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IDC Reengineering Phase 2 & 3 (RP2 & RP3) Cost Estimate Summary

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(RP2 & RP3)
Cost Estimate Summary

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Abstract

Sandia National Laboratories has prepared a cost estimate budgetary planning for the
IDC Reengineering Phase 2 & 3 effort. This report provides the cost estimate and
describes the methodology, assumptions, and cost model details used to create the
cost estimate.

REVISIONS

Version	Date	Author/Team	Revision Description	Authorized by
1.0	8/29/2014	SNL IDC Reengineering Team	Initial Release for I2	R. M. Huelskamp

CONTENTS

1 PROJECT BACKGROUND

The CTBTO's International Data Centre (IDC) has recognized the need to reengineer their waveform data processing software system. In the 16 years since the delivery of the first version of IDC software, major components of the system have been replaced in response to advances in monitoring technologies leading to new functional requirements and infrastructure changes. In the absence of an up-to-date, overarching architecture, the result of these development activities is an increasingly fragmented software landscape with little software reuse, code duplication, and outdated technologies. Such a system is increasingly difficult to maintain and enhance as new technologies become available.

In response, the Provisional Technical Secretariat (PTS) has established a three-phase reengineering effort. Phase 1 focused on enhancements to individual components of the system and is near completion. Moving forward, Reengineering Phase 2 (RP2) & 3 (RP3) will address development of a modern, model-based component architecture as the foundation for a cost-effective, maintainable and extensible system that will allow the CTBTO to meet its treaty monitoring requirements for the next 20+ years.

2 COST ESTIMATE OVERVIEW

To support budgetary planning for the IDC Reengineering effort, the SNL project team has developed an initial Rough Order of Magnitude (ROM) cost estimate for RP2 & RP3. This current version of the estimate is v1.0 (released August 2014). Updated estimates will be produced periodically to account for refinements in project knowledge, and to address evolution of project scope, assumptions, requirements, and constraints. A separate report will be provided with each updated estimate. The Air Force Technical Applications Center (AFTAC) has begun a modernization project for the US NDC system that can be leveraged to realize substantial cost savings for the IDC. IDC RP2 & RP3 estimates for two scenarios are provided:

- The *Independent Estimate* assumes a standalone effort to reengineer the IDC system only ('Independent Estimate' figures in Table 1) *without* leveraging a fully-funded US NDC modernization effort

- A second estimate is provided assuming a combined reengineering project addressing both the IDC and US NDC systems ('Leveraging US NDC Modernization' figures in Table 1).

For each of the two scenarios, costs are provided in FY2014 dollars at the 80% confidence level based on Monte Carlo analysis of cost uncertainty (see *Section 3.2* for more information on cost-risk analysis methodology). Table 1 summarizes cost information for RP2 & RP3. At 80% confidence, the total estimated cost for a standalone IDC Reengineering effort addressing RP2 & RP3 is $126.0M. The corresponding cost for RP2 & RP3 based on leveraging a *fully-funded* US NDC reengineering effort is $44.9M. The costs shown here account for IDC-unique extensions to the shared system. The substantial cost savings for the latter estimate is due to the assumed leveraging of the Air Force Technical Applications Center (AFTAC) NDC Modernization project.

Cost sources in the estimate include labor as well as purchases & travel. Purchase estimates account for hardware and software acquisition and recurring licensing costs required for the project development environment. Delivered system hardware & software purchases are assumed to be funded by other elements of the PTS, and are excluded from this estimate.

IDC Reengineering Phase 2 & 3	Independent Estimate	Leveraging fully funded US NDC Modernization
	80% Confidence	80% Confidence
RP2 - Inception	$1,261 K	$1,081 K
RP2 - Elaboration	$5,930 K	$4,933 K
RP3 - Development & Transition	$118,845 K	$38,904 K
Total Cost	$126,036 K	$44,918 K
Current Investment in IRP - Inception	$1,081 K	$1,081 K
Balance Due	$124,955 K	$43,837 K

Table 1. IDC RP2 & RP3 Cost Summary

Figures 1 & 2 show cost profiles for RP2 & RP3. Figure 1 shows the full cost for an independent IDC Reengineering effort; Figure **2** shows the development cost for IDC Reengineering if leveraging a fully-funded US NDC Modernization effort. For both scenarios, the standard Rational Unified Process (RUP) funding profile for the Inception & Elaboration phases (RP2) has been scaled to lower initial funding based on known budgetary constraints. This approach defers some Elaboration effort to the Development phase (RP3).

	CY2014	CY2015	CY2016	CY2017	CY2018	CY2019	CY2020	CY2021
Yearly Cost	$1,261 K	$2,918 K	$3,012 K	$19,560 K	$26,700 K	$27,699 K	$28,145 K	$16,741 K
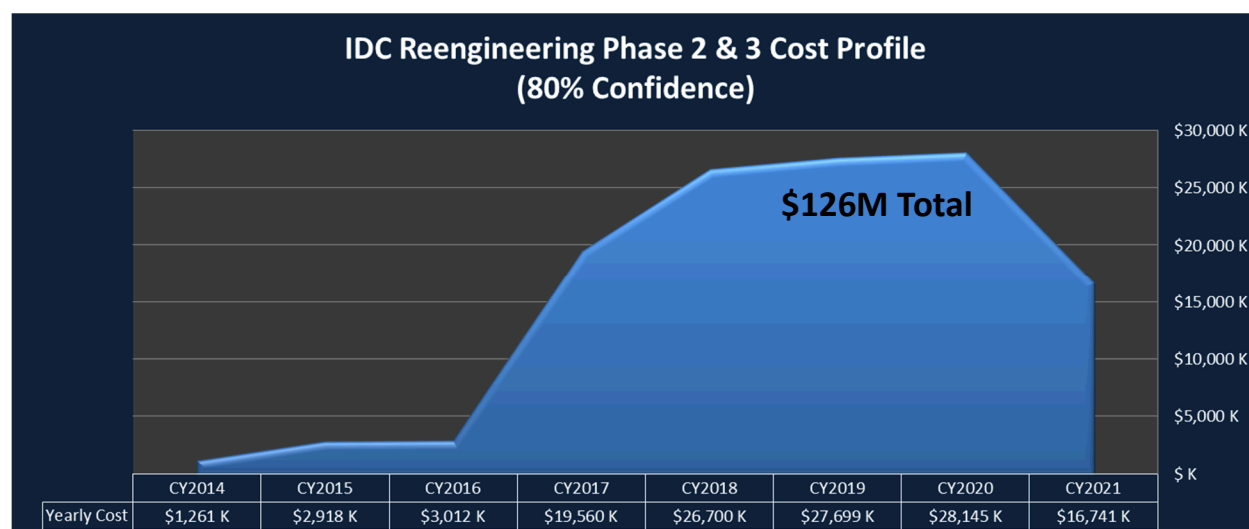
**Figure 1. IDC Reengineering Project Cost Profile -
Full Independent Development Cost**

	CY2014	CY2015	CY2016	CY2017	CY2018	CY2019	CY2020	CY2021
Yearly Cost	$1,081 K	$2,427 K	$2,506 K	$7,511 K	$8,002 K	$8,615 K	$8,747 K	$6,028 K
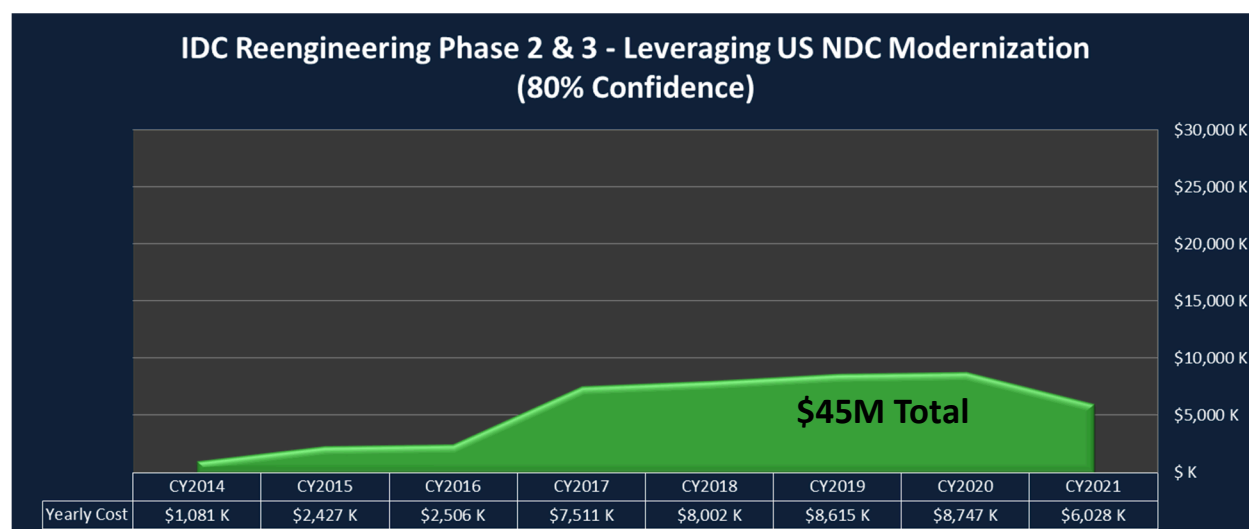
**Figure 2. IDC Reengineering Project Cost Profile -
Leveraging a *Fully-Funded* US NDC Modernization Project**

3 METHODOLOGY

The cost estimates presented here were developed using a combination of parametric models and engineering judgment, informed by experience with similar projects.

Software engineering costs were estimated using parametric cost models based on project assumptions regarding scope, staffing, development processes and schedule. The SNL project team used the *SEER for Software*[1] (SEER) cost estimation product to develop these parametric models. SEER is an industry standard cost estimation tool.

SEER parametric models were used to produce estimates of software engineering effort, and that effort was then converted to cost through the application of staffing profiles with applicable labor rates and inflation factors. For the IDC Reengineering cost estimate, a staffing profile based on the Rational Unified Process (RUP)[2] was applied using SNL rates for the labor bands appropriate for the effort in each RUP discipline. The SEER model was calibrated for SNL staff productivity factors so should be used with SNL labor rates. Standard SNL forward pricing factors were applied to account for inflation.

Purchases and travel costs for the modernized system were estimated using engineering judgment based on actual costs from similar projects.

3.1 Software Sizing

Logical Source Lines of Code (SLOC) were used as the primary measure of system size for this cost estimate; function points were used to a limited degree to model Commercial Off-The-Shelf (COTS) components, following the default SEER modeling approach. SLOC estimates for the reengineered IDC system were derived from code counts provided for the current US NDC system. Existing SLOC were scaled to account for anticipated reductions in code size resulting from the elimination of duplicative and dormant code. Future estimates will update the SLOC to reflect current IDC code counts.

3.2 Cost Risk Analysis

The SEER parametric modeling tool supports Monte Carlo analysis of total cost, accounting for uncertainty model parameters. Inputs to the tool, including SLOC and project assumptions, were modeled as three-point distributions representing least, likely and greatest values. The distributions were sampled within the SEER model to produce a cumulative frequency distribution representing software engineering effort as a function of confidence. The 80% confidence estimate of the software engineering effort has been provided. This estimate translates into an 80% chance that the total cost of the system will be at or under the estimated cost. It is typically used as an industry standard for fixed-price contract budgets, and accounts for the margin needed to mitigate cost risk.

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[1] www.galorath.com

[2] The staffing profile used for the US NDC Modernization cost estimate is based on the RUP-based framework available at www.scribd.com/doc/7183531/Project-Planning-Best-Practices

4   KEY ASSUMPTIONS

The assumptions detailed in the following sections were used to develop the initial IDC Reengineering project cost estimate.

4.1 Scope Assumptions

The cost estimate includes RP2 & RP3. Together, these two phases account for all four of the Rational Unified Process phases (see *Section 4.3* for more on the Rational Unified Process, RUP). The Reengineering project will address all IDC deployments and subsystems, including:

- Operational (OPS) & alternate (ALT) processing deployments
- Standalone system
- Testing and Training subsystems

An all-new modular, service-based software architecture will be developed for the reengineered system, accommodating expanded sensor networks and facilitating the integration of new computational modeling techniques, computer network technologies, and geophysical data analysis processes. It is assumed that:

1) Most of the legacy software will not be compatible with the modernized system architecture and design. Exceptions to the software replacement rule include the data acquisition software and common libraries.
2) Most of the existing IDC system software (~80%) is expected to be replaced.
3) Most of the data acquisition software is expected to be reused with moderate changes. This area of the system is considered to be more robust and maintainable than others and has not been identified as a priority for the modernization effort.
4) The common libraries are not expected to be heavily impacted by the changes in system architecture.
5) The overall size of the reengineered system software is expected to decrease by 20-30% percent as a result of duplicate/dormant code elimination and reorganization of the code in the new architecture.

4.2 IDC / US NDC Commonality Assumptions

For the purposes of the leveraged IDC /US NDC Reengineering project scenario, the IDC and US NDC systems are assumed to overlap significantly in requirements, architecture and software components.

AFTAC has begun a modernization project for the US NDC system that can be leveraged to realize substantial cost savings for the IDC. The ROM estimate for the leveraged IDC project assumes that 75% of the software in each system is common. The IDC Systems Requirements Document (SRD) lends credence to this assumption. ***Nearly 85% of the IDC requirements were found to be common with the US NDC requirements.***

4.3 Development Process Assumptions

This estimate assumes that RP2 & RP3 will be executed using an incremental, iterative software development approach leveraging best practices developed at Sandia National Laboratories for similar systems based on the RUP framework (http://en.wikipedia.org/wiki/RUP).

In keeping with the Rational Unified Process, the project will be organized into four high-level phases: *Inception*, *Elaboration*, *Development* and *Transition*.

1) RP2 will execute the Inception & Elaboration phases; RP3 will execute the Development and Transition phases.
2) The underlying project schedule accounting for these phases will be divided *iterations*, each of which will encompass a complete development cycle, including requirements analysis, architecture analysis & design, implementation, integration, and test as applicable based on the project phase.
3) During RP3, each iteration will produce a functional version of the system.

4.4 Schedule Assumptions

The RP2 & RP3 project schedule is assumed to span the 8-year period CY2014 – CY2021. The schedule for the project phases is as follows:

RP2

a. *Inception* (Q1 CY2014 – Q4 CY2014)
> This phase will focus on definition of system requirements and use cases.

b. *Elaboration* (Q1 CY2015 – Q4 CY2016)
> This phase will focus on definition of system architecture and prototyping of core system components.

RP3

a. *Development* (Q1 CY2017 – Q4 CY2020)
> This phase will focus on incremental implementation, integration and deployment of system software and hardware components.

b. *Transition* (Q1 FY2021 – Q4 FY2021)
> This phase will focus on verification, validation & delivery of the complete operational capability, as well as delivery of system documentation and user training.

4.5 Deployment Assumptions

Mission operations must be maintained during the transition to the reengineered system. To meet this requirement:

1) Mission capabilities will be transferred incrementally from legacy to new system components as they are integrated, verified and validated.
2) This incremental capability transfer will occur during RP3.
3) Operations and Maintenance (O&M) of the reengineered system following the end of RP3 are expected to be managed separately within the PTS, and have not been included in the estimate.

4.6 Staffing Assumptions

RP2 and RP3 will be executed through a collaborative effort between the SNL & PTS project teams.

- The PTS team will be responsible for development of the system requirements, and will provide review and oversight of system specifications, use cases, and architecture products developed by the SNL project team.
- The SNL project team will be responsible for development of the system specification, use cases, architecture definition and supporting prototypes.
- The PTS project team will serve as the system integrator for incremental deliveries of the reengineered IDC system components during the RP3.
- SNL will provide on-site support, as needed, at the IDC in Vienna during RP2 and RP3.
- The non-US teams collaborating in RP3 will be fully trained in RUP methodology.
- The SNL project team will retain responsibility for architecture definition during RP3 and integration of software components provided by other contributors.

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