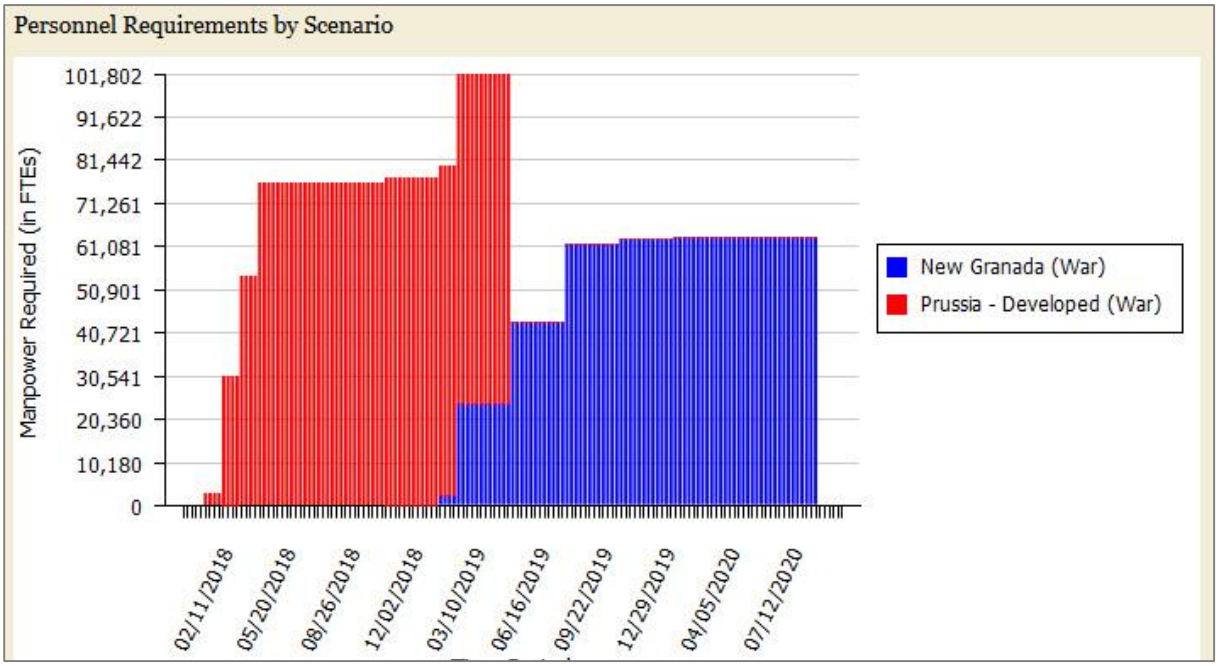


Figure 4. Prussia phase 3 of 28 weeks analysis: *Personnel Requirements by Scenario*

13. Click "Continue".
14. Go to tab **Risk in Using Non-Military Personnel**.
15. Click "Continue: Run Analysis".
16. Click "Run Analysis".

7 Month Phase 3 Duration Analysis Results

The goal of this analysis is to understand the impacts of increasing Prussia's phase 3 duration toe 28 weeks. First, let's compare this analysis to the baseline analysis (created in section 2.1. Baseline Analysis). Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select the baseline analysis. The use cost table shows that extending phase 3 by five months costs $4.1B. The increased cost is due to increased use of the military, instead of a dramatic increase in U.S. contractors like the other examples discussed.

Go to the *Assignments* graph. Set the personnel group to "Military – Active" and click through the capabilities. Even with the five month overlap, there are no overages. There are still sufficient military personnel available to fulfill the increased demand.

Go to the *Assignments by Capability* graph. The graphs show that active and reserve military primarily perform Force Application (which can only be performed by military according to the Manpower Business rules) and Logistics work.

2.3.2. What happens if Prussia's phase 3 duration could last anywhere from two-28 weeks?

The previous analyses assumed that the phase durations are known. What if the exact durations are unknown? What happens if Prussia's phase 3 duration could last anywhere from 8-28 weeks? If phase 3 lasts 8 or 12 weeks, then there will be no overlap. If phase 3 lasts 16 to 28 weeks, then Prussia and New Granada will overlap.

You could run six analyses, increasing the duration of phase 3 by 4 weeks in each subsequent analysis. This situation is not so bad, but if uncertainty is added to two or more phases, then an analysis would have to be created for every combination of phase durations. That's a lot of analyses. CCOT-P allows you to enter a range for the durations of phases 3, 4, and 5. In this analysis, you will be creating an analysis with uncertainty for Prussia's phase 3 duration.

All mission scenarios and data are notional.

1. Find your baseline analysis (created in section 2.1. Baseline Analysis) in the Analysis Manager.
2. Click the "Branch" button in the same row as the baseline analysis.
3. **Scenario Selection**: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Prussia: Phase 3 uncertainty".
5. Set the description to "Analysis where Prussia's phase 3 could last 8-28 weeks."
6. Under Analysis Type, select "Uncertainty of the duration of Phases 3, 4, & 5".
7. Click "Continue".
8. Go to tab **Manpower Availability & Phase Durations**.
9. Under Phase Durations, modify Prussia's Phase 3 duration so the minimum value is 8 and the maximum value is 28:

	Start Date	FY	0	1	2	3-	3+	4-	4+	5-	5+
New Granada	2019-01-06	2019	4	12	12	12	12	12	12	32	32
Prussia - Developed	2018-01-07	2018	4	4	4	8	28	8	8	20	20

10. Click "Save Changes".
11. Note: The "Personnel Requirements by Scenario" graph will only show requirements based on the minimum value for phase durations 3, 4 and 5.
12. Go to tab **Risk in Using Non-Military Personnel**.
13. Click "Continue: Run Analysis".
14. Click "Run Analysis". An uncertainty analysis will take longer to run than a normal analysis as the model must consider all permutations of the phase 3 duration.

Phase 3 Uncertainty Analysis Results
Usually, analysis begins using the *Analyses Comparison* graph. CCOT-P currently only supports the comparison of normal analyses' results.

Since this is an uncertainty analysis, the output graphs don't have the exact same meaning as for normal analyses. All the results graphs (except for Overages) now show lines representing the distribution of results at the 25th, 50th, and 75th percentiles. It is helpful to read about percentiles in section 4.1 Percentiles to better understand the results discussion below.

Go to the *Overages* graph. Clicking through the capabilities, no overages (staff shortfall) are shown for the military. This is good as it means all personnel requirements can be met.

Go to the *Budget Summary* graph. The stacked bar graphs are showing the expected value (section 4.2. Expected Value) of the budget. Since there is a range of durations for phase 3, this will cause a range of budgets. The line graphs show the 25th, 50th, and 75th percentile budgets that can occur. This graph is helpful in showing the range of potential costs that could occur. The graph shows the most volatility in cost is in 2019, when the two mission scenarios would overlap if phase 3 lasts 16 weeks or longer.

- The budgets in 2018 and 2020 are not impacted by uncertainty. This is shown by all three lines converging to the same point in these two years.
- In 2019
    - In 75% of the cases, the total budget would be ~$9B.
    - In 50% of the cases, the total budget would be ~$7.8B.
    - In 25% of the cases, the total budget would be ~ $6.7B

The percentiles help you to understand how much coverage different budget levels will buy (e.g., $8B will cover 50% of the cases; $7B will cover 25% of the cases). The range in budgets is impacted by the phase 3 duration uncertainty. The longer the total mission scenario duration, the longer people will be employed, which increases total cost.

Go to the *Total Assignments* graph. This graph provides an overview of the timeframes and ranges of uncertainty. When only a single line is displayed, this means the percentiles have converged (no uncertainty about the assignment values). There are two places where there is uncertainty (Figure 5): July-September 2018 and January-March 2019.

To which events do these two timeframes correspond?

By looking at the "Total Personnel Requirements by Scenario" graph (Figure 6) under *Analysis Inputs* on the *Manpower Availability & Phase Durations* tab, we can see that the July-September 2018 uncertainty occurs at the start of Prussia's phase 4 and that the January-March 2019 uncertainty occurs at the end of the Prussia mission scenario. This is not surprising as the start date of phase 4 and the end date of the Prussia mission scenario are impacted by the variable length of phase 3. Prussia's phase 5 start date is also impacted by phase 3, but since it has the same FTE requirements as phase 4, the two phases can be thought of as a combined phase. If phase 5 had different FTE requirements, we might see another set of uncertainty bounds for it.

For the July-September 2018

- In 75% of the cases, FTE requirements increase to ~82,000 at the beginning of July. This includes results from the 50th and 25th percentile conditions.
- In 50% of the cases, the increase occurs in August. This includes results from the 25th percentile condition.
- In 25% of the cases, the increase occurs in September

For January-March 2019

- In 75% of the cases, FTE requirements start increasing at the beginning of January with a prolonged spike in February and March. This includes results from the 50th and 25th percentile conditions.
- In 50% of the cases, the increase follows the same pattern as the 75% percentile, but has a very brief spike in February. This includes results from the 25th percentile condition.
- In 25% of the cases, there is no increase. FTE requirements decrease at the beginning of January and then starts to increase again in February.

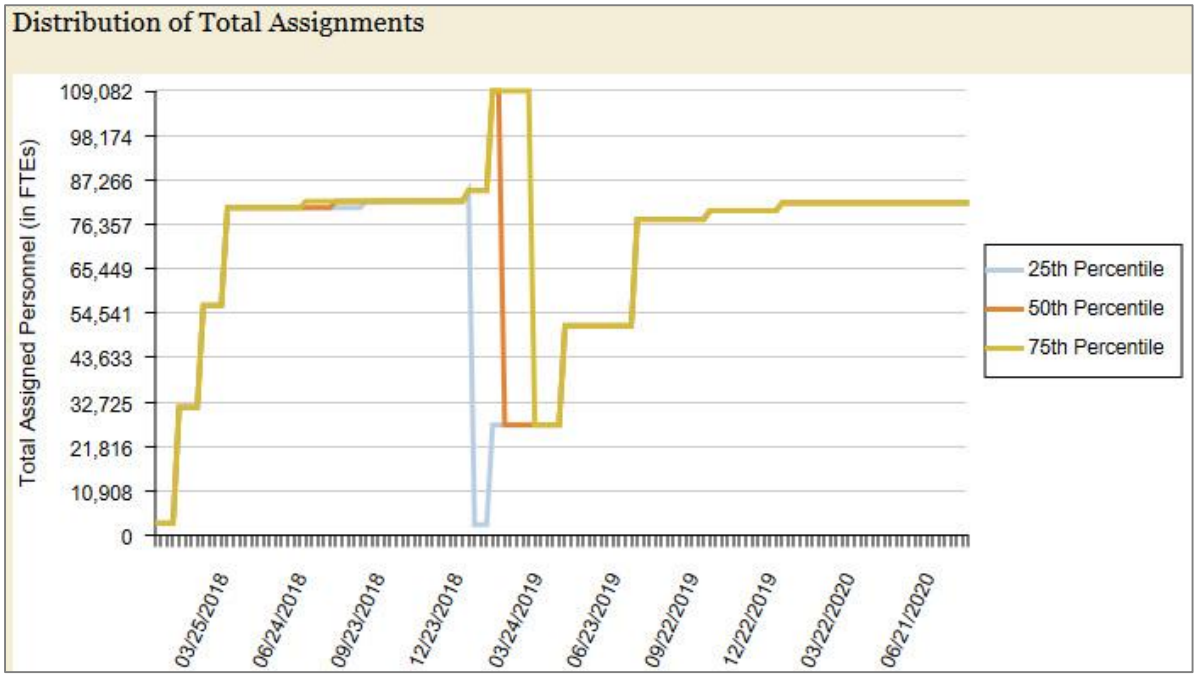


Figure 5. *Distribution of Total Assignments* for Prussia phase 3 uncertainty.

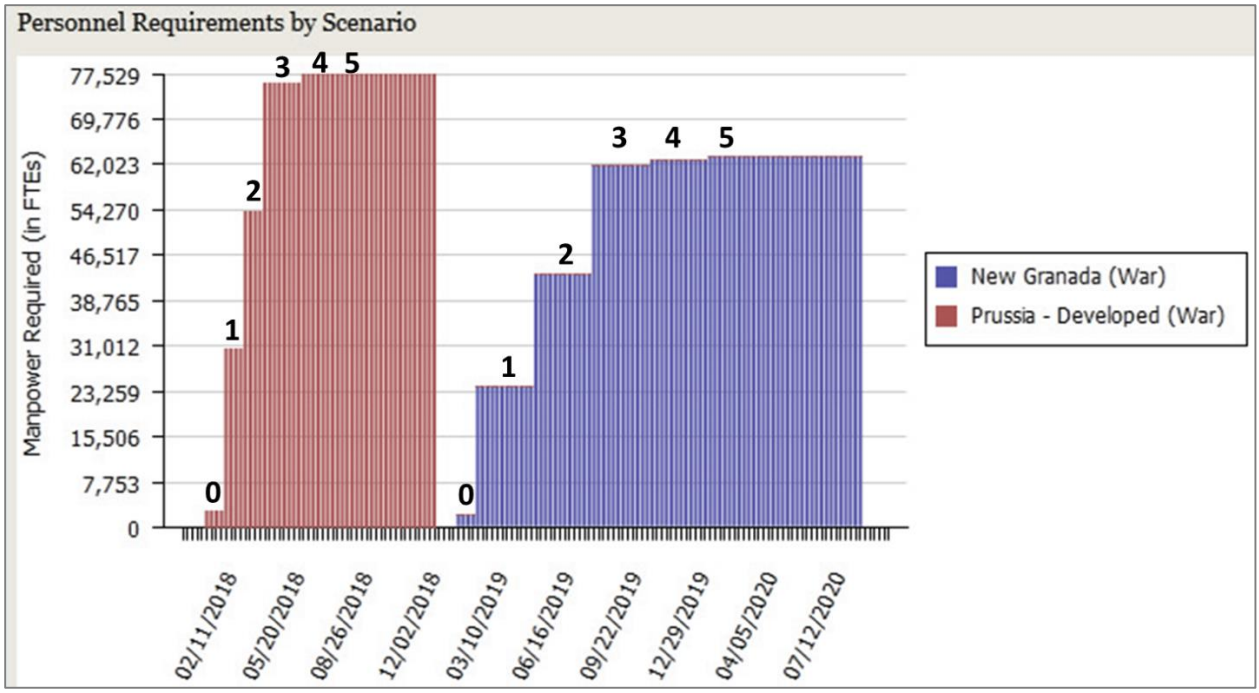


Figure 6. *Total Personnel Requirements by Scenario* with phases marked. This shows the case where Prussia phase 3 is 8 weeks and where there is no mission overlap.

Go to the *Assignments over all Capabilities* graph. Set the personnel group to "Military – Active". This shows the total FTEs assigned to active military over time, across all capabilities (Figure 7). When only a single line is displayed, this means the percentiles have converged (no uncertainty about the assignment values). The three lines do diverge in two places. These are shown in black boxes in Figure 7.

There is minimal impact to active military assignments in July-September 2018. Let's explore the January-March 2019 uncertainty, since there is a significant difference in the lines. This is due to the end date of the Prussia mission scenario being impacted by the phase 3 duration uncertainty.

- In 25% of the cases, the military FTEs decrease off significantly in January, and then rebound in February. This represents the cases where there is minimal to no overlap of the two mission scenarios. Remember that for the shortest phase 3 duration, Prussia will end in December 2018. New Granada begins in January 2019, but requires minimal military FTEs until February (see Figure 8).
- In 50% of the cases, the military FTEs decrease in February. This represents the cases with some mission scenario overlap, in addition to the cases in the 25th percentile condition. Since Prussia is lasting longer, the military FTEs are needed longer.
- In 75% of the cases, the military FTEs don't drop until March. This represents the cases with significant mission scenario overlap, in addition to the cases in the 25th and 50th percentile conditions. For the longest phase 3 duration, Prussia will end in April 2019. Once again, Prussia's increased duration means the military FTEs are needed longer (see Figure 9).

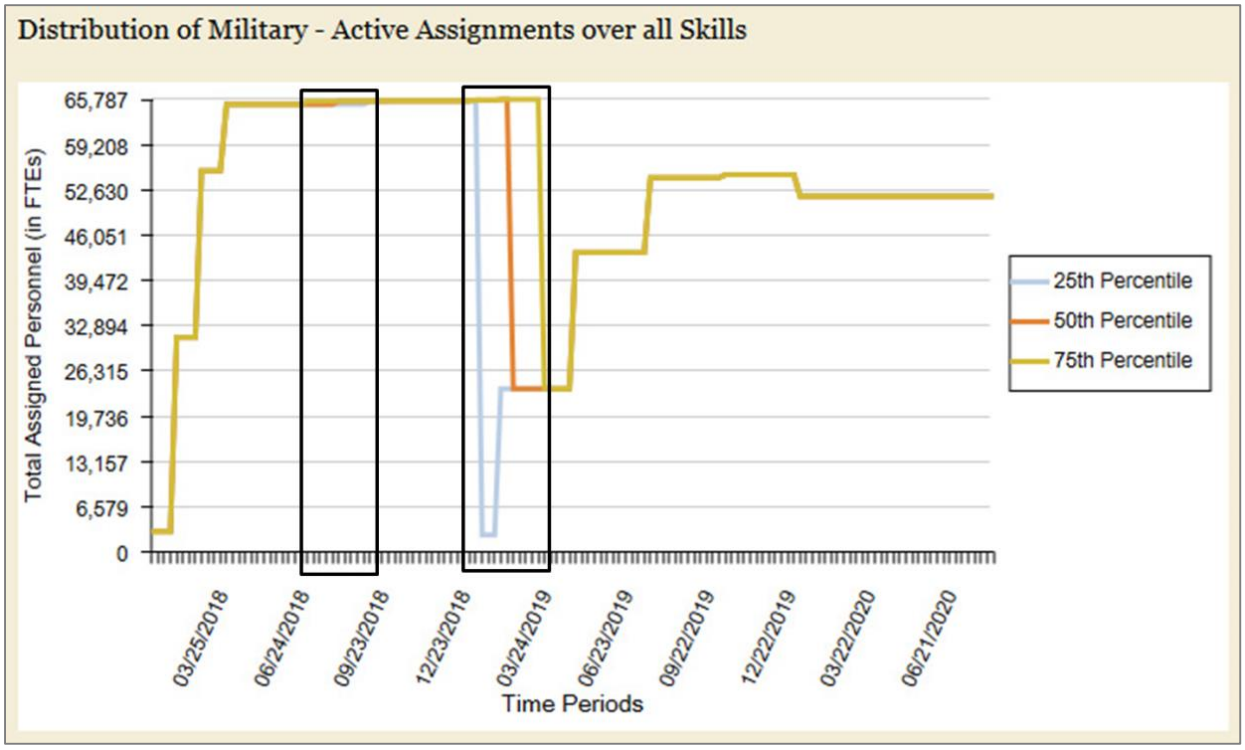


Figure 7. Distribution of Military – Active assignments with Prussia phase 3 uncertainty.

Figure 8 and Figure 9 are presented for comparisons to see how the degree of mission scenario overlap impacts military assignments. The scales of the three graphs are similar, so it's easy to visually compare them. Remember that the Prussia scenario starts in January 2018, and the New Granada scenario starts in January 2019.

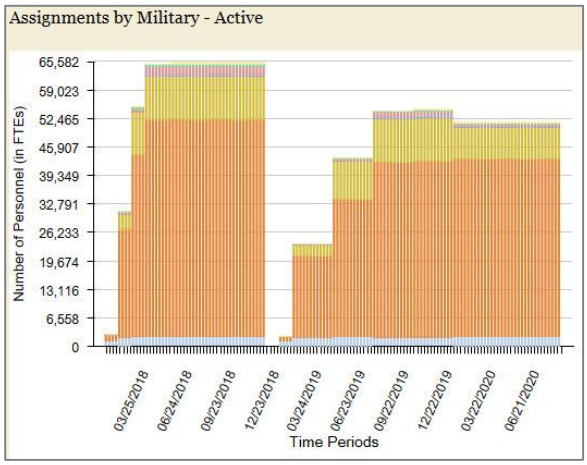


Figure 8. Military-Active assignments for Prussia phase 3 of 8 weeks (baseline analysis)

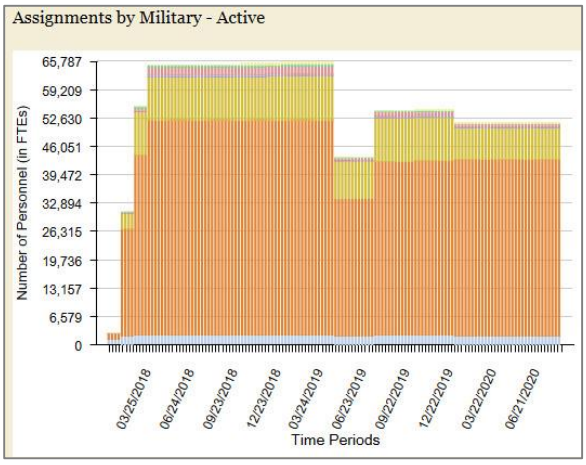


Figure 9. Military-Active assignments for Prussia phase 3 of 28 weeks (example from section 2.3.1. What if Prussia's phase 3 duration is 28 weeks?).

Now set the personnel group to "U.S. Contractors". This shows the total FTEs assigned to U.S. contractors over time, across all capabilities (Figure 10). You will notice that U.S. contractors are primarily used for Prussia. This is because the "U.S. Personnel only" policy was applied to

Prussia, so the less expensive LN and TCN contractors could not be used. The three lines diverge in the same two places as for active military: July-September 2018 and January-March 2019 (shown in black boxes in Figure 10).

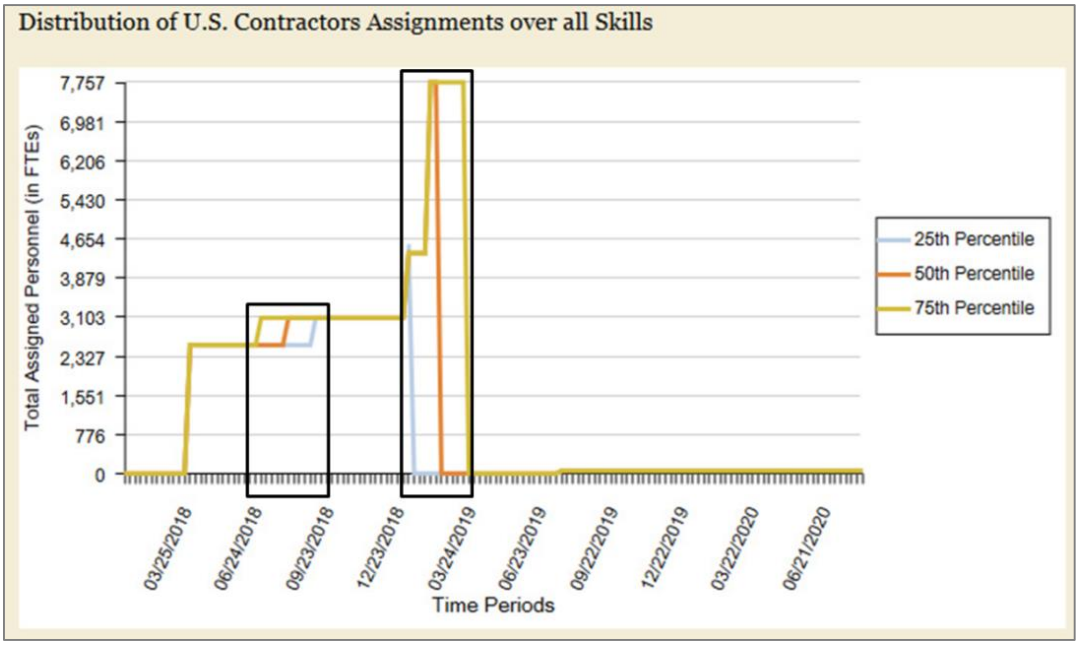


Figure 10. Distribution of U.S. Contractors assignments with Prussia phase 3 uncertainty.

The July-September 2018 uncertainty occurs due to the phase 3 duration uncertainty impacting the start of phase 4, when the U.S. contractor demand increases by ~700 FTEs (Figure 10):

- For 25% of the cases, demand increases in September when phase 4 begins for the cases with the longest phase 3 durations.
- For 50% of the cases, demand increases in August when phase 4 begins for the cases with intermediate phase 3 durations, in addition to the cases in the 25th percentile condition.
- For 75% of the cases, demand increases in July when phase 4 begins for the cases with the shortest phase 3 durations, in addition to the cases in the 25th and 50th percentile conditions.

For the January-March 2019 uncertainty (where the Prussia end date is impacted by the phase 3 duration uncertainty):

- In 25% of the cases, the U.S. contractor FTEs peak at ~4,500 and drop off in January. This represents the cases where there is minimal to no overlap of the two mission scenarios. Remember that for the shortest phase 3 duration, Prussia will end in December 2018. New Granada begins in January 2019, but requires minimal U.S. contractor support (see Figure 11).
- In 50% of the cases, the U.S. contractor FTEs briefly peak at ~7,700 and drop off in February. This represents the cases with some mission scenario overlap, in addition to the cases in the 25th percentile condition. Recall that Prussia can only use U.S. personnel, so U.S. contractor support increases to backfill for the active military FTEs that must now support two missions.
- In 75% of the cases, the military FTEs have a longer peak at ~7,700 and drop off in March. This represents the cases with significant mission scenario overlap, in addition to

the cases in the 25th and 50th percentile conditions. For the longest phase 3 duration, Prussia will end in April 2019. Once again, Prussia's increased duration means the U.S. contractor FTEs are needed longer (see Figure 12).

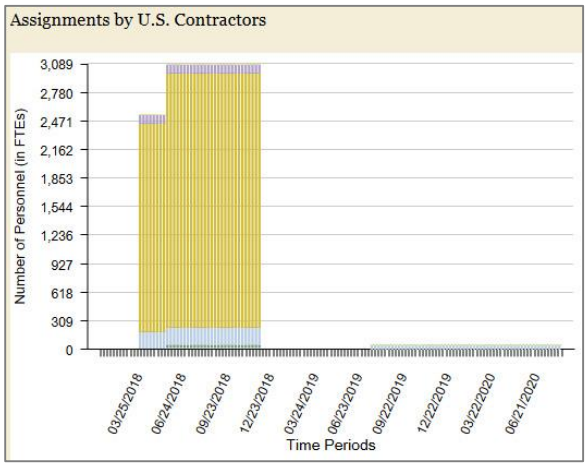


Figure 11. U.S. Contractors total assignments for Prussia phase 3 of 8 weeks (baseline analysis). Max value is ~3,300 FTEs.

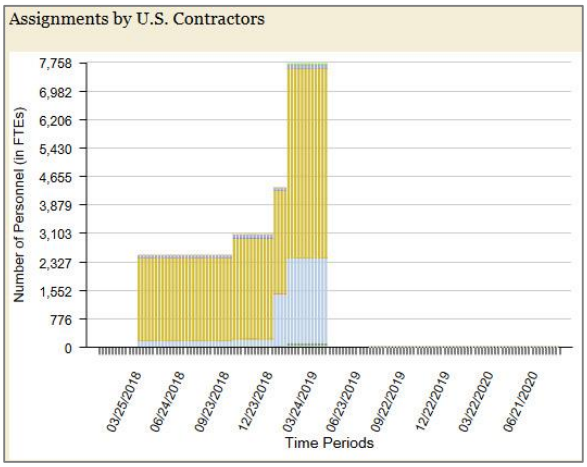


Figure 12. U.S. Contractors total assignments for Prussia phase 3 of 28 weeks (example from section 2.3.1. What if Prussia's phase 3 duration is 28 weeks?). Max value is ~7,700 FTEs.

Figure 11 and Figure 12 are presented for comparisons to the uncertainty graph to see how the degree of mission scenario overlap impacts U.S. contractor assignments. Note that the scales of graphs are different: Figure 11 has a max value of ~3,000, and Figure 10 and Figure 12 have a max value of ~7,700.

The graphs for an uncertainty analysis show a range of outcomes and don't provide a single answer for what is the optimal manpower mix, but they are useful for showing the timeframes and ranges of uncertainty. For planners, this is useful to understand what range of situations they need to be prepared to address and when these events may occur.

In our example, when planning for U.S. contractors, if you decide to use the values in the 75th percentile, you'll cover 75% of the potential cases when phase 3 lasts anywhere from 8 weeks to 28 weeks. However, there is the potential of being overstaffed. Vice versa, if you decide to use the values in the 25th or 50th percentiles, there is the potential of being understaffed.

The above analysis helps you understand the uncertainty around FTE requirements at the personnel group level. To understand which capabilities are required per personnel group, go to the *Assignments by Personnel Group and Capability*. Set the personnel group to "Military-Active" and click through the capabilities. Notice that not all capabilities are impacted by the July-September 2018 uncertainty period.

3. ANALYSIS OF ZAMUNDA AND NEW GRANADA WARS

The analyses in this section all examine the occurrence of a humanitarian assistance mission scenario and a war, Zamunda and New Granada, respectively. There are two major questions in this analysis section:

- What is the impact of increased/decreased evacuee numbers?
- What is the impact of decreasing operational risk of using contractors?

New Granada is a major combat operation (MCO), has two bases, and will last 84 weeks (21 months). Its peak personnel requirement is 63,512 FTEs*/month.

Zamunda is a humanitarian assistance mission scenario response to a civil war. It has one base and will last only 28 weeks. There are two versions of the Zamunda scenario in this prototype. "Zamunda - 100k" assumes that the U.S. will be assisting 100,000 evacuees at the one base. "Zamunda – 50k" assumes that the U.S. will be assisting 50,000 evacuees at the one base. Since the difference in the number of evacuees impacts additional support needed at the base (especially in terms of logistics), two different mission scenarios were created.

"Zamunda – 50k" has a peak personnel requirement of 25,854 FTES/month.

"Zamunda – 100k" is the same as Zamunda – 50k except that it has additional support needs added to the personnel requirements to support the increased number of evacuees.

*FTE requirements by week for each mission scenario can be viewed on the *Manpower Availability & Phase Durations* page under the *Analysis Inputs* tab. View "Graph: Total Personnel Requirements by Scenario" under Page Contents. This graph only shows the personnel requirements imported from a TPFDD-like data set and does not include additional support needs that may have been added on the *Manpower Requirements* page.

3.1. Baseline Analysis

Create a new analysis with mission scenarios "Zamunda – 50k" and "New Granada".

All mission scenarios and data are notional.

1. Login as Analyst.
2. Find Baseline 3 "FY 2012 Q1 Baseline" in the Analysis Manager.
3. Click "Start New Analysis."

Scenario Selection:

4. Take note of the analysis ID number. You will need this number later to locate this analysis.
5. Set the title to "New Granada & Zamunda – 50k Baseline".
6. Set the description to "Baseline analysis with only 50,000 evacuees in Zamunda".
7. Set the Analysis Type to "Normal".
8. Add mission scenarios "New Granada" and "Zamunda – 50k".
9. Click "Continue".

Budget & Costs:

10. Check the "No budget constraints" box.
11. Set the costs for 3rd-Country National (TCN) and Local Nation (LN) contractors. These should be:
    a. New Granada
        i. TCN: $68
        ii. LN: $44
    b. Zamunda – 50k
        i. TCN: $68
        ii. LN: $32
12. Click "Continue".

Manpower Substitutions:

13. Set the substitution values for TCN and LN. These should be:
    a. New Granada
        i. TCN: 85%
        ii. LN: 70%
    b. Zamunda – 50k
        i. TCN: 85%
        ii. LN: 60%

Manpower Requirements

14. Set the planning factors under Additional Support Needs. These should be:

Iberia AFB - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	5%	0%	80%	5%	0%	0%	10%	20%

Iberia AFB - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	5%	0%	80%	5%	0%	0%	10%	20%

Rhodes AFB - Zamunda - 50k (Civil War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	0%	0%	0%	0%	0%	0%	0%	0%	0%

15. Click "Continue".

Manpower Availability & Phase Durations:

16. Set the values for Manpower Availability. These should be:
    a. No contractor limits (Set Contractor Limits is not checked).

	Military – Active	**Military – Reserve**	**DoD Civilians**	**JCA Totals**
Force Support	350	100	50	500
Battlespace Awareness	2000	500	100	2,600
Force Application	50000	50000	0	100,000
Logistics	10000	7500	900	18,400
Command and Control	500	500	100	1,100
Net-Centric	500	400	75	975
Protection	10000	5000	0	15,000
Building Partnerships	500	0	50	550
Corporate Mgmt & Spt	750	250	100	1,100
	74,600	64,250	1,375	140,225

17. Set the start dates and phase durations to:

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-01-06	2019	4	12	12	12	12	32
Zamunda – 50k	2019-08-11	2019	0	0	4	8	8	8

17. Click “Save Changes”.

18. Click on “Graph: Total Personnel Requirements by Scenario”. A window will open.
19. Personnel Requirements by Scenario graph should look like Figure 13. It can take a while to load.
    a. Note: “Save Changes” needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    b. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

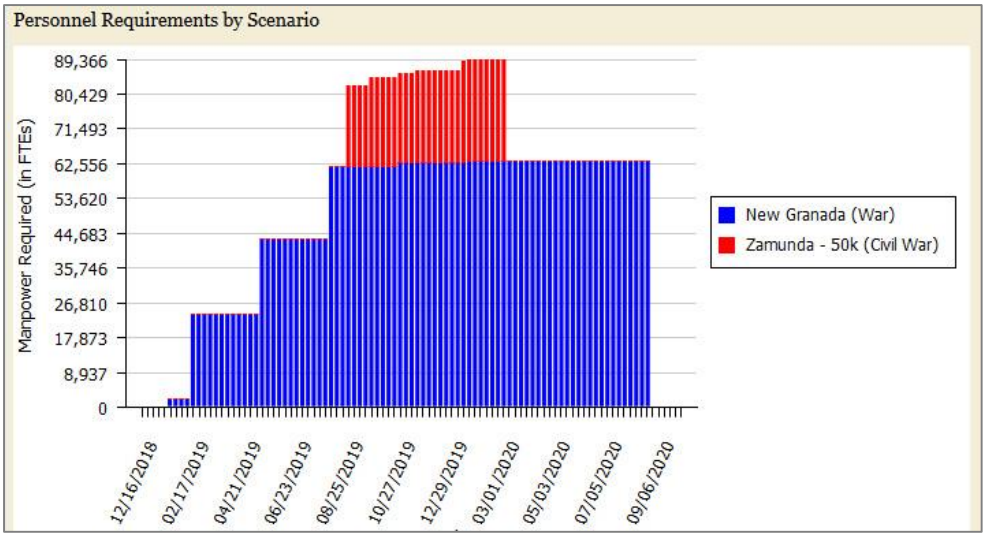


Figure 13. Zamunda & New Granada baseline analysis: Personnel Requirements by Scenario.

18. Click “Continue”.

Policies & Guidance:

19. Add the following policies to each of the bases:
    a. New Granada:
        i. Iberia AFB: add “No Non-CAAF contractors”
        ii. Ft. Nasrid: add “No Non-CAAF contractors”
    b. Zamunda – 50k:
        i. Rhodes AFB: add “U.S. Personnel Only”
        ii. Should already have policy No Non-CAAF contractors
20. Click “Continue”.

Risk in Using Non-Military Personnel:

21. Set the risk values. These should be:

Mission Scenario	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
New Granada						
Iberia AFB	Medium	Medium	Medium	Medium	Medium	Low
Ft. Nasrid	Medium	Medium	High	High	Medium	Low
Zamunda – 50k						
Rhodes AFB	Low	Low	Medium	Medium	Medium	Low

22. Click “Continue: Run Analysis”.
23. Click “Run Analysis”.

Baseline Analysis Results

Go to the *Manpower Mix* graph under the *Analysis Results* tab. This pie chart shows us that the majority of the manpower mix includes U.S. personnel. Select “Zamunda – 50k” in the scenario dropdown. Note that no LN or TCN Contractors are included in the manpower mix, and the majority of the workforce is U.S. Contractors. Select “New Granada” in the scenario dropdown. Note that many TCN Contractors are included in the manpower mix, but no LN Contractors. This makes sense since the selected policies prevented the use of TCN and LN contractors in Zamunda (U.S. Personnel Only) and LN contractors in New Granada (No Non-CAAF contractors).

To help us remember when each mission occurs, go to *Assignments by Scenario*. Here we see that New Granada starts in January 2019, and Zamunda starts in August.

Go to the *Assignments* graph. Set the personnel group menu to “Military – Active”, and click through all of the capabilities. You will notice that overages occur for Logistics. An overage is an inability to meet demand (staff shortfall). Even though it is not possible to meet the demand, the model tries to identify the cheapest personnel group as if it were possible. The model will always assign the overage to the cheapest personnel group that is allowed to complete the work. In this model run, the Military Active is cheapest of the allowable personnel groups (remember TCN and LN cannot be used in Zamunda). The “Military – Reserve” is maxed out for Force Support, Battlespace Awareness, Logistics, and Net-Centric during the mission scenario overlap period (August 2019 – February 2020).

What is causing the overage? Go to the *Manpower Availability & Phase Durations* page under the *Analysis Inputs* tab. Click on the link “Graph: Required vs Available Personnel by Capability” at the top of the page. This graph shows how resource requirements compare to military availability. Set the menu to “Logistics”. The Logistics overage occurs during the overlap period. Why not hire more contractors to fulfill the demand for this capability? The risk settings on *Risk in Using Non-Military Personnel* is limiting the number of contractors that can be hired. The model hired as many contractors as possible (within the contractor risk limitations), and the demand for Logistics still could not be met.

Go to the *Assignments by Personnel Group*. Set the capability and scenario menus to “All”. The majority of the requirements are fulfilled by the active military and TCN due to both mission scenarios excluding the use of LN Contractors. Select Zamunda in the scenario menu. U.S. Contractors are used exclusively in Zamunda due to its U.S. Personnel Only policy. Select New Granada in the scenario menu. New Granada heavily relies on TCN, who are significantly cheaper than U.S. Contractors.

The rest of the analyses to be created will be branches (children) of this baseline analysis. They all use the same parameters as this baseline, with minor modifications. They all examine the occurrence of New Granada and Zamunda.

3.2. Analysis with More Evacuees

The next three analyses examine the situation where 100,000 evacuees require assistance.

3.2.1. What if 100,000 evacuees arrive at the base?

All mission scenarios and data are notional.

1. Find your baseline analysis in the Analysis Manager.
2. Click the "Branch" button in the same row as the baseline analysis.

Scenario Selection:

3. Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Zamunda – 100k Baseline".
5. Set the description to "Analysis where Zamunda evacuees increase to 100,000".
6. Remove scenario "Zamunda – 50k".
7. Add scenario "Zamunda – 100k".
8. Click "Continue".

Budget & Costs:

9. Check the "No budget constraints" box.
10. Set the costs for 3rd-Country National (TCN) and Local Nation (LN) contractors. These should be:
    a. New Granada
        i. TCN: $68
        ii. LN: $44
    b. Zamunda – 50k
        i. TCN: $68
        ii. LN: $32
11. Click "Continue".

Manpower Substitutions:

12. Set the substitution values for TCN and LN. These should be:
    a. New Granada
        i. TCN: 85%
        ii. LN: 70%
    b. Zamunda – 50k
        i. TCN: 85%
        ii. LN: 60%

Manpower Requirements

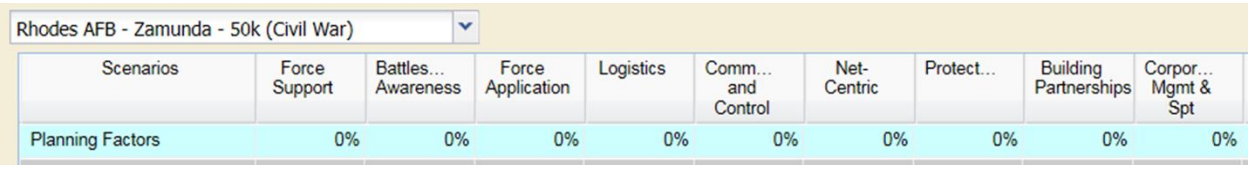
13. Set the planning factors under Additional Support Needs. These should be:

Iberia AFB - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	5%	0%	80%	5%	0%	0%	10%	20%

Ft. Nasrid - New Granada (War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	20%	0%	0%	90%	0%	0%	0%	12%	15%



Rhodes AFB - Zamunda - 50k (Civil War)

Scenarios	Force Support	Battles... Awareness	Force Application	Logistics	Comm... and Control	Net-Centric	Protect...	Building Partnerships	Corpor... Mgmt & Spt
Planning Factors	0%	0%	0%	0%	0%	0%	0%	0%	0%

14. Click "Continue".

Manpower Availability & Phase Durations:

15. Set the values for Manpower Availability. These should be:
    a. No contractor limits (Set Contractor Limits is <u>not</u> checked).

	Military – Active	**Military – Reserve**	**DoD Civilians**	**JCA Totals**
Force Support	350	100	50	500
Battlespace Awareness	2000	500	100	2,600
Force Application	50000	50000	0	100,000
Logistics	10000	7500	900	18,400
Command and Control	500	500	100	1,100
Net-Centric	500	400	75	975
Protection	10000	5000	0	15,000
Building Partnerships	500	0	50	550
Corporate Mgmt & Spt	750	250	100	1,100
	74,600	64,250	1,375	140,225

16. Set the start dates and phase durations to:

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-01-06	2019	4	12	12	12	12	32
Zamunda – 100k	2019-08-11	2019	0	0	4	8	8	8

17. Click "Save Changes".
20. Click on "Graph: Total Personnel Requirements by Scenario". A window will open.
21. Personnel Requirements by Scenario graph should look like Figure 14. It can take a while to load.
    a. Note: "Save Changes" needs to be clicked in any changes are made to start dates or phase durations. Otherwise, this chart will not reflect the changes.
    b. If you view the chart, make changes, click save, and then re-open the chart, the old chart will temporarily be displayed (slightly faded out) as the new data is loaded into the chart. Please be patient as it can take a while to load.

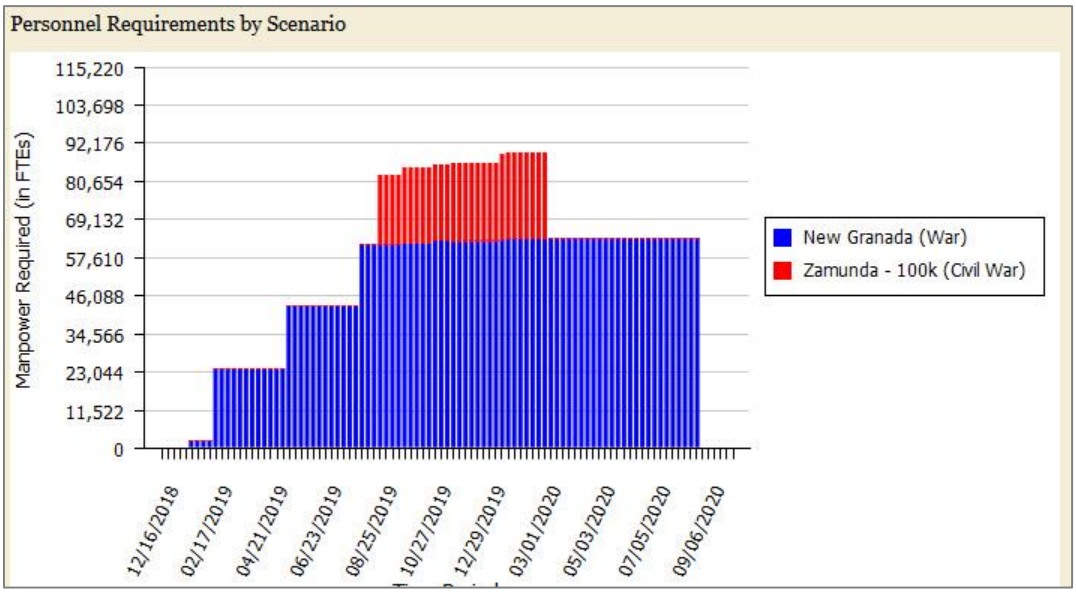


Figure 14. 100,000 Evacuees analysis: *Personnel Requirements by Scenario*

Policies & Guidance:

18. Set the following policies to each of the bases:
    a. New Granada:
        a. No Change. "No Non-CAAF contractors" should already be added to both bases.
    b. Zamunda – 100k:
        a. Rhodes AFB: add "U.S. Personnel Only"
            i. "No Non-CAAF contractors" should already be added.
19. Click "Continue".

Risk in Using Non-Military Personnel:

20. Set the risk values. These should be:

Mission Scenario	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
New Granada						
Iberia AFB	Medium	Medium	Medium	Medium	Medium	Low
Ft. Nasrid	Medium	Medium	High	High	Medium	Low
Zamunda – 100k						
Rhodes AFB	Low	Low	Medium	Medium	Medium	Low

21. Click "Continue: Run Analysis".
22. Click "Run Analysis".

100,000 Evacuees Analysis Results

The goal of this analysis is to understand the impact of an increased number of evacuees. First, let's compare this analysis to the baseline. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select your baseline analysis. You may need to use the baseline analysis ID number. One can compare the manpower mixes side by side. Twice as many U.S. Contractors are needed to support the increased number of evacuees. U.S. Contractors are used because Zamunda has a U.S. Personnel only policy. The table below displays the cost per personnel group. The U.S. Contractors account for the majority of the $1.7B cost increase. Since more evacuees will require more services to support them, it is not surprising that doubling the number of evacuees increases total cost.

Go to the *Manpower Mix* graph under the *Analysis Results* tab. This pie chart shows us that the majority of the manpower mix includes U.S. personnel. This makes sense since the policies prevented the use of TCN and LN contractors in Zamunda and LN contractors in New Granada.

Go to the *Assignments* graph. Select "Military – Active" in the menu and click through all of the capabilities. You will see overages for Force Support and Logistics.

What is causing the overage? Go to the *Manpower Availability & Phase Durations* page under the *Analysis Inputs* tab. Click on the link "Graph: Required vs Available Personnel by Capability" at the top of the page. This graph shows how resource requirements compare to military availability. Set the menu to "Logistics". The Logistics overage occurs during the overlap period. Set the menu to "Force Support". Most of the Force Support overage occurs during the overlap period, but there are still some overages in the final months of New Granada. Why not hire more contractors to fulfill the demand for these two capabilities? The risk settings on *Risk in Non-Military Personnel* is limiting the number of contractors that can be hired. The model hired as many contractors as possible (within the contractor risk limitations), and the demand for these two capabilities still could not be met.

Return to the *Assignments* graph. Select "Military – Reserve" in the menu. You will notice that Force Support, Battlespace Awareness and Logistics are maxed out during the overlap period.

Go to the *Assignments by Capability* graph. Set the menu to "U.S. Contractors". The majority are used for Logistics during the overlap. A small number perform Battlespace Awareness during the same period. They are only employed during the overlap period. Set the menu to "3rd-Country Contractors". The majority are used for Logistics.

Go to the *Assignments by Scenario* graph. Set the menus to "Logistics" and "U.S Contractors". U.S. contractors are only employed for Logistics work in Zamunda. Set the menu to "3rd-Country Contractors". TCN are only employed for Logistics work in New Granada.

Are U.S. Contractors only used in Zamunda? Set the personnel group menu to "U.S. Contractors". Click through the capabilities. U.S. Contractors are used in New Granada for Battlespace Awareness. 15 U.S. Contractors are also used for Building Partnerships in Zamunda, a value that is too small to see on the *Assignments by Capability* graph.

3.2.2. What is the impact of relaxing policy?

The increased cost of supporting 100,000 evacuees in Zamunda is mainly due to exclusively hiring U.S. Contractors, the most expensive personnel group. What can be done to reduce reliance on U.S. Contractors?

This analysis explores the impacts of relaxing policy by allowing TCN Contractors. This analysis will use the same parameters as the previous analysis ("New Granada & Zamunda – 100k Baseline"), but the Zamunda policy will be changed from "U.S. Personnel Only" to "No Non-CAAF Contractors".

All mission scenarios and data are notional.

1. Find your 100k baseline analysis (created in section 3.2.1. What if 100,000 evacuees arrive at the base?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection**: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Zamunda – 100k: Relaxed policies".
5. Set the description to "Analysis of 100,000 evacuees in Zamunda where policies for using TCN contractors are relaxed".
6. Click "Continue".
7. Go to tab **Policies & Guidance**.
8. Set the following policies:
    a. Zamunda – 100k:
        i. Rhodes AFB: remove "U.S. Personnel only"
        ii. The "No Non-CAAF Contractors" policy should already be applied to Rhodes. It is not removable since it was added by the planning manager.
9. Click "Continue".
10. Go to tab **Risk in Using Non-Military Personnel**.
11. Click "Continue: Run Analysis".
12. Click "Run Analysis".

Relaxed Policy Analysis Results
The goal of this analysis is to understand the impact of allowing TCN to be used in Zamunda. First, let's compare this analysis to the Zamunda 100k baseline analysis. Go to the *Analyses Comparison* graph under the *Analysis Results* tab. In the "Select a Model to Compare" menu, select your baseline analysis. You may need to use the baseline analysis ID number. You can compare the manpower mixes side by side. Relaxing the contractor policy has dramatically reduced the use of U.S. Contractors and increased the use of TCN Contractors.

The cost table shows that relaxing the policy decreases cost by $1.9B.

Go to the *Assignments* tab. Select "Military – Active" in the menu and click through all of the capabilities. You will still see overages for Force Support and Logistics. Why didn't relaxing the policy remove the overages? Go to the *Risk in Using Non-Military Personnel* page under the

Analysis Inputs tab. While relaxing the policy now allows TCN contractors to be used in Zamunda, the risk levels for both mission scenarios still cap the number of contractors that can be used during each phase. Relaxing the policy only changed *which* contractors can be used, not the number of contractors that can be used to fulfill capability requirements.

3.2.3. What is the impact of allowing the use of more contractors?

The prior analysis shows that relaxing policy does not remove the overages for Force Support and Logistics. Also, relaxing policy may not be an option. If U.S. personnel must be used in Zamunda, what will be the impact of allowing the use of more contractors? This analysis will use the same parameters as "New Granada & Zamunda – 100k Baseline", but the risk levels will be lowered for some phases. We know that the overages are occurring during the overlap period of the mission scenarios.

On the *Manpower Availability & Phase Durations* tab of the 100k baseline analysis, we see that Zamunda starts during phase 3 of New Granada (Zamunda begins 32 weeks after New Granada). We know that the overages are occurring when the two mission scenarios overlap.

	Start Date	FY	0	1	2	3	4	5
New Granada	2019-01-06	2019	4	12	12	12	12	32
Zamunda – 100k	2019-08-11	2019	0	0	4	8	8	8

On the *Risk in Using Non-Military Personnel* tab, we see that phases 2-4 have the most restrictive risk levels for Zamunda. Risk level Medium only allows 50% of the workforce to be non-military.

Mission Scenario	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
New Granada						
Iberia AFB	Medium	Medium	Medium	Medium	Medium	Low
Ft. Nasrid	Medium	Medium	High	High	Medium	Low
Zamunda – 100k						
Rhodes AFB	Low	Low	Medium	Medium	Medium	Low

This means that to have the most impact, some combination of risk levels for phases 2-4 must be reduced.

All mission scenarios and data are notional.

1. Find your 100k baseline analysis (created in section 3.2.1. What if 100,000 evacuees arrive at the base?) in the Analysis Manager.
2. Click the "Branch" button in the same row as the 16 week overlap analysis.
3. **Scenario Selection**: Take note of the analysis ID number. You will need this number later to locate this analysis.
4. Set the title to "New Granada & Zamunda – 100k: Reduced risk levels".
5. Set the description to "Analysis of 100,000 evacuees in Zamunda where the risk levels of some phases is reduced for both mission scenarios".

6. Click “Continue”.
7. Go to tab **Policies & Guidance**.
8. Check that the following policies are applied:
    a. New Granada:
        i. Iberia AFB: “No Non-CAAF contractors”
        ii. Ft. Nasrid: “No Non-CAAF contractors”
    b. Zamunda – 100k:
        i. Rhodes AFB: “U.S. Personnel Only “
9. Go to tab **Risk in Using Non-Military Personnel**.
10. Set all phases of Zamunda to Low risk.
11. Set Phase 4 for both New Granada bases to Low risk.
12. Click “Continue: Run Analysis”.
13. Click “Run Analysis”.

More Contractors Analysis Results

The goal of this analysis is to understand the impact of allowing more U.S. Contractors. Go to the *Assignments* graph. Select “Military – Active” in the menu and look at Force Support and Logistics. There is no longer an overage for Force Support. The overage for Logistics has been reduced, but there is still a sizable overage. While the contractor risk has been set to “low”, that still only allows 75% of the workforce to be contractors. Logistics demand is so great that it exceeds military availability even with increased use of contractors.

This means risk levels for New Granada phases 2 and 3 will need to be further reduced, which may not be desirable. Another option is to increase (through hiring or training) the number of active and reserve military with Logistics capability to deal with the overage.

4. RESULTS FOR UNCERTAINTY OF PHASES 3, 4 & 5 DURATIONS

The graph results from model runs that include uncertainty of phases 3, 4 and 5 durations are not as straight forward to interpret. The most obvious difference is that the Budget Costs and Assignments graphs are displayed as line graphs instead of simple bar graphs. To better understand the graph results, it helps to understand how the model handles uncertainty.

Current analysis uses predetermined profiles and start dates for each mission scenario. For each mission scenario, you enter a specific start date and a specific duration for each phase. In reality, the exact requirements for executing mission scenarios are uncertain. In this version of the planning tool, you can specify a range of possible durations for phases 3, 4 and 5 of each mission scenario.

Additional insight can be gained when uncertainty is added to an analysis. Without uncertainty, all of the results described in User Manual section 3.2.5 are a single estimate given one possible outcome for the mission scenarios. Uncertainty introduces a range of situations that can occur, and this in turn introduces a range of outcomes.

For example, let phase 3 have a range of 2-7 weeks and phase 4 have a duration of 2 weeks (the minimum and maximum durations are both set to 2 weeks). Instead of solving a single event with fixed values for the phase durations, like in the normal model run, the model has to consider six different events, each one accounting for a different phase 3 duration (Table 4. Event Combinations for Phase 3 Duration Uncertainty.).

Table 4. Event Combinations for Phase 3 Duration Uncertainty.

Event	Phase 3 Duration	Phase 4 Duration
A	2	2
B	3	2
C	4	2
D	5	2
E	6	2
F	7	2

If the phase 4 duration were to vary as well, there would be even more events for the model to solve. Every value of phase 3 would have to be solved with every value of phase 4. For example, let phase 4 now have a range of 2-3 weeks. This results in twelve different events (6 x 2) to solve (**Error! Reference source not found.**).

Table 5. Event Combinations for Phase 3 and 4 Duration Uncertainty.

Event	Phase 3 Duration	Phase 4 Duration
A	2	2
B	3	2
C	4	2
D	5	2
E	6	2
F	7	2
G	2	3
H	3	3
I	4	3
J	5	3
K	6	3
L	7	3

This is just for a single mission scenario. If two mission scenarios have phase duration uncertainty, every variation of the first mission scenario has to be solved with every variation of the second mission scenario. This explains why increasing the uncertainty range for durations makes the model run longer – it increases the number of event combinations to solve.

NOTE: Since the possible number of combinations to analyze can be large, a sampling procedure is used to estimate the uncertainty outputs. A stratified sampling approach is used. This approach was chosen over simple random sampling because it encourages diversity in the sampled durations from each of the mission scenarios. Details on the sampling procedure can be found in Appendix A of *Contingency Contractor Optimization Phase 3, Model Description and Formulation (SAND2013-8788)* [1].

Each of these events will have a different cost. As the phase duration increases, the cost will increase, since you have to pay salaries for longer periods of time. If the mission scenarios overlap, increasing the phase durations in one mission scenario may increase the overlap with the second mission scenario. Increased mission scenario overlap means increased competition for personnel resources. This in turn means that the manpower mix assignments will change as the mission scenario overlap changes in each event. Changes in manpower mix assignments will also impact the total cost.

With all of the variations among the events, a single answer would not accurately describe the entire range of outcomes. This is why the Budget Summary and Assignments graphs show 25th, 50th and 75th percentiles (see section 4.1 Percentiles for explanation) and why the Overages graph shows the likelihood and average size of an overage.

Why do the rest of the graphs show a single outcome like the normal model run results?
The rest of the graphs do have a range of outcomes, but they are displaying the expected value of those outcomes. They do not show the 25th, 50th and 75th percentiles results for two main reasons:

(1) The graphs would be too difficult to read. The Budget Summary and Assignments graphs are showing aggregated results, which require only a single line for the 25th, 50th and 75th percentiles. The other graphs are showing results broken down into personnel groups or capabilities, which would require three lines (25th, 50th, 75th percentiles) per personnel group or capability.

For the Assignments by Personnel Groups graph, there would be three lines (25th, 50th, 75th percentiles) for each personnel group (six total), for a total of eighteen (3x6) lines in the graph. This would be a very busy graph to read. Assignments by Capability would be even worse, with three lines (25th, 50th, 75th percentiles) for each capability (nine total), resulting in twenty-seven (3x9) lines on the graph.

This is why most of the uncertainty graphs display the expected values. While having the 25th, 50th, 75th percentiles information would be beneficial and give analysts a better understanding of the range of uncertainty in the results, the graphs are visually too difficult to decipher.

(2) Uncertainty results cannot be displayed as normalized data. Using the Manpower Mix pie chart as an example, each pie wedge represents a percentage of the total. All of the wedge percentages must sum to 100%. In the normal, deterministic model run, this pie chart represents one single event. In the uncertainty cases, there would be multiple events. Next consider an uncertainty run with six events with the manpower mixes shown in Table 6. Example Manpower Mix Results for Six Events.

Table 6. Example Manpower Mix Results for Six Events.

Personnel Groups	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
Military - Active	50%	50%	55%	53%	60%	60%
Military – Reserve	5%	5%	2%	2%	0%	0%
DoD Civilian	5%	1%	3%	4%	3%	5%
U.S. Contractors	20%	15%	20%	15%	27%	20%
Local National Contractors	5%	15%	20%	6%	7%	5%
Third-Country National Contractors	15%	14%	0%	20%	3%	10%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Based on these six events, the 25th, 50th and 75th percentiles values are shown in Table 7.

Table 7. 25th, 50th and 75th Percentiles Values for the Six Events.

Personnel Groups	25th	50th	75th
Military - Active	50%	54%	60%
Military – Reserve	0%	2%	5%
DoD Civilian	1%	3.5%	5%
U.S. Contractors	15%	20%	27%
Local National Contractors	5%	6.5%	20%
Third-Country National Contractors	0%	12%	20%
Total	**71%**	**98%**	**137%**

These values cannot be displayed in a pie chart because each column will not necessarily sum to 100%.

This issue also applies to the other graphs, which are stacked bar charts on a timeline. Each stacked bar is like a pie chart: all of its segments must sum to 100%. We have shown above that we cannot expect this to be true for the uncertainty runs. Thus, the uncertainty results can't be displayed as stacked bar charts. Only the expected values of the uncertainty results can be displayed as pie charts and stacked bar charts.

4.1 Percentiles

In general, the k^{th} percentile is a value such that approximately k percent of all observations fall below that value [1]. In practice, there are several methods for calculating percentiles. This example uses the Inclusive Percentile function used in Microsoft Excel 2010. Consider the following collection of 11 numbers that represent possible phase 4 durations in weeks:

{5, 16, 40, 45, 46, 53, 57, 63, 70, 85, 97}

The percentiles for each of these values are shown in Table 8 below. Percentiles can be used to understand the distribution of data. Observe that difference between the 20^{th} and 80^{th} percentiles is only 30 units/weeks wide (40-70). This region is narrower than the distance between the 0^{th} and 20^{th} percentile (5-40). This indicates that most of the results are confined to a reasonably small region, with some increased variability on the high and low values.

Table 8. Percentile for Example Case

Percentile	Phase 4 Duration
0^{th} (Min)	5
10^{th}	16
20^{th}	40
30^{th}	45
40^{th}	46
50^{th} (Median)	53
60^{th}	57
70^{th}	63
80^{th}	70
90^{th}	85
100^{th} (Max)	97

This example also illustrates why the 25^{th}, 50^{th} and 75^{th} percentiles are reported in the tool instead of values such as the minimum, maximum, 10^{th} or 90^{th} percentiles. Consider the 100^{th} percentile (maximum). If another data value was observed that had a value of 115, the 100^{th} percentile would change from 97 to 115, whereas the 50^{th} percentile would only change from 53 to 55. In general, when only a small set of samples can be taken, percentiles nearer to the 50^{th} percentile are preferred since they are less variable than those nearer to the 0^{th} or 100^{th} percentile.

4.2. Expected Value

Informally, the expected value of a random variable is the average of all values that the random variable can take. Even more informally, "the expected value is what you expect to happen *on average*" [2]. If all values can occur with equal probability, then the expected value is a simple average. If not, then the expected value is a weighted average, as described below.

> *"Expected value" ... is a mathematical definition that assigns a fixed value to an object whose true value is subject to uncertainty.*
>
> *Suppose an object might be worth either V_1 or V_2 dollars, and suppose the probability is P_1 that it is worth V_1, and P_2 that it is worth V_2. Then the expected value is defined to be*
>
> *$P_1 \times V_1 + P_2 \times V_2$.*
>
> *For instance, suppose you place a bet on a horse that has a 1/10 chance of winning, and the bet pays $100. Then the probability is (1/10) that your ticket will be worth $100 and (9/10) that your ticket will be worth nothing. So, the expected value of the ticket is*
>
> *(1/10) x $100 + (9/10) x 0 = $10.*

Why is $10 a good definition of the value of the ticket? Because if you spent a week at the track and bought, say, 250 such tickets, you'd probably end up winning about 25 times; you'd make $2,500, or $10 per ticket. So, if you were paying more than $10 for each ticket, you'd be a loser; less, and you'd be a winner. [3]

5. REFERENCES

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