NIST Special Publication
NIST SP 800-221 ipd

Enterprise Impact of Information and Communications Technology Risk:

Governing and Managing ICT Risk Programs Within an Enterprise Risk Portfolio

Stephen Quinn
Nahla Ivy
Julie Chua
Matthew Barrett
Larry Feldman
Daniel Topper
Greg Witte
R. K. Gardner
Karen Scarfone

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.800-221.ipd

NIST
NATIONAL INSTITUTE OF
STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

NIST Special Publication
NIST SP 800-221 ipd

Enterprise Impact of Information and Communications Technology Risk:

Governing and Managing ICT Risk Programs Within an Enterprise Risk Portfolio

Stephen Quinn
Applied Cybersecurity Division
Information Technology Laboratory

Nahla Ivy
Enterprise Risk Management Office
Office of Financial Resource Management

Julie Chua
Office of Information Security
Office of the Chief Information Officer (OCIO)
U.S. Department of Health and Human Services

Matthew Barrett
CyberESI Consulting Group, Inc.
Baltimore, MD

Larry Feldman
Daniel Topper
Greg Witte
Huntington Ingalls Industries
Annapolis Junction, MD

R. K. Gardner
New World Technology Partners
Annapolis, MD

Karen Scarfone
Scarfone Cybersecurity
Clifton, VA

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.800-221.ipd

July 2022

U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

Authority

This publication has been developed by NIST in accordance with its statutory responsibilities under the Federal Information Security Modernization Act (FISMA) of 2014, 44 U.S.C. § 3551 *et seq.*, Public Law (P.L.) 113-283. NIST is responsible for developing information security standards and guidelines, including minimum requirements for federal information systems, but such standards and guidelines shall not apply to national security systems without the express approval of appropriate federal officials exercising policy authority over such systems. This guideline is consistent with the requirements of the Office of Management and Budget (OMB) Circular A-130.

Nothing in this publication should be taken to contradict the standards and guidelines made mandatory and binding on federal agencies by the Secretary of Commerce under statutory authority. Nor should these guidelines be interpreted as altering or superseding the existing authorities of the Secretary of Commerce, Director of the OMB, or any other federal official. This publication may be used by nongovernmental organizations on a voluntary basis and is not subject to copyright in the United States. Attribution would, however, be appreciated by NIST.

National Institute of Standards and Technology Special Publication 800-221 ipd
Natl. Inst. Stand. Technol. Spec. Publ. 800-221, 73 pages (July 2022)
Initial Public Draft
CODEN: NSPUE2

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.800-221.ipd

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by NIST, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

There may be references in this publication to other publications currently under development by NIST in accordance with its assigned statutory responsibilities. The information in this publication, including concepts and methodologies, may be used by federal agencies even before the completion of such companion publications. Thus, until each publication is completed, current requirements, guidelines, and procedures, where they exist, remain operative. For planning and transition purposes, federal agencies may wish to closely follow the development of these new publications by NIST.

Organizations are encouraged to review all draft publications during public comment periods and provide feedback to NIST. Many NIST cybersecurity publications, other than the ones noted above, are available at https://csrc.nist.gov/publications.

Public comment period: July 20, 2022 - September 6, 2022

Submit comments on this publication to: ictrm@nist.gov

National Institute of Standards and Technology
Attn: Applied Cybersecurity Division, Information Technology Laboratory
100 Bureau Drive (Mail Stop 2000) Gaithersburg, MD 20899-2000

All comments are subject to release under the Freedom of Information Act (FOIA).

Reports on Computer Systems Technology

The Information Technology Laboratory (ITL) at the National Institute of Standards and Technology (NIST) promotes the U.S. economy and public welfare by providing technical leadership for the Nation's measurement and standards infrastructure. ITL develops tests, test methods, reference data, proof of concept implementations, and technical analyses to advance the development and productive use of information technology. ITL's responsibilities include the development of management, administrative, technical, and physical standards and guidelines for the cost-effective security and privacy of other than national security-related information in federal information systems. The Special Publication 800-series reports on ITL's research, guidelines, and outreach efforts in information system security, and its collaborative activities with industry, government, and academic organizations.

Abstract

All enterprises should ensure that information and communications technology (ICT) risk receives appropriate attention within their enterprise risk management (ERM) programs. This document is intended to help individual organizations within an enterprise improve their ICT risk management (ICTRM). This can enable enterprises and their component organizations to better identify, assess, and manage their ICT risks in the context of their broader mission and business objectives. This document explains the value of rolling up and integrating risks that may be addressed at lower system and organizational levels to the broader enterprise level by focusing on the use of ICT risk registers as input to the enterprise risk profile.

Keywords

enterprise risk management (ERM); enterprise risk profile (ERP); enterprise risk register (ERR); information and communications technology (ICT); ICT risk; ICT risk management (ICTRM); ICT risk measurement; risk appetite; risk register; risk tolerance.

Audience

The primary audience for this publication is both Federal Government and non-Federal Government professionals at all levels who understand ICT risk management (ICTRM) for one or more ICT domains, but may be unfamiliar with ERM. The secondary audience includes both federal and non-Federal Government corporate officers, high-level executives, ERM officers and staff members, and others who understand ERM but may be unfamiliar with the unique characteristics of ICTRM. All readers are expected to gain an improved understanding of how ICTRM and ERM relate to each other, as well as the benefits of integrating their use.

Trademark Information

Document Conventions

For the purposes of this document, "assets" are defined as technologies that may compose an information or communications system. The term "asset" or "assets" is used in multiple frameworks and documents. Examples include laptop computers, desktop computers, servers, sensors, data, mobile phones, tablets, routers, and switches. In instances where the authors mean "assets" as they might be discussed at the enterprise level, the word "asset" will be preceded by words such as "enterprise," "high-level," "balance sheet," or "Level 1" to differentiate context.

This document uses the phrase "information and communications technology" for ICT. As of this writing, both this phrase and the same phrase with "communication" instead of "communications" are widely used. The phrases essentially mean the same thing.

This document references two types of controls, each of which is essential and should not be confused with the other:

- **Internal controls** are the overarching mechanisms used to achieve and monitor enterprise objectives. The COSO Internal Control – Integrated Framework defines internal control as "a process effected by an entity's board of directors, management and other personnel designed to provide reasonable assurance of the achievement of objectives." [COSOERM] These internal controls are an important factor at the enterprise level. In fact, the title of OMB Circular A-123 is "Management's Responsibility for Enterprise Risk Management and Internal Control."
- **Risk management controls** represent the safeguards or countermeasures prescribed for an information system or an organization to protect ICT in line with mission and business objectives. These controls provide the management, administrative, and technical methods for responding to ICT risks by deterring, detecting, preventing, or correcting threats and vulnerabilities.

Note to Reviewers

The authors are grateful for the feedback and support provided by the community in response to draft publications. In support of the final edition of this report, NIST asks that readers review the following questions and consider these in your feedback and recommendations.

1. Is the treatment of discipline-specific risks (cybersecurity, privacy, supply chain, communications, etc.) clearly expressed in context and relationship to categorization of ICT, operational, and enterprise risk?
2. Has the consideration/treatment of risk associated with the intricacies and complexities of interconnectivity, as part of the broader enterprise risk portfolio, been appropriately addressed? Would examples/use-cases depicting this notion further, in the form of supplemental material, be useful?
3. Are risk appetite and risk tolerance clearly explained and example use demonstrated?
4. Should BIA (business impact analysis) be addressed in this document or as a separate Special Publication?
5. Does this publication effectively relate to both private and public sector enterprises through its structure, terminologies, and examples?
6. Has this publication provided a clear definition and understanding of positive risk?

7. Does the information outlined in this publication provide sufficient information to inform any mandatory/required disclosures (e.g., U.S. Securities and Exchange Commission [SEC], Internal Revenue Service [IRS])?
8. Does this publication provide sufficient information to enable the allocation tradeoffs of an organization's operating expenses (OpEx) and capital expenditures (CapEx) for ICT risk and issues?
9. Does this publication provide actionable guidance to identify, measure, and manage the new dimension of risk inherent in ICT "systems-of-systems"?
10. Are there additional ICTRM/ERM-related topics that would be helpful to include in future iterations of this publication?

Call for Patent Claims

This public review includes a call for information on essential patent claims (claims whose use would be required for compliance with the guidance or requirements in this Information Technology Laboratory (ITL) draft publication). Such guidance and/or requirements may be directly stated in this ITL Publication or by reference to another publication. This call also includes disclosure, where known, of the existence of pending U.S. or foreign patent applications relating to this ITL draft publication and of any relevant unexpired U.S. or foreign patents.

ITL may require from the patent holder, or a party authorized to make assurances on its behalf, in written or electronic form, either:

a) assurance in the form of a general disclaimer to the effect that such party does not hold and does not currently intend holding any essential patent claim(s); or
b) assurance that a license to such essential patent claim(s) will be made available to applicants desiring to utilize the license for the purpose of complying with the guidance or requirements in this ITL draft publication either:
    i. under reasonable terms and conditions that are demonstrably free of any unfair discrimination; or
    ii. without compensation and under reasonable terms and conditions that are demonstrably free of any unfair discrimination.

Such assurance shall indicate that the patent holder (or third-party authorized to make assurances on its behalf) will include in any documents transferring ownership of patents subject to the assurance, provisions sufficient to ensure that the commitments in the assurance are binding on the transferee, and that the transferee will similarly include appropriate provisions in the event of future transfers with the goal of binding each successor-in-interest.

The assurance shall also indicate that it is intended to be binding on successors-in-interest regardless of whether such provisions are included in the relevant transfer documents.

Such statements should be addressed to: ictrm@nist.gov

Executive Summary

All types of organizations, from corporations to federal agencies, face a broad array of risks. For federal agencies, the Office of Management and Budget (OMB) Circular A-11 defines risk as "the effect of uncertainty on objectives" [OMB-A11]. The effect of uncertainty on *enterprise* mission and business objectives may then be considered as an "enterprise risk" that must be similarly managed. An *enterprise* is an organization that exists at the top level of a hierarchy with unique risk management responsibilities. Managing risks at that level—*enterprise risk management (ERM)*—calls for understanding the core risks that an enterprise faces, determining how best to address those risks, and ensuring that the necessary actions are taken. In the Federal Government, ERM is considered "an effective agency-wide approach to addressing the full spectrum of the organization's significant risks by understanding the combined impact of risks as an interrelated portfolio rather than addressing risks only within silos" [OMB-A11]. OMB Circular A-123 "establishes an expectation for federal agencies to proactively consider and address risks through an integrated…view of events, conditions, or scenarios that impact mission achievement" [OMB-A123].

The information and communications technology (ICT) on which an enterprise relies is managed through a broad set of risk disciplines. For more than 50 years, NIST publications have provided important guidance for individual programs such as manufacturing excellence, privacy, supply chain, and cybersecurity. But, as the OMB quotes above point out, enterprise risk considerations and decisions must take a portfolio perspective. Individual risk programs have an important role *and* must integrate activities as part of that enterprise portfolio. Doing so ensures a focus on achieving enterprise objectives and helps identify those risks that will have the most significant impact on the entity's mission. This publication extends that NIST risk program guidance, recognizing that risk extends beyond the boundaries of individual programs. ICT risk considerations and disciplines (e.g., Internet of Things, supply chain, privacy, cybersecurity) as well as risk management frameworks (e.g., those for artificial intelligence and for information systems and organizations) support the management of a mosaic of interrelated risks. Effectively addressing these ICT risks at the enterprise level requires coordination, communication, and collaboration. This publication examines the relationships among ICT risk disciplines and enterprise risk practices.

The broad set of ICT disciplines forms an adaptive system-of-systems composed of many interdependent components and channels. The resulting data represents information, control signals, and sensor readings. As with other complex systems-of-systems, the interconnectedness of these technologies produces system behaviors that cannot be determined by the behavior of individual components. That interconnectedness causes risks which exist between risk programs and across multiple risk programs. As our systems become more complex, they present exploitable vulnerabilities, emergent risks, and system instabilities that, once triggered, can have a runaway effect with multiple severe, often irreversible consequences. In the contemporary enterprise, emergency and real-time circumstances can turn a relatively minor ICT-based risk into true operational risks that disrupt an organization's ability to perform mission or business functions.

This publication supports an interconnected approach to risk frameworks and programs that addresses ICT risk as a special subset of enterprise risk. This publication encourages the practice

of aggregating and normalizing ICT risk information, helping to identify, quantify, and communicate risk scenarios and their consequences. Doing so supports effective decision-making. That integrated approach ensures that shareholder and stakeholder value is quantified in financial, mission, and reputation metrics similar to those attributed to other (non-technical) enterprise risks, enabling executives and officials to prudently reallocate resources among all the varied competing risk types.

While NIST is widely recognized as a source of cybersecurity guidance, cyber is only one portion of a large and complex set of uncertainties including financial, legal, legislative, safety, and strategic risks. As part of an ERM program, senior leaders (e.g., corporate officers, government senior executive staff) often have fiduciary and reporting responsibilities that other organizational stakeholders do not, so they have a unique responsibility to holistically manage the combined set of risks. ERM provides the umbrella under which risks are aggregated and prioritized so that all risks can be evaluated and "stovepiped" risk reporting can be avoided. ERM also provides an opportunity for identification of operational risk, a subset of the enterprise risks so significant that potential losses could jeopardize one or more aspects of operations. Risk managers will determine whether a failed internal process (related to enterprise people, processes, technology, or governance) will directly cause a significant operational impact. Some risk response activities are there to directly protect mission operations. Enterprise leaders should define these operational risk parameters as part of enterprise risk strategy.

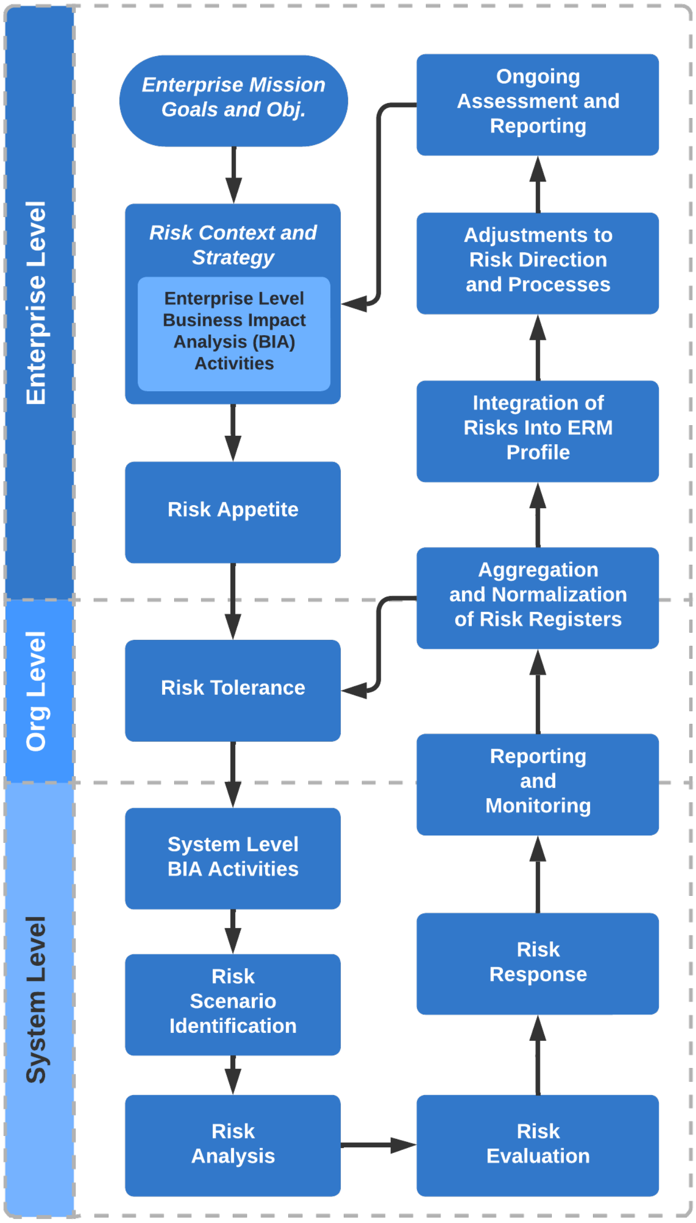

Enterprise Level
Org Level
System Level
Enterprise Mission Goals and Obj.
Risk Context and Strategy
Enterprise Level Business Impact Analysis (BIA) Activities
Risk Appetite
Risk Tolerance
System Level BIA Activities
Risk Scenario Identification
Risk Analysis
Risk Evaluation
Risk Response
Reporting and Monitoring
Aggregation and Normalization of Risk Registers
Integration of Risks Into ERM Profile
Adjustments to Risk Direction and Processes
Ongoing Assessment and Reporting

Figure 1: ICTRM Integration Cycle

This publication explores the high-level ICT risk management (ICTRM) process illustrated by Figure 1. Many resources – such as well-known frameworks from the Committee of Sponsoring Organizations (COSO), OMB circulars, and the International Organization for Standardization (ISO) – document ERM frameworks and processes. They generally include similar approaches: identify context, identify risks, analyze risk, estimate risk importance, determine and execute the risk response, and identify and respond to changes over time. The process recognizes that no risk response should occur without understanding stakeholder expectations for managing risk to an acceptable level, as informed by leadership's risk appetite and risk tolerance statements.

To ensure that leaders can be provided a composite understanding of the various threats and consequences facing each organization and enterprise, risk information is recorded and shared through *risk registers*.[1] At higher levels in the enterprise structure, various risk registers (including those related to ICTRM) are aggregated, normalized, and prioritized into *risk profiles*. While it is critical that enterprises address potential negative impacts on mission and business objectives, it is equally critical (and required for federal agencies) that enterprises plan for success. OMB states that "the [Enterprise Risk] profile must identify sources of uncertainty, both positive (opportunities) and negative (threats)." [OMB-A123] Enterprise-level decision makers use the risk profile to choose which enterprise risks to address, allocate resources, and delegate responsibilities to appropriate risk owners. ERM strategy includes defining terminology, formats, criteria, and other guidance for risk inputs from lower levels of the enterprise.

Integrated risk management information from throughout the enterprise helps create a composite enterprise risk register (ERR) and a prioritized enterprise risk profile (ERP) to inform company executives and agency officials' ERM deliberations, decisions, and actions. It describes the inclusion of ICT risks (including various operational technology, supply chain, privacy, and cybersecurity risks) as part of financial, valuation, mission, and reputation exposure. A comprehensive ERR and ERP support communication and disclosure requirements. The integration of technology-specific risk management activities supports an understanding of exposures related to corporate reporting (e.g., income statements, balance sheets, cash flow) and similar requirements (e.g., reporting for appropriation and oversight authorities) for public-sector entities. The iterative ICTRM process enables adjustments to risk direction. As leaders receive feedback regarding enterprise progress, strategy can be adjusted to take advantage of an opportunity or to better address negative risk as information is collected and shared.

Application of a consistent approach to identify, assess, respond to, and communicate risk throughout the enterprise about the entire portfolio of ICT risk disciplines will help ensure that leaders and executives are always informed and able to support effective strategic and tactical decisions. While the methods for managing risk among different disciplines will vary widely, an ICT-wide approach to directing that risk management, reporting and monitoring the results, and adjusting to optimize achievement of enterprise objectives will provide valuable benefits.

[1] OMB Circular A-11 defines a *risk register* as "a repository of risk information including the data understood about risks over time" [OMB-A11].

Table of Contents

List of Appendices

List of Figures

List of Tables

1 Introduction

The Office of Management and Budget (OMB) defines *risk* as “the effect of uncertainty on objectives” [OMB-A11]. The effect of uncertainty on enterprise mission and business objectives may then be considered an *enterprise risk* that must be similarly managed. The process of managing risks at the enterprise level is known as *enterprise risk management (ERM)*, and it calls for:

- identifying and understanding the core risks facing an enterprise,
- determining how best to address those risks, and
- ensuring that the necessary actions are taken.

Playbook: Enterprise Risk Management for the U.S. Federal Government [ERMPLAYBOOK] defines numerous types of risk, including compliance, financial, information and communications technology (ICT), legal, legislative, operational, reputational, and strategic.[2] Enterprises use ERM to holistically manage the combined set of risks. OMB Circular A-123 “establishes an expectation for federal agencies to proactively consider and address risks through an integrated…view of events, conditions, or scenarios that impact mission achievement” [OMB-A123]. OMB considers ERM to be “an effective agency-wide approach to addressing the full spectrum of the organization’s significant risks by understanding the combined impact of risks as an interrelated portfolio, rather than addressing risks only within silos.” [OMB-A123] In the private sector, the Committee of Sponsoring Organizations (COSO) publication, *Enterprise Risk Management – Integrating with Strategy and Performance,* defines ERM as the “culture, capabilities, and practices that organizations integrate with strategy-setting and apply when they carry out that strategy, with a purpose of managing risk in creating, preserving, and realizing value.” [COSOERM]

Many ICT risk management (ICTRM) disciplines, including cybersecurity, supply chain, and privacy, have evolved into full-fledged risk programs because of organizations’ reliance on ICT. The rapid evolution of ICTRM disciplines sometimes has led to miscommunication and inefficiencies between those risk programs and the overarching ERM portfolio of risks. In recent years, NIST has published guidance to codify risk management practices for several individual ICT risk programs, such as general cybersecurity (Cybersecurity Framework), general privacy (Privacy Framework), information system and organization cybersecurity and privacy (Risk Management Framework), artificial intelligence (AI Risk Management Framework), Internet of Things (IoT) cybersecurity, and cyber supply chain risk management.

1.1 Purpose and Scope

This publication broadens NIST’s existing ICT risk guidance by recognizing and incorporating ICTRM within the overall sphere of ERM. All ICT risk programs can work together to support ERM and can be integrated into risk portfolios for ERM. Comparing the outputs of ICTRM

[2] While an updated ERM Playbook has been drafted, that publication has not been publicly distributed. Special Publication (SP) 800-221 draws from the original (2016) edition of that guide but remains consistent with the updated edition.

activities with effective inputs to ERM activities, and the outputs of ERM with effective inputs for ICTRM, enables stakeholders to identify opportunities to close gaps.

This document is intended to help improve communication (including risk information sharing) between and among ICT professionals and system owners, high-level executives, and corporate officers at multiple levels. The goal is to assist personnel in better identifying, assessing, and managing ICT risks in the context of their broader mission and business objectives. This document will help professionals understand what executives and corporate officers need for them to carry out ERM. This includes what data to collect, what analyses to perform, and how to consolidate and condition this discipline-specific risk information. This document will also help executives and officers to understand the challenges that ICT professionals face.

This document references some materials that are specifically intended for use by federal agencies, but the concepts and approaches are intended to be useful for all enterprises.

Other NIST resources supporting this document include the following:

- NIST Special Publication (SP) 800-221A, *Information and Communications Technology (ICT) Risk Outcomes: Integrating ICT Risk Management Programs with the Enterprise Risk Portfolio* [SP800221A] provides a framework of outcomes that applies to all types of ICT risk. It complements the content of this document. The outcomes defined in SP 800-221A are also available in spreadsheet format from the NIST Cybersecurity and Privacy Reference Tool (CPRT) website.[3]
- An informative reference that links the contents of SP 800-221A with the NIST Cybersecurity Framework is posted as part of the National Online Informative References (OLIR) Program.[4]
- The NIST Interagency or Internal Report (IR) 8286 [IR8286] series of publications describe an example implementation of the ICTRM process. They illustrate integrated risk identification, assessment, monitoring, and reporting through cybersecurity examples and describe processes that are analogous for many types of ICT risk.

1.2 Document Structure

The remainder of this document is organized into the following major sections:

- Section 2 provides a brief introduction to ICTRM and explores common challenges involved in integrating ICTRM with ERM processes.
- Section 3 discusses ICT risk considerations throughout the ERM process in detail, highlighting the use of the risk register to document ICT risk as ERM input.
- Section 4 examines how ICT risk registers can be used for adopting a portfolio view of risk at the enterprise level based on normalizing and aggregating ICT risk registers into an enterprise risk register, then applying prioritization to it to generate an enterprise risk profile to support senior executive decision-making during boardroom deliberations.

[3] See the Cybersecurity and Privacy Reference Tool (CPRT) website for more details.
[4] See NIST Online Informative Reference Program (OLIR) for more details.

- Section 5 explores enterprise strategy for ICT risk coordination. While this section is mainly for enterprise leaders, others may also find its contents useful.
- A References section provides information about the external sources used in this publication.
- Appendix A contains the acronyms used in the document.
- Appendix B provides a notional example of a risk detail record (RDR).

2 Introduction to ICTRM and Challenges with ERM Integration

This section provides a brief introduction to ICTRM and explores common challenges involved in integrating ICTRM with ERM processes.

2.1 Comparing ICTRM and ERM

Distinguishing ICTRM from ERM and understanding how they relate requires first differentiating the terms *organization* and *enterprise*. Although they are often used interchangeably,[5] for the purposes of this document an *organization* is an entity of any size, complexity, or position within a larger organizational structure (e.g., a federal agency or company), and an *enterprise* is an organization at the top level of the hierarchy. Figure 2 shows a notional enterprise with subordinate organizations, illustrating that one of those subordinates is itself an enterprise. Both government and industry are represented in this depiction.

Consider the example of the Department of Commerce as a **higher-level enterprise** with bureaus (e.g., Census Bureau, National Oceanic and Atmospheric Administration [NOAA], NIST) as **lower-level enterprises** and their subordinates (e.g., NOAA's National Weather Service, NIST laboratories) representing **organizations**. In industry, consider mergers and acquisitions where an enterprise acquires another company, which itself was an enterprise, and then subordinates it within the higher-level enterprise's conglomeration of organizations and systems. Each enterprise is supported by various ***systems***, each a discrete set of information resources organized expressly for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information.

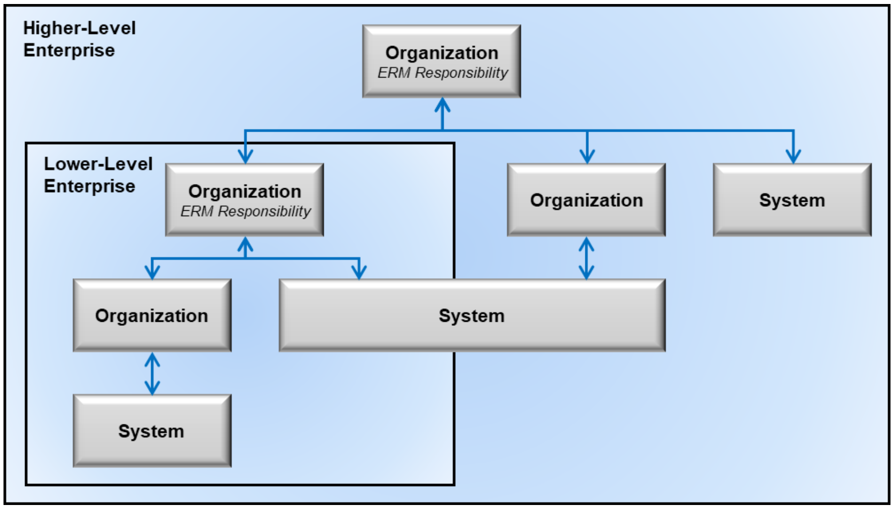


Figure 2: Enterprise Hierarchy

Most ICTRM responsibilities tend to be carried out by the individual organizations within an enterprise. In contrast, the ERM responsibility for tracking key enterprise risks and their impacts on objectives is at the highest-level enterprise, held by top-level corporate officers and board members who have fiduciary and reporting duties not performed elsewhere in the enterprise.

ERM requires identifying and understanding the various types of risk, including ICT risks, that an enterprise faces; determining the probability that these risks will occur; and estimating their

[5] For example, NIST IR 8170 uses *enterprise risk management* and *organization-wide risk management* interchangeably. The scope of NIST IR 8170 includes smaller enterprises than this publication does, so an *enterprise* as defined there may be comprised of a single organization. The enterprises discussed in this publication have more complex compositions. [IR8170]

potential impact. ERM processes provide senior enterprise executives with a portfolio view of key risks across the enterprise, and this portfolio considers the outputs of all ICTRM disciplines.[6]

Public and private enterprises have a common primary purpose for ERM: to safeguard the enterprise's mission, finances (e.g., net revenue, capital, free cash flow), and reputation (e.g., stakeholder trust) in the face of natural, accidental, and adversarial threats.

2.2 ICTRM Life Cycle

There are many models for risk management processes. Table 1 illustrates similarities among several common risk management models, including establishing context, identifying risks, analyzing risks, estimating risk importance, determining and executing risk response, and monitoring and responding to changes over time. The entries in Table 1 indicate (in parentheses) their identifier or section number from the source material whenever available. Table 1 provides a high-level comparison and is not intended as a crosswalk for relationships among the models, but instead to show that risk management disciplines that aggregate into the ERM process follow similar steps to manage risk.

The resources in Table 1 are from the *ERM Playbook* [ERMPLAYBOOK], the COSO ERM Framework [COSOERM], International Organization for Standardization (ISO) 31000 [ISO31000], OMB Circular A-123 [OMB-A123], and the U.S. Government Accountability Office (GAO) *Standards for Internal Control in the Federal Government* [GREENBOOK].

Table 1: Similarities Among Selected ERM and Risk Management Documents

ERM Playbook	COSO ERM Framework	ISO 31000:2018		OMB A-123	GAO Green Book
Identify the Context	• Governance and Culture • Strategy and Objective Setting	Establish External Context (5.3.2), Establish Internal Context (5.3.3)		Establish Context	Define objectives and risk tolerances (6.01)
Identify the Risks	• Performance • Review and Revision • Information, Communication and Reporting	Risk Assessment	Risk Identification (5.4.2)	Identify Risks	Identification of Risks (7.02)
Analyze the Risks			Risk Analysis (5.4.3)	Analyze and Evaluate	Analysis of Risks (7.05)
Assess Likelihood			Calculate Level of Risk		Management estimates the significance of a risk and considers the magnitude of impact, the likelihood of occurrence, and the nature of the risk
Assess Impact					
Prioritize Risks					
Calculate Exposure					
Plan and Execute Response Strategies			Risk Evaluation (5.4.4)	Develop Alternatives	Response to Risks (7.08)
		Risk Treatment (5.5)		Respond to Risks	

[6] This is defined by OMB as "insight into all areas of organizational exposure to risk […] thus increasing an Agency's chances of experiencing fewer unanticipated outcomes and executing a better assessment of risk associated with changes in the environment" [OMB-A123].

ERM Playbook	COSO ERM Framework	ISO 31000:2018	OMB A-123	GAO Green Book
Monitor, Evaluate, and Adjust	• Performance • Review and Revision • Information, Communication and Reporting	Monitoring and Review (5.6)	Monitor and Review	Identification of Change (9.02) Analysis of and Response to Change (9.04)

This document uses the processes of the ERM Playbook (column 1 in Table 1) as a basis for describing the ICTRM life cycle and explaining, at a high level, how ICTRM integrates with ERM. This is not meant to imply that all enterprises should use these particular steps; enterprises should determine and apply the appropriate approach to achieve ICTRM/ERM integration, communication, and monitoring. The six steps in the notional ICTRM life cycle are:

- **Step 1. Identify the context.** Context is the external and internal environment in which the enterprise operates and is influenced by the risks involved. This step includes determining and documenting the enterprise mission, including goals and objectives, and the enterprise risk management strategy. This step also includes enterprise leaders communicating risk management expectations to their component organizations.
- **Step 2. Identify the risks.** This means identifying the comprehensive set of positive and negative risks and determining which events could enhance or impede objectives, including the risk of failing to pursue an opportunity.
- **Step 3. Analyze the risks.** This involves estimating the likelihood that each identified risk event will occur and the potential impact of the consequences described.
- **Step 4. Prioritize the risks.** The exposure is calculated for each risk based on likelihood and potential impact, and the risks are then prioritized based on their exposure.
- **Step 5. Plan and execute risk response strategies.** The appropriate response is determined for each risk and informed by risk guidance from leadership.
- **Step 6. Monitor, evaluate, and adjust risk management.** Continual monitoring ensures that enterprise risk conditions remain within the defined risk appetite levels as risks change.

Steps 2 through 6 usually utilize risk registers. OMB Circular A-11 describes a *risk register* as “a repository of risk information, including the data understood about risks over time.” It also states, “Typically, a risk register contains a description of the risk, the impact if the risk should occur, the probability of its occurrence, mitigation strategies, risk owners, and a ranking to identify higher priority risks.” [OMB-A11] Each register evolves and matures as other risk activities take place.

Not all risk management methodologies generate an artifact called a risk register or risk log. However, the output of each methodology contains the underpinnings of (or can serve as an input to) a risk register. Because they can be useful information-gathering constructs, organizations not yet familiar with or using risk registers are strongly urged to adopt and integrate them into whatever risk management methodology they are currently using. Risk registers represent an organizing principle for communicating ICT risks to the OMB Circular A-123 ERM process for organizations already familiar with this management construct. Documenting and tracking ICT risks in risk registers provides a common organizing method and fosters communication from ICT risk disciplines to senior decision makers.

Figure 3 depicts a notional ICTRM life cycle with numbers to indicate where each step occurs. Section 3 provides more detail about each step and all the elements within Figure 3.

2.3 ICTRM and ERM Integration

ERM and ICTRM have several points of integration. First, enterprise governance activities for ERM direct the strategy and methods for ICTRM and other risk management disciplines to use. Based on this guidance, each discipline within each organization uses risk registers to document its risks – in the case of ICTRM, risks derived from system-level assessments. Next, these risk registers are aggregated and normalized, then used to create enterprise-level risk registers for each discipline. These, in turn, become part of a broader *enterprise risk register (ERR)* that encompasses all disciplines.

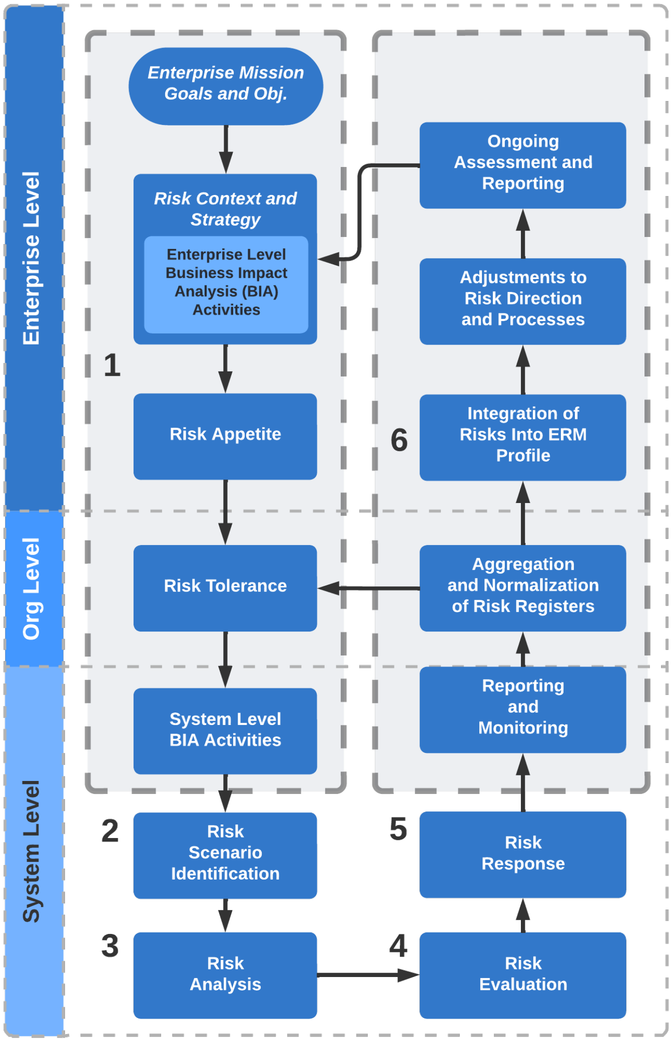

Enterprise Level
Org Level
System Level
Enterprise Mission Goals and Obj.
Risk Context and Strategy
Enterprise Level Business Impact Analysis (BIA) Activities
1
Risk Appetite
Risk Tolerance
System Level BIA Activities
2
Risk Scenario Identification
3
Risk Analysis
4
Risk Evaluation
5
Risk Response
Reporting and Monitoring
Aggregation and Normalization of Risk Registers
6
Integration of Risks Into ERM Profile
Adjustments to Risk Direction and Processes
Ongoing Assessment and Reporting

Figure 3: Notional Life Cycle for Integrated ICTRM/ERM

Figure 4 demonstrates that ERM and ICTRM are not separate processes; ICTRM represents an important subset of the broader portfolio of ERM. Documenting and tracking ICT risks in lower-level risk registers supports better management of ICT risks at the enterprise level.

The ERR is prioritized by those with fiduciary and oversight responsibilities, creating an *enterprise risk profile (ERP)*, also known as an *ERM risk profile*.[7] An ERP is created by considering enterprise risks in relation to achieving objectives as typically outlined in an organizational strategic plan. OMB Circular A-123 [OMB-A123] requires ERPs to include four kinds of objectives: *strategic*, *operations* (operational effectiveness and efficiency), *reporting* (reporting reliability), and *compliance* (compliance with applicable laws and regulations). While there may be some overlap among the categories of objectives, understanding uncertainty as it

[7] OMB Circular A-123 recommends (and requires for federal users) recording enterprise risks in an enterprise risk profile.

affects these objectives will help inform effective and timely decision-making. Effective ERM balances achieving objectives with optimizing resources.

Section 3 discusses ICTRM and ERM integration in much greater detail.

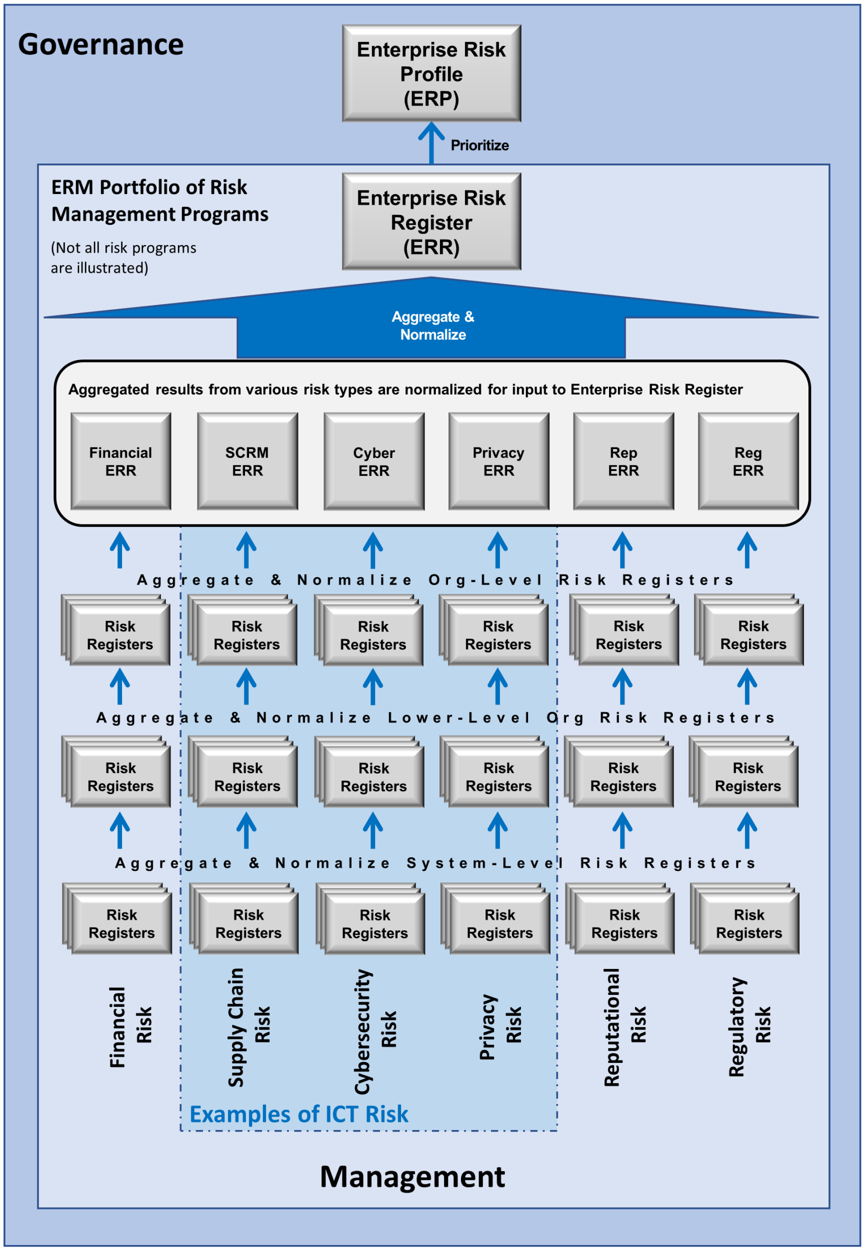

Governance
Enterprise Risk Profile (ERP)
Prioritize
ERM Portfolio of Risk Management Programs
(Not all risk programs are illustrated)
Enterprise Risk Register (ERR)
Aggregate & Normalize
Aggregated results from various risk types are normalized for input to Enterprise Risk Register
Financial ERR
SCRM ERR
Cyber ERR
Privacy ERR
Rep ERR
Reg ERR
Aggregate & Normalize Org-Level Risk Registers
Risk Registers
Aggregate & Normalize Lower-Level Org Risk Registers
Risk Registers
Aggregate & Normalize System-Level Risk Registers
Risk Registers
Financial Risk
Supply Chain Risk
Cybersecurity Risk
Privacy Risk
Reputational Risk
Regulatory Risk
Examples of ICT Risk
Management

Figure 4: ICTRM As Part of ERM

2.4 Shortcomings of Typical Approaches to ICTRM

Historically, in many enterprises, ICTRM disciplines have not been well integrated with ERM processes. While ICTRM follows many of the same high-level principles as the ERM framework, ICTRM is typically executed quite differently, and its outputs are not always properly conditioned as ERM inputs. Some common contributors to those shortcomings are described below.

2.4.1 Increasing System and Ecosystem Complexity

Many systems today are complex, adaptive "system-of-systems" composed of thousands of interdependent components and myriad channels. The systems operate in a rapidly changing socio-political-technological environment that presents threats from individuals and groups with shifting alliances, attitudes, and agendas. The constant introduction of new technologies has changed and complicated cyberspace. Wireless connections, big data, cloud computing, and the IoT present new complexities and concomitant vulnerabilities. Information and technology are no longer like simple, automated filing systems. Rather, they are like the central nervous system – a delicately balanced and intricate part of an organization or enterprise that coordinates and controls the most fundamental assets of most organizations. This ecosystem's increasing complexity gives rise to systemic risks and exploitable vulnerabilities that, once triggered, can have a runaway effect with multiple severe consequences for enterprises.

Managing ICT risk for these ecosystems is incredibly challenging because of their dynamic complexity. This complexity increases risk to specific systems, and that risk can cascade to create additional risks at the system, organization, and enterprise levels. Emerging risk conditions created by the interdependence of systems and counterparty risk must also be identified, tracked, and managed.

2.4.2 Lack of Standardized Measures

ICT risk measurement has been extensively researched for decades. As measurement techniques have evolved, the complexity of digital assets has also greatly increased, making the measurement problem more difficult to solve. Some low-level measures[8] have been standardized, like the estimated likelihood and impact of a particular vulnerability being exploited. However, for many aspects of ICT risk, there are no standard measures. Without consistent measures, there is little basis for analyzing risk or expressing risk in comparable ways across digital assets and the systems composed of those assets.

2.4.3 Informal Analysis Methods

Risk analysis for ICT tends to be inconsistent compared to many other forms of risk. Even where guidance is provided, such as in NIST publications, the resulting risk assessment reports from agencies differ significantly. Moreover, foundational inputs for likelihood and impact calculations generally lack a standardized methodology or are at the discretion of vendors who provide a scoring system. Decisions are often made based on an individual's instinct, experience, and knowledge of conventional wisdom and typical practices. In addition, there is usually little analysis performed after controls are deployed to determine whether risks have been reduced to a level deemed acceptable (i.e., within the established risk tolerance parameters).

2.4.4 Overly Focused on the System Level

The management of ICT risk is conducted in different ways at various levels, including at the system, organization, and enterprise levels. A common practice is for individual system-level teams to be responsible for tracking relevant risks. While system *reporting* to the organizational level may occur, there is typically no mechanism in place to *consolidate* the risk data for systems to the organization level, much less to the enterprise level. When organization or enterprise managers receive system risk data, it is often a vague risk map or at such a volume as to be impractical. Therefore, it is not surprising that higher levels of an organization or enterprise tend to struggle with understanding ICT risk. This struggle may be less pronounced in organizations with an enterprise architecture that maps systems onto the business processes they support.

Many enterprise risks are interdependent. A common industry example is that while cybersecurity, privacy, and credit risks are different elements of the ERM portfolio, it is quite

[8] NIST typically uses the term "measures" instead of "metrics." For more information on the distinction, see https://www.nist.gov/itl/ssd/software-quality-group/metrics-and-measures.

possible that a cybersecurity breach of personally identifiable information might result in a credit downgrade or a loss of public confidence. These interdependencies make it important that enterprise managers collaborate, communicate, and recognize that information, technology, and business risks are not isolated issues.

2.4.5 The Gap Between ICTRM Output and ERM Input

An enterprise that seeks to avoid all ICT risk might stifle innovation or efficiencies to the point where little value would be produced. At the other end of the spectrum, an enterprise that applies technology without regard to actual risk increases the chances that it might fall victim to undesirable consequences. Effectively balancing the benefits of technology with the potential risks and consequences of a threat event is more likely to result in effective ICTRM that supports a comprehensive ERM approach. Enterprises, organizations, and practitioners should consider the influence of risks on achieving enterprise strategic, operations, reporting, and compliance objectives. Enterprise risk officers should clearly communicate these enterprise objectives so that practitioners can take actions and provide relevant risk inputs to ERM programs. They also need to consider relevant policy decisions and regulatory impacts.

For ERM purposes, there should be a process for integrating the risk registers of various ICTRM disciplines. This allows for the easy exchange of risk knowledge between ICTRM and ERM participants. Many organizations do not conduct these activities in consistent, repeatable ways. Quantifying and aggregating ICT risks are often done in an ad hoc fashion and are not performed with the rigor used for other types of risk. This lowers the quality of ICT risk information provided to ERM.

2.4.6 Losing the Context of the Positive Risk

As aggravated by the multi-level nature of risk management, sometimes risks identified and managed at the system and organizational levels lose the context of associated positive risks. The basic rationalization for addressing negative risks with resources, time, and funding is that positive risks warrant those investments. Only by evaluating the value of positive risks alongside the expense of negative risks can we understand whether continued pursuit of positive risks and investment in negative risks is “worth it.” Losing track of positive risks can result in over-investing in the corresponding negative risks.

3 ICT Risk Considerations

This section discusses ICT risk considerations, with the content structured according to the six steps in the notional ICTRM life cycle described in Figure 3:

1. Identify the context.
2. Identify the risks.
3. Analyze (quantify) the risks.
4. Prioritize the risks.
5. Plan and execute risk response strategies.
6. Monitor, evaluate, and adjust risk management.

Following those, Section 3.7 briefly discusses considerations for positive risks.

3.1 Identify the Context

In the risk management life cycle, the first step in managing ICT risks is understanding *context* – the environment in which the organization operates and is influenced by the risks involved. The context provides important input into the other risk management life cycle steps by documenting the expectations and drivers to be considered. The risk context includes two factors:

- **External context** involves the expectations of outside stakeholders who affect and are affected by the organization, such as customers, regulators, legislators, and business partners. These stakeholders have objectives, perceptions, and expectations about how risk will be communicated, managed, and monitored.
- **Internal context** relates to many of the factors within the organization and relevant considerations across the enterprise. This includes any internal factors that influence risk management, such as the organization and enterprise's objectives, governance, culture, risk appetite, risk tolerance, policies, and practices.

Several NIST frameworks begin with determining these context factors. NIST Cybersecurity Framework Step 1: *Prioritize and Scope* states that organizations make strategic decisions regarding ICT implementations and determine the scope of the systems and assets that support the selected business line or process. These context exercises identify the organization mission drivers and priorities used for subsequent assessment and planning.

3.1.1 Risk Governance

As an important component of ERM, ICTRM helps assure that ICT risks do not hinder accomplishment of established enterprise mission objectives. ICTRM also helps ensure that exposure from ICT risk remains within the limits assigned by enterprise leadership. The method for connecting enterprise operations and communications to strategy is *governance*. Governance represents the methods for evaluating strategic options and directing activities to achieve that strategy. Through a governance model, enterprise objectives are determined, providing direction for prioritization and decision-making. Governance is often described as distinct from management in the same way that a directive from a ship's captain is distinct from the many activities performed to fulfill the directive. Similarly, *risk governance* is the process by which risk management evaluation, decisions, and actions are connected to enterprise strategy and objectives.

Risk governance provides the transparency, responsibility, and accountability that enables managers to acceptably manage risk. In this regard, there can be multiple participants in the governance process, depending on context and enterprise type. Larger entities might implement risk governance mechanisms across the enterprise with more specific governance mechanisms at the organization (e.g., division, portfolio, or bureau) and apply that strategy to systems or programs.

Table 2 illustrates some notional roles and responsibilities at each level.

Table 2: Examples of Risk Oversight Roles and Responsibilities

Risk Functions	Notional Private-Sector Roles	Notional Federal Government Roles	Notional Responsibilities
Enterprise-Level Oversight	Board of Directors, Regulators, Chief Executive Officer, Chief Operating Officer	OMB, U.S. Congressional Oversight Committees, Head of Agency	Ensures alignment with strategic priorities; monitors and corrects misalignments; holds management accountable for performance; receives periodic progress reports.
Enterprise-Level Risk Governance	Chief Risk Officer (or Enterprise Risk Officer), Vice President - Risk Management, ERM Council	Senior Accountable Official for Risk Management, Chief Risk Officer, Senior Agency Information Security Officer, Senior Agency Official for Privacy, Risk Executive (Function) (e.g., ERM Council)	Provides oversight, direction, and priorities for the ERM function. Identifies those risks that may require external reporting or disclosure to the public, stakeholders, or regulators.
Enterprise-Level Risk Management	Chief Operating Officer, Chief Financial Officer or Controller,[9] Chief Risk Officer	Chief Operating Officer, Chief Financial Officer, Chief Risk Officer, Enterprise Risk Management Officer	Leads and implements the ERM program. Ensures frequent visibility for high-priority risks that affect the enterprise (e.g., reports quarterly to senior executives on top risks and the status of integrating risk management principles in various functions/lines of business). Aggregates and normalizes risks for comparison at the enterprise level in consultation with risk owners. Determines enterprise risk threshold (risk appetite and tolerance) for high-priority risks in consultation with business leads and ensures that it is communicated and known by the appropriate staff.

[9] In the U.S. Federal Government, the Chief Financial Officer may be given purview over ERM functions due to the partnership of those functions with internal controls per OMB Circular A-123. In some agencies, the Chief Operating Officer leads these functions to achieve an integrated view of all types of risk.

Risk Functions	Notional Private-Sector Roles	Notional Federal Government Roles	Notional Responsibilities
Organization-Level Risk Governance (Subsidiary, Bureau, Operative, or Division)	Division President, Director of Security, Chief Information Officer, Chief Information Security Officer, Division/Unit Risk Officer	Division/Unit Risk Officer, Senior Agency/Chief Information Security Officer, Chief Information Officer, Chief Data Officer, Senior Agency Official for Privacy, Risk Executive (Function)	Establishes and communicates risk management policies, priorities, and expectations across and through the organization in specific risk domains. Partners with enterprise-level risk functions to ensure continued visibility of organization-level risk. Ensures sub-organization staff are aware of policies, procedures, and risk parameters (e.g., risk appetite and tolerance) to effectively balance risk with mission performance.
System-Level Risk Management	Business System Owner, Risk Owner, Information Owner, Information System Security Manager	Authorizing Official, System Owner, Risk Owner, Information Owner, Information System Security Manager, Information System Security Officer	Coordinates with organization-level risk managers (e.g., the CISO) to document and track identified risks and provide input on alignment with established risk parameters. Ensures that risks are being monitored, that the status is periodically reported to the CISO, and that risk response decisions are communicated back to the risk owner.

As shown in the table, certain enterprise and organization risk governance functions may be delegated to other senior leaders. Individual risk programs – including cybersecurity, privacy, and cyber supply chain risk management (C-SCRM) – might then further translate enterprise risk direction (e.g., risk appetite statements) into program-specific risk direction, enabling holistic risk processes while supporting system owners' decision authority. The division of responsibility is typical in larger organizations where an officer is specifically assigned to be responsible for program governance (e.g., chief information security officer, chief privacy officer).

3.1.2 Risk Appetite and Risk Tolerance

This document draws on ERM principles regarding integration with culture, strategy, and performance. One such principle is that an "organization must manage risk to strategy and business objectives in relation to its *risk appetite* – that is, the types and amount of risk, on a broad level, it is willing to accept in its pursuit of value." [COSOERM] OMB adapted this language for government use in Circular A-123 by similarly stating that risk appetite "is the broad-based amount of risk an organization is willing to accept in pursuit of its mission/vision" [OMB-A123]. Risk appetite is defined by the enterprise's senior-level leadership as part of risk governance. Risk appetite serves as the guidepost for the types and amount of risk, on a broad level, that senior leaders are willing to accept in pursuit of mission objectives and enterprise value.[10] Risk appetite may be qualitative or quantitative.

Another important ERM concept is *risk tolerance* – the organization's or stakeholders' readiness to bear the remaining risk *after responding to or considering the risk* in order to achieve its objectives (while recognizing that such tolerance can be influenced by legal or regulatory

[10] OMB Circular A-123 defines risk appetite as "the broad-based amount of risk an organization is willing to accept in pursuit of its mission/vision. It is established by the organization's most senior level leadership and serves as the guidepost to set strategy and select objectives."

requirements). In Circular A-123, OMB again adapted the COSO language [COSOERM] by stating that risk tolerance "is the acceptable level of variance in performance relative to the achievement of objectives." Risk tolerance can be defined at the enterprise level, but OMB Circular A-123 offers a bit of discretion to organizations, stating that risk tolerance is "generally established at the program, objective, or component level," which this publication references as the "organization level."

While risk appetite is defined at the enterprise level and risk tolerance at the enterprise or organization level, risk appetite is **interpreted** at the organizational and system levels to develop specific ICT risk tolerance. Risk tolerance represents the specific level of performance risk deemed acceptable within the risk appetite set by senior leadership (while recognizing that such tolerance can be influenced by legal or regulatory requirements).[11] Risk tolerance is **interpreted** and applied by the receiving custodians of the risk management discipline (e.g., cybersecurity, financial, legal, privacy) at the organization or system level.

Risk appetite and risk tolerance are related but distinct in a similar manner to the relationship between governance and management activities. Risk appetite statements define the overarching risk guidance, and risk tolerance statements define the specific application of that direction. This means that risk tolerance statements are always more specific than the corresponding risk appetite statements. Together, risk appetite and risk tolerance statements represent risk limits, help communicate risk expectations, and improve the focus of risk management efforts. They also help to address other factors, such as findings from internal audits or external reports. The definition of these risk parameters places the enterprise in a better position to identify, prioritize, treat, and monitor risks that may lead to unacceptable loss. Risk tolerance should always stay within the boundaries established by senior leadership, within the parameters of and informed by legal and regulatory requirements.

An example of a statement of risk appetite is: "Email service shall be available during the large majority of a 24-hour period." An associated risk tolerance statement for this appetite would be narrower: "Email services shall not be interrupted more than five minutes during core hours." Table 3 provides additional examples of actionable, measurable risk tolerance, illustrating the application of risk appetite to specific contexts within the organization-level structure. Several NIST documents, including the NIST IR 8286 series and *Cyber Supply Chain Risk Management Practices for Systems and Organizations*, NIST SP 800-161, Revision 1, also provide detailed examples of risk appetite and risk tolerance statements and how they are interpreted and applied with the associated risk defined, managed, and communicated back to executive management via the risk register [SP800161].

[11] OMB Circular A-123 states, "Risk must be analyzed in relation to achievement of the strategic objectives established in the Agency strategic plan (see OMB Circular No. A-11, Section 230), as well as risk in relation to appropriate operational objectives. Specific objectives must be identified and documented to facilitate identification of risks to strategic, operations, reporting, and compliance" [OMB-A123].

Table 3: Examples of Risk Appetite and Risk Tolerance

Example Enterprise Type	Example Risk Appetite Statement	Example Risk Tolerance Statement
Global Retail Firm	Our customers associate reliability with our company's performance, so service disruptions must be minimized for any customer-facing websites.	Regional managers may permit website outages lasting up to four hours for no more than five percent of its customers.
Government Agency	Mission-critical systems must be protected from known ICT vulnerabilities.	Critical software vulnerabilities (severity score of 10) must be patched on systems designated as mission-critical within 14 days of discovery.
Internet Service Provider	The company has a low risk appetite with regard to failure to meet customer service level agreements, including network availability and communication speeds.	Patches must be applied to avoid attack-related outages but must also be well-tested and deployed in a manner that does not reduce availability below agreed-upon service levels.
Academic Institution	The institution understands that mobile computers are a necessary part of the daily life of students, and some loss is expected. The leadership, however, has no appetite for the loss of any sensitive data (as defined by the Data Classification Policy).	Because the cost of loss prevention for students' laptops is likely to exceed the cost of the devices, it is acceptable for up to 10 percent to be misplaced or stolen if and only if sensitive institution information is prohibited from being stored on students' devices.
Healthcare Provider	The Board of Directors has decided that the enterprise has a low risk appetite for any exposures caused by inadequate access control or authentication processes.	There will always be some devices that do not yet support advanced authentication, but 100 percent of critical healthcare business applications must use multi-factor authentication.

3.1.3 Risk Management Strategy

As part of their governance responsibilities, senior enterprise executives should establish clear and actionable risk management guidance based on enterprise mission and business objectives to the organizations within their purview. This should include an enterprise strategy regarding mission priority, risk appetite and tolerance (typically in the form of risk appetite and risk tolerance statements), and capital and operating budgets to manage risks to an acceptable level. Organizations then manage and monitor processes that properly balance risks and resource allocation with the value created by ICT. Measurements (e.g., from key risk indicators, or KRIs) demonstrate where risk tolerances have been exceeded or validate that the enterprise is operating within the defined appetite.

As the risk landscape evolves (e.g., due to technological or environmental changes), enterprise leaders should continually review and adjust the risk strategy. For example, an enterprise subject to outside regulation is likely to receive specific guidance regarding updated federal statutes and directives that must be considered when evaluating acceptable risk.

Differing assumptions may occur at all levels of the organization, so it is important to determine internal and external stakeholders' expectations regarding risk communications and to use readily understandable and agreed-upon terms and categories, such as strategic objectives, organizational priorities, decision-making processes, and risk reporting or tracking methodologies (e.g., regular risk management committee discussions and meetings). It is also critical that enterprise leaders provide guidance regarding risk calculations. Establishing a common scale for assessing levels of risk will support consistent risk estimation, measurement, and reporting. The strategy may also include guidance regarding the mechanisms and frequency of risk reporting.

As risks are recorded, tracked, and reassessed throughout the cycle, this foundation ensures that all agree about how various types of risk will be communicated and managed to ensure adherence to risk guidance and expectations.

Risk management strategy is similar for both public- and private-sector enterprises. For example, public officials and corporate boards typically measure and weigh the impact and likelihood of each type of significant risk (e.g., market, operational, labor, geopolitical, technology, data) to determine their individual and total impacts on the enterprise's mission, finances, and reputation. The public officials or board members then determine their risk appetite and resource allocations for each type of risk commensurate with likelihood and impact and balanced among all calculated enterprise risk exposures (the product of likelihood and impact). Public officials and board members also provide guidance to their corporate officers at the enterprise level and to high-level executives at the organization level. This includes guidance on ceilings for capital expenditures (CapEx) and operating expenses (OpEx) and objectives for free cash flow. For the Federal Government, similar requirements are expressed through OMB guidance and strategic direction from senior agency officials, chief executives, and other designees (e.g., an ERM Council).

For both private- and public-sector entities, leaders issue guidance to continue, accelerate, reduce, delay, or cancel significant enterprise initiatives. They do this while making decisions about what constitutes prudent risk disclosures, balancing the competing objectives of a) properly informing stakeholders and overseers (including regulators) through required filings and statements at hearings, versus b) protecting sensitive information from competitors and adversaries.

3.2 Identify the Risks

The second step in the risk management life cycle involves identifying a comprehensive set of risks and recording them in the risk register. This involves identifying those events that could enhance or impede objectives, including the risks involved in failing to pursue opportunities. ICT risk identification is composed of four inputs:

1. identification of the organization's mission-supporting assets and their valuation,
2. determination of potential threats that might jeopardize the security or performance of those assets and potential ICT opportunities that might benefit the organization,
3. consideration of the vulnerabilities of those assets, and
4. evaluation of the potential consequences of risk scenarios.

Sections 3.2.1 through 3.2.4 discuss each of these four inputs in more detail.

Risk practitioners often perform risk identification as both top-down and bottom-up exercises. For example, after the organization has considered critical or mission-essential functions, it may consider various types of issues that could jeopardize those functions as an input to risk scenario development. Subsequently, as a detailed threat and vulnerability assessment occurs, assessors consider how those threats might affect various assets by conducting a bottom-up assessment. This bidirectional approach helps support holistic and comprehensive risk identification.

3.2.1 Inventory and Valuation of Assets

Since ICT risk reflects, at least in part, the effect of uncertainty on digital components that support enterprise objectives, practitioners identify the assets that are necessary to achieve those objectives. The value of an asset extends beyond its replacement cost. For example, an organization could calculate the direct cost of research and development for a new product offering, but the long-term losses associated with the theft of that intellectual property could impact future revenue, share prices, enterprise reputation, and competitive advantage. A core concept in ERM is prioritizing attention and resources on those assets that have the greatest impact on an enterprise's ability to achieve its mission (and, in the case of federal agencies, impact that affects the public.)

Risk managers should leverage a business impact analysis (BIA) template that can be used to consistently evaluate, record, and monitor the criticality and sensitivity of enterprise assets.[12] It is vitally important to gain senior stakeholders' guidance regarding the determination of which assets are critical or sensitive. Federal agencies are required to identify and record *high value assets*, or HVAs. The relative importance of each enterprise asset is a necessary input for considering the impact portion of risk analysis.

Note that many of the assets on which an organization depends are not within its direct control. External technical assets may include cloud-based software or platform services, telecommunications circuits, and video monitoring. Personnel may include the internal workforce, external service providers, and third-party partners.

3.2.2 Determination of Potential Threats

ICT risk is not inherently good or bad. Rather, it represents the effects of uncertain circumstances, so risk managers should consider a broad array of potential positive and negative risks. The following sections primarily deal with negative risks. A *threat* represents any circumstance or event with the potential to adversely impact organizational operations (a *negative risk*)[13]. The threat could arise from a malicious person with harmful intent or from an unintended or unavoidable situation (e.g., a natural disaster, technical failure, or human errors) that may trigger a vulnerability. Numerous threat modeling techniques are available for analyzing specific threats. It may be helpful to consider both a top-down approach (i.e., reviewing critical or sensitive assets for what could potentially go wrong, regardless of threat source) and a bottom-up approach (i.e., considering the potential impact of a given set of threat or vulnerability scenarios).

[12] For more information on BIA, see NIST IR 8286D [IR8286D].

[13] The term *threat* is used throughout this publication to describe the source of any problem, circumstance, or event with the potential to adversely impact organizational operations. The word *threat* may have specific meaning, and possibly greater or lesser importance, within a given risk program.

One source of threat information is a high-level assessment based on various frameworks (e.g., NIST Cybersecurity Framework, Privacy Framework, Secure Software Development Framework). These frameworks often provide a way to determine the enterprise's currently implemented practices (i.e., current state) and ways to review the risk implications of that state to identify potential risk scenarios.

One commonly used method that may help organizations identify potential risk outcomes is a *SWOT* (strengths, weaknesses, opportunities, threats) analysis. Applying SWOT analysis helps users identify opportunities that arise from organizational strengths (e.g., a well-respected software development team) and threats (e.g., supply chain issues) that reflect an organizational weakness. The use of SWOT analysis helps describe and consider the context described in Section 3.1, including internal factors (strengths and weaknesses internal to the organization), external factors (the opportunities and threats presented by the external environment), and ways in which these factors relate to each other.

While it is critical that enterprises address potential negative impacts on mission and business objectives, it is equally critical (and required for federal agencies) that enterprises plan for success. OMB states in Circular A-123 that "the profile must identify sources of uncertainty, both positive (opportunities) and negative (threats)." However, the notion of "planning for success" by identifying and realizing positive risks (opportunities) is a relatively new concept in ICTRM that is influencing other risk management disciplines. For the moment, it should be noted that both positive and negative risks follow the same processes, from identification to analysis to inclusion in the ERP.

Whatever means are used to determine potential threats, it is important to consider them in terms of both the *threat actors* (i.e., the sources of risks with the capability to result in harmful impact) and the *threat events* caused by their actions.

Combinations of multiple risks should also be considered. For example, if one risk in the register refers to a website outage and another risk refers to an outage of the customer help desk, there may need to be a third risk in the register that considers the likelihood and impact of an outage affecting **both** services at once. It is also important to identify cascading risks where one primary risk event may trigger a secondary and even a tertiary event. Analysis of the likelihood and impact of these first-, second-, and third-order risks is described in Section 3.3.

During the threat modeling process, it is important for the practitioner to look out for and mitigate instances of cognitive bias. Some common issues of bias include:

- **Overconfidence** – The tendency for stakeholders to be overly optimistic about risk scenarios (e.g., unreasonably low likelihood of a threat event, overstated benefits of an opportunity, exaggerated estimation of the ability to handle a threat)
- **Group think** – Rendering decisions as a group about potential threat sources and threat events in a way that discourages creativity or individual responsibility
- **Following trends** – Blindly following the latest hype or craze without a detailed analysis of the specific threats facing the organization

- **Availability bias** – The tendency to focus on issues (such as threats) that come readily to mind because one has heard or read about them, perhaps in ways that are not representative of the actual likelihood of a threat event occurring and resulting in adverse impact

3.2.3 Determination of Exploitable and Susceptible Conditions

The next key input to risk identification is understanding the potential conditions that enable a threat event to occur. It is important to consider all types of vulnerabilities in all assets, including people, facilities, and information. For the purposes of this document, *vulnerability* is simply a condition that enables a threat event to occur. It could be an unpatched software flaw, a raw material limitation, a process that leads to human error, or a physical environmental condition (like a wooden structure being flammable). The presence of a vulnerability does not cause harm in and of itself, as there needs to be a threat present to exploit it. Moreover, a threat that does not have a corresponding vulnerability may not result in a negative risk. Identifying negative risks includes understanding the potential threats and vulnerabilities to organizational assets, which can then be used to develop scenarios that describe potential risks.

Some weaknesses, such as software flaws or misconfigurations, can be identified using automated scanners. These automated techniques may help to quickly identify some common vulnerabilities, but ICT weaknesses are not limited to enterprise hardware and software. For the ICT risk disciplines of privacy, supply chain, and cybersecurity, reviewing the controls described in NIST SP 800-53, *Security and Privacy Controls for Information Systems and Organizations*, may help highlight many potential weaknesses. [SP80053]

3.2.4 Evaluation of Potential Consequences

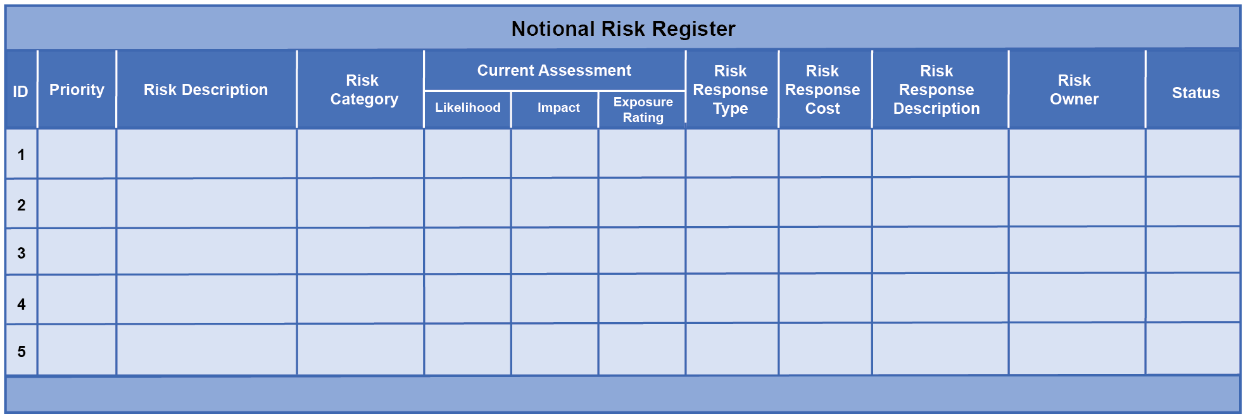
The final component of risk identification is documenting the potential consequences of each risk listed in the register. Many organizations incorrectly express risks outside of their context. For example, a stakeholder might say, “I’m worried about floods,” or “I’m concerned about a denial-of-service attack.” These examples cannot be analyzed or considered without knowing the full picture. Considering the above factors, an effective example of an identified risk might be (as expressed in cause-and-effect terminology), “If a hurricane causes a storm surge, it could flood the data center and damage multiple critical file servers.”

Notably, ICT risks that cause unexpected or unreliable behavior in a system do not always result in the complete failure of that system to fulfill its duty in support of business objectives. Many elements of a risk management plan are implemented to support redundancy and resilience so that a highly likely threat event might result in manageable consequences. Resilient enterprise systems may be able to continue operating in the face of adverse circumstances.

3.2.5 Risk Register Use

Risk registers are used within organizations to communicate and track ICT risks over time. By combining the results of Sections 3.2.1 through 3.2.4, the practitioner can create a set of risk scenarios in the *Risk Description* column of the risk register. *Risk scenarios* provide a means to present detailed risk information in context. A complete risk scenario describes the source of uncertainty, predisposing conditions, resources affected, and anticipated result. For ICT risks, a scenario might include a threat source, a threat event, a vulnerability that threat source might exploit, enterprise assets impacted by the threat, and the resulting harmful impact. For example, “Construction activity severs a critical fiber optic cable that was not protected in conduit, interrupting communications to the data center and resulting in the loss of availability of enterprise financial systems.” Scenarios may also help to describe positive risk (i.e., opportunity). An example of this might be, “Construction of a new alternate data center improves the resilience of financial infrastructure and reduces the likelihood of an interruption.”

Figure 5 shows a notional risk register template. The notional template includes many of the elements suggested by OMB Circular A-11. It illustrates only the current risk assessment (i.e., likelihood, impact, and resulting exposure value). Organizations will need to determine which assessments should be reflected in the risk register. Because this document describes the risk register as an input into ERM processes, only the current risk assessment results are depicted. Some organizations may wish to include both the current risk assessment (before risk response is applied) and the anticipated changes to risk that are expected to result based on the risk response.



Notional Risk Register

ID	Priority	Risk Description	Risk Category	Current Assessment			Risk Response Type	Risk Response Cost	Risk Response Description	Risk Owner	Status
				Likelihood	Impact	Exposure Rating					
1											
2											
3											
4											
5											

Figure 5: Notional Risk Register Template

Table 4 describes each of the elements in the notional risk register template. The actual composition of the register will vary among enterprises and may contain more or fewer data points than those described in Table 4. For example:

- If the register is to be updated after the risk response, the results of a post-response assessment could be reflected in the register as the *residual risk*.
- Organizations might document a desired risk state based on risk appetite/tolerance, the *target residual risk*.

Table 4: Descriptions of Notional Risk Register Template Elements

Register Element	Description
ID (Risk Identifier)	A sequential numeric identifier for referring to a risk in the risk register.
Priority	A relative indicator of the criticality of this risk, either expressed in ordinal value (e.g., 1, 2, 3) or in reference to a given scale (e.g., high, moderate, low).
Risk Description	A brief explanation of the risk scenario (potentially) impacting the organization and enterprise. Risk descriptions are often written in a cause-and-effect format, such as “if X occurs, then Y happens.”

Register Element	Description
Risk Category	An organizing construct that enables multiple risk register entries to be consolidated. Consistent risk categorization is helpful for comparing risk registers during the risk aggregation step of ERM.
Current Assessment – Likelihood	An estimation of the probability that this scenario will occur before any risk response. On the first iteration of the risk cycle, this may also be considered the **initial assessment.**
Current Assessment – Impact	Analysis of the potential benefits or consequences that might result from this scenario if no additional response is provided. On the first iteration of the risk cycle, this may also be considered the **initial assessment.**
Current Assessment – Exposure Rating	A calculation of the probability of risk exposure based on the likelihood estimate and the determined benefits or consequences of the risk. Throughout this report, the combination of impact and likelihood is referred to as *exposure*. Other common frameworks use different terms for this combination, such as *level of risk* (e.g., ISO 31000). On the first iteration of the risk cycle, this may also be considered the **initial assessment**.
Risk Response Type	The risk response (sometimes referred to as the *risk treatment*) for handling the identified risk. Values for risk response types are listed in Table 5 of this document.
Risk Response Cost	The estimated cost of applying the risk response.
Risk Response Description	A brief description of the risk response. For example, "Implement software management application XYZ to ensure that software platforms and applications are inventoried," or "Develop and implement a process to ensure the timely receipt of threat intelligence from [name of specific information sharing forums and sources]."
Risk Owner	The designated party responsible and accountable for ensuring that the risk is maintained in accordance with enterprise requirements. The risk owner may work with a designated risk manager who is responsible for managing and monitoring the selected risk response.
Status	A field for tracking the current condition of the risk and any next activities.

Regardless of which model is selected for use as a risk register, it is important for the enterprise to ensure that the model is used in a consistent and iterative way. As the risk professional progresses through the steps in Section 3, the risk register will be populated with relevant information. Once decisions have been made as part of a subsequent review of the risks, the agreed-upon risk response becomes the current state after mitigations are put in place, and the cycle begins anew.

Using risk registers for ICT uncertainty provides consistency in capturing, organizing, and communicating risk-related information throughout the ICTRM and ERM processes. The risk registers used at each level convey information about risk assessments, evaluation decisions, responses, and monitoring activities. The remainder of this section provides guidance and useful information for completing and using registers and integrating them with ERM.

While the risk register itself can be used to document and communicate information about current risks and responses, it may be necessary to supplement the register with a *risk detail record* (RDR). A notional example of an RDR is provided in Appendix B. The use of RDRs enables the documentation of details regarding the considerations, assumptions, and results of risk management activity. It also enables the enterprise to record personnel involved in those considerations, any actions to be taken, and schedules. Contents of an RDR may include:

- Information regarding the risk itself, such as a detailed risk scenario description and underlying threats, vulnerabilities, assets threatened, risk category, and risk assessment results

- Roles involved in risk decisions and management (e.g., risk owner, risk manager, action owner for specific activities, stakeholders involved in risk response decisions, contractual agreements for supply chain/external partners)
- Schedule considerations, such as the date the risk was first documented, the date of the last risk assessment, completion dates for mitigations, and the date of the next expected assessment
- Risk response decisions and follow-up, including detailed plans, status, and risk indicators

An RDR may be stored and maintained in a written record, as part of an organizational knowledge management system, or as a database entry in risk-specific software, such as a Governance, Risk, and Compliance (GRC) application.

3.3 Analyze (Quantify) the Risks

In Step 3 of the risk management life cycle, each ICT risk is analyzed to estimate the likelihood that the risk event will occur, and the potential impact of the consequences is described.

3.3.1 Risk Analysis Types

Relying solely on an informal risk analysis may impair effective ICTRM decision support. A broad array of risk analysis methodologies is available to aid in making a more accurate estimation, such as International Electrotechnical Commission (IEC) 31010:2019 [IEC31010] and the Open Group's Open Factor Analysis of Information Risk (FAIR) standards [OPENFAIR]. Risk analysis methods include:

- *Qualitative analysis,* based on the assignment of a descriptor, such as low, medium, or high. The scale can be formed or adjusted to suit the circumstances, and different descriptions may be used for different risks. Qualitative analysis is helpful as an initial assessment or when intangible aspects of risk are to be considered. To improve the accuracy of qualitative analysis, values and data can be leveraged from external sources, such as industry benchmarks or standards, metrics from similar previous risk scenarios, or findings from inspections and assessments.
- *Quantitative analysis* involves numerical values, which are assigned to both impact and likelihood. These values are based on statistical probabilities and a monetized valuation of loss or gain. The quality of the analysis depends on the accuracy of the assigned values and the validity of the statistical models used. Consequences may be expressed in terms of financial, technical, or human impacts.

Some practitioners apply a semi-quantitative assessment that uses a numerical scale that represents some range of values or meanings in the enterprise context. The application of this model helps translate risk analysis into qualitative terms that support risk communications for decision makers while also supporting relative comparisons (such as within a particular scale or range).

Each of these analysis types has advantages and disadvantages, so the type performed should be consistent with the context associated with the risk. The methods to be selected and under what circumstances depend on many organizational factors and might be included in the risk management discussions described in Section 3.1. While qualitative methods are commonplace, the practitioner may benefit from considering a quantitative methodology with a more scientific approach to estimating the likelihood and the impact of consequences where the data is available for this type of analysis. This may help to better prioritize risks or prepare more accurate risk exposure forecasts. The benefits of such an approach may be offset by the fact that changing the risk assessment methodology may require time and resources for development and training.

Common ERM practices include both qualitative and quantitative types of risk analysis. When selecting the most appropriate type of risk analysis at the system or organization level, practitioners should consider both consistency with ERM at the enterprise level and the accuracy of measuring ICT risks.

3.3.2 Techniques for Estimating Likelihood and Impact

Since one of the primary goals of ICTRM is to identify potential risks that are most likely to have a significant impact, an accurate reflection of risk details is critical. Fortunately, risk management has been practiced for many years, and there are many effective techniques for analyzing risk in comparison with enterprise risk appetite and system or organizational risk tolerance. IEC 31010 [IEC31010] is an international standard that describes and provides guidance on 17 risk assessment techniques that can be used for analyzing controls, dependencies, and interactions; understanding consequence and likelihood; and measuring overall risk. In addition to analysis techniques like those described below, understanding the likelihood of threat events and their potential impacts will also draw on experimentation, investigations into previous risk events, and research into the risk experiences of similar organizations.

The likelihood and impact elements of a risk can be broken into sub-factors. For example, consider a risk scenario in which a critical business server becomes unavailable to an organization’s financial department. The age of the server, the network on which it resides, and the reliability of its software all influence the likelihood of a failure. The impact of this scenario can also be considered through various factors. If another server is highly available through a fault-tolerant connection, the loss of the initial server may have little consequence. Other factors also impact risk analysis, such as timing. If the financial server supports an important payroll function, the impact of a loss occurring shortly before payday may be significantly higher than if it were to occur after paychecks are distributed. The impact may vary greatly depending on whether the server is used for archiving legacy records or performing urgent stock trades. There are many considerations that go into estimating exposures and the events that can trigger them. Whichever sub-factors an organization chooses to consider, they should be clearly delineated and defined to ensure consistency in their use for likelihood and frequency estimation as well as overall risk register assessment and aggregation.

The calculation of multiple or cascading impacts is an important consideration, and each permutation should be individually included in the risk register. Secondary loss events should be captured with primary loss events to represent the total impact and cost of a risk scenario. The omission of secondary losses in the assessment of a risk scenario would underestimate the total impact, thereby misinforming risk response selection and prioritization. For example, while the organization might consider a risk that a telecommunications outage would result in the loss of availability of a critical web server, there may also be secondary loss events, including the loss of customers from frustration with unavailable services or penalties resulting from the failure to meet contractual service levels. An analysis of cascading risks should include the consideration of factors that would lead to a secondary risk, such as the outage described above.

Examples of techniques for estimating the probability that a risk event will occur include:

- **Bayesian analysis** – A model that helps inform a statistical understanding of probability as more evidence or information becomes available
- **Monte-Carlo** – A simulation model that draws upon random sample values from a given set of inputs, performs calculations to determine results, and iteratively repeats the process to build up a distribution of the results
- **Event tree analysis** – A modeling technique that represents a set of potential events that could arise following an initiating event from which quantifiable probabilities could be considered graphically

Both tangible (e.g., direct financial losses) and less tangible impacts (e.g., reputational damage and impairment of mission) should be considered when evaluating the potential consequences of risk events. These are connected since direct losses will affect reputation, and reputational risk events will nearly always result in risk response expenses. OMB Circular A-123 states that "reputational risk damages the reputation of an agency or component of an agency to the point of having a detrimental effect capable of affecting the agency's ability to carry out mission objectives." There is a broad range of stakeholders to be considered when estimating reputational risk, including the workforce, partners, suppliers, regulators, legislators, public constituents, and clients/customers.

Practitioners document and track the potential consequences of each ICT risk that would significantly impact enterprise objectives, such as causing material reputation damage or significant financial losses to the enterprise. Documenting and tracking these consequences at the organization or system level streamlines the step of providing ICT risk inputs to the ERM program.

The estimation of the likelihood and impact of a risk event should account for existing and planned controls. The ERM Playbook provides the following guidance:

> Identifying existing controls is an important step in the risk analysis process. Internal controls (such as separation of duties or conducting robust testing before introducing new software) can reduce the likelihood of a risk materializing and the impact. […] One way to estimate the effect of a control is to consider how it reduces the threat likelihood and how effective it is against exploiting vulnerabilities and the impact of threats. Execution is key – the presence of internal controls does not mean they are necessarily effective. [ERMPLAYBOOK]

The estimated likelihood and impact of each risk are recorded in the appropriate columns within the risk register. After risk responses are determined, the analysis should be revised to reflect the mitigation (of likelihood and impact) from each risk response. The residual risk (i.e., the remaining risk after applying risk responses) should then be recorded in the risk register's

Residual Risk column. To simplify the process of normalizing risk registers when developing an ERR, a consistent time frame should be used for estimating the likelihood of each risk. Likewise, the level of impact helps to normalize the risk during the aggregation and prioritization process.

3.4 Prioritize Risks

After identifying and analyzing applicable risks and recording them in risk registers, the priorities of those risks should be determined and indicated. This is accomplished by determining the exposure presented by each risk (i.e., based on the likelihood that a threat event will occur and result in an adverse impact).

An ICT risk can have adverse effects on achieving organizational objectives. Based on the analysis conducted using the processes described in Section 3.3, such effects could range from negligible to severe, so exposure determination is important. Additionally, since organizations have limited resources, it is helpful to sort the risks within the register in order of importance to prioritize risk response. As shown in the template in Figure 5, this result helps complete the Priority column.[14]

When completing the Priority column of the risk register, consider the following:

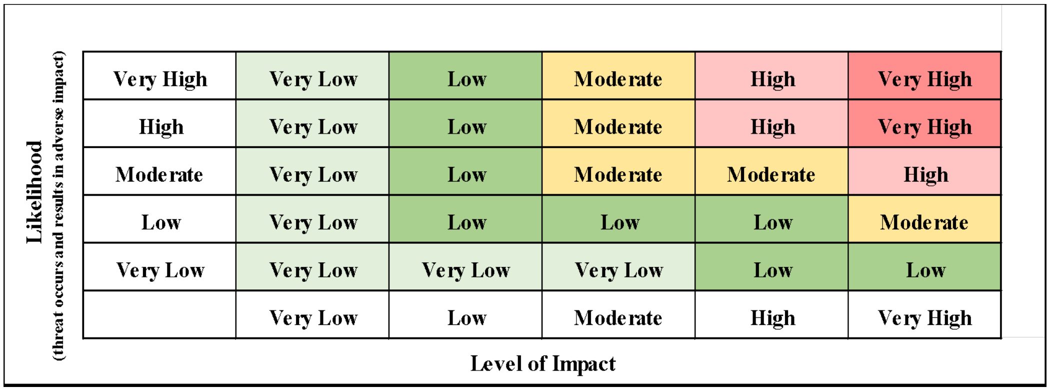
- How to combine the calculations of likelihood and impact to determine exposure[15]
- How to determine and measure the potential benefits of pursuing a particular risk response
- When to seek additional guidance on how to evaluate risk exposure levels, such as while evaluating exposures germane to risk tolerance statements

Practitioners use both qualitative and quantitative models for calculating and communicating about exposure. Figure 6 demonstrates the use of qualitative descriptors for likelihood and impact as well as how these might be used to determine an overall exposure value.[16] Each risk is evaluated in light of the risk's likelihood and impact as determined during risk analysis. The thresholds for ranges of exposure can be established and published as part of the enterprise governance model and used by stakeholders to prioritize each risk in the register.

[14] While risks in the register are assigned a priority to help rank their relative importance, this prioritization is distinct from (but may help inform) the enterprise-level prioritization performed by senior leaders to create the enterprise risk profile.

[15] The formula for calculating risk exposure is the total loss if the risk occurs multiplied by the probability that the risk will happen. Loss is calculated through a traditional BIA used in conjunction with the risk register model to inform the senior-level decision-making process.

[16] Individual risk programs may have varying views on how to calculate and record likelihood in program risk registers. Most risk programs view likelihood as a factor of threat and vulnerability. Risk programs are encouraged to use the risk adjudication and communication process as an opportunity to discuss and standardize any program-specific likelihood calculation.



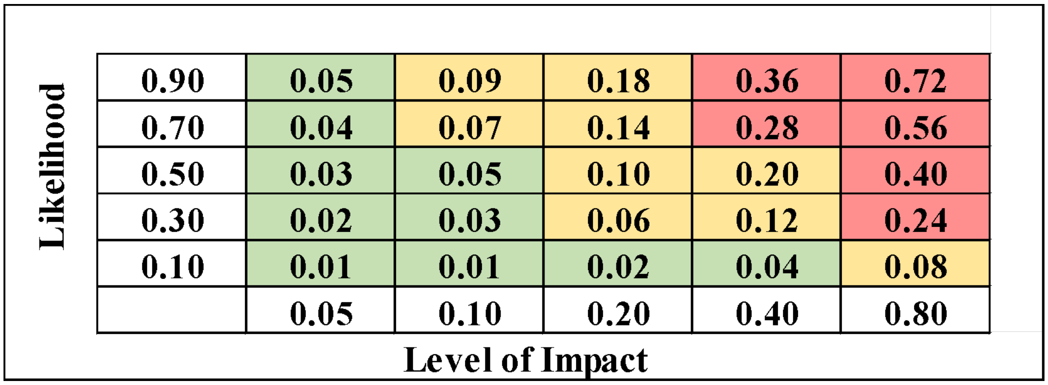
Likelihood (threat occurs and results in adverse impact)

Very High	Very Low	Low	Moderate	High	Very High
High	Very Low	Low	Moderate	High	Very High
Moderate	Very Low	Low	Moderate	Moderate	High
Low	Very Low	Low	Low	Low	Moderate
Very Low	Very Low	Very Low	Very Low	Low	Low
	Very Low	Low	Moderate	High	Very High

Level of Impact

Figure 6: Example of a Qualitative Risk Matrix

Figure 7 depicts a quantitative example. In this illustration, the enterprise has provided guidance that any risk above 0.20 (based on likelihood times impact) represents a high risk, and risks rated between 0.06 and 0.20 are designated as moderate.



Likelihood

0.90	0.05	0.09	0.18	0.36	0.72
0.70	0.04	0.07	0.14	0.28	0.56
0.50	0.03	0.05	0.10	0.20	0.40
0.30	0.02	0.03	0.06	0.12	0.24
0.10	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80

Level of Impact

Figure 7: Example of a Quantitative Risk Matrix

While prioritization will be strongly influenced by the risk exposure determination, other factors such as enterprise context or stakeholder priorities may also influence those decisions. Stakeholders might also define a minimum level of exposure to include on the risk register through the risk management strategy or other directives. While ICT risks should not arbitrarily be omitted from the register, there are likely to be many that represent such a low exposure that they need not be included. Guidance for this threshold should be applied consistently throughout the enterprise.

For those ICT risks that *are* included and prioritized in the risk register, an evaluation should be performed to identify an appropriate risk response, as described in the next topic.

3.5 Plan and Execute Risk Response Strategies

The fifth step of the risk management life cycle is to determine the appropriate response to each risk. The goal of effective risk management, including ICT risks, is to identify ways to keep risk aligned with the risk appetite or tolerance in as cost-effective a way as possible. In this stage, the practitioner will determine whether the exposure associated with each risk in the register is within acceptable levels based on the potential consequences. If not, that practitioner can identify and select cost-effective risk response options to achieve ICT objectives.

Planning and executing risk responses is an iterative activity and should be based on the risk strategy guidance described in Section 3.1.3. As the risk oversight authorities monitor the success of those responses, they will provide operational leaders with financial and mission guidance to inform future risk management activities. In some cases, risk evaluation may lead to a decision to undertake further analysis to confirm estimates or more closely monitor results (as described in Section 4.2). Note that risk responses themselves may introduce new risks. For example, adding multi-factor authentication to a business system to reduce an access control risk may introduce a new risk of decreased productivity when users have difficulty authenticating.

While there is some variance among the terms used by risk management frameworks, there are four types of actions available (as described in Table 5) for responding to negative ICT risks: *accept, transfer, mitigate,* and *avoid*.

Table 5: Response Types for Negative ICT Risks

Type	Description
Accept	Accept ICT risk within risk tolerance levels. No additional risk response action is needed except for monitoring.
Transfer	For ICT risks that fall outside of tolerance levels, reduce them to an acceptable level by sharing a portion of the consequences with another party (e.g., ICT insurance). While some of the financial consequences may be transferable, there are often consequences that cannot be transferred, like a loss of customer trust.
Mitigate	Apply actions (e.g., risk management controls) that reduce a given risk to an acceptable level. Responses could include those that help prevent a loss (i.e., reducing the probability of occurrence or the likelihood that a threat event materializes or succeeds) or that help limit such a loss by decreasing the amount of damage and liability.
Avoid	Apply responses to ensure that the risk (specifically the threat) does not occur. Avoiding a risk may be the best option if there is not a cost-effective method for reducing the ICT risk to an acceptable level. The cost of the lost opportunity associated with such a decision should be considered as well.

In many cases, mitigation to bring exposure to negative ICT risks within risk tolerance levels is accomplished using risk management controls. For example, if the risk executive function declares that the organization must avoid risks with likelihood and impact values of high/high for all costs over $500,000, the Risk Response Type column of the risk register (see Figure 5) can be updated with a response type from Table 5. While including a particular informative reference (e.g., security controls or Cybersecurity Framework and/or Privacy Framework categories and subcategories) may be helpful in guiding and describing risk response, additional information is likely to be required.

In general, people, processes, and technology combine to provide risk management controls that can be applied to achieve an acceptable level of risk. Examples of controls include:

- **Preventative:** Reduce or eliminate specific instances of a weakness
- **Deterrent:** Reduce the likelihood of a threat event by dissuading a threat actor
- **Detective:** Provide warning of a successful or attempted threat event
- **Corrective:** Reduce exposure by offsetting the impact of consequences after a risk event

- **Compensating:** Apply one or more controls to adjust for a weakness in another control

Consider an organization that identifies several high-exposure negative risks, including that poor authentication practices (e.g., weak or reused passwords) could enable the disclosure of sensitive customer financial information and that employees of the software provider might gain unauthorized access to and tamper with the financial data. The organization can apply several deterrent controls (documenting the applied control identifiers and any applicable notes in the Risk Register Comments column), including warning banners and the threat of prosecution for any threat actors that intentionally attempt to gain unauthorized access. Preventative controls include applying strong identity management policies and using multi-factor authentication tokens that help reduce authentication vulnerabilities. The software provider has installed detective controls that monitor access logs and alert the organization's security operations center if internal staff connect to the customer database without a need for access. Furthermore, the financial database is encrypted so that it protects its data if the file system is exfiltrated.

Risk response will often involve creating a *risk reserve* to avoid or mitigate an identified negative risk or to realize or enhance an identified positive risk. A risk reserve is similar to other types of management reserves in that funding or labor hours are set aside and employed if a risk is triggered to ensure that the opportunity is realized or the threat is avoided. For example, the technical skills needed to recover after an ICT attack may not be available with current staffing resources. A risk reserve can also be used with the *accept* response type to address this (e.g., by setting aside funds during project planning to employ a qualified third party to augment the internal incident response and recovery effort.)

3.6 Monitor, Evaluate, and Adjust Risk Management

Risk management should not be simply managing lists of risks. For the activities to be meaningful, risk managers throughout the enterprise must be informed about objectives, results, priorities, and opportunities. A key purpose of the various risk registers is to enable ongoing *monitoring* of enterprise risk activities. Based on those activities, senior leaders *evaluate* available options and *adjust* guidance and operations to help realize opportunities and minimize harmful impacts. This Monitor-Evaluate-Adjust (MEA) cycle is depicted in Figure 8. This iterative approach begins with an understanding of what risk limits are acceptable, given enterprise context and strategic objectives. The purpose of ICTRM integration is to enable senior leaders to remain aware of ongoing risk management activities and apply corrective measures in order to achieve strategic objectives.

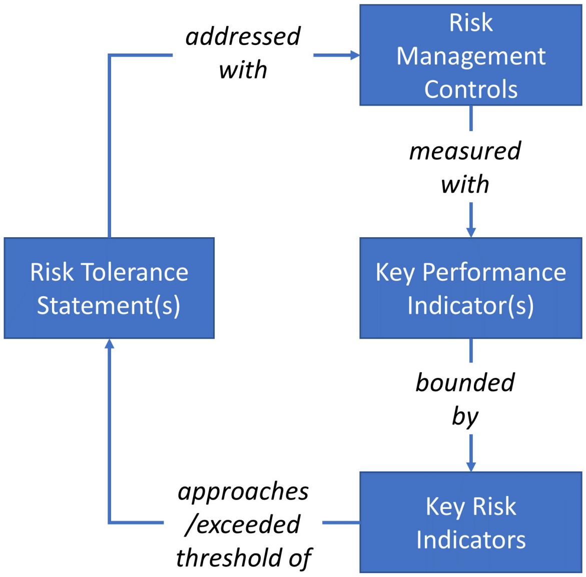

addressed with
Risk Management Controls
measured with
Risk Tolerance Statement(s)
Key Performance Indicator(s)
bounded by
approaches /exceeded threshold of
Key Risk Indicators

Figure 8: Monitor-Evaluate-Adjust Cycle

As risk response activities occur, they are recorded in ICT risk registers. The results are monitored, and performance measurements are collected through KPIs and KRIs and compared with risk strategy and risk direction (based on risk appetite and risk tolerance statements). Leaders provide direction regarding an overall appetite for risk, which is then interpreted at a more granular level as risk tolerance statements. Those risk directives are achieved through the application of various controls that modify the risk conditions. The metrics are reported to managers and leaders, enabling oversight and management of the achievement of the risk tolerance.

Previous discussions highlighted risk direction based on risk appetite statements and their interpretation as risk tolerance statements. There is a third component of risk direction that must be observed – that of *risk capacity*, defined as the maximum amount of risk that an organization is able to endure. While the enterprise should always take steps not to exceed risk appetite, the consequences of doing so are rarely catastrophic. Exceeding risk capacity, on the other hand, could have dire consequences and may even jeopardize the continuance of the enterprise. Catastrophic results are not limited to the private sector. Many government entities have experienced severe consequences because their risk management processes permitted those enterprises to approach or exceed risk capacity. Such cases can end the career of senior leaders whose risk monitoring should have identified the risk conditions.

It is noteworthy that, like risk appetite and tolerance, risk capacity can extend throughout the hierarchical enterprise layers. For example, if a business unit or government bureau exceeded its risk capacity, that portion of the enterprise could be severely impeded or closed. ISACA states that exceeding risk capacity could result in the enterprise's continued existence being questioned [ISACA]. ISO 31010:2019 describes a similar example: "For a commercial firm, capacity might be specified in terms of maximum retention capacity covered by assets, or the largest financial loss the company could bear without having to declare bankruptcy." [IEC31010] While exceeding risk capacity might not immediately result in enterprise extinction, it is clearly a criterion that must be monitored closely. Because capacity reflects the aggregate risk, it is an important consideration for those aggregating ICTRM and evaluating the overall risk posture.

3.6.1 When a Risk Event Passes Without Triggering the Event

Risk responses will often be adjusted as opportunities and threats evolve. The concept is similar to the topic sometimes called the "Cone of Uncertainty" within project management practices; over time, additional understanding about an identified risk will come to light. For changes in identified risk, one mitigation technique is the use of risk reserves, as introduced in Section 3.5. For this risk response, it is important that the risk owners collaborate with the acquisition or procurement teams and budget owners. With appropriate budget planning, risk reserves can be released for other predetermined funding requirements after the risk has been reduced to an acceptable level or the time has passed for the risk to occur.

While many industry-based enterprises can return unused funds to shareholders or pay down corporate debt, unused reserves are more difficult for government agencies to use without pre-planning. Most government procurement cycles are rigidly based on the government fiscal year. Identified opportunities can be "planned for" in government procurement cycles as "optional" tasking or purchases. For example, unused funds could be used to expand a vendor assessment program to ensure that all supply chain providers (including both immediate service providers and their downstream providers) fulfill data processing and privacy risk management requirements. If the current fiscal year only allows for the purchase of half of the required materials, an option can be included at the time of the base contract award for the other half of the materials (but not funded at the time of the base contract award). When the practitioner liberates the risk reserve after the chance of the negative risk occurring has passed, the funding can be used to exercise the already awarded option that lacked the initial funding when the base contract was awarded. Exercising an option in government contracting is trivial (often 30 days or less) when compared to the long lead time for initial contract procurements.

3.7 Considerations of Positive Risks as an Input to ERM

Planning for success is equally as important as avoiding disasters. As mentioned in Section 3.2.2, OMB states in Circular A-123 that, regarding the inclusion of opportunities (positive risks) as a function of the ERM profile, "the profile must identify sources of uncertainty, both positive (opportunities) and negative (threats)." In ICT disciplines, a significant portion of risk information is collected and reported with regard to weaknesses and threats that could result in negative consequences. However, positive risks (opportunities) also inform decisions by senior leaders for setting the risk appetite and tolerance of the enterprise.

From an opportunity standpoint, risk appetite statements can identify areas where the organization needs to stretch further to reach goals and are expressed as those targeted areas where some loss is acceptable without crossing important lines of demarcation (e.g., innovative solutions should be pursued but not at the cost of life, safety, compliance with laws/regulations, or reputation). Understanding that private-sector organizations pursue risk as part of their growth strategies and competitive advantage, this aspect should not be forgotten. Similarly, public-sector agencies typically have stretch goals to keep up with industry needs, customer expectations, market demands, or other influences.

An example of identifying positive risks is conducting a SWOT analysis that considers strengths *and* weaknesses as well as threats *and* opportunities. Consider, for example, an organization that is evaluating moving a major financial system from an in-house data center to a commercial hosting provider. If the organization maintains vast amounts of land and warehouses, the move could be considered a strength of the organization, and they might increase revenue by offering space to a commercial vendor to host both their own and other organizations' data centers. The Federal Government has realized many opportunities of this nature, including consolidating payroll functions under the National Finance Center (NFC) and consolidating reporting requirements in the Department of Justice Cyber Security Assessment and Management (CSAM) application.

Section 3.2.2 describes the need to treat threat actors and threat sources as inputs into an estimation of risk. If the enterprise chooses to include positive risk scenarios in the register, then the process should similarly consider *sources of opportunity* that might provide benefits. A consideration of both threats and opportunities may enable discussions regarding the benefits and risks of a particular endeavor. Alternatively, the organization could manage an *opportunity risk register* separately from the traditional threat-based risk register since positive risks (i.e., opportunities) often have to be assessed on a slightly different scale.

In addition to the threat modeling examples above, methods for identifying ICT-related opportunities are also available and could be as simple as an employee suggestion box. Industry publications, such as those from commercial industry associations and agencies like NIST, regularly provide information and ideas regarding potential innovations or advances for areas such as supply chain, privacy, and cybersecurity improvements.

Numerous formal methods are available for identifying opportunities, including:

- **Brainstorming** – A group innovation technique, often led by a facilitator, that elicits views from participants to identify and describe opportunities
- **Delphi** – A procedure to gain consensus from a group of subject matter experts using one or more individual questionnaires that are collected and collated to identify opportunities to pursue
- **Ideation** – A consistent process of observing an environment, discerning opportunities for improvement, experimenting with possible resolutions, and developing innovative solutions

The same formal methods can be used for determining other inputs, such as those described in Sections 3.2.3 and 3.2.4.

With regard to positive risk response, consider the previous example of an organization that has identified the positive risk of increasing revenue by providing physical space for a commercial vendor to offer an outsourcing service. Analysis of the risk has determined that the opportunity would be highly beneficial to the enterprise. The colocation also provides a moderate opportunity to improve availability as an element of supply chain risk management. The Risk Response Type column of the risk register should also be updated using a response type from Table 5, the comment field updated to contain information pertinent to the opportunity, and the residual risk uncertainty of not realizing the opportunity calculated.

With these controls and methods in place and assessed as effective, the remaining risks can be analyzed to determine the residual impact, likelihood, and exposure, as described in Section 3.3. If the residual exposure falls within risk tolerance levels, then stakeholders can proceed in gaining the benefits of the opportunity. Each of these values is added to the risk register for enterprise reporting and monitoring.

Where positive risks are to be considered and included in risk registers, there are four generally used response types, as described in Table 6.

Table 6: Response Types for Positive ICT Risks

Type	Description
Realize	Eliminate uncertainty to make sure the opportunity is actualized (sometimes referenced as *exploit)*.
Share	Allocate ownership to another party that is better able to capture the opportunity.
Enhance	Increase the probability and positive impact of an opportunity (e.g., hire a risk management staff member to better focus on an organization’s privacy risk and data processing protections).
Accept	Take advantage of an opportunity if it happens to present itself (e.g., identify and prioritize those supply chain risk gaps that should be addressed at the first opportunity).

As with negative risks, positive entries in the ICT risk registers should be normalized and aggregated into the enterprise-level risk register.

As shown in Figure 9, this publication focuses on the integration of ICT risk from various disciplines in support of an ERM integration cycle. The document acknowledges the need for ongoing bidirectional communication between ERM and risk programs, recognizing that the risk disciplines both inform and receive direction from ERM. It shows that the communication of *risk appetite* statements from the ERM portfolio is a way for risk programs to better identify and monitor risks using a variety of related methods such as *risk tolerance* statements, *key performance indicators*, *key risk indicators*, and *controls*. Similarly, this publication formalizes the use of *risk registers* to communicate risks and risk responses among program and portfolio levels. It highlights industry practices for coordination through elevation of risks for oversight and escalating risks for higher-level ownership.

4 Building ERRs and ERPs from ICTRM-Specific Risk Registers

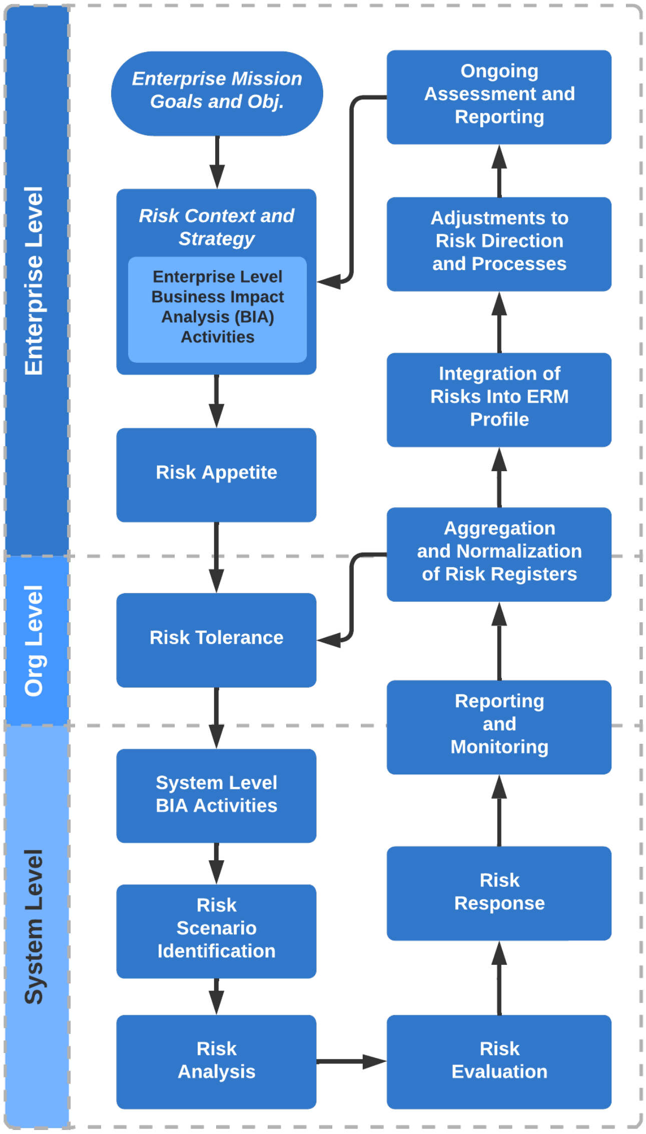

Enterprise Level
Org Level
System Level
Enterprise Mission Goals and Obj.
Risk Context and Strategy
Enterprise Level Business Impact Analysis (BIA) Activities
Risk Appetite
Risk Tolerance
System Level BIA Activities
Risk Scenario Identification
Risk Analysis
Risk Evaluation
Risk Response
Reporting and Monitoring
Aggregation and Normalization of Risk Registers
Integration of Risks Into ERM Profile
Adjustments to Risk Direction and Processes
Ongoing Assessment and Reporting

Figure 9: ICTRM Integration Cycle

The achievement of defined expectations is conveyed through risk registers that document and communicate risk decisions. Risk assessment results and risk response actions at the system level are reflected in the ICT risk registers. The registers from multiple systems are collated, aggregated, and normalized, then provided to business managers at the organization level to provide a composite risk understanding. Those managers can evaluate results and refine risk tolerance criteria to optimize value delivery, resource utilization, and risk. The enterprise-level aggregation of all the various risk registers into an enterprise risk register (ERR), then a prioritized enterprise risk profile (ERP), enables senior leaders to monitor risk responses while considering the expectations set.

This section takes a closer look at how ICT risk registers are used as the inputs for building an ERR and ultimately an ERP, as depicted in Figure 9.

4.1 Creating and Maintaining Enterprise-Level ICT Risk Registers

A key outcome of the risk identification and communications elements is the ability to create enterprise-level ICT risk registers as input to the broader ERR (Section 4.2). As described throughout Section 3, the application of a consistent risk register with agreed-upon criteria and categories enables various data points to be normalized, aggregated, and sorted into an enterprise view.

Risk registers are composed and maintained at all levels: enterprise (including higher-level and lower-level enterprises), organization (including suborganizations and business units), and system.[17] The vertical columns in Figure 4 should not be interpreted as guidance to address such risks as isolated silos, but rather that information for various types of ICT risks should be shared with those in higher organizational levels for the benefit of the whole enterprise. Similarly, ICTRM should not be isolated at only one organizational level nor within a single ICT risk

[17] OMB Circular A-130 defines an information system as “a discrete set of information resources organized for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information.” [OMB-A123]

discipline. Instead, those in an organizational level should collaborate and communicate about issues, problems, and opportunities identified. As lessons learned about successes and challenges are shared among peers, that information can be conveyed to other organizations and to enterprise management, including by using risk registers and RDRs.

For each risk discipline, as the risk registers from each system and organization are completed, they are provided to the designated risk officers at the relevant level (i.e., system or organization) and shared with senior management to conduct the following actions: 1) *normalize* (e.g., ensure definitions and values as recorded by various enterprise entities are consistent and remove duplicate risk reporting) and 2) *aggregate* risks in similar categories into a concise view.

To support the subsequent aggregation of various risk registers, enterprise risk guidance should identify the enterprise objectives to which various types of ICT risk should be aligned. The ERP reflects risks that may have impact in each of four discrete enterprise objectives: strategic, operations, reporting, and compliance. These same four objectives were key factors in the original COSO ERM framework and are often used as guideposts for enterprise risk reporting. Clear direction from senior leaders about how to align various types of ICT risk with enterprise objectives will help enable subsequent aggregation, normalization, and prioritization. Objective alignments include:

- **Strategic** risks related to the implementation of a new service offering; opportunities for innovation within an ICT area; change management improvements and challenges.
- **Operations** issues regarding product or service quality and resilience (e.g., supply chain interruption that disables a manufacturing process); processes and procedures for privacy risk posture; operational technology considerations; business continuity/disaster recovery issues.
- **Reporting** regarding ICT risk issues, including insurance considerations and material risk factors that affect disclosures or statutory reporting.
- **Compliance** risks where a negative event might result in a failure to meet a contractual service agreement or in a regulatory penalty or fine.

Direction may be needed regarding how to account for those risks that cross multiple boundaries and how each organizational level should perform an aggregation of subordinate risk registers.

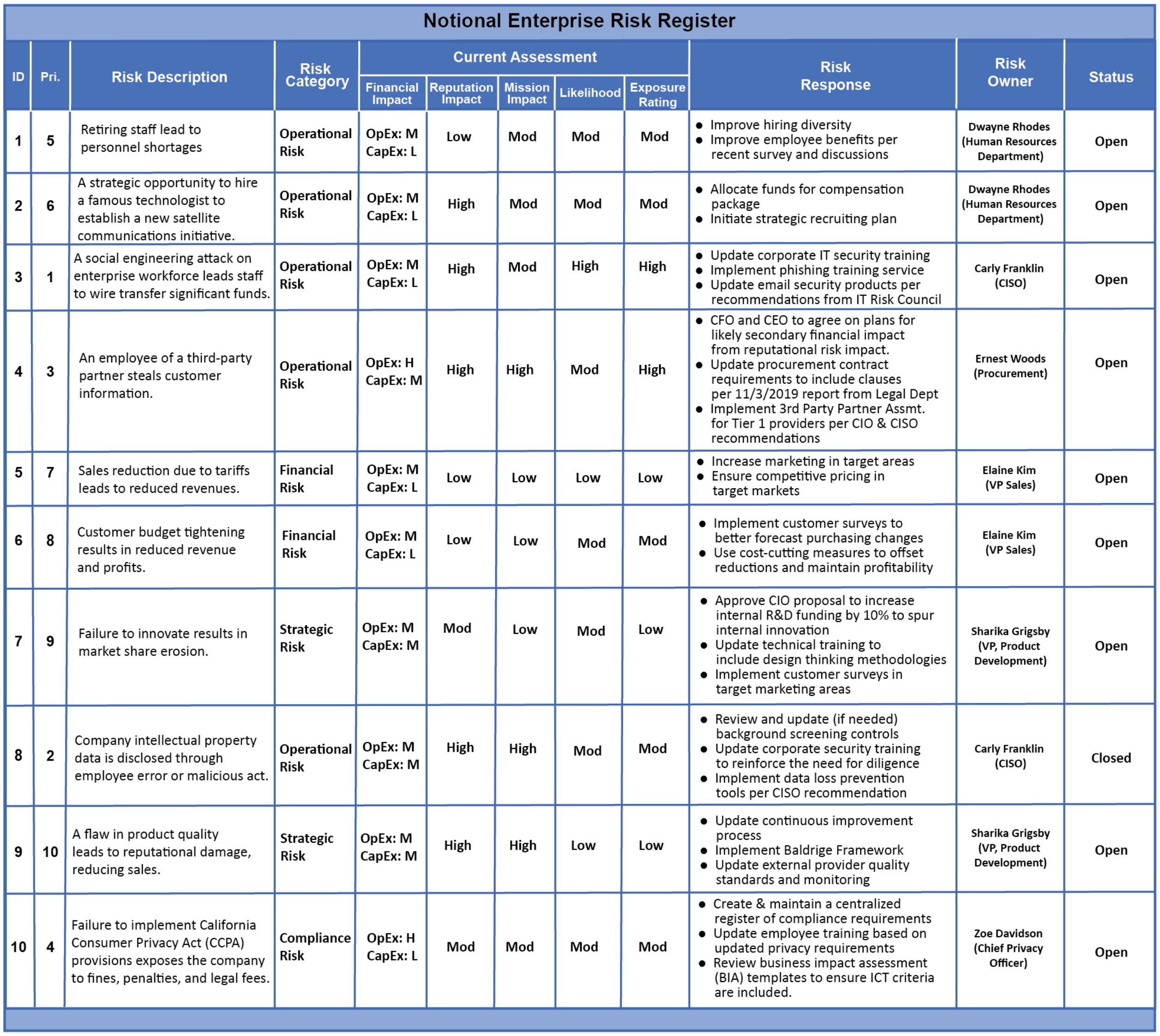
4.2 Creating the Enterprise Risk Register (ERR)

Enterprise risk officers collect all risk inputs, including the ICT risk registers, and analyze potential risk events, consequences, and impacts at the enterprise level to create the ERR. The ERR is subsequently prioritized to create the enterprise risk profile (ERP) discussed in Section 4.3, which enables key executive stakeholders to stay aware of critical risks, including those that are ICT-related.

As part of their risk guidance, enterprise leaders designate ERM process participants and the responsibilities of each role. That guidance should declare which role is responsible for creating and maintaining the ERR, how frequently it will be updated, and how the risks within it will be communicated to various stakeholders. This document will assume that role to be assigned to the enterprise risk officer, although the responsibility could fall upon any designated party, including other roles as described in Section 3.1.1.

The creation and maintenance of the ERR also supports a periodic review of enterprise risk guidance, including risk definitions, context, and risk appetite criteria. It provides an opportunity to review and validate enterprise definitions for risks, risk categories, and risk assessment scales. If any changes or updates to the risk context or guidance need to occur, the enterprise risk officer (or equivalent) is likely to have sufficient seniority to ensure appropriate updates to those enterprise processes. Practitioners should consider any positive risks present in the rolled-up report and add other opportunities as inputs to the ERR.

Figure 10 provides a notional ERR that combines both federal agency and critical infrastructure risks, illustrating the integration of various ICT risks alongside other key enterprise risks.



Notional Enterprise Risk Register

ID	Pri.	Risk Description	Risk Category	Current Assessment					Risk Response	Risk Owner	Status
				Financial Impact	Reputation Impact	Mission Impact	Likelihood	Exposure Rating			
1	5	Retiring staff lead to personnel shortages	Operational Risk	OpEx: M CapEx: L	Low	Mod	Mod	Mod	● Improve hiring diversity ● Improve employee benefits per recent survey and discussions	Dwayne Rhodes (Human Resources Department)	Open
2	6	A strategic opportunity to hire a famous technologist to establish a new satellite communications initiative.	Operational Risk	OpEx: M CapEx: L	High	Mod	Mod	Mod	● Allocate funds for compensation package ● Initiate strategic recruiting plan	Dwayne Rhodes (Human Resources Department)	Open
3	1	A social engineering attack on enterprise workforce leads staff to wire transfer significant funds.	Operational Risk	OpEx: M CapEx: L	High	Mod	High	High	● Update corporate IT security training ● Implement phishing training service ● Update email security products per recommendations from IT Risk Council	Carly Franklin (CISO)	Open
4	3	An employee of a third-party partner steals customer information.	Operational Risk	OpEx: H CapEx: M	High	High	Mod	High	● CFO and CEO to agree on plans for likely secondary financial impact from reputational risk impact. ● Update procurement contract requirements to include clauses per 11/3/2019 report from Legal Dept ● Implement 3rd Party Partner Assmt. for Tier 1 providers per CIO & CISO recommendations	Ernest Woods (Procurement)	Open
5	7	Sales reduction due to tariffs leads to reduced revenues.	Financial Risk	OpEx: M CapEx: L	Low	Low	Low	Low	● Increase marketing in target areas ● Ensure competitive pricing in target markets	Elaine Kim (VP Sales)	Open
6	8	Customer budget tightening results in reduced revenue and profits.	Financial Risk	OpEx: M CapEx: L	Low	Low	Mod	Mod	● Implement customer surveys to better forecast purchasing changes ● Use cost-cutting measures to offset reductions and maintain profitability	Elaine Kim (VP Sales)	Open
7	9	Failure to innovate results in market share erosion.	Strategic Risk	OpEx: M CapEx: M	Mod	Low	Mod	Low	● Approve CIO proposal to increase internal R&D funding by 10% to spur internal innovation ● Update technical training to include design thinking methodologies ● Implement customer surveys in target marketing areas	Sharika Grigsby (VP, Product Development)	Open
8	2	Company intellectual property data is disclosed through employee error or malicious act.	Operational Risk	OpEx: M CapEx: M	High	High	Mod	Mod	● Review and update (if needed) background screening controls ● Update corporate security training to reinforce the need for diligence ● Implement data loss prevention tools per CISO recommendation	Carly Franklin (CISO)	Closed
9	10	A flaw in product quality leads to reputational damage, reducing sales.	Strategic Risk	OpEx: M CapEx: M	High	High	Low	Low	● Update continuous improvement process ● Implement Baldrige Framework ● Update external provider quality standards and monitoring	Sharika Grigsby (VP, Product Development)	Open
10	4	Failure to implement California Consumer Privacy Act (CCPA) provisions exposes the company to fines, penalties, and legal fees.	Compliance Risk	OpEx: H CapEx: L	Mod	Mod	Mod	Mod	● Create & maintain a centralized register of compliance requirements ● Update employee training based on updated privacy requirements ● Review business impact assessment (BIA) templates to ensure ICT criteria are included.	Zoe Davidson (Chief Privacy Officer)	Open

Figure 10: Notional Example of an ICT-Inclusive ERR

This example illustrates the inclusion of a positive risk (item 2) beside negative risks. Of course, an actual ERR would include many more entries, both positive and negative. Most of the columns in the example are the same as their lower-level risk register counterparts. The notable exception is that the example ERR splits the Current Assessment—Impact into three columns, which are described in Table 7.

Table 7: Descriptions of Additional Notional ERR Elements

ERR Element	Description
Current Assessment—Financial Impact	Analysis of the financial potential benefits or consequences resulting from this scenario, including cost considerations. While this element could be quantitative, it is often qualitative (e.g., high, moderate, low) at the enterprise level. Financial considerations may be expressed as 1) capital expenditures that represent a longer-term business expense, such as property, facilities, or equipment, and 2) operating expenses that support day-to-day operations.
Current Assessment—Reputation Impact	Analysis of the potential benefits or consequences that the scenario might have on the stature, credibility, or effectiveness of the enterprise. Some enterprises perform a formal sentiment analysis using commercial services or other technical tools to support assessment.
Current Assessment—Mission Impact	Analysis of the potential benefits or consequences that the scenario might have on the ability of the enterprise to successfully achieve mission objectives

As was described for lower-level risk registers, there is value in both a single point of reference (the ERR) and detailed risk information (the RDR). The ERR provides an easily consumed summary for understanding the risk landscape, while the RDR provides additional information. The RDR also enables the documentation of additional information, such as historical information, detailed risk analysis data, and information about individual and organizational accountability. Additional information for inclusion in an enterprise RDR might include:

- Detailed risk information (e.g., full risk statement, detailed scenario description, key risk indicators, enterprise status for this particular risk)
- Information regarding various risk roles (e.g., risk owner, risk manager, risk approver) and affected stakeholders
- Historical timeline information (e.g., last update date, next expected review)
- Risk analysis information, including the aggregate understanding of threats, weaknesses/pre-existing conditions, resources affected, and impact
- Detailed risk response information (e.g., responses implemented, status and results of previous responses, additional responses planned)

The ERR provides input for those performing enterprise risk oversight, such as an executive risk committee. By tracking the status of each risk, including the exposure value of each, enterprise stakeholders can identify the most relevant risks (e.g., a top ten list that may be used to further inform enterprise risk decisions). Summary reports about the highest-priority risks may be used to inform stakeholders (e.g., for federal departments and agencies, those in an oversight role such as Congress, OMB, or GAO) about existing risks, risk responses, and planned activities.

Since it is difficult to compare dissimilar risk exposures, such as employee retention and disaster recovery, risks are often translated into financial impact and may be further broken down into the direct cost (i.e., the impact of a given risk on the capital budget and operating expenses), the financial cost of reputational damage, and direct financial implications of impact on the enterprise mission. The relative financial impact of each type of risk can provide further input into risk management prioritization and monitoring decisions for enterprise risk managers. Reputation exposure can be similarly determined in the ERR (e.g., by the chief risk officer) by combining high-impact attacks, enterprise sector, and consequences with a histogram (trend) analysis of stakeholder sentiment (for each stakeholder type). This last action of prioritization creates the ERP, as discussed in Section 4.3.

For federal agencies, OMB Circular A-123 requires that the enterprise risk register consider both inherent and residual risk.[18] The COSO ERM Framework [COSOERM] further describes these terms and differentiates between actual residual risk and target (desired) risk:

- "Inherent risk is the risk to an entity in the absence of any direct or focused actions by management to alter its severity."
- "Target residual risk is the amount of risk that an entity prefers to assume in the pursuit of its strategy and business objectives, knowing that management will implement or has implemented direct or focused actions to alter the severity of the risk."
- "Actual residual risk is what remains after management has taken action to alter its severity. Actual residual risk should be equal to or less than the target residual risk."

OMB A-123 examples reference *inherent risk* that describes "conditions in the absence of risk management actions." There are often likely to be at least *some* elements that help mitigate risks, so this publication typically refers to *current risk* rather than *inherent risk* when representing a baseline risk posture.

4.3 Developing the Enterprise Risk Profile (ERP)

As risk information is transmitted up from lower levels of the organization, each level's risk register should contain the pertinent information for creating a prioritized risk profile for the level immediately above it. For example, a subject matter expert in a particular ICT risk discipline might provide their own prioritization of risks within their discipline, for consideration by the next level of risk experts.

Subordinate organizations' impacts may be different, similar, conflicting, overlapping, or unavailable and must be properly combined by financial and mission analysis at the level immediately above the reporting organization. While the impacts of ICT risk on various assets may be determined at lower levels, the overall cash flow and capital implications of all of the risks can only be normalized and aggregated (and recorded in the ERR) by enterprise fiduciaries (e.g., CFOs). Similarly, enterprise mission impacts must be aggregated and expressed by those senior executives most directly accountable to stakeholders.

The ERR informs the ERP once the risks are prioritized at the highest level of the risk management function in the enterprise, as depicted in Figure 11. The ERP is a subset of carefully selected risks from the larger ERR.

[18] While both Circular A-123 and some COSO documents reference inherent risk, this publication focuses on current risk.

OPERATIONS OBJECTIVE – Manage the Risks of a Remote Workforce							
Risk Description	**Exposure Factors**	**Assessment**			**Current Risk Response**	**Proposed Risk Response**	**Risk Owner**
		Last	**Current**	**Residual**			
A global pandemic may necessitate a remote workforce where Agency X could face: • a forced reliance on potentially insecure networks; • a reduction in managerial oversight; and • a deterioration of Agency culture.	**Impact**	High	Medium	Medium	REDUCTION: Agency X has: • Facilitated secure remote access via the setup of a Virtual Private Network (VPN) • Modified existing standard operating procedures to include formal mechanisms for increased transparency and self-reporting. • Established a formal remote/telework policy including means of social interaction (e.g., virtual gatherings, campfire sessions, etc.) to foster team building.	Agency X will begin allowing employees to work remotely one day per week and closely monitor employee productivity.	Primary - Chief Operating Officer (COO)
	Likelihood	Low	Low	Low			
REPORTING OBJECTIVE - Privacy Policies Must Accurately Describe Organizational Handling of PII							
Agency X's privacy policies and disclosures are found to inaccurately describe its collection, use, storage, and disclosure of personally identifiable information (PII).	**Impact**	High	High	Medum	REDUCTION: Agency X has begun an assessment of existing methods of PII processing to ensure they align with existing policies and are within the bounds of all applicable regulatory requirements.	Agency X will establish a quarterly audit of PII processing and develop a privacy-specific change management plan for inclusion of any necessary updates.	Primary - Chief Privacy Officer (CPO)
	Likelihood	Medium	Medium	Low			
OPERATIONS OBJECTIVE - Manage the Risk of Sudden Interruptions in the Supply Chain							
A key supplier of Agency X has abruptly gone bankrupt.	**Impact**	High	High	Medium	REDUCTION: Agency X has begun to formally analyze downstream demand and other market variables to have a better understanding of their current suppliers' ability to handle the dynamic nature of demand.	Agency X is seeking to ensure redundancy within their supply chain by identifying backup/alternative suppliers and seeking to reduce the potential time needed to transition to a new supplier.	Primary - Logistics Coordinator
	Likelihood	Medium	Medium	Medium			

Figure 11: Notional Example of an Enterprise Risk Profile

The ERP reflects assessments of mission, financial, and reputation exposures organized according to the four enterprise objectives. They may be full-value exposures or modified (and so noted) by the likelihood assessments of enterprise leaders. At the top enterprise level, ERM officials have the prerogative to add their own judgment of likelihood and impact as part of the normalization process, along with other members of the enterprise risk executive function. While the ERM process helps drive the discussion and calculation of likely risk scenarios, recent natural disasters have demonstrated that actual consequences can far exceed initial loss expectations. Enterprise executives should continually observe industry trends and actual occurrences to readjust likelihood and impact estimations and reserves based on a changing risk landscape. ERPs should also reflect comparable occurrence incidents and trends for the subject enterprise and peer organizations.

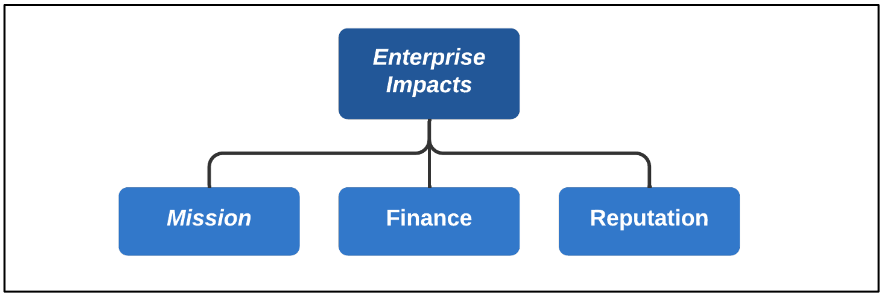


Figure 12: Impacts (Consequences) of Enterprise Assets for a Business or Agency

The ERP supports the governance and management for measuring significant financial, reputational, and missional impact (consequences). Some enterprises may also use this taxonomy to support a broader risk breakdown structure (RBS), a topic that may be explored in a future NIST publication. As shown in Figure 12, considerations include:

- **Financial impact** – Various risk scenarios are converted into actual capital and operational expenses, enabling executive leaders to conduct a fiscally responsible cost/benefit analysis that considers the recommended strategies for risk response. (These presentations are equivalent to the financial disclosures in Form 10-Q and Form 10-K filings to the U.S. Securities and Exchange Commission [SEC] by commercial public companies each quarter and for Form 8-K filings as risk incidents occur.)
- **Reputation impact** – While subordinate risk registers describe risk scenarios, including those that may impact reputation, executive leaders record the evaluation of consequences on the enterprise's reputation. This also supports consideration of other downstream impacts, such as financial losses or credit risk, that are likely to result from damage to reputation.
- **Mission impact** – Executive leaders record the evaluation of consequences on the overall ability for the enterprise to conduct its mission and achieve strategic objectives. (Mission impact in commercial public enterprises is often expressed in Share Value/Market Cap and Share Volatility tables, also disclosed in SEC filings and shareholder communications.)

These three high-level impact considerations are then used in conjunction with other enterprise risk responses to determine tolerances, allocations, and disclosures commensurate with risk exposure.

4.4 Translating the ERP to Inform Leadership Decisions

For some organizations, the information from the ERP will need to be provided to senior managers that have a fiduciary duty to remain aware of and help manage risks. In this way, enterprise leaders will have the necessary information and opportunity to consider risk exposures as factors for budgets or corporate balance sheet reporting. Both private-sector and public-sector enterprises will benefit from the use of this risk register integration process; creation of an ERP is mandated by OMB Circular A-123 for federal agencies.[19] (Section B1 of OMB A-123 refers to the Agency Risk Profile.) The "primary purpose of a risk profile is to provide analysis of the

[19] Enterprise-level treatment, communication, and prioritization are discussed in Section 5 of this document.

risks an [enterprise] faces toward achieving its strategic objectives arising from its activities and operations, and to identify appropriate options for addressing significant risks. The risk profile assists in facilitating a determination around the aggregate level and types of risk that the agency and its management are willing to assume to achieve its strategic objectives." This prioritization is supported by one of COSO's key principles: "The organization prioritizes risks as a basis for selecting responses to risks." [COSOERM] Prioritization helps managers to evaluate the costs and benefits of allocating resources to mitigate one risk compared to another.

Senior leadership must have actionable information for their decision-making (e.g., during industry boardroom deliberations and their federal counterparts). Table 8 provides a notional Enterprise Risk Profile Supplement that reflects a portfolio evaluation of various organizational risk profiles. This information, having been populated and prioritized, directly informs executive decision-making.

Table 8: Notional Enterprise Risk Portfolio View for a Private Enterprise

Financial Risk Profile						
	Current Period			Previous Period		
	Net Revenue	Capital	Free Cash Flow	Net Revenue	Capital	Free Cash Flow
Enterprise						
Dept A						
Dept B						
…						
Dept N						
Reputation Risk Profile						
	Current Period			Previous Period		
	Public	Regulators	Partners	Public	Regulators	Partners
Enterprise						
Dept A						
Dept B						
…						
Dept N						
Mission Risk Profile						
	Current Period			Previous Period		
	Product/Service Capability	Philanthropy	Share Value	Product/Service Capability	Philanthropy	Share Value
Enterprise						
Dept A						
Dept B						
…						
Dept N						

5 Enterprise Strategy for ICT Risk Coordination

As part of their governance responsibilities, executive leaders should establish clear and actionable risk management guidance based on enterprise mission and business objectives. Expressing clear expectations regarding ICT risk enables participants at each level of the enterprise to manage uncertainty to an acceptable level. As the risk landscape evolves, such as due to technological and environmental changes, enterprise leaders should continually review and adjust the risk strategy. For example, an enterprise subject to outside regulation is likely to receive specific guidance regarding updated federal statutes and directives that must be considered in evaluating acceptable risk.

5.1 Risk Integration and Coordination Activities

Figure 13 provides a simplified illustration of risk integration and coordination activities. Each enterprise is unique, so enterprise leadership may wish to tailor the approach for their unique circumstances. For example, while risk appetite statements usually originate from the most senior leaders, those leaders may choose to delegate the creation of ICT risk appetite statements to a senior ICT risk official. Readers should note that the processes described are cyclical. Early iterations may include the definition of terms, strategies, and objectives. Subsequent iterations may focus on refining those objectives based on previous results, observations of the risk landscape, and changes within the enterprise.

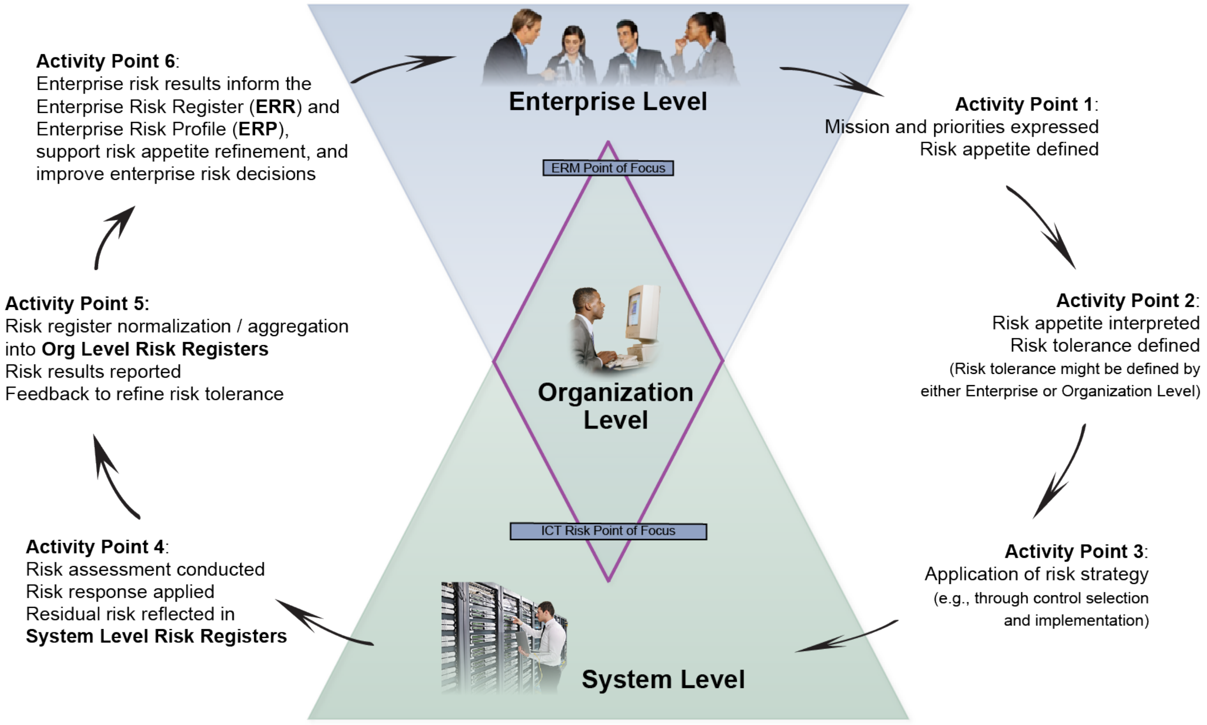

Enterprise Level
ERM Point of Focus
Organization Level
ICT Risk Point of Focus
System Level
Activity Point 1:
Mission and priorities expressed
Risk appetite defined
Activity Point 2:
Risk appetite interpreted
Risk tolerance defined
(Risk tolerance might be defined by either Enterprise or Organization Level)
Activity Point 3:
Application of risk strategy
(e.g., through control selection and implementation)
Activity Point 4:
Risk assessment conducted
Risk response applied
Residual risk reflected in
System Level Risk Registers
Activity Point 5:
Risk register normalization / aggregation into Org Level Risk Registers
Risk results reported
Feedback to refine risk tolerance
Activity Point 6:
Enterprise risk results inform the Enterprise Risk Register (ERR) and Enterprise Risk Profile (ERP), support risk appetite refinement, and improve enterprise risk decisions

Figure 13: Illustration of Enterprise Risk Management Integration and Coordination

Table 9 describes the process by which senior leaders express expectations and receive results about managing ICT risk throughout the enterprise.

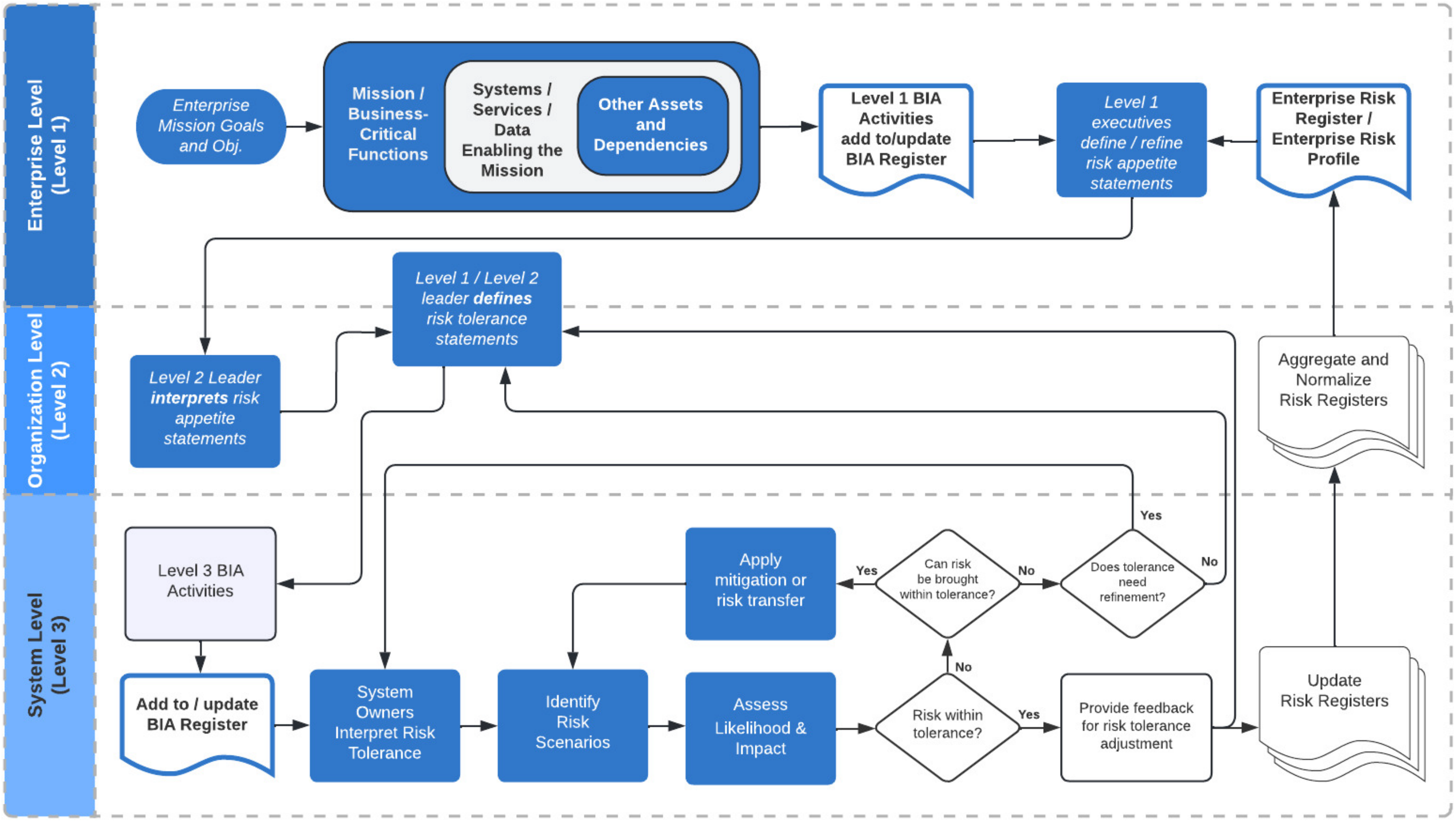
Table 9: Inputs and Outputs for ERM Governance and Integrated ICTRM

Activity Point	Inputs	Outputs
1. Set risk expectations and priorities	Internal and external risk context; enterprise roles and responsibilities; governance framework and governance systems for managing all types of risks.	Documentation of enterprise priorities in light of mission objectives and stakeholder values; direction regarding budget (e.g., authorization for capital and operating expenditures); risk appetite statements pertaining to each risk management discipline, including ICT.
2. Interpret risk appetite to define risk tolerance statements	Enterprise priorities in light of mission objectives and stakeholder values; direction regarding budget (e.g., authorization for capital and operating expenditures); risk appetite statements.	Risk tolerance statements (and metrics) to apply risk appetite direction at the organization level; direction regarding methods to apply ICTRM (e.g., centralized services, compliance/auditing methods, shared controls to be inherited and applied at the system level).
3. Apply risk tolerance statements to achieve system-level ICTRM	Risk tolerance statements; direction regarding shared services and controls; lessons learned from previous ICTRM implementation (and those of peers).	Inputs to preparatory activities; system categorization; selection and implementation of risk management controls.
4. Assess ICT risks and report system-level risk response through risk registers	Security plans; risk response; system authorization (or denial of authorization with referral back for plan revision).	Risk assessment results; risk registers describing residual risk and response actions taken; risk categorization and metrics that support ongoing assessment, authorization, and continuous monitoring.
5. Aggregate organization-level risk registers	Risk registers show system-level risk decisions and metrics; internal reports from compliance/auditing and monitoring processes to confirm alignment with enterprise risk strategy; observations regarding ICTRM achievement in light of risk strategy.	Risk registers aggregated, normalized, and communicated based on enterprise-defined risk categories and measurement criteria; refinement of risk tolerance statements, if needed, to ensure balance among value, resources, and risk.
6. Integrate risk registers into ERR and ERP	Normalized and harmonized risk registers from various organization-level ICTRM reports; compliance and audit reports; results from other non-technology risk management activities (e.g., credit risk, market risk, labor risk); observations regarding ERM and ICTRM achievement.	Integrated ERR aligning ICTRM results with those of other risk categories; refinement of risk appetite tolerance statements and risk management direction to ensure balance among value, resources, and risk; ERP for monitoring and reporting overall risk management activities and results.

5.1.1 Detailed Risk Integration Strategy

Figure 14 illustrates a more detailed information flow of inputs and outputs among ICTRM participants at the three levels. Senior leaders and business managers define risk tolerance direction that is applied at the system level. System-level practitioners interpret those risk tolerance statements and apply ICTRM activities to achieve risk management objectives. Through risk monitoring, results are then reviewed to confirm effectiveness, highlight opportunities for improvement, and identify important trends that might require organization- or enterprise-level action. The output of this activity helps improve communication about the performance, risk trends, and opportunities among all levels. The specific process activities will be based on the risk management methods applied but will generally include those below.

1669


Enterprise Level (Level 1)
Organization Level (Level 2)
System Level (Level 3)
Enterprise Mission Goals and Obj.
Mission / Business-Critical Functions
Systems / Services / Data Enabling the Mission
Other Assets and Dependencies
Level 1 BIA Activities add to/update BIA Register
Level 1 executives define / refine risk appetite statements
Enterprise Risk Register / Enterprise Risk Profile
Level 1 / Level 2 leader defines risk tolerance statements
Level 2 Leader interprets risk appetite statements
Aggregate and Normalize Risk Registers
Level 3 BIA Activities
Add to / update BIA Register
System Owners Interpret Risk Tolerance
Identify Risk Scenarios
Assess Likelihood & Impact
Risk within tolerance?
Yes
No
Provide feedback for risk tolerance adjustment
Update Risk Registers
Can risk be brought within tolerance?
Yes
No
Apply mitigation or risk transfer
Does tolerance need refinement?
Yes
No

1670 **Figure 14: Continuous ERM/ICTRM Interaction**[20]

[20] This figure demonstrates select communications, processes, and decisions germane to the risk appetite, risk tolerance, and risk register interactions among the three levels of an enterprise addressed by this report; it is not intended to be exhaustive.

The activities in Figure 14 are discussed below. Further details are provided later in this section.

Risk Context and Strategy Activities

- Based on the enterprise mission, executives identify the systems and services that represent “mission/business-critical functions” that are essential to the successful operation of the enterprise. Based on that list, the executives and senior leaders identify the enterprise-level assets that enable those functions. Those assets inherit the criticality/priority of the functions they support. Enterprise assets supporting those objectives are identified (e.g., through a BIA).[21]
- As described in the previous section, leaders at Level 1 (enterprise) and Level 2 (organization) define specific and measurable risk appetite and risk tolerance statements that reinforce enterprise mission objectives and organization goals.
- At Level 3 (system), practitioners interpret criticality/priority direction from leaders, expressed through risk appetite and risk tolerance statements, to determine the ICT assets, processes, and activities that support mission-essential delivery operations. System-level assets are categorized based on the sensitivity and criticality to enterprise operations, in line with the enterprise-level BIA results. Those in various roles (e.g., system owners, security officers) work together to derive system-level requirements and record impact understanding in the system BIA register.

Risk Identification Activities

- The value of each asset of a given system (e.g., information type, technical component, personnel, service provider) is appraised to determine how critical or sensitive it is to the operation of the system. Subsequent risk decisions depend on an accurate understanding of the importance of each resource to the system.
- For each of these components, the practitioner identifies threat sources that might have a harmful effect and the vulnerabilities or conditions that might enable such an effect. To complete development of the risk scenario, the practitioner determines the adverse effect of the threat source exploiting the vulnerable conditions. The scenario is recorded in the risk register’s Risk Description column. The category for the scenario is recorded in the Risk Category column based on enterprise criteria to support risk correlation, aggregation, and reporting.

Risk Analysis Activities

- The practitioner performs risk analysis to determine the likelihood that the threat events and vulnerable conditions would result in harmful impacts to the system asset. Similarly, the practitioner analyzes the impact value and calculates the risk exposure using the methodology defined in the enterprise risk strategy (e.g., as the product of [risk likelihood] x [risk impact].) The results of these analyses are recorded in the risk register’s Current Assessment column as “Likelihood,” “Impact,” and “Exposure.”

[21] For practitioners integrating cybersecurity with ERM, NIST IR 8286D, *Using Business Impact Analysis to Inform Risk Prioritization and Response* provides additional information about the use of BIA. [IR8286D]

Risk Response Activities

- The determined exposure is compared with the risk tolerance.
  - If exposure is within risk tolerance limits, the risk may be **accepted**.
- If exposure exceeds tolerable levels of risk, practitioners can consider whether they can achieve risk tolerance through other forms of risk response.
  - In many cases, controls may be applied to **mitigate** risk by reducing its likelihood or impact to a tolerable level. Controls should be implemented with a corresponding performance scale (i.e., KPI), which is used as the basis for KRIs.
  - Risk response may also include risk **transfer**, also known as risk sharing. For example, an organization might hire an external organization to process sensitive transactions (e.g., payment card transactions), thus reducing the likelihood that such sensitive data would be processed by an in-house system. Another common risk transfer method involves the use of ICT insurance policies that can help reduce the economic impact if an adverse event occurs.
  - In some cases, it might be determined that the exposure exceeds risk tolerance and cannot be brought within limits through any combination of mitigation or risk transfer. In this case, practitioners (e.g., the system owner) may need to work with Level 2 leaders to **revisit the risk tolerance itself**. This negotiation presents an opportunity for the Level 2 and Level 3 managers to determine the best course of action to refine risk direction in light of mission objectives (e.g., through an exception process, an adjustment to the risk tolerance statement, or increased security requirements for the relevant system). In any case, stakeholders will have applied a proactive approach to balancing risk and value.
  - If an unacceptable ICT risk cannot be adequately treated in a cost-effective manner, that risk must be **avoided**. Such a condition may require a significant redesign of the system or service. These circumstances should be rare, and they highlight the value of risk coordination early in the system engineering process. Notably, risk avoidance is not the same as ignoring a risk.

5.1.2 Risk Monitoring and Communication Activities

As described in Section 3.6, risk managers throughout the enterprise must be informed about objectives, results, priorities, and opportunities that result from the risk responses above. A key purpose of the various risk registers is to enable ongoing *monitoring* of enterprise risk activities. Much of that monitoring occurs through observations of performance metrics, including those that indicate changes in risk (KRIs). KRIs inform organizations whether controls are adequately addressing risk and whether risks are changing over time. When KRIs fall outside of pre-established thresholds, this indicates that a risk response is beyond acceptable levels. In this case, organizations should evaluate risks and make any necessary adjustments to controls. Results of risk activities and decisions are recorded in the risk register.

Table 109 provides several examples of ICT-related risk appetite, risk tolerance, controls, KPIs, and leading and lagging KRIs. These all help support the Monitor-Evaluate-Adjust (MEA) cycle depicted in Section 3.6, Figure 8.

Table 10: Notional ICT-Related Examples Supporting the MEA Cycle

	Example 1	Example 2	Example 3
Risk Appetite	Mission-critical systems must be protected from known cybersecurity vulnerabilities.	In keeping with the enterprise designation as a data processor, as described in the GDPR (European Union General Data Protection Regulation), all personal data processed is kept confidential.	Our customers associate reliability with our company's performance, so outsourced hosting services must minimize outages for any customer-facing websites.
Risk Tolerance	Systems designated as mission-critical must be patched against critical software vulnerabilities (severity score of 10) within 14 days of discovery.	While there may be some tolerance for limited low-risk corporate information disclosures, there is zero tolerance for disclosure of PII.	Regional managers may permit website outages by supply chain partners, but those must not exceed two hours and may affect no more than five percent of customers.
Controls	• Periodic vulnerability assessments • Patch deployment capabilities	• Authentication method(s) • PII processing and transparency policy • Authority to process PII • Audit log alerting/evaluation	• Service level agreements • Redundant provider circuits • Web load balancers • Web servers
KPIs	• Percentage of vulnerabilities patched	• Days without a loss of PII	• Outage time in hours
Leading KRIs	• Number of computers with critical vulnerabilities (CVSS score of 10) that have not been patched in 10 days	• Failed facility reviews for unprotected physical records • Audit log records showing violation of separation of duty requirements	• Outages affecting more than five percent of customers that have lasted 1.5 hours • Outages lasting over two hours and affecting fewer than five percent of customers
Lagging KRIs	• Number of computers with critical vulnerabilities that have not been patched in 15 days	• One or more violation indications from data loss prevention tools	• Current outages affecting more than five percent of customers that have lasted more than two hours

It is important for enterprise processes to ensure adequate communication of risk that has been accepted (and risk that is implicitly accepted, such as through an exception process). A key purpose of the various risk registers and reporting methods is to ensure that adequate governance information is available to monitor enterprise risk decisions.

Risk activities may also be informed through the integration of relevant internal and external audit findings. Significant audit findings often have enterprise-level impacts. However, lower-severity findings may spread through multiple systems to create risk in aggregate if they are not addressed adequately. The coordination of audit findings may span multiple levels of the enterprise. For example, as operational teams address shortcomings or system deficiencies at the system level, key findings might be communicated and tracked by an audit committee (organization level). As responses to findings occur and are documented (such as through a corrective action plan), they assist in the planning of subsequent ERM.

The process continues until all ICT assets and processes have been evaluated for risk from currently understood threats and vulnerabilities. For some enterprises, the composite set of system risks, responses applied, and other relevant artifacts will be reviewed by a senior official to confirm that risk decisions and risk responses align with risk tolerance and risk appetite directives.[22]

Subsequently, risk registers for various risk management disciplines from throughout the organization level are normalized and aggregated to provide a composite view of the risk posture and decisions for that organization. As Level 2 managers consider feedback from system-level risk activities, they may decide to refine risk tolerance levels. It may be that the aggregate risk across multiple systems represents too great an exposure and needs to be reduced. In other cases, based on successful risk management results, stakeholders may be able to permit a little more risk in some areas if such a decision would support mission objectives and potentially save resources or allow them to be directed to areas that require additional resources to meet expected risk tolerances.

Similar reviews and refinement occur at Level 1 to support enterprise governance and risk management decisions. Some types of enterprises may be required to formally disclose risk factors (e.g., through annual reports), and this aggregate understanding of ICT risks and risk decisions can support their fiduciary responsibilities. These activities may also help others, such as Federal Government agencies, to comply with mandatory requirements, such as those established by OMB.

Interpreting risk tolerance at Level 3, practitioners develop requirements and apply controls to achieve an acceptable level of risk. This process helps to ensure that risk management occurs in a cost-effective way. As an example, consider a global retail firm where a system owner of a customer-facing website will select controls that will ensure adherence to availability service levels. In deciding which controls to apply, the system owner collaborates with a security team to consider methods to meet service level objectives. The team can contact the local power utility supplier to determine electrical availability history and gather other information regarding the likelihood of a loss of power to the important website. This additional information might help the system owner decide whether to invest in a backup generator to ensure sufficient power availability.

Results from previous assessments can be useful for estimating the likelihood of achieving risk goals in the future. The team would then move to the next risk scenario (e.g., perhaps an internet service outage) and review the history and reliability of the organization’s telecommunications provider to ascertain the likelihood and impact of a loss of service. Iterating through each potential risk, as described in Figure 14, practitioners can develop a risk-based approach to fulfilling risk management objectives based on risk appetite and risk tolerance. This, in turn, helps risk practitioners demonstrate how their actions directly support mission objectives and enterprise success.

[22] For Federal Government agencies, much of their ICT is accounted for under what is considered a FISMA system (Federal Information Security Modernization Act) and thus subject to FISMA privacy and security requirements, so the system authorization process might represent an example of this cycle.

5.2 Aggregation and Normalization of Risk Registers

The value of using consistent risk registers for ICT uncertainty should now be clear. The precise contents and format will vary by enterprise but will generally follow the structure that has been illustrated throughout this publication.

5.2.1 Aggregation of ICT Risk Information

The activities described earlier provide guidance to help complete the risk register for a given system, using that form to record information about known risk scenarios, analysis of their impacts, and actual or planned activities to respond to those risks.

Aggregation activities are performed among the hierarchical levels shown previously. System-level risk registers are combined with others from the same lower-level organization (e.g., business department, branch office, division). In a similar way, the now-combined risk registers at the organization level (e.g., business unit, government bureau) and enterprise level are aggregated and normalized. The method for managing the risk ID is up to the practitioner, but a source identifier might be needed to provide traceability to the original register (e.g., "System A" risk register ID #1 might be tagged as aggregated risk ID A-1).

5.2.2 Normalization of Risk Register Information

While aggregation is occurring, the ICT risk manager will also be normalizing the information contained in the various risk registers. As data points are brought together, there will likely be some risks that occur so infrequently (or are of low enough consequence) that they do not merit inclusion in the next-level register. Decisions about what to integrate and how to do so depend on the use of a common risk rating scheme that enables risk assessments to be translated and integrated at higher enterprise levels. At a minimum, the normalization process at the higher level (for example, for the ERR) should use the same rating criteria to enable comparison and tracking. This typically includes definitions for how negative (and positive) consequences and likelihood are to be measured to allow comparability across assessment results. Risk criteria may also describe how time factors, such as risk velocity, should be considered in determining the risk severity. As noted in this publication, risk criteria may consider the organization's objectives and internal/external context. Criteria for risk escalation or risk elevation may also be considered as part of the equation for whether specific ICT risks meet the minimum threshold for enterprise-level discussion. For example, the enterprise may note shared risks that represent a broad threat that would benefit from centralized risk mitigation or a reputational risk that demands immediate preventive action.

During normalization, risk managers review the results from the various risk registers to support consistent risk treatment and communication. Some examples of ICT risk normalization are described in Table 11. A key element of normalization is the identification and resolution of cases where a similar risk scenario is treated differently by different enterprise participants. There may be no issue with such a difference since context and circumstances might be different, but the underlying cause should be understood, and the disparity should be recognized.

Table 11: Examples of ICT Risk Normalization

De-duplicate and combine identical or similar risks	● An external attacker deploys a remote access tool and uses it to exfiltrate the plans for the company's upcoming merger. ● External threat actors steal information about marketing plans through malicious code deployed in the sales department. ● Malicious parties plant a web shell in an external site that enables them to access documents stored in the Legal Affairs shared document folder, resulting in the loss of critical corporate information.
Reprioritize according to risk appetite, tolerance, and sensibilities	● Since priorities have been established at organization and system levels, it may be necessary to review their collective priority and recommend adjustments to a higher or lower priority.
Resolve risk register disparities	One of two alternatives might be applied: ● The combined risk description could be listed in the risk register for each risk response selected by system owners at lower levels. If two system owners had mitigated the above exfiltration risk and one had chosen to accept it, then the risk would appear in the combined risk register twice, with each row indicating the respective response. ● The combined ICT risk would be included once in the risk register, with both of the responses included in the Risk Response Type column.
Adjudicate key risks	● Those risks that warrant tracking and further communication in the ERR are highlighted and reviewed by enterprise-level risk managers.

The categories of each ICT risk in each register are likely to be limited and consistent, so that column provides a practical key for the initial sorting exercise. After all of the risks at a given level are combined, aggregation is a straightforward activity but may require some manual adjustment. Various risk owners will likely use differing risk descriptions for the same scenario. The risk manager of that business unit would transliterate these ICT risks into a single representative risk on the business unit's risk register, perhaps "External malicious party uses malicious code to exfiltrate sensitive business-related documents." In this case, the risk must describe the type of information that is at risk of theft, since the loss of internal business documents, patient healthcare records, and employee financial information might each represent differing likelihoods and impacts. The criteria for delineating these factors will be determined by each enterprise. For example, if sufficiently detailed risk appetite and risk tolerance statements have been recorded, they might provide input into those risk criteria.

The activities described in this document are solely intended to support public- and private-sector enterprise information gathering and reporting. Actions for an immediate response, escalation, or notification for any particular adverse event should be handled through the enterprise's incident response processes. Similarly, raw risk information from each risk register should be fully available for any manager's review. Aggregated summarization is a valuable reporting tool but should not impede the ability of managers to review specific risk decisions.

Aggregating the risk analysis from multiple risk registers will vary by enterprise, but, for example, a three-point estimation could be used to complete the likelihood and impact columns on the combined register. The business unit risk manager could calculate these values using the lowest observed value as the best case, the highest value as the worst case, and the mean value of the others as the most likely. That manager could also apply their knowledge of the personnel and processes used to generate the risk registers, such that, if they know that a particularly detailed study had been performed to develop one or more of the estimates, that might influence the understanding of the most likely value.

5.2.3 Integrating Risk Register Details

For some enterprises, aggregation of these risk analysis and risk response values may be more art than science. Some organizations have skilled practitioners with actuarial experience who can statistically aggregate multiple data points and draw a scientific conclusion about the likelihood and impact (and therefore exposure rating) of various risks. Other organizations will simply work to normalize a list of highs and lows, with risk managers using their best judgment to estimate the combined exposure. Because the process of analyzing and responding to risk factors is highly iterative, an enterprise might need to begin with qualitative risk values and identify opportunities to increasingly apply quantitative approaches as more information and history become available.

Information sharing and communications on risk response is vital as risk response could be ongoing, iterative, or span different reporting cycles. The information provides valuable data that will guide enterprise-level risk decisions, but the level of precision needed at higher hierarchical levels will likely be less than is needed at the system level.

Completion of the remaining columns presents opportunities for enterprise determination as follows:

- For an aggregation of the risk response cost column, in some cases, an organization-level risk manager may wish to record a statistically weighted average of the risk response costs. In other cases, the manager may wish to provide a total cost allocated across all subsidiary systems and organizations.
- The column for risk owner should indicate an organization-level representative who has the accountability and authority to manage that risk. Risk ownership is a key information point that must be carefully considered and applied. The party designated as the risk owner must be continually knowledgeable about relevant risk conditions and must also have the accountability and authority to manage the risk. Since risk conditions may change as information is aggregated, responsibility and accountability should be periodically reviewed to ensure that the risk owner is the appropriate designee.
- The risk status for each aggregated ICT risk should use a consistent set of indicators. Status could be a simple indicator (e.g., open, closed, pending) or provide a more detailed explanation (e.g., “Risk accepted pending review by the Jan. 24 quarterly risk committee meeting”).

While the methods and algorithms used will vary by enterprise, there should be a consistent risk aggregation strategy that is expressed as part of a policy within a given enterprise. Given the roll-up process, ICTRM – working in conjunction with enterprise risk managers – can include relevant risk policy statements, including requirements for registering risks, providing updates regularly, and communicating risk activities with enterprise managers and leadership.

Through these procedures and policy statements, the various ICT risks are integrated into a comprehensive ERR. Note that the processes are described as a bottom-up integration, but realworld scenarios are likely to be interactive and iterative. Integration is important for gathering data and provides opportunities for analysis and adjustment.

5.3 Adjusting Risk Responses

Based on the evaluation, risk managers adjust their risk response approach. In some cases, the evaluation will provide evidence that risk response has been effective and is efficiently achieving the necessary level of risk treatment. In other cases, adjustments may be necessary to risk direction, risk treatment, or both.

Aristotle is commonly credited with teaching that the whole is not the same as the sum of its parts. Such an observation highlights that the composite set of enterprise risk likelihood and impact is something besides and not necessarily equivalent to the sum of the risk analyses described in the various risk registers.

As controls are applied throughout the enterprise, and as indicators are produced (and reported through metrics), various managers and leaders will consider the evaluation produced in the previous section. Given the resulting observations, several adjustments may be warranted, as described below.

- **Adjust strategic direction –** Based on collective results, senior leaders may update risk appetite statements to increase or decrease risk limits, including potentially adjusting specific quantitative direction. In addition to or in place of risk appetite adjustment, risk tolerance interpretation may similarly be adjusted to take advantage of opportunities or to reduce the likelihood or impact of harmful risks.
- **Adjust risk responses –** To address inconsistent responses to risks or to achieve a different result, leaders may choose to direct specific response actions to one or more risk scenarios. For example, if some organizations decided to mitigate a given risk type and others chose to accept it, risk managers may clarify which treatment is the appropriate response (or clarify the criteria by which that decision is made). As with previous discussions, this adjustment may either be to reduce the overall exposure by enacting a more stringent response, or to loosen restrictions to gain some advantage in exchange for a measured risk increase. Such changes may occur gradually to ensure sufficient ICTRM at all hierarchical levels.
- **Adjust KPIs and KRIs –** While the enterprise may adjust its specific direction or treatment of risk, the result of the evaluation will often be increased monitoring of the various conditions. Especially when conditions indicate broad variance in resulting metrics, managers may direct changes to the KPIs and KRIs that are monitored to gain better visibility. If changes to impact and likelihood cannot be adequately observed with the current indicators, then different (or additional) metrics may be justified. Increased frequency is indicated when impact and likelihood change more rapidly than the current monitoring interval.

The adjustments described are intended to provide improvements that are directly based on the observations resulting from monitoring and evaluating risk results. Additional adjustments may be based on external direction, such as requirements by a regulator for increased risk management or new reporting criteria (e.g., prohibiting sharing or disclosing information from a smart utility meter about a customer's usage without that customer's consent).

5.3.1 Factors Influencing Prioritization

Numerous factors (e.g., financial loss, enterprise reputation, shareholder sentiment) influence priority and should be included in the enterprise risk strategy. An ICT risk that directly impacts the mission is likely to be a high priority, but many other considerations – such as agency or corporate reputation – may move a particular type of risk to the top of the list. Another consideration could occur if a corporate entity was preparing for a merger. The community has seen recent examples that have demonstrated that the discovery of an ICT risk can affect the valuation of an enterprise and subsequent negotiations. There may also be factors that are not directly related to risk but that could support organizational improvement (e.g., quick wins that build team confidence and gain momentum, risks related to an objective that leaders have established as a key priority). Priority values such as low, moderate, and high are often used as risk prioritization categories. This qualitative approach may be more limiting than quantitative analysis in that it is easier to sort a range of numerical values – even those that are relatively close – than it is to sort a list of risks marked "Very High." In most enterprises, risk strategy should provide direction for both generalization (e.g., low, moderate, high) and more specific risk prioritization methods.

5.3.2 ICT Risk Optimization

A key goal of ERM/ICTRM coordination is to help enterprise stakeholders collect various risk data for decision support, monitoring, and communications. Several foundational definitions are relevant to properly prioritizing risk at each stage of the life cycle, including aggregating and prioritizing the risk register data discussed in this document:

- **Risk aggregation** – The combination of several risks into one risk to develop a more complete understanding of the overall risk [ISO73].
- **Risk criteria** – Terms of reference against which the significance of a risk is evaluated, such as organizational objectives, internal/external context, and mandatory requirements (e.g., standards, laws, policies) [ISO73].
- **Risk optimization** – A risk-related process to minimize negative and maximize positive consequences and their respective probabilities; risk optimization depends on risk criteria, including costs and legal requirements.

The processes to aggregate, prioritize, and optimize risk will be different at each level of the enterprise, based on the risk criteria relevant to that level. At hierarchically lower levels in an enterprise, a certain amount of risk prioritization and treatment authority will have been delegated by the stated risk strategy guidance to streamline operations, but there might need to be additional collaboration based on observations by those performing oversight at higher levels.

The methods used for optimizing risk are at the discretion of enterprise leaders and are often carried out by a risk leadership council or other risk governance body. Since capital and operating expense budgets for risk response are likely to be limited, each method must include a process for how to respond to those scenarios when funding is not available. Some examples include:

- **Fiscal optimization** – A straightforward ranking of risks in descending order from most impactful to least. Risk managers tally the total risk response costs until funding is exhausted.
- **Algorithmic optimization** – The application of mathematical formulas to calculate the aggregate cost-benefit to the enterprise, given the estimated costs, in a purely mechanical approach.
- **Operational optimization** – The selection of those risks from the register that are most important to operations (based on leadership preferences, mission objectives, and stakeholder sentiment. Operational coordination depends upon an iterative communications cycle of risk reporting and analytics.
- **Forced ranking optimization** – Prioritizing risks in the way that will best use available resources to achieve the maximum benefit, given specific negative and positive consequences. Various business drivers and risk consequences have differing weights for developing a score, helping to move beyond the simplistic "threat multiplied by vulnerability" approach to build business objectives into that equation. Because these factors and their weights are based on business drivers, the factors should be defined by senior stakeholders but can be applied at all levels of the enterprise, subject to adjustment and refinement. Notably, while forced ranking is often the default method of optimization, the methods above are equally valid and beneficial to the enterprise.

Ultimately, the optimization performed will likely be some combination of these methods. For some enterprises, risk optimization may also have a temporal factor. For example, risk owners might be willing to accept some risk scenarios to reduce expenses and boost profitability near the end of a fiscal quarter. Those same scenarios might be fully treated in more favorable financial circumstances. The goal of this report is not to advocate for any particular optimization process but rather to determine how optimization and prioritization will occur, since these decisions must precede risk response itself.

Keep in mind that these management processes are iterative. Generally speaking, as risk information is aggregated throughout the enterprise, more information becomes available about risk commonalities. As risk managers observe similar types of positive and negative risk events, they can note contributing factors, highlight common opportunities, and gain a broader understanding of risk conditions. Because leaders and executives often have a broader view of factors that contribute to and result from various risks, including ICT risks, they can provide additional criteria to hierarchically lower levels to help sort and prioritize.

5.3.3 ICT Risk Priorities at Each Enterprise Level

In support of risk prioritization, as with ICT risks themselves, the ranking factors reflect the various strata of the enterprise. At the system level, the risk register reflects risk priorities related to particular systems and technologies. The organization level has priorities based on unique mission and business unit drivers. The enterprise has overarching ICT priorities that may not be the same as those at lower technical levels of abstraction, and they can be of varying priority when considered along with other enterprise risks. **This balance is foundational to the concept of ICTRM as an input to ERM.** While risks to institutional information and technology are critical parts of the enterprise and a primary focus of those charged with leading ICTRM, corporate officers and fiduciaries have a broad perspective and must balance the dozens of types of uncertainty in the enterprise risk universe. Bidirectional communication is critical, enabling senior leaders to convey strategy and direction while also enabling the system- and business-level managers to keep leadership informed.

This process does not mean that every system-level risk decision should be elevated to top leadership, but rather that many risk decisions at the system and organization levels should be considered provisional and that leaders may subsequently recommend a different priority or approach based on their understanding of the aggregate impact to enterprise factors (e.g., revenue, reputation, regulations, political).

5.4 Enterprise Adjustments Based on ICT Risk Results

In many organizations, ICT enables a flexible approach to achieving the enterprise mission and ensuring stakeholder value. ICT aspects evolve rapidly, as does the ICT risk landscape, so periodic adjustments to ICTRM are likely to be needed. The Federal Government has observed that additional technical capabilities are often needed to provide better services to citizens even as agencies recognize the increased risk presented by the underlying technology. Budgets may need to be allocated for this emerging technology, and strict guidance on how to manage risk to that ICT may be provided. Subsequently, results of previous iterations of the ICTRM cycle may support management decisions to adjust funding and risk parameters to achieve enterprise objectives.

5.4.1 Adjustments to ICT Program Budget Allocation

In both public- and private-sector enterprises, resource considerations are often described as a contributing factor for risk. To some extent, the claim that a program “needs more resources” is justifiable in that there are always more tools, personnel, and services that could be added. However, effective ICTRM requires a balance among risk optimization, resource optimization, and the value delivered by the technology being used to support mission objectives. If any of these three factors results in an imbalance, the solution is untenable. ICTRM informs the decisions around what areas receive priority within limited budget environments.

The factors that have been discussed thus far can help in evaluating the extent to which the risk/resource balance is well-tuned. For example, because risk decisions are based on stakeholder needs (and the resulting enterprise and alignment objectives), ICT activities can be traced back to mission and business value.

In theory, one can simply build a business case that demonstrates the value proposition of investment in ICT protection, detection, and response resources. In reality, it can be quite challenging to directly report the subsequent return on that investment. One way to address this challenge is by applying detailed risk assessment and reporting activities, such as those described in this document. Quantitative methods provide specific calculations that enable the risk practitioner to simulate risk likelihood and financial impact before and after implementation of the ICT improvement. This then drives a straightforward cost-benefit analysis regarding the resource investment.

Another budgetary consideration results from the aggregation activities described above. As managers and leaders review the activities performed and the risk results provided, they may identify opportunities to centrally fund and operate risk management activities that had previously been the responsibility of individual system owners. It might make fiscal sense to combine particular activities to gain efficiencies or reduce duplication. As such opportunities become apparent during the review of risk register reports and results, leaders may make fiscal adjustments to gain an advantage.

5.4.2 Adjustments to Risk Appetite and Risk Tolerance

In addition to fiscal considerations, observations during the life cycle may also provide feedback regarding leaders' risk criteria regarding risk appetite and tolerance. Figure 14 illustrates several key decision points, including:

- Risk acceptance at the system level – in selecting the appropriate controls for a given information system (or shared set of controls), is a risk already acceptable, given the applicable risk tolerance statements?
    - If it is not acceptable, the system owner has the option of applying additional risk response, either through risk sharing or through mitigation by various controls.
    - At times, risk cannot be brought within tolerance through any combination of controls, or the cost of the controls might be unreasonable for the system. In such a case, it is possible that there might be limited ability to adjust risk tolerance. In either case, discussion with decision makers is necessary to determine the appropriate course of action. That discussion might also support guidance for other enterprise systems facing similar risk scenarios.
- Additional decision points occur after the aggregation and integration of risk registers at various levels. As risk managers review the risk registers and RDRs, risk management results will be compared with stakeholder expectations. Based on the aggregated results, ICT risk managers might need to consider the following questions:
    - Is risk response consistent across various organizational structures and levels? Based on risk analysis, response, and monitoring results, risk managers may determine that additional guidance is needed to better achieve repeatable and reliable risk management activity. Adjustments in policy, procedure, staff training, and other governance components may be necessary to improve process maturity.
    - Has the risk environment evolved (perhaps due to changes in internal or external context, such as new regulations or customer agreements) to such an extent that risk direction or criteria need to be adjusted? If so, this provides an opportunity to repeat the cycle.

In addition to these programmatic adjustments, specific risk treatment adjustments might be identified during continuous monitoring and ongoing assessment activities.

5.4.3 Reviewing Whether Constraints Are Overly Stringent

A challenge for senior managers is ensuring that their organizations are permitting enough risk, especially those risks that help realize benefits (e.g., opportunities, rewards). These introspective questions help those in risk governance roles identify whether their risk managers are using the risk governance tools and processes correctly or if those tools and processes need adjustment.

It is rare that an opportunity can be realized without a negative risk. One might also question why anyone would embark on a circumstance that results in a negative risk without a corresponding opportunity that makes such an endeavor worthwhile. A basic objective of risk management programs is to identify individual negative risks so that they can be matched to their corresponding positive risks, enabling tradeoff analysis. With individual negative risks identified, the risk program is prepared to move ahead with a risk response should the tradeoff analysis render a decision to proceed with the positive risk.

5.4.4 Adjustments to Priority

A final program-level adjustment relates to enterprise priorities. ICT risk decisions flow from the enterprise mission and priorities. This is illustrated by Activity Point 1 in Figure 13 where senior leaders establish the mission and priorities, which drive strategic objectives and planning, which are then used to direct ICTRM activities. Subsequently, identified and assessed risks are recorded in the risk register in accordance with those priorities. The order in which risks are addressed, the direction of appropriate response, and even the agreement about which risks will be addressed all derive from the enterprise priorities. For this reason, a key enterprise activity will be a periodic review of those priorities and the effects that they have on ICTRM. Based on the results of such reviews, priorities might be adjusted or clarified to ensure continued alignment between ICTRM activity and mission objectives.

References

[COSOERM] Committee of Sponsoring Organizations (COSO) of the Treadway Commission (2017) Enterprise Risk Management—Integrating with Strategy and Performance, Executive Summary. Available at https://www.coso.org/Shared%20Documents/2017-COSO-ERM-Integrating-with-Strategy-and-Performance-Executive-Summary.pdf

[ERMPLAYBOOK] Chief Financial Officers Council (CFOC) and Performance Improvement Council (PIC) (2016) Playbook: Enterprise Risk Management for the U.S. Federal Government. Available at https://www.cfo.gov/wp-content/uploads/2016/07/FINAL-ERM-Playbook.pdf

[GREENBOOK] U.S. Government Accountability Office (GAO) (2014) Standards for Internal Control in the Federal Government. Available at https://www.gao.gov/assets/670/665712.pdf

[IEC31010] International Electrotechnical Commission (IEC) (2019) Risk management – Risk assessment techniques. IEC 31010:2019. Available at https://www.iso.org/standard/72140.html

[IR8170] Marron J, Pillitteri V, Boyens J, Quinn S, Witte G, Feldman L (2020) Approaches for Federal Agencies to Use the Cybersecurity Framework. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Interagency or Internal Report (IR) 8170. https://doi.org/10.6028/NIST.IR.8170-upd

[IR8286] Stine KM, Quinn SD, Witte GA, Gardner RK (2020) Integrating Cybersecurity and Enterprise Risk Management (ERM). (National Institute of Standards and Technology, Gaithersburg, MD), NIST Interagency or Internal Report (IR) 8286. https://doi.org/10.6028/NIST.IR.8286

[IR8286D] Quinn SD, Ivy N, Barrett MP, Witte GA, Topper D, Feldman L, Gardner RK (2022) Using Business Impact Analysis to Inform Risk Prioritization and Response. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Interagency or Internal Report (IR) 8286D. https://doi.org/10.6028/NIST.IR.8286D.ipd

[ISACA] "Risk Capacity," ISACA Glossary. Available at https://www.isaca.org/en/resources/glossary#glossr

[ISO31000] International Organization for Standardization (ISO) (2018) Risk management— Guidelines. ISO 31000:2018. Available at https://www.iso.org/standard/65694.html

[ISO73] International Organization for Standardization (ISO) (2009) Risk management – Vocabulary. ISO Guide 73:2009. Available at https://www.iso.org/standard/44651.html

[OMB-A11] Office of Management and Budget (2019) Preparation, Submission, and Execution of the Budget. (The White House, Washington, DC), OMB Circular No. A-11, December 18, 2019. Available at https://www.whitehouse.gov/wp-content/uploads/2018/06/a11.pdf

[OMB-A123] Office of Management and Budget (2016) OMB Circular No. A-123, Management's Responsibility for Enterprise Risk Management and Internal Control. (The White House, Washington, DC), OMB Memorandum M-16-17, July 15, 2016. Available at https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2016/m-16-17.pdf

[OPENFAIR] The Open Factor Analysis of Information Risk (FAIR) Body of Knowledge is comprised of the Open Group Risk Analysis standard (https://publications.opengroup.org/c13g) and the Open Group Risk Taxonomy (https://publications.opengroup.org/c13k).

[SP80053] Joint Task Force (2020) Security and Privacy Controls for Information Systems and Organizations. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 800-53, Rev. 5. Includes updates as of December 10, 2020. https://doi.org/10.6028/NIST.SP.800-53r5

[SP800161] Boyens J, Smith A, Bartol N, Winkler K, Holbrook A, Fallon M (2022) Cybersecurity Supply Chain Risk Management Practices for Systems and Organizations. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 800-161 Revision 1. https://doi.org/10.6028/NIST.SP.800-161r1

[SP800221A] Quinn S, Ivy N, Chua J, Scarfone K, Barrett M, Feldman L, Topper D, Witte G, Gardner RK (2022) Information and Communications Technology (ICT) Risk Outcomes: Integrating ICT Risk Management Programs with the Enterprise Risk Portfolio. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 800-221A. https://doi.org/10.6028/NIST.SP.800-221A.ipd

Appendix A—Acronyms and Abbreviations

Selected acronyms and abbreviations used in this paper are defined below.

BIA	Business Impact Analysis
CapEx	Capital Expenditures
CFO	Chief Financial Officer
CFOC	Chief Financial Officers Council
CIO	Chief Information Officer
CISO	Chief Information Security Officer
COO	Chief Operating Officer
COSO	Committee of Sponsoring Organizations
CPO	Chief Privacy Officer
CPRT	(NIST) Cybersecurity and Privacy Reference Tool
CSAM	Cyber Security Assessment and Management
C-SCRM	Cyber Supply Chain Risk Management
CVSS	Common Vulnerability Scoring System
ERM	Enterprise Risk Management
ERP	Enterprise Risk Profile
ERR	Enterprise Risk Register
FAIR	Factor Analysis of Information Risk
FISMA	Federal Information Security Modernization Act
FOIA	Freedom of Information Act
GAO	U.S. Government Accountability Office
GDPR	European Union General Data Protection Regulation
GRC	Governance, Risk, and Compliance
HVA	High Value Asset
ICT	Information and Communications Technology
ICTRM	Information and Communications Technology Risk Management
IEC	International Electrotechnical Commission
IoT	Internet of Things
IR	Interagency or Internal Report
IRS	Internal Revenue Service
ISO	International Organization for Standardization

IT	Information Technology
ITL	Information Technology Laboratory
KPI	Key Performance Indicator
KRI	Key Risk Indicator
MEA	Monitor-Evaluate-Adjust
NFC	National Finance Center
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
OLIR	National Online Informative References Program
OMB	Office of Management and Budget
OpEx	Operating Expenses
OT	Operational Technology
PIC	Performance Improvement Council
PII	Personally Identifiable Information
RBS	Risk Breakdown Structure
RDR	Risk Detail Record
SEC	U.S. Securities and Exchange Commission
SP	Special Publication
SWOT	Strengths, Weaknesses, Opportunities, Threats
VPN	Virtual Private Network

Appendix B—Notional Example of a Risk Detail Record (RDR)

In support of an ICT risk register, a *risk detail record*, or RDR, enables communication of additional information. As shown in the following notional example, an RDR may help provide information regarding each risk, relevant stakeholders, date and schedule considerations, and planned activities.

Notional Risk Detail Record		
Risk ID numbers		
System affected		
Organization or business unit		
Risk Scenario Description		
Assets affected		
Threat sources/actors (with intent? with motivation?)		
Threat vectors		
Threat events		
Vulnerability/predisposing conditions		
Primary adverse impact (be sure to reconcile impact vs consequences)		
Secondary adverse impacts		
Other scenario details		
Risk category		
Current risk analysis		
Likelihood before controls (%):	**Impact before controls ($):**	**Exposure rating before controls ($):**
Planned residual risk response	Select all that apply: □ **Accept** □ **Avoid** □ **Transfer** □ **Mitigate**	
Planned risk response description		
Resource requirements for planned risk response		
Planned response cost ($)		
Likelihood after controls will be (%):	**Impact ($)**:	**Expected exposure rating ($)**:
Residual risk response as Implemented	**Actual response cost ($)**:	
After controls are in place, measured Likelihood is (%):	**Impact ($)**:	**Final exposure rating ($)**:
Risk owner/point of contact		
Date of risk identification		
Source of risk information		
Current status date		
Dependencies		
Follow-up date		
Comments		

Figure 15: Notional Risk Detail Record

JSON-based digital expressions of the risk register and the RDR notional template, with examples, are available from the NIST Computer Security Resource Center.