



# CYBERSECURITY MATURITY MODEL CERTIFICATION (CMMC)

Version 1.02 | March 18, 2020

# NOTICES

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DM19-0824

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# 1. Introduction

The theft of intellectual property and sensitive information from all industrial sectors due to malicious cyber activity threatens economic security and national security. The Council of Economic Advisors estimates that malicious cyber activity cost the U.S. economy between \$57 billion and \$109 billion in 2016 [1]. The Center for Strategic and International Studies estimates that the total global cost of cybercrime was as high as \$600 billion in 2017 [2].

Malicious cyber actors have targeted, and continue to target the Defense Industrial Base (DIB) sector and the supply chain of the Department of Defense (DoD). The DIB sector consists of over 300,000 companies that support the warfighter and contribute towards the research, engineering, development, acquisition, production, delivery, sustainment, and operations of DoD systems, networks, installations, capabilities, and services. The aggregate loss of intellectual property and certain unclassified information from the DoD supply chain can undercut U.S. technical advantages and innovation as well as significantly increase risk to national security.

As part of multiple lines of effort focused on the security and resiliency of the DIB sector, the DoD is working with industry to enhance the protection of the following types of unclassified information within the supply chain:

- *Federal Contract Information (FCI)*: FCI is information provided by or generated for the Government under contract not intended for public release [3].
- *Controlled Unclassified Information (CUI)*: CUI is information that requires safeguarding or dissemination controls pursuant to and consistent with laws, regulations, and government-wide policies, excluding information that is classified under Executive Order 13526, Classified National Security Information, December 29, 2009, or any predecessor or successor order, or Atomic Energy Act of 1954, as amended [4].

Towards this end, the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD(A&S)) has developed the Cybersecurity Maturity Model Certification (CMMC) framework in concert with DoD stakeholders, University Affiliated Research Centers (UARCs), Federally Funded Research and Development Centers (FFRDCs), and the DIB sector.

This document focuses on the CMMC model which measures cybersecurity maturity with five levels and aligns a set of processes and practices with the type and sensitivity of information to be protected and the associated range of threats. The model consists of maturity processes and cybersecurity best practices from multiple cybersecurity standards, frameworks, and other references, as well as inputs from the broader community.

The model encompasses the *basic safeguarding requirements* for FCI specified in Federal Acquisition Regulation (FAR) Clause 52.204-21 and the *security requirements* for CUI specified in National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 per Defense Federal Acquisition Regulation Supplement (DFARS) Clause 252.204-7012 [3, 4, 5].

The CMMC framework adds a certification element to verify the implementation of processes and practices associated with the achievement of a cybersecurity maturity level. CMMC is designed to provide increased assurance to the DoD that a DIB contractor can adequately protect CUI at a level commensurate with the risk, accounting for information flow down to its subcontractors in a multi-tier supply chain.

When implementing CMMC, a DIB contractor can achieve a specific CMMC level for its entire enterprise network or for particular segment(s) or enclave(s), depending upon where the information to be protected is handled and stored.

## 1.1 Document Organization

This document is organized as follows. Section 2 presents the CMMC model and each of its elements in detail. Appendix A provides the model as a matrix. Appendix B includes the discussion and clarifications associated with each process and practice in the model. Appendix C is the glossary. Appendix D lists the abbreviations and acronyms. Appendix E maps the CMMC model to other sources. Finally, Appendix F provides the references contained in the document.

## 2. CMMC Model

### 2.1 Background on Maturity Models

In general, a *maturity model* is a set of characteristics, attributes, indicators, or patterns that represent capability and progression in a particular discipline. The content of such a model typically exemplifies best practices and may incorporate standards or other codes of practice of that discipline. A maturity model thus provides a benchmark against which an organization can evaluate the current level of capability of its processes, practices, and methods and set goals and priorities for improvement. To measure progression, maturity models typically have *levels* along a scale [9,10].

### 2.2 Overview

The Cybersecurity Maturity Model Certification (CMMC) framework consists of maturity processes and cybersecurity best practices from multiple cybersecurity standards, frameworks, and other references, as well as inputs from the Defense Industrial Base (DIB) and Department of Defense (DoD) stakeholders. The model framework (Figure 1) organizes these *processes* and *practices* into a set of *domains* and maps them across five *levels*. In order to provide additional structure, the framework also aligns the practices to a set of *capabilities* within each domain. The ensuing subsections provide additional information regarding each element of the model.

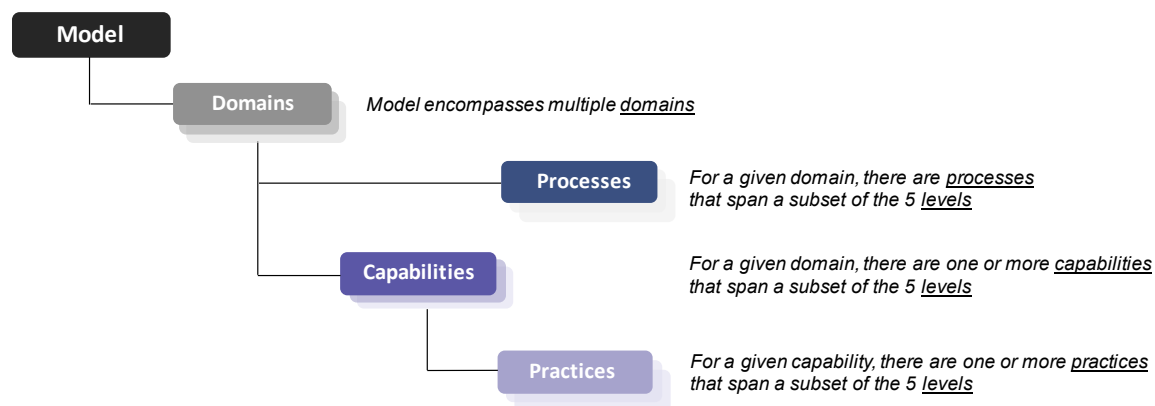


Figure 1. CMMC Model Framework (Simplified Hierarchical View)

### 2.3 CMMC Levels

#### 2.3.1 Descriptions

The CMMC model measures cybersecurity maturity with five levels. Each of these levels, in turn, consists of a set of processes and practices which are characterized in Figure 2. The

processes range from ‘Performed’ at Level 1 to ‘Optimizing’ at Level 5 and the practices range from ‘Basic Cyber Hygiene’ at Level 1 to ‘Advanced/Progressive’ at Level 5.

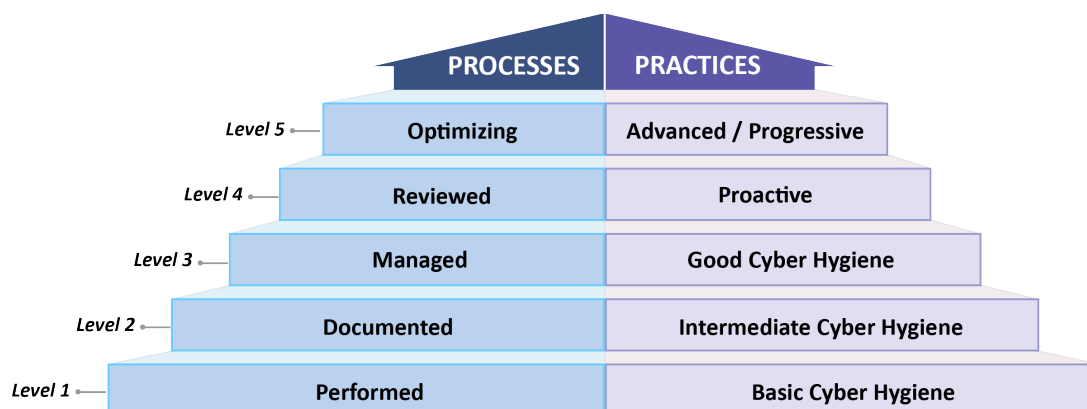


Figure 2. CMMC Levels and Descriptions

The CMMC levels and the associated sets of processes and practices across domains are cumulative. More specifically, in order for an organization to achieve a specific CMMC level it must also demonstrate achievement of the preceding lower levels.

Furthermore, an organization must demonstrate both the requisite institutionalization of processes (i.e., the left side in Figure 2) and the implementation of practices (i.e., the right side in Figure 2) for a specific CMMC level and the preceding lower levels in order to achieve that level. For the case where an organization demonstrates different achievements with respect to process institutionalization and practice implementation, the organization will be certified at the lower of the two levels.

### 2.3.2 Focus

In addition to the previous CMMC level descriptions, the specification and mapping of processes and practices to a particular level take into account multiple considerations including regulations, type and sensitivity of information, threats, costs, implementation complexity, diversity within the DIB sector, assessment implications, and other factors. The CMMC model, in effect, provides a means of improving the alignment of maturity processes and cybersecurity practices with the type and sensitivity of information to be protected and the range of threats. As a result, the CMMC levels can also be characterized by this alignment or more simply, their focus, as follows:

- Level 1: Safeguard Federal Contract Information (FCI)
- Level 2: Serve as transition step in cybersecurity maturity progression to protect CUI
- Level 3: Protect Controlled Unclassified Information (CUI)
- Levels 4-5: Protect CUI and reduce risk of Advanced Persistent Threats (APTs)



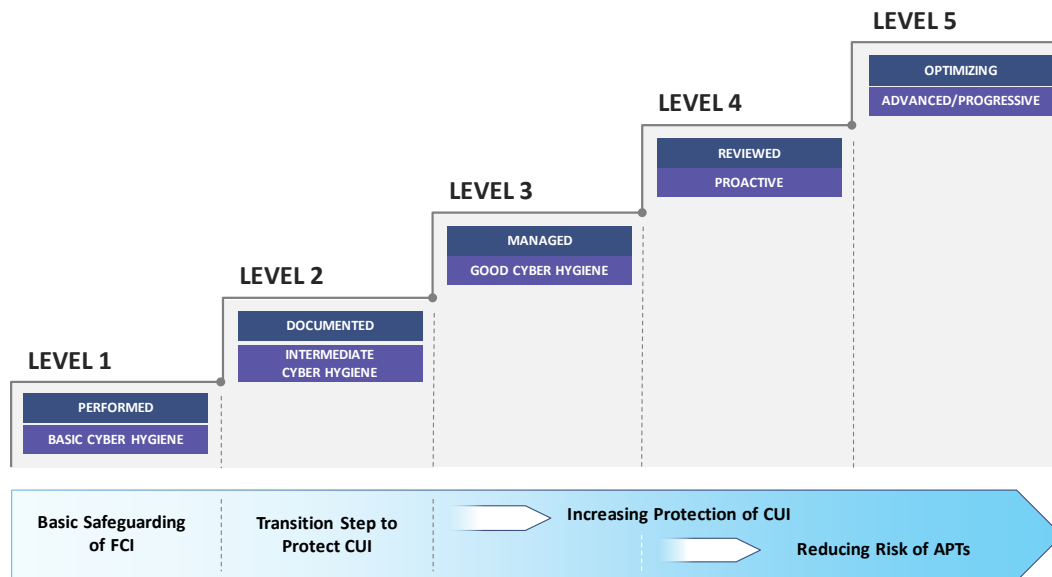


Figure 3. CMMC Levels and Associated Focus

The achievement of higher CMMC levels enhances the ability of an organization to protect CUI and, for Levels 4-5, reduces the risk of APTs (Figure 3). An APT is an adversary that possesses sophisticated levels of expertise and significant resources which allow it to create opportunities to achieve its objectives by using multiple attack vectors (e.g., cyber, physical, and deception) [6,11].

### 2.3.3 CMMC Level 1

- **Processes: Performed**

Level 1 requires that an organization performs the specified practices. Because the organization may only be able to perform these practices in an ad-hoc manner and may or may not rely on documentation, process maturity is not assessed for Level 1.

- **Practices: Basic Cyber Hygiene**

Level 1 focuses on the protection of FCI and consists only of practices that correspond to the basic safeguarding requirements specified in 48 CFR 52.204-21 (“Basic Safeguarding of Covered Contractor Information Systems”) [3].

### 2.3.4 CMMC Level 2

- **Processes: Documented**

Level 2 requires that an organization establish and document practices and policies to guide the implementation of their CMMC efforts. The documentation of practices enables individuals to perform them in a repeatable manner. Organizations develop mature capabilities by documenting their processes and then practicing them as documented.

- **Practices: Intermediate Cyber Hygiene**

Level 2 serves as a progression from Level 1 to Level 3 and consists of a subset of the security requirements specified in NIST SP 800-171 [4] as well as practices from other standards and references. Because this level represents a transitional stage, a subset of the practices reference the protection of CUI.

### 2.3.5 CMMC Level 3

- **Processes: Managed**

Level 3 requires that an organization establish, maintain, and resource a plan demonstrating the management of activities for practice implementation. The plan may include information on missions, goals, project plans, resourcing, required training, and involvement of relevant stakeholders.

- **Practices: Good Cyber Hygiene**

Level 3 focuses on the protection of CUI and encompasses all of the security requirements specified in NIST SP 800-171 [4] as well as additional practices from other standards and references to mitigate threats.

It is noted that DFARS clause 252.204-7012 (“Safeguarding of Covered Defense Information and Cyber Incident Reporting”) [5] specifies additional requirements beyond the NIST SP 800-171 security requirements such as incident reporting.

### 2.3.6 CMMC Level 4

- **Processes: Reviewed**

Level 4 requires that an organization review and measure practices for effectiveness. In addition to measuring practices for effectiveness, organizations at this level are able to take corrective action when necessary and inform higher level management of status or issues on a recurring basis.

- **Practices: Proactive**

Level 4 focuses on the protection of CUI from APTs and encompasses a subset of the enhanced security requirements from Draft NIST SP 800-171B [6] as well as other cybersecurity best practices. These practices enhance the detection and response capabilities of an organization to address and adapt to the changing tactics, techniques, and procedures (TTPs) used by APTs.

### 2.3.7 CMMC Level 5

- **Processes: Optimizing**

Level 5 requires an organization to standardize and optimize process implementation across the organization.

- **Practices: Advanced/Proactive**

Level 5 focuses on the protection of CUI from APTs. The additional practices increase the depth and sophistication of cybersecurity capabilities.

## 2.4 CMMC Domains

The CMMC model consists of 17 domains. The majority of these domains originate from the security-related areas in Federal Information Processing Standards (FIPS) Publication 200 [12] and the related security requirement families from NIST SP 800-171 [4]. The CMMC model also includes the three domains of Asset Management (AM), Recovery (RE), and Situational Awareness (SA).

These domains and their abbreviations are shown in Figure 4 below.



**Figure 4. CMMC Domains**

## 2.5 CMMC Capabilities

As previously noted (Figure 1), each domain consists of a set of processes and capabilities (and in turn, practices) across the five levels. Table 1 itemizes the 43 capabilities associated with the 17 domains in the CMMC model.

**Table 1. CMMC Capabilities**

Domain	Capability
Access Control (AC)	<ul style="list-style-type: none"> <li>Establish system access requirements</li> <li>Control internal system access</li> <li>Control remote system access</li> <li>Limit data access to authorized users and processes</li> </ul>
Asset Management (AM)	<ul style="list-style-type: none"> <li>Identify and document assets</li> <li>Manage asset inventory</li> </ul>
Audit and Accountability (AU)	<ul style="list-style-type: none"> <li>Define audit requirements</li> <li>Perform auditing</li> <li>Identify and protect audit information</li> <li>Review and manage audit logs</li> </ul>
Awareness and Training (AT)	<ul style="list-style-type: none"> <li>Conduct security awareness activities</li> <li>Conduct training</li> </ul>
Configuration Management (CM)	<ul style="list-style-type: none"> <li>Establish configuration baselines</li> <li>Perform configuration and change management</li> </ul>
Identification and Authentication (IA)	<ul style="list-style-type: none"> <li>Grant access to authenticated entities</li> </ul>
Incident Response (IR)	<ul style="list-style-type: none"> <li>Plan incident response</li> <li>Detect and report events</li> <li>Develop and implement a response to a declared incident</li> <li>Perform post incident reviews</li> <li>Test incident response</li> </ul>
Maintenance (MA)	<ul style="list-style-type: none"> <li>Manage maintenance</li> </ul>
Media Protection (MP)	<ul style="list-style-type: none"> <li>Identify and mark media</li> <li>Protect and control media</li> <li>Sanitize media</li> <li>Protect media during transport</li> </ul>
Personnel Security (PS)	<ul style="list-style-type: none"> <li>Screen personnel</li> <li>Protect CUI during personnel actions</li> </ul>
Physical Protection (PE)	<ul style="list-style-type: none"> <li>Limit physical access</li> </ul>
Recovery (RE)	<ul style="list-style-type: none"> <li>Manage backups</li> <li>Manage information security continuity</li> </ul>
Risk Management (RM)	<ul style="list-style-type: none"> <li>Identify and evaluate risk</li> <li>Manage risk</li> <li>Manage supply chain risk</li> </ul>
Security Assessment (CA)	<ul style="list-style-type: none"> <li>Develop and manage a system security plan</li> <li>Define and manage controls</li> <li>Perform code reviews</li> </ul>
Situational Awareness (SA)	<ul style="list-style-type: none"> <li>Implement threat monitoring</li> </ul>
Systems and Communications Protection (SC)	<ul style="list-style-type: none"> <li>Define security requirements for systems and communications</li> <li>Control communications at system boundaries</li> </ul>
System and Information Integrity (SI)	<ul style="list-style-type: none"> <li>Identify and manage information system flaws</li> <li>Identify malicious content</li> <li>Perform network and system monitoring</li> <li>Implement advanced email protections</li> </ul>

## 2.6 CMMC Processes

### 2.6.1 Background

The term *institutionalization* characterizes the extent to which an activity is embedded or ingrained in the operations of an organization [9,10]. The more deeply ingrained an activity, the more likely it is that an organization will continue to perform the activity – including under times of stress – and that the outcomes will be consistent, repeatable, and of high quality [9,10].

The CMMC maturity levels serve as a way to measure an organization’s process maturity or *process institutionalization*.

### 2.6.2 Processes

Within the context of the CMMC model, process institutionalization provides additional assurances that the practices associated with each level are implemented effectively. The CMMC model consists of five maturity processes that span Maturity Levels (ML) 2-5 and apply to all domains (Table 2). As previously noted, organizations perform practices at Level 1 but process maturity is not assessed for ML 1.

**Table 2. CMMC Processes**

Maturity Level	Maturity Level Description	Processes
<b>ML 1</b>	<b>Performed</b>	<i>There are no maturity processes assessed at Maturity Level 1. An organization performs Level 1 practices but does not have process institutionalization requirements.</i>
<b>ML 2</b>	<b>Documented</b>	Establish a policy that includes [DOMAIN NAME].
		Document the CMMC practices to implement the [DOMAIN NAME] policy.
<b>ML 3</b>	<b>Managed</b>	Establish, maintain, and resource a plan that includes [DOMAIN NAME].
<b>ML 4</b>	<b>Reviewed</b>	Review and measure [DOMAIN NAME] activities for effectiveness.
<b>ML 5</b>	<b>Optimizing</b>	Standardize and optimize a documented approach for [DOMAIN NAME] across all applicable organization units.

## 2.7 CMMC Practices

### 2.7.1 Overview

The CMMC model measures not only process maturity or institutionalization, but also the implementation of practices. The model consists of 171 practices that are mapped across the five levels for all capabilities and domains. This mapping and the cumulative nature of the model is shown in Figure 5.

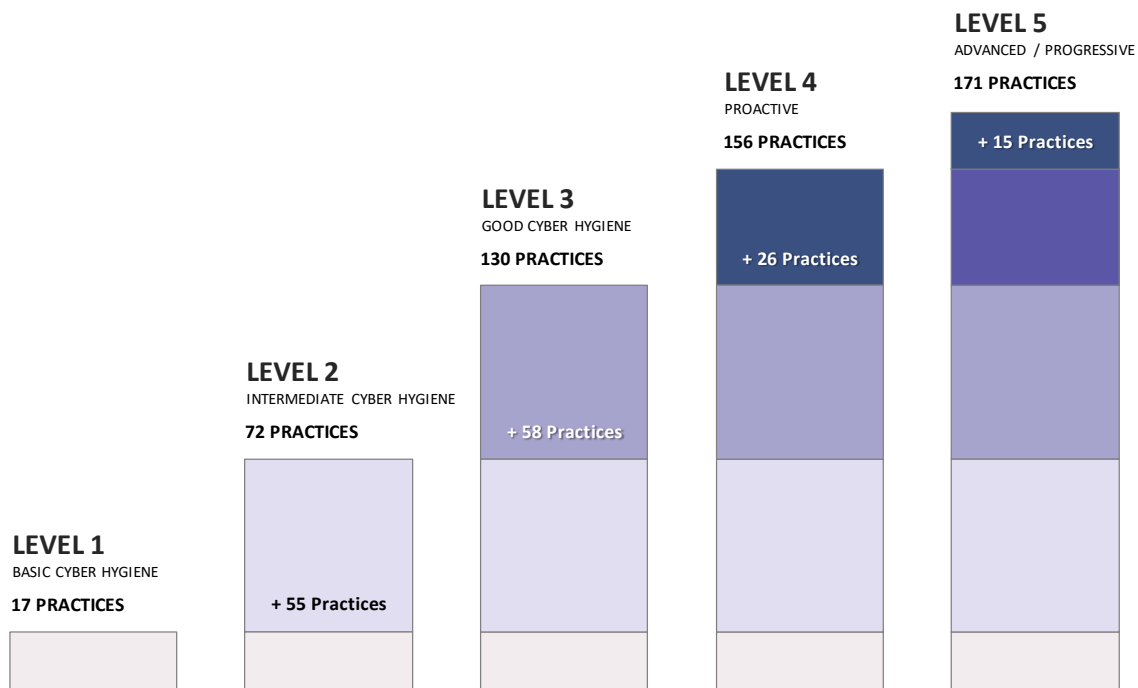


Figure 5. CMMC Practices Per Level

The majority of the practices (110 of 171) originate from the safeguarding requirements and security requirements specified in FAR Clause 52.204-21 [3] and DFARS Clause 252.204-7012 [5], respectively. Although previously noted, the following is restated for emphasis:

- Level 1 is equivalent to all of the safeguarding requirements from FAR Clause 52.204-21.
- Level 3, building on Levels 1 and 2, includes all of the security requirements in NIST SP 800-171 plus other practices.

The remaining practices stem from multiple references as well as inputs from the DIB and DoD stakeholders (Table 3). Due to various considerations, CMMC Levels 4-5 include only a subset of the enhanced security requirements from Draft NIST SP 800-171B [6].

Table 3. Source for CMMC Practices Per Level

CMMC Level	Number of Practices Introduced at CMMC Level	Source			
		48 CFR 52.204-21	NIST SP 800-171r1	Draft NIST SP 800-171B	Other
1	17	15*	17*	–	–
2	55	–	48	–	7
3	58	–	45	–	13
4	26	–	–	11	15
5	15	–	–	4	11
<b>Total</b>	<b>171</b>	<b>15</b>	<b>110</b>	<b>15</b>	<b>46</b>

\*Note: 15 safeguarding requirements from 48 CFR 52.204-21 correspond to 17 security requirements in NIST SP 800-171.

The distribution of practices across domains per level is shown in Figure 6. The six domains of AC, AU, IR, RM, SC, and SI account for the majority of all practices (105 of 171). The distribution of practices across domains for Levels 4-5 is relatively more uniform than for Levels 1-3.

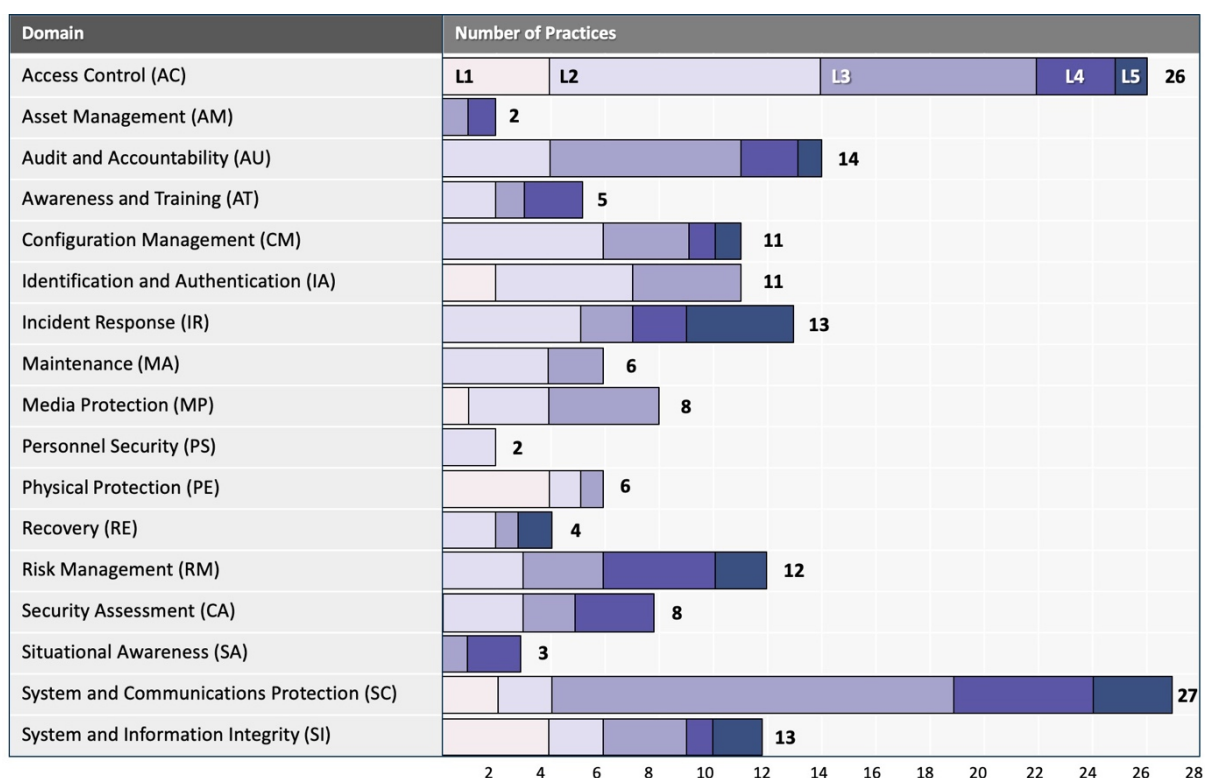


Figure 6. CMMC Practices Across Domains Per Level

## 2.7.2 List of Practices

This subsection itemizes the practices for each domain and at each level.

Each practice is specified using the convention of [DOMAIN].[LEVEL].[PRACTICE NUMBER] where:

- DOMAIN is the two letter domain abbreviation;
- LEVEL is the level number; and
- PRACTICE NUMBER is the identifier assigned to that practice.

### ACCESS CONTROL (AC)

---

#### Level 1

- |                 |  |
|-----------------|--|
| <b>AC.1.001</b> | Limit information system access to authorized users, processes acting on behalf of authorized users, or devices (including other information systems). |
| <b>AC.1.002</b> | Limit information system access to the types of transactions and functions that authorized users are permitted to execute.                             |
| <b>AC.1.003</b> | Verify and control/limit connections to and use of external information systems.   |
| <b>AC.1.004</b> | Control information posted or processed on publicly accessible information systems.  |

#### Level 2

- |                 |   |
|-----------------|---|
| <b>AC.2.005</b> | Provide privacy and security notices consistent with applicable CUI rules.  |
| <b>AC.2.006</b> | Limit use of portable storage devices on external systems.  |
| <b>AC.2.007</b> | Employ the principle of least privilege, including for specific security functions and privileged accounts.       |
| <b>AC.2.008</b> | Use non-privileged accounts or roles when accessing nonsecurity functions.  |
| <b>AC.2.009</b> | Limit unsuccessful logon attempts.  |
| <b>AC.2.010</b> | Use session lock with pattern-hiding displays to prevent access and viewing of data after a period of inactivity. |
| <b>AC.2.011</b> | Authorize wireless access prior to allowing such connections.   |
| <b>AC.2.013</b> | Monitor and control remote access sessions.   |
| <b>AC.2.015</b> | Route remote access via managed access control points.  |
| <b>AC.2.016</b> | Control the flow of CUI in accordance with approved authorizations.   |

#### Level 3

- |                 |   |
|-----------------|---|
| <b>AC.3.017</b> | Separate the duties of individuals to reduce the risk of malevolent activity without collusion.                             |
| <b>AC.3.018</b> | Prevent non-privileged users from executing privileged functions and capture the execution of such functions in audit logs. |
| <b>AC.3.019</b> | Terminate (automatically) user sessions after a defined condition.  |



- AC.3.012** Protect wireless access using authentication and encryption.
- AC.3.020** Control connection of mobile devices.
- AC.3.014** Employ cryptographic mechanisms to protect the confidentiality of remote access sessions.
- AC.3.021** Authorize remote execution of privileged commands and remote access to security-relevant information.
- AC.3.022** Encrypt CUI on mobile devices and mobile computing platforms.

#### Level 4

- AC.4.023** Control information flows between security domains on connected systems.
- AC.4.025** Periodically review and update CUI program access permissions.
- AC.4.032** Restrict remote network access based on organizationally defined risk factors such as time of day, location of access, physical location, network connection state, and measured properties of the current user and role.

#### Level 5

- AC.5.024** Identify and mitigate risk associated with unidentified wireless access points connected to the network.

### ASSET MANAGEMENT (AM)

---

#### Level 3

- AM.3.036** Define procedures for the handling of CUI data.

#### Level 4

- AM.4.226** Employ a capability to discover and identify systems with specific component attributes (e.g., firmware level, OS type) within your inventory.

### AUDIT AND ACCOUNTABILITY (AU)

---

#### Level 2

- AU.2.041** Ensure that the actions of individual system users can be uniquely traced to those users so they can be held accountable for their actions.
- AU.2.042** Create and retain system audit logs and records to the extent needed to enable the monitoring, analysis, investigation, and reporting of unlawful or unauthorized system activity.
- AU.2.043** Provide a system capability that compares and synchronizes internal system clocks with an authoritative source to generate time stamps for audit records.
- AU.2.044** Review audit logs.

#### Level 3

- AU.3.045** Review and update logged events.

<b>AU.3.046</b>	Alert in the event of an audit logging process failure.
<b>AU.3.048</b>	Collect audit information (e.g., logs) into one or more central repositories.
<b>AU.3.049</b>	Protect audit information and audit logging tools from unauthorized access, modification, and deletion.
<b>AU.3.050</b>	Limit management of audit logging functionality to a subset of privileged users.
<b>AU.3.051</b>	Correlate audit record review, analysis, and reporting processes for investigation and response to indications of unlawful, unauthorized, suspicious, or unusual activity.
<b>AU.3.052</b>	Provide audit record reduction and report generation to support on-demand analysis and reporting.

#### Level 4

<b>AU.4.053</b>	Automate analysis of audit logs to identify and act on critical indicators (TTPs) and/or organizationally defined suspicious activity.
<b>AU.4.054</b>	Review audit information for broad activity in addition to per-machine activity.

#### Level 5

<b>AU.5.055</b>	Identify assets not reporting audit logs and assure appropriate organizationally defined systems are logging.
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### AWARENESS AND TRAINING (AT)

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#### Level 2

<b>AT.2.056</b>	Ensure that managers, system administrators, and users of organizational systems are made aware of the security risks associated with their activities and of the applicable policies, standards, and procedures related to the security of those systems.
<b>AT.2.057</b>	Ensure that personnel are trained to carry out their assigned information security-related duties and responsibilities.

#### Level 3

<b>AT.3.058</b>	Provide security awareness training on recognizing and reporting potential indicators of insider threat.
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#### Level 4

<b>AT.4.059</b>	Provide awareness training focused on recognizing and responding to threats from social engineering, advanced persistent threat actors, breaches, and suspicious behaviors; update the training at least annually or when there are significant changes to the threat.
<b>AT.4.060</b>	Include practical exercises in awareness training that are aligned with current threat scenarios and provide feedback to individuals involved in the training.

## CONFIGURATION MANAGEMENT (CM)

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### Level 2

- CM.2.061** Establish and maintain baseline configurations and inventories of organizational systems (including hardware, software, firmware, and documentation) throughout the respective system development life cycles.
- CM.2.062** Employ the principle of least functionality by configuring organizational systems to provide only essential capabilities.
- CM.2.063** Control and monitor user-installed software.
- CM.2.064** Establish and enforce security configuration settings for information technology products employed in organizational systems.
- CM.2.065** Track, review, approve, or disapprove, and log changes to organizational systems.
- CM.2.066** Analyze the security impact of changes prior to implementation.

### Level 3

- CM.3.067** Define, document, approve, and enforce physical and logical access restrictions associated with changes to organizational systems.
- CM.3.068** Restrict, disable, or prevent the use of nonessential programs, functions, ports, protocols, and services.
- CM.3.069** Apply deny-by-exception (blacklisting) policy to prevent the use of unauthorized software or deny-all, permit-by-exception (whitelisting) policy to allow the execution of authorized software.

### Level 4

- CM.4.073** Employ application whitelisting and an application vetting process for systems identified by the organization.

### Level 5

- CM.5.074** Verify the integrity and correctness of security critical or essential software as defined by the organization (e.g., roots of trust, formal verification, or cryptographic signatures).

## IDENTIFICATION AND AUTHENTICATION (IA)

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### Level 1

- IA.1.076** Identify information system users, processes acting on behalf of users, or devices.
- IA.1.077** Authenticate (or verify) the identities of those users, processes, or devices, as a prerequisite to allowing access to organizational information systems.

### Level 2

- IA.2.078** Enforce a minimum password complexity and change of characters when new passwords are created.
- IA.2.079** Prohibit password reuse for a specified number of generations.

- IA.2.080** Allow temporary password use for system logons with an immediate change to a permanent password.
- IA.2.081** Store and transmit only cryptographically-protected passwords.
- IA.2.082** Obscure feedback of authentication information.

### Level 3

- IA.3.083** Use multifactor authentication for local and network access to privileged accounts and for network access to non-privileged accounts.
- IA.3.084** Employ replay-resistant authentication mechanisms for network access to privileged and non-privileged accounts.
- IA.3.085** Prevent the reuse of identifiers for a defined period.
- IA.3.086** Disable identifiers after a defined period of inactivity.

## INCIDENT RESPONSE (IR)

---

### Level 2

- IR.2.092** Establish an operational incident-handling capability for organizational systems that includes preparation, detection, analysis, containment, recovery, and user response activities.
- IR.2.093** Detect and report events.
- IR.2.094** Analyze and triage events to support event resolution and incident declaration.
- IR.2.096** Develop and implement responses to declared incidents according to pre-defined procedures.
- IR.2.097** Perform root cause analysis on incidents to determine underlying causes.

### Level 3

- IR.3.098** Track, document, and report incidents to designated officials and/or authorities both internal and external to the organization.
- IR.3.099** Test the organizational incident response capability.

### Level 4

- IR.4.100** Use knowledge of attacker tactics, techniques, and procedures in incident response planning and execution.
- IR.4.101** Establish and maintain a security operations center capability that facilitates a 24/7 response capability.

### Level 5

- IR.5.106** In response to cyber incidents, utilize forensic data gathering across impacted systems, ensuring the secure transfer and protection of forensic data.
- IR.5.102** Use a combination of manual and automated, real-time responses to anomalous activities that match incident patterns.

- IR.5.108** Establish and maintain a cyber incident response team that can investigate an issue physically or virtually at any location within 24 hours.
- IR.5.110** Perform unannounced operational exercises to demonstrate technical and procedural responses.

## MAINTENANCE (MA)

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### Level 2

- MA.2.111** Perform maintenance on organizational systems.
- MA.2.112** Provide controls on the tools, techniques, mechanisms, and personnel used to conduct system maintenance.
- MA.2.113** Require multifactor authentication to establish nonlocal maintenance sessions via external network connections and terminate such connections when nonlocal maintenance is complete.
- MA.2.114** Supervise the maintenance activities of personnel without required access authorization.

### Level 3

- MA.3.115** Ensure equipment removed for off-site maintenance is sanitized of any CUI.
- MA.3.116** Check media containing diagnostic and test programs for malicious code before the media are used in organizational systems.

## MEDIA PROTECTION (MP)

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### Level 1

- MP.1.118** Sanitize or destroy information system media containing Federal Contract Information before disposal or release for reuse.

### Level 2

- MP.2.119** Protect (i.e., physically control and securely store) system media containing CUI, both paper and digital.
- MP.2.120** Limit access to CUI on system media to authorized users.
- MP.2.121** Control the use of removable media on system components.

### Level 3

- MP.3.122** Mark media with necessary CUI markings and distribution limitations.
- MP.3.123** Prohibit the use of portable storage devices when such devices have no identifiable owner.
- MP.3.124** Control access to media containing CUI and maintain accountability for media during transport outside of controlled areas.
- MP.3.125** Implement cryptographic mechanisms to protect the confidentiality of CUI stored on digital media during transport unless otherwise protected by alternative physical safeguards.

## PERSONNEL SECURITY (PS)

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### Level 2

- PS.2.127** Screen individuals prior to authorizing access to organizational systems containing CUI.
- PS.2.128** Ensure that organizational systems containing CUI are protected during and after personnel actions such as terminations and transfers.

## PHYSICAL PROTECTION (PE)

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### Level 1

- PE.1.131** Limit physical access to organizational information systems, equipment, and the respective operating environments to authorized individuals.
- PE.1.132** Escort visitors and monitor visitor activity.
- PE.1.133** Maintain audit logs of physical access.
- PE.1.134** Control and manage physical access devices.

### Level 2

- PE.2.135** Protect and monitor the physical facility and support infrastructure for organizational systems.

### Level 3

- PE.3.136** Enforce safeguarding measures for CUI at alternate work sites.

## RECOVERY (RE)

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### Level 2

- RE.2.137** Regularly perform and test data back-ups.
- RE.2.138** Protect the confidentiality of backup CUI at storage locations.

### Level 3

- RE.3.139** Regularly perform complete, comprehensive, and resilient data back-ups as organizationally defined.

### Level 5

- RE.5.140** Ensure information processing facilities meet organizationally defined information security continuity, redundancy, and availability requirements.

## RISK MANAGEMENT (RM)

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### Level 2

- RM.2.141** Periodically assess the risk to organizational operations (including mission, functions, image, or reputation), organizational assets, and individuals, resulting from the operation of organizational systems and the associated processing, storage, or transmission of CUI.
- RM.2.142** Scan for vulnerabilities in organizational systems and applications periodically and when new vulnerabilities affecting those systems and applications are identified.
- RM.2.143** Remediate vulnerabilities in accordance with risk assessments.

### Level 3

- RM.3.144** Periodically perform risk assessments to identify and prioritize risks according to the defined risk categories, risk sources, and risk measurement criteria.
- RM.3.146** Develop and implement risk mitigation plans.
- RM.3.147** Manage non-vendor-supported products (e.g., end of life) separately and restrict as necessary to reduce risk.

### Level 4

- RM.4.149** Catalog and periodically update threat profiles and adversary TTPs.
- RM.4.150** Employ threat intelligence to inform the development of the system and security architectures, selection of security solutions, monitoring, threat hunting, and response and recovery activities.
- RM.4.151** Perform scans for unauthorized ports available across perimeter network boundaries over the organization's Internet network boundaries and other organizationally defined boundaries.
- RM.4.148** Develop and update as required, a plan for managing supply chain risks associated with the IT supply chain.

### Level 5

- RM.5.152** Utilize an exception process for non-whitelisted software that includes mitigation techniques.
- RM.5.155** Analyze the effectiveness of security solutions at least annually to address anticipated risk to the system and the organization based on current and accumulated threat intelligence.

## SECURITY ASSESSMENT (CA)

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### Level 2

- CA.2.157** Develop, document, and periodically update system security plans that describe system boundaries, system environments of operation, how security requirements are implemented, and the relationships with or connections to other systems.
- CA.2.158** Periodically assess the security controls in organizational systems to determine if the controls are effective in their application.
- CA.2.159** Develop and implement plans of action designed to correct deficiencies and reduce or eliminate vulnerabilities in organizational systems.

**Level 3**

- CA.3.161** Monitor security controls on an ongoing basis to ensure the continued effectiveness of the controls.
- CA.3.162** Employ a security assessment of enterprise software that has been developed internally, for internal use, and that has been organizationally defined as an area of risk.

**Level 4**

- CA.4.163** Create, maintain, and leverage a security strategy and roadmap for organizational cybersecurity improvement.
- CA.4.164** Conduct penetration testing periodically, leveraging automated scanning tools and ad hoc tests using human experts.
- CA.4.227** Periodically perform red teaming against organizational assets in order to validate defensive capabilities.

**SITUATIONAL AWARENESS (SA)**

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**Level 3**

- SA.3.169** Receive and respond to cyber threat intelligence from information sharing forums and sources and communicate to stakeholders.

**Level 4**

- SA.4.171** Establish and maintain a cyber threat hunting capability to search for indicators of compromise in organizational systems and detect, track, and disrupt threats that evade existing controls.
- SA.4.173** Design network and system security capabilities to leverage, integrate, and share indicators of compromise.

**SYSTEM AND COMMUNICATIONS PROTECTION (SC)**

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**Level 1**

- SC.1.175** Monitor, control, and protect organizational communications (i.e., information transmitted or received by organizational information systems) at the external boundaries and key internal boundaries of the information systems.
- SC.1.176** Implement subnetworks for publicly accessible system components that are physically or logically separated from internal networks.

**Level 2**

- SC.2.178** Prohibit remote activation of collaborative computing devices and provide indication of devices in use to users present at the device.
- SC.2.179** Use encrypted sessions for the management of network devices.



### Level 3

- SC.3.177**      Employ FIPS-validated cryptography when used to protect the confidentiality of CUI.
- SC.3.180**      Employ architectural designs, software development techniques, and systems engineering principles that promote effective information security within organizational systems.
- SC.3.181**      Separate user functionality from system management functionality.
- SC.3.182**      Prevent unauthorized and unintended information transfer via shared system resources.
- SC.3.183**      Deny network communications traffic by default and allow network communications traffic by exception (i.e., deny all, permit by exception).
- SC.3.184**      Prevent remote devices from simultaneously establishing non-remote connections with organizational systems and communicating via some other connection to resources in external networks (i.e., split tunneling).
- SC.3.185**      Implement cryptographic mechanisms to prevent unauthorized disclosure of CUI during transmission unless otherwise protected by alternative physical safeguards.
- SC.3.186**      Terminate network connections associated with communications sessions at the end of the sessions or after a defined period of inactivity.
- SC.3.187**      Establish and manage cryptographic keys for cryptography employed in organizational systems.
- SC.3.188**      Control and monitor the use of mobile code.
- SC.3.189**      Control and monitor the use of Voice over Internet Protocol (VoIP) technologies.
- SC.3.190**      Protect the authenticity of communications sessions.
- SC.3.191**      Protect the confidentiality of CUI at rest.
- SC.3.192**      Implement Domain Name System (DNS) filtering services.
- SC.3.193**      Implement a policy restricting the publication of CUI on externally owned, publicly accessible websites (e.g., forums, LinkedIn, Facebook, Twitter).

### Level 4

- SC.4.197**      Employ physical and logical isolation techniques in the system and security architecture and/or where deemed appropriate by the organization.
- SC.4.228**      Isolate administration of organizationally defined high-value critical network infrastructure components and servers.
- SC.4.199**      Utilize threat intelligence to proactively block DNS requests from reaching malicious domains.
- SC.4.202**      Employ mechanisms to analyze executable code and scripts (e.g., sandbox) traversing Internet network boundaries or other organizationally defined boundaries.
- SC.4.229**      Utilize a URL categorization service and implement techniques to enforce URL filtering of websites that are not approved by the organization.

### Level 5

- SC.5.198**      Configure monitoring systems to record packets passing through the organization's Internet network boundaries and other organizationally defined boundaries.

- SC.5.230** Enforce port and protocol compliance.
- SC.5.208** Employ organizationally defined and tailored boundary protections in addition to commercially available solutions.

## SYSTEM AND INFORMATION INTEGRITY (SI)

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### Level 1

- SI.1.210** Identify, report, and correct information and information system flaws in a timely manner.
- SI.1.211** Provide protection from malicious code at appropriate locations within organizational information systems.
- SI.1.212** Update malicious code protection mechanisms when new releases are available.
- SI.1.213** Perform periodic scans of the information system and real-time scans of files from external sources as files are downloaded, opened, or executed.

### Level 2

- SI.2.214** Monitor system security alerts and advisories and take action in response.
- SI.2.216** Monitor organizational systems, including inbound and outbound communications traffic, to detect attacks and indicators of potential attacks.
- SI.2.217** Identify unauthorized use of organizational systems.

### Level 3

- SI.3.218** Employ spam protection mechanisms at information system access entry and exit points.
- SI.3.219** Implement email forgery protections.
- SI.3.220** Utilize sandboxing to detect or block potentially malicious email.

### Level 4

- SI.4.221** Use threat indicator information relevant to the information and systems being protected and effective mitigations obtained from external organizations to inform intrusion detection and threat hunting.

### Level 5

- SI.5.222** Analyze system behavior to detect and mitigate execution of normal system commands and scripts that indicate malicious actions.
- SI.5.223** Monitor individuals and system components on an ongoing basis for anomalous or suspicious behavior.

### 3. Summary

The Cybersecurity Maturity Model Certification (CMMC) framework contains five maturity processes and 171 cybersecurity best practices progressing across five maturity levels. The CMMC maturity processes institutionalize cybersecurity activities to ensure they are consistent, repeatable, and of high quality. The CMMC practices provide a range of mitigation across the levels, starting with basic safeguarding at Level 1, moving to the broad protection of Controlled Unclassified Information (CUI) at Level 3, and culminating with reducing the risk from Advanced Persistent Threats (APTs) at Levels 4 and 5. The CMMC framework is coupled with a certification program to verify the implementation of processes and practices.

Created in collaboration with a community of Department of Defense (DoD) stakeholders, University Affiliated Research Centers (UARCs), Federally Funded Research and Development Centers (FFRDCs), and the Defense Industrial Base (DIB) sector, the CMMC framework addresses the needs of the DoD to protect its unclassified information (i.e., Federal Contract Information (FCI) and CUI) during the acquisition and sustainment of products and services from the DIB. This model represents one of multiple lines of effort that the Department and industry are pursuing to enhance the security and resiliency of the DIB sector. These efforts are instrumental in establishing cybersecurity as a foundation for future DoD acquisitions.

