

**NIST Special Publication
NIST SP 800-161r1**

Cybersecurity Supply Chain Risk Management Practices for Systems and Organizations

Jon Boyens
Angela Smith
Nadya Bartol
Kris Winkler
Alex Holbrook
Matthew Fallon

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.SP.800-161r1>



**NIST Special Publication
NIST SP 800-161r1**

**Cybersecurity Supply Chain Risk
Management Practices for Systems
and Organizations**

Jon Boyens
Angela Smith
*Computer Security Division
Information Technology Laboratory*

Nadya Bartol
Kris Winkler
Alex Holbrook
Matthew Fallon
Boston Consulting Group

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.SP.800-161r1>

May 2022



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

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Undersecretary 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 800-161r1
Natl. Inst. Stand. Technol. Spec. Publ. 800-161r1, 326 pages (May 2022)
CODEN: NSPUE2

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.SP.800-161r1>

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>.

Submit comments on this publication to: scrm-nist@nist.gov

National Institute of Standards and Technology
Attn: Computer Security Division, Information Technology Laboratory
100 Bureau Drive (Mail Stop 8930) Gaithersburg, MD 20899-8930

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

Organizations are concerned about the risks associated with products and services that may potentially contain malicious functionality, are counterfeit, or are vulnerable due to poor manufacturing and development practices within the supply chain. These risks are associated with an enterprise's decreased visibility into and understanding of how the technology they acquire is developed, integrated, and deployed or the processes, procedures, standards, and practices used to ensure the security, resilience, reliability, safety, integrity, and quality of the products and services.

This publication provides guidance to organizations on identifying, assessing, and mitigating cybersecurity risks throughout the supply chain at all levels of their organizations. The publication integrates cybersecurity supply chain risk management (C-SCRM) into risk management activities by applying a multilevel, C-SCRM-specific approach, including guidance on the development of C-SCRM strategy implementation plans, C-SCRM policies, C-SCRM plans, and risk assessments for products and services.

Keywords

acquire; C-SCRM; cybersecurity supply chain; cybersecurity supply chain risk management; information and communication technology; risk management; supplier; supply chain; supply chain risk assessment; supply chain assurance; supply chain risk; supply chain security.

Acknowledgments

The authors – Jon Boyens of the National Institute of Standards and Technology (NIST), Angela Smith (NIST), Nadya Bartol, Boston Consulting Group (BCG), Kris Winkler (BCG), Alex Holbrook (BCG), and Matthew Fallon (BCG) – would like to acknowledge and thank Alexander Nelson (NIST), Murugiah Souppaya (NIST), Paul Black (NIST), Victoria Pillitteri (NIST), Kevin Stine (NIST), Stephen Quinn (NIST), Nahla Ivy (NIST), Isabel Van Wyk (NIST), Jim Foti (NIST), Matthew Barrett (Cyber ESI), Greg Witte (Huntington Ingalls), R.K. Gardner (New World Technology Partners), David A. Wheeler (Linux Foundation), Karen Scarfone (Scarfone Cybersecurity), Natalie Lehr-Lopez (ODNI/NCSC), Halley Farrell (BCG), and the original authors of NIST SP 800-161, Celia Paulsen (NIST), Rama Moorthy (Hatha Systems), and Stephanie Shankles (U.S. Department of Veterans Affairs) for their contributions. The authors would also like to thank the C-SCRM community, which has provided invaluable insight and diverse perspectives for managing the supply chain, especially the departments and agencies who shared their experience and documentation on NIST SP 800-161 implementation since its release in 2015, as well as the public and private members of the Enduring Security Framework who collaborated to provide input to Appendix F.

Patent Disclosure Notice

NOTICE: The Information Technology Laboratory (ITL) has requested that holders of patent claims whose use may be required for compliance with the guidance or requirements of this publication disclose such patent claims to ITL. However, holders of patents are not obligated to respond to ITL calls for patents and ITL has not undertaken a patent search in order to identify which, if any, patents may apply to this publication.

As of the date of publication and following call(s) for the identification of patent claims whose use may be required for compliance with the guidance or requirements of this publication, no such patent claims have been identified to ITL.

No representation is made or implied by ITL that licenses are not required to avoid patent infringement in the use of this publication.

Table of Contents

1. INTRODUCTION.....	1
1.1. Purpose	4
1.2. Target Audience	4
1.3. Guidance for Cloud Service Providers	5
1.4. Audience Profiles and Document Use Guidance	5
1.4.1. Enterprise Risk Management and C-SCRM Owners and Operators.....	5
1.4.2. Enterprise, Agency, and Mission and Business Process Owners and Operators	5
1.4.3. Acquisition and Procurement Owners and Operators	6
1.4.4. Information Security, Privacy, or Cybersecurity Operators.....	6
1.4.5. System Development, System Engineering, and System Implementation Personnel.....	7
1.5. Background	7
1.5.1. Enterprise's Supply Chain.....	9
1.5.2. Supplier Relationships Within Enterprises	10
1.6. Methodology for Building C-SCRM Guidance Using NIST SP 800-39; NIST SP 800-37, Rev 2; and NIST SP 800-53, Rev 5.....	13
1.7. Relationship to Other Publications and Publication Summary	14
2. INTEGRATION OF C-SCRM INTO ENTERPRISE-WIDE RISK MANAGEMENT	18
2.1. The Business Case for C-SCRM	19
2.2. Cybersecurity Risks Throughout Supply Chains	20
2.3. Multilevel Risk Management	22
2.3.1. Roles and Responsibilities Across the Three Levels.....	23
2.3.2. Level 1 – Enterprise	27
2.3.3. Level 2 – Mission and Business Process.....	30
2.3.4. Level 3 – Operational.....	32
2.3.5. C-SCRM PMO	34
3. CRITICAL SUCCESS FACTORS.....	37
3.1. C-SCRM in Acquisition	37
3.1.1. Acquisition in the C-SCRM Strategy and Implementation Plan.....	38
3.1.2. The Role of C-SCRM in the Acquisition Process	39
3.2. Supply Chain Information Sharing.....	43
3.3. C-SCRM Training and Awareness.....	45
3.4. C-SCRM Key Practices.....	46
3.4.1. Foundational Practices	47

3.4.2. Sustaining Practices	48
3.4.3. Enhancing Practices	49
3.5. Capability Implementation Measurement and C-SCRM Measures	49
3.5.1. Measuring C-SCRM Through Performance Measures	52
3.6. Dedicated Resources	54
REFERENCES.....	58
APPENDIX A: C-SCRM SECURITY CONTROLS	64
C-SCRM CONTROLS INTRODUCTION	64
C-SCRM CONTROLS SUMMARY	64
C-SCRM CONTROLS THROUGHOUT THE ENTERPRISE	65
APPLYING C-SCRM CONTROLS TO ACQUIRING PRODUCTS AND SERVICES.....	65
SELECTING, TAILORING, AND IMPLEMENTING C-SCRM SECURITY CONTROLS ...	68
C-SCRM SECURITY CONTROLS.....	71
FAMILY: ACCESS CONTROL	71
FAMILY: AWARENESS AND TRAINING.....	77
FAMILY: AUDIT AND ACCOUNTABILITY	80
FAMILY: ASSESSMENT, AUTHORIZATION, AND MONITORING	84
FAMILY: CONFIGURATION MANAGEMENT	87
FAMILY: CONTINGENCY PLANNING.....	97
FAMILY: IDENTIFICATION AND AUTHENTICATION	101
FAMILY: INCIDENT RESPONSE	104
FAMILY: MAINTENANCE.....	109
FAMILY: MEDIA PROTECTION	113
FAMILY: PHYSICAL AND ENVIRONMENTAL PROTECTION.....	115
FAMILY: PLANNING.....	119
FAMILY: PROGRAM MANAGEMENT	122
FAMILY: PERSONNEL SECURITY	128
FAMILY: PERSONALLY IDENTIFIABLE INFORMATION PROCESSING AND TRANSPARENCY.....	130
FAMILY: RISK ASSESSMENT	131
FAMILY: SYSTEM AND SERVICES ACQUISITION	134
FAMILY: SYSTEM AND COMMUNICATIONS PROTECTION	143
FAMILY: SYSTEM AND INFORMATION INTEGRITY	149
FAMILY: SUPPLY CHAIN RISK MANAGEMENT.....	153
APPENDIX B: C-SCRM CONTROL SUMMARY.....	158
APPENDIX C: RISK EXPOSURE FRAMEWORK.....	166

SAMPLE SCENARIOS.....	171
SCENARIO 1: Influence or Control by Foreign Governments Over Suppliers	171
SCENARIO 2: Telecommunications Counterfeits	176
SCENARIO 3: Industrial Espionage	180
SCENARIO 4: Malicious Code Insertion.....	185
SCENARIO 5: Unintentional Compromise	188
SCENARIO 6: Vulnerable Reused Components Within Systems	192
APPENDIX D: C-SCRM TEMPLATES	196
1. C-SCRM STRATEGY AND IMPLEMENTATION PLAN	196
1.1..C-SCRM Strategy and Implementation Plan Template.....	196
2. C-SCRM POLICY	203
2.1..C-SCRM Policy Template.....	203
3. C-SCRM PLAN	208
3.1..C-SCRM Plan Template	208
4. CYBERSECURITY SUPPLY CHAIN RISK ASSESSMENT TEMPLATE	218
4.1..C-SCRM Template	218
APPENDIX E: FASCSA	233
INTRODUCTION	233
Purpose, Audience, and Background.....	233
Scope.....	233
Relationship to NIST SP 800-161, Rev. 1, <i>Cybersecurity Supply Chain Risk Management Practices for Systems and Organizations</i>	234
SUPPLY CHAIN RISK ASSESSMENTS (SCRAs)	235
General Information.....	235
Baseline Risk Factors (Common, Minimal)	236
Risk Severity Schema	246
Risk Response Guidance	247
ASSESSMENT DOCUMENTATION AND RECORDS MANAGEMENT	249
Content Documentation Guidance	249
Assessment Record	251
APPENDIX F: RESPONSE TO EXECUTIVE ORDER 14028's CALL TO PUBLISH GUIDELINES FOR ENHANCING SOFTWARE SUPPLY CHAIN SECURITY	252
APPENDIX G: C-SCRM ACTIVITIES IN THE RISK MANAGEMENT PROCESS	253
TARGET AUDIENCE	255
ENTERPRISE-WIDE RISK MANAGEMENT AND THE RMF	255
Frame	255

Assess	277
Respond	287
Monitor	293
APPENDIX H: GLOSSARY	298
APPENDIX I: ACRONYMS	307
APPENDIX J: RESOURCES	313
RELATIONSHIP TO OTHER PROGRAMS AND PUBLICATIONS.....	313
NIST Publications.....	313
Regulatory and Legislative Guidance	314
Other U.S. Government Reports	315
Standards, Guidelines, and Best Practices	315

List of Figures

Fig. 1-1: Dimensions of C-SCRM	8
Fig. 1-2: An Enterprise’s Visibility, Understanding, and Control of its Supply Chain	11
Fig. 2-1: Risk Management Process	18
Fig. 2-2: Cybersecurity Risks Throughout the Supply Chain	21
Fig. 2-3: Multilevel Enterprise-Wide Risk Management	22
Fig. 2-4: C-SCRM Documents in Multilevel Enterprise-wide Risk Management	23
Fig. 2-5: Relationship Between C-SCRM Documents	27
Fig. 3-1: C-SCRM Metrics Development Process	52
Fig. A-1: C-SCRM Security Controls in NIST SP 800-161, Rev. 1	65
Fig. D-1: Example C-SCRM Plan Life Cycle	217
Fig. D-2: Example Likelihood Determination	230
Fig. D-3: Example Risk Exposure Determination	230
Fig. G-1: Cybersecurity Supply Chain Risk Management (C-SCRM).....	253
Fig. G-2: C-SCRM Activities in the Risk Management Process	254
Fig. G-3: C-SCRM in the Frame Step.....	257
Fig. G-4: Risk Appetite and Risk Tolerance	274
Fig. G-5: Risk Appetite and Risk Tolerance Review Process	275
Fig. G-6: C-SCRM in the Assess Step	279
Fig. G-7: C-SCRM in the Respond Step	288
Fig. G-8: C-SCRM in the Monitor Step	295

List of Tables

Table 2-1: Cybersecurity Supply Chain Risk Management Stakeholders	24
Table 3-1: C-SCRM in the Procurement Process	41
Table 3-2: Supply Chain Characteristics and Cybersecurity Risk Factors Associated with a Product, Service, or Source of Supply	44
Table 3-3: Example C-SCRM Practice Implementation Model.....	51
Table 3-4: Example Measurement Topics Across the Risk Management Levels	53
Table A-1: C-SCRM Control Format	69
Table B-1: C-SCRM Control Summary	158
Table C-1: Sample Risk Exposure Framework	169
Table C-2: Scenario 1	173
Table C-3: Scenario 2	178
Table C-4: Scenario 3	182
Table C-5: Scenario 4	186
Table C-6: Scenario 5	189
Table C-6: Scenario 6	193
Table D-1: Objective 1 – Implementation milestones to effectively manage cybersecurity risks throughout the supply chain	199
Table D-2: Objective 2 – Implementation milestones for serving as a trusted source of supply for customers.....	200

Table D-3: Objective 3 – Implementation milestones to position the enterprise as an industry leader in C-SCRM	201
Table D-4: Version Management Table.....	202
Table D-5: Version Management Table.....	208
Table D-6: System Information Type and Categorization.....	210
Table D-7: Security Impact Categorization	210
Table D-8: System Operational Status.....	211
Table D-9: Information Exchange and System Connections.....	212
Table D-10: Role Identification	214
Table D-11: Revision and Maintenance	216
Table D-12: Acronym List.....	216
Table D-13: Information Gathering and Scoping Analysis	220
Table D-14: Version Management Table.....	232
Table E-1: Baseline Risk Factors.....	238
Table E-2: Risk Severity Schema	247
Table E-3: Assessment Record – Minimal Scope of Content and Documentation	250
Table G-1: Examples of Supply Chain Cybersecurity Threat Sources and Agents	261
Table G-2: Supply Chain Cybersecurity Threat Considerations.....	264
Table G-3: Supply Chain Cybersecurity Vulnerability Considerations.....	266
Table G-4: Supply Chain Cybersecurity Consequence and Impact Considerations	268
Table G-5: Supply Chain Cybersecurity Likelihood Considerations	270
Table G-6: Supply Chain Constraints	271
Table G-7: Supply Chain Risk Appetite and Risk Tolerance.....	275
Table G-8: Examples of Supply Chain Cybersecurity Vulnerabilities Mapped to the Enterprise Levels	283
Table G-9: Controls at Levels 1, 2, and 3	292