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# Contingency Contractor Optimization Phase 3 Sustainment, Platform Requirements Contingency Contractor Optimization Tool - Prototype

Justin D. Durfee, Christopher R. Frazier, Alisa Bandlow, Jared L. Gearhart, Katherine A. Jones

Prepared by  
Sandia National Laboratories  
Albuquerque, New Mexico 87185 and Livermore, California 94550

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Phase 3 Sustainment, Platform Requirements  
Contingency Contractor Optimization Tool -  
Prototype**

Justin D. Durfee, Christopher R. Frazier, Alisa Bandlow, Jared L. Gearhart, Katherine A. Jones  
Operations Research and Computational Analysis  
Sandia National Laboratories  
P.O. Box 5800  
Albuquerque, New Mexico 87185-MS1138



**Contents**

- 1. Scope..... 7
- 2. Platform Requirements ..... 9
  - 2.1. Hardware Requirements ..... 9
  - 2.2. Software Requirements ..... 9
  - 2.3. Network Requirements ..... 10
  - 2.4. Security Requirements ..... 10
- 3. Architecture Overview ..... 11
  - 3.1. Client Tier ..... 11
  - 3.2. Application Tier ..... 11
  - 3.3. Data Tier ..... 12
- 4. Engineering Prototype Specification ..... 13
  - 4.1. Hardware ..... 13
  - 4.2. Software ..... 13
    - 4.2.1 IBM ILOG CPLEX Optimizer License ..... 14
  - 4.3. Network ..... 15
  - 4.4. Security ..... 16
- References ..... 19
- Distribution ..... 21

**Figures**

- Figure 1. CCOT-P Architecture Overview ..... 11



## 1. SCOPE

Sandia National Laboratories (Sandia) is in Phase 3 Sustainment of development of a prototype tool, currently referred to as the Contingency Contractor Optimization Tool - Prototype (CCOT-P), under the direction of OSD Program Support. CCOT-P is intended to help provide senior Department of Defense (DoD) leaders with comprehensive insight into the global availability, readiness and capabilities of the Total Force Mix. The CCOT-P will allow senior decision makers to quickly and accurately assess the impacts, risks and mitigating strategies for proposed changes to force/capabilities assignments, apportionments and allocations options, focusing specifically on contingency contractor planning.

During Phase 2 of the program, conducted during fiscal year 2012, Sandia developed an electronic storyboard prototype of the Contingency Contractor Optimization Tool that can be used for communication with senior decision makers and other Operational Contract Support (OCS) stakeholders. Phase 3 used feedback from demonstrations of the electronic storyboard prototype to develop an engineering prototype for planners to evaluate. Sandia worked with the DoD and Joint Chiefs of Staff strategic planning community to get feedback and input to ensure that the engineering prototype was developed to closely align with future planning needs. The intended deployment environment was also a key consideration as this prototype was developed. Initial release of the engineering prototype was done on servers at Sandia in the middle of Phase 3. In 2013, the tool was installed on a production pilot server managed by the OUSD(AT&L) eBusiness Center.

The purpose of this document is to specify the CCOT-P engineering prototype platform requirements as of May 2016. Sandia developed the CCOT-P engineering prototype using common technologies to minimize the likelihood of deployment issues. CCOT-P engineering prototype was architected and designed to be as independent as possible of the major deployment components such as the server hardware, the server operating system, the database, and the web server.

This document describes the platform requirements, the architecture, and the implementation details of the CCOT-P engineering prototype.



## 2. PLATFORM REQUIREMENTS

Sandia worked to identify the platform requirements of CCOT-P and learned some details about preferred and prohibited hardware and software via a conference call on November 29, 2012 and follow up correspondence with SOUTHCOM IT staff including Gladys York (USSOUTHCOM/ 525<sup>th</sup> Signal Company), Juanita Cox (USSOUTHCOM/ 525<sup>th</sup> Signal Company), and Jody Clemesha (USSOUTHCOM/ 525<sup>th</sup> Signal Company). The discussion was for information gathering purposes only.

During the third quarter of 2013, the decision was made to install CCOT-P on the production pilot server managed by the OUSD(AT&L) eBusiness Center. Sandia worked to identify the new platform requirements through correspondence with eBusiness Center staff, including Integration Team Lead Chris Manor.

This information was incorporated into the Phase 3 and Phase 3 Sustainment development activities and is discussed in this section.

### 2.1. Hardware Requirements

eBusiness Center can be contacted regarding requirements for their physical servers.

As of this writing, CPLEX (the optimization solver) licenses are tied to hardware configuration. Therefore, if there is an upgrade to the server hosting the CPLEX solver, IBM should be consulted for determination of any new licensing requirements. See section 4.2.1 IBM ILOG CPLEX Optimizer License for more details.

### 2.2. Software Requirements

The CCOT-P engineering prototype must implement in software all of the requirements outlined in separate documents titled “Contingency Contractor Optimization Tool Phase 3, Requirements Document” [1] and “Contingency Contractor Optimization Tool Phase 3 Sustainment, Requirements Document” [2].

The CCOT-P engineering prototype must use a linear programming solver that is freely distributable in terms of number of users. While CPLEX is not exactly “freely distributable”, the license is based on the processor hardware and the number of installations. By making CCOT-P a web application, the application invokes the single installation of CPLEX as needed. Thus, the number of users is limited by the load the server can handle.

To be installed on the eBusiness Center’s production pilot server, all CCOT-P code, including third-party software, must pass a security scan. All items marked as “High” or “Critical” by the scan must be corrected, even issues found in third-party software. An exception request (Request For Change form) to the security scan can be submitted for commercial software used by CCOT-P.

The CCOT-P engineering prototype will try not to include any software that is not freely distributable with the exception of software that is reasonably expected to be available in an IT environment, such as Microsoft SQL Server or a similar database. However, due to the required

security scan, in some cases it is preferable to use commercial software instead of free/open source software. It may not be possible to correct “High” or “Critical” issues found in free/open source software.

The CCOT-P engineering prototype must not use MySQL as its database, as that is not typically approved for use on DoD servers.

### **2.3. Network Requirements**

Specific network requirements of the CCOT-P engineering prototype remained undetermined as of September 2013.

### **2.4. Security Requirements**

Originally, eBusiness Center used Single Sign-On (SSO) for user authentication. In 2015, they migrated to EDS/SAML. However, it was cost prohibitive for the project to modify CCOT-P to be in compliance with EDS/SAML. Since CCOT-P will eventually reside on a server outside of the eBusiness Center, we were granted permission to use another authentication method. With agreement from the eBusiness Center, CCOT-P currently uses Tomcat authentication to manage user authentication. The eBusiness Center will be required to manage user access by modifying the *tomcat-users.xml* file as needed. The Tomcat authentication method is described in greater detail in 4.4 Security.

### 3. ARCHITECTURE OVERVIEW

The CCOT-P engineering prototype is implemented with a three-tier architecture, as illustrated below in Figure 1. This architecture minimizes the requirements of the users' desktops, as only a browser is required. A centralized database makes it possible for an administrator and a strategic planner to input and routinely update data for use by multiple analysts and for analysts to share model runs and analysis results. The optimization solver executes on an application server, which can provide more processing power than a typical desktop.

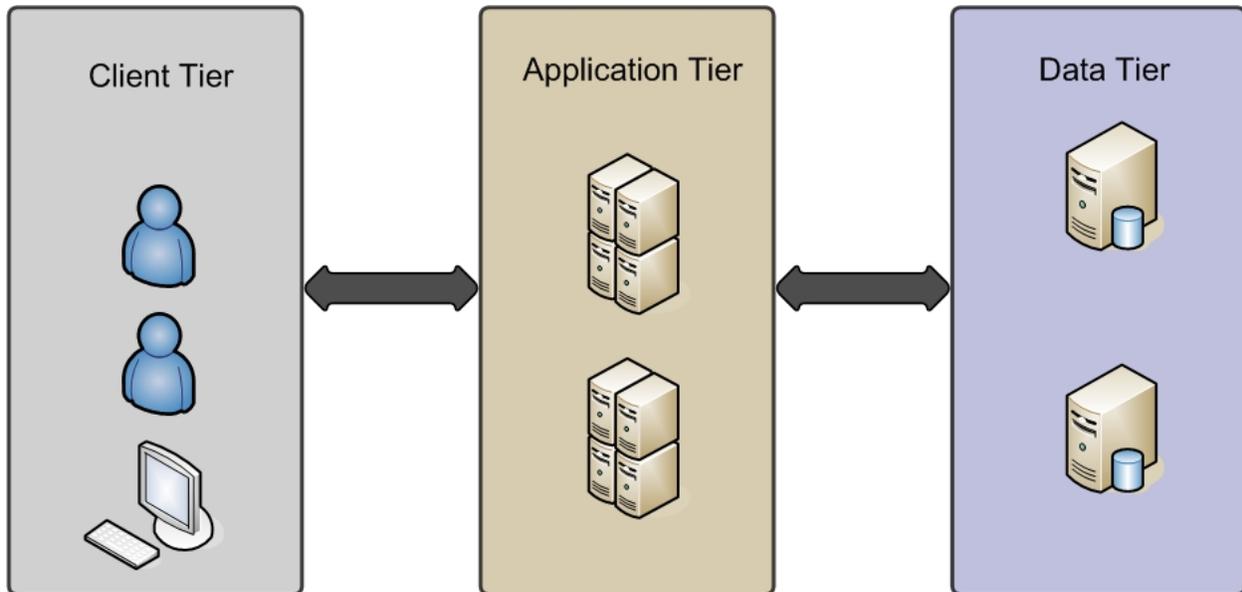


Figure 1. CCOT-P Architecture Overview

#### 3.1. Client Tier

The only component of the client tier is a modern web browser. The engineering prototype currently supports the most common web browsers (including Firefox, Safari, Chrome, and Internet Explorer), although Firefox renders the application best. The application can be tailored to a specific browser if required by the deployment environment.

#### 3.2. Application Tier

The components of the application tier include a Java Runtime Engine (JRE), a servlet engine, a web server (HTTP/HTTPS server), the application code, and an optimization solver. The engineering prototype uses JRE version 1.7, Apache Tomcat version 7, and the CPLEX optimization solver. The application code consists primarily of Java classes, some of which are translated by GWT into HTML/JavaScript for rendering by a web browser.

The engineering prototype uses the commercial CPLEX optimization solver. The purpose of the optimization solver is to solve user-created instances of the CCOT-P optimization model. Instances of the CCOT-P optimization model are created by combining data from the database with the mathematical model. Once created, an instance of the CCOT-P problem is passed to a

server which invokes the CPLEX solver. The output of the solver is written back to the database and displayed to the user for viewing and analysis.

The engineering prototype code has been developed using ordinary Java objects to implement the logic; the Google Web Toolkit, Sencha GXT, and Google Chart Tools to implement a rich client interface; and Hibernate and JDBC to access the database.

*Authentication* is the responsibility of the web server hosting the CCOT-P application. As of this writing, SNL's local installation uses Apache Tomcat and its built-in authentication. The engineering prototype itself provides *authorization* in order to assign users to specific roles (administrator, planner, or analyst).

### **3.3. Data Tier**

The only component of the data tier is a database, which can be hosted on the same server hardware as the application server or on a dedicated server. The engineering prototype uses SQL Server as the database.

## 4. ENGINEERING PROTOTYPE SPECIFICATION

This section provides specific information regarding the implementation of the CCOT-P engineering prototype, including the type of hardware necessary for execution, the software that has been used for development, the software that is necessary for execution, the network ports and protocols used, and how security is currently handled.

CCOT-P is currently installed on the production pilot server managed by the OUSD(AT&L) eBusiness Center.

### 4.1. Hardware

The execution of the solver and the desired level of performance are the primary drivers of the hardware requirements.

- **Servers:** One to three servers will be needed to host the CCOT-P engineering prototype. With one server, the web application, the solver, and the database will be collocated on one server. With two servers, the web application and the database will be located on one server and the solver on the other server. With three servers, the web application, the solver, and the database will all be on separate servers. Specific requirements of and recommendations regarding the characteristics of the servers will be provided. A Windows computer with an Intel Core 2 Quad CPU running at 3.00 GHz with 8GB of RAM has been used to test the solvers and host the CCOT-P engineering prototype and has proven to provide good performance.
- **Desktop:** The CCOT-P engineering prototype can also be installed on a desktop for use by a single user. In this case, the web application, the solver, and the database will be collocated on a desktop. The performance of the prototype will depend upon the desktop hardware. If connected to a network, the desktop should use a firewall to limit access to the database port and web server port to the local host only, unless the intent is to use the desktop as a server to support multiple users.

### 4.2. Software

Sandia is developing the CCOT-P engineering prototype using common technologies in order to be as flexible as possible and to minimize the impact of adjusting to alternate technologies if necessary. The following software packages are required by the current instantiation of the CCOT-P engineering prototype.

- **Operating system:** Windows 7 or newer, or equivalent Windows Server.
- **Java Runtime Environment (JRE):** The web application component of the engineering prototype has been developed using the Java programming language and requires an instance of a suitable Java Runtime Environment for execution. The version of the JRE must be 1.7 or greater.
- **Database:** Microsoft SQL Server. A minimum of SQL Server 2008 R2 must be used.
- **Servlet engine:** Any servlet engine which will pass an authenticated user name to the CCOT-P Java servlet may be used. The default servlet engine is Apache Tomcat. The engineering prototype has been developed and tested with Tomcat versions 7 and 8.

- **Web server:** If an additional web server (such as Microsoft IIS) is desired, any web server that will pass the authenticated user name to the Java servlet engine for use by the engineering prototype may be used.
- **Browser:** Firefox. The most common browsers will be supported, including Microsoft Internet Explorer (IE), Firefox, Chrome, and Safari, but the CCOT-P engineering prototype will be tuned to render the best with Firefox, as it is a mature, stable, cross-platform browser.
- **Solver:** IBM ILOG CPLEX Optimizer. CPLEX is an optimization software package used for linear programs in CCOT-P. As of this writing, CPLEX (the optimization solver) licenses are tied to hardware configuration. Therefore, if there is an upgrade to the server hosting the CPLEX solver, IBM should be consulted for determination of any new licensing requirements. See section 4.2.1 IBM ILOG CPLEX Optimizer License for more details.
- **Third-Party Software:** Additional software required by CCOT-P is detailed in “*Contingency Contractor Optimization Phase 3, Third Party Software*” [3].

#### 4.2.1 IBM ILOG CPLEX Optimizer License

As of this writing, CPLEX (the optimization solver) licenses are tied to hardware configuration. Therefore, if there changes to the system hosting the CPLEX solver, IBM should be consulted for determination of any new licensing requirements.

The licensing requirements for CPLEX is based on hardware used and, in the case of virtual deployments, how the virtual server is set up. The first thing that needs to be determined is the PVU per core rating of the hardware. A PVU (Processor Value Unit) is how IBM measures the performance of a server. The tables IBM uses to determine PVU per core can be found at the following link:

[https://www-01.ibm.com/software/passportadvantage/pvu\\_licensing\\_for\\_customers.html](https://www-01.ibm.com/software/passportadvantage/pvu_licensing_for_customers.html)

CCOT-P requires a web service, a database service and a model run (CPLEX) service. These can all be on the same server or different servers. Ideally, we would put the CPLEX service on a different server from the other two, since it has the most restrictive license.

In order to determine the PVUs per Core, we need to know the number of sockets per server. Once we know the number of PVUs per core, we need to determine the number of available cores. If this were a physical server it would just be the number of cores on the server. For virtual deployments, it is the number of core to which the virtual server has access.

#### Virtual Deployment

For a virtual deployment, the question is whether it is possible to run a one core VM. If this is possible, we would probably want to run the CPLEX service on a one core VM and the web and database services on a different VM (this second server would not have a restriction on the number of cores).

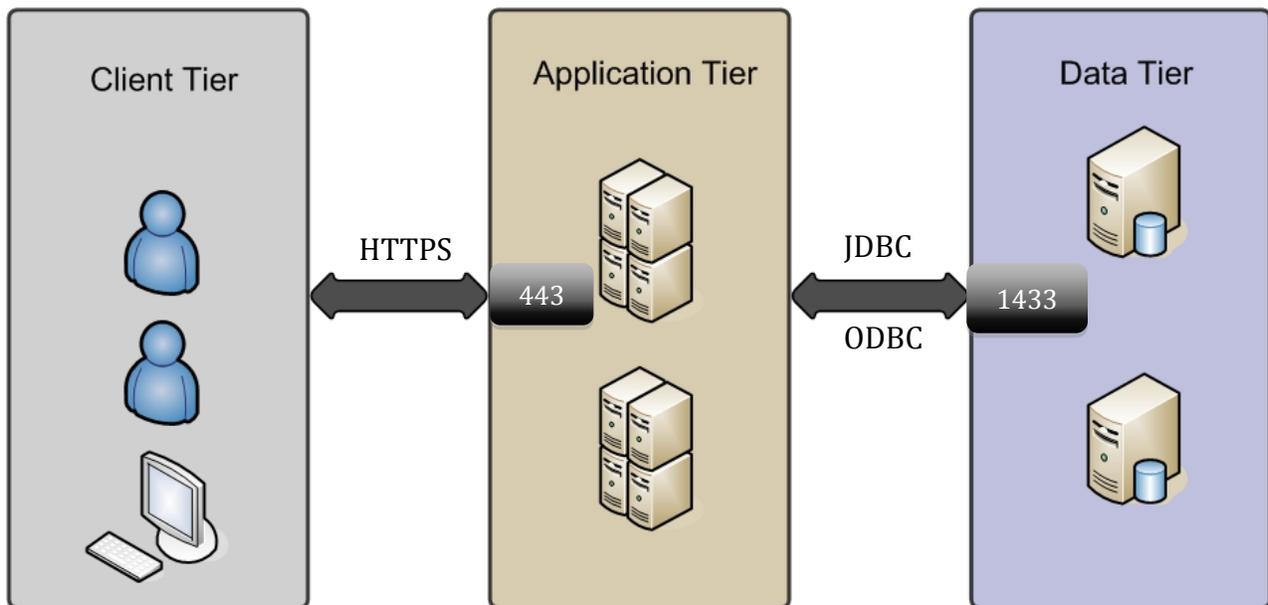
When using IBM products on a virtual server, IBM requires periodic monitoring to make sure that the software only has access to a portion of the cores on the server. This can be done by manually verifying/logging the VM configuration each quarter or automatically by running an IBM product that checks and logs the number of cores available to the VM. For the automatic

method, the software can be configured to automatically send reports to IBM or just log the usage in a text file that is saved locally. The link to the monitoring tool is:

<https://www-01.ibm.com/software/passportadvantage/ibmlicensemetricool.html>

### 4.3. Network

The CCOT-P engineering prototype is being developed using a common web-based architecture in order to minimize the overall network requirements and related security concerns. The actual network requirements and configuration depend heavily on the chosen server configuration as described in the Hardware section above (section 4.2). The following specifications are based on the recommended two-server configuration in which one server hosts the database and the other server hosts the web application and the solver.



The ports and protocols used for communication between the three tiers are shown in the diagram above and discussed below.

- **Web application <-> Database connection and Solver <-> Database connection:** Both the CCOT-P web application and the solver communicate with the SQL Server database via a TCP/IP connection. The CCOT-P web application uses JDBC (Java Database Connectivity) while the solver uses ODBC (Open Database Connectivity). The default SQL Server port is 1433, and client ports are assigned a random value between 1024 and 5000. Port 1433 is the official Internet Assigned Number Authority (IANA) port number for SQL Server, but a different port can be used if required. Specific bandwidth requirements are yet to be determined.
- **Browser <-> Web application connection:** The browser communicates with the CCOT-P web application through the web server via HTTPS (Hypertext Transfer Protocol Secure) on the default port of 443. Port 443 is the official IANA port number for HTTPS, but a different port can be used if required. The HTTPS protocol is being used to encrypt the data between the browser and the web application. If such encryption is unnecessary, HTTP and port 80 can also be used. The use of HTTPS does require an

appropriate web server certificate. Specific bandwidth requirements are yet to be determined.

- **Browser <-> Database connection:** There is no direct connection between the browser and the database. The CCOT-P web application or the solver performs all database access.

#### 4.4. Security

The CCOT-P engineering prototype requires that authentication and initial authorization be handled externally and that an authenticated user name be passed to the application for additional access control. In Sandia's test environment, authentication and authorization are handled via Apache Tomcat basic authentication. The web server securely passes the authenticated user name to the web application servlet. The web application then checks the user name against a list of users in the CCOT-P database to determine 1) if this user is authorized and 2) what CCOT-P roles (administrator, planning manager, and/or analyst) this user may access. The user is then presented with the home screen of the CCOT-P engineering prototype.

On the eBusiness Center's production pilot server, CCOT-P is using the Tomcat authentication method for user authentication. An eBusiness Center system administrator manages user accounts in the *tomcat-users.xml* file. For example, this creates the role "ccotp" which will be used to control access to the application. It then creates two users (john and jane), their passwords, and the ability to access anything with the ccotp role.

```
<role rolename="ccotp" />
<user username="john" password="pw_john01" roles="ccotp" />
<user username="jane" password="pw_jane02" roles="ccotp" />
```

Security constraints are specified in the application's *web.xml* file (located in the application's WEB-INF directory). These specify the security constraint for the application, what authentication to use, and the role allowed to access it:

```
<security-constraint>
  <web-resource-collection>
    <web-resource-name>CCOTP</web-resource-name>
    <url-pattern>/*</url-pattern>
  </web-resource-collection>
  <auth-constraint>
    <role-name>ccotp</role-name>
  </auth-constraint>
  <user-data-constraint>
    <transport-guarantee>NONE</transport-guarantee>
  </user-data-constraint>
</security-constraint>

<login-config>
  <auth-method>BASIC</auth-method>
</login-config>

<security-role>
  <role-name>ccotp</role-name>
```

</security-role>

The web server prompts the user for a user name and password. The user credentials must match user name and password in the *tomcat-users.xml* file that has been granted a “ccotp” role.

The CCOT-P engineering prototype assigns authenticated users to one of three roles with decreasing levels of privilege: administrator, planning manager, and analyst. The roles are specified independently of one another in the CCOT-P database.



## REFERENCES

1. K.A. Jones, K.L. Adair, A. Bandlow, T.R. Brounstein, J.D. Durfee, J.L. Gearhart, N. Martin, "Contingency Contractor Optimization Phase 3, Requirements Document, Contingency Contractor Optimization Tool – Prototype," Sandia National Laboratories, October 2013.
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