NIST Interagency Report
NIST IR 8441

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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## Abstract

The space sector is transitioning towards Hybrid Satellite Networks (HSN) which is an aggregation of independently owned and operated terminals, antennas, satellites, payloads, or other components that comprise a satellite system. The elements of an HSN may have varying levels of assurance.

HSNs may interact with government systems and critical infrastructure (as defined by the Department of Homeland Security). A framework is required to assess the security posture of the individual components while still enabling the HSN to provide its function. This report applies the NIST Cybersecurity Framework to HSNs with an emphasis on the interfaces between the participants of the HSN.

In collaboration with subject matter experts including satellite builders, consultants, acquisition authorities, operators (commercial and government), academia, and other interested parties, the National Institute of Standards and Technology (NIST) has developed the HSN Cybersecurity Framework CSF Profile (HSN Profile) to guide space stakeholders. The resulting profile provides a starting point for stakeholders who are assessing the cybersecurity posture of their HSN.

## Keywords

Cybersecurity Framework; Hybrid satellite networks; HSN; hosted payload; payload; payload control center; PCC; shared services; virtual payload command center.

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# 1. Introduction

The space sector is transitioning away from traditional vertically integrated entities and towards an aggregation of independently owned and operated segments.

A Hybrid Satellite Network (HSN), uses independently owned and operated terrestrial and space components to realize a space system that may provide extended global services across diverse missions and connecting points. The HSN architecture typically consists of a combination of independently owned terminals, antennas, satellites, payloads, or other components that communicate across disparate networks. An HSN may interact with government systems and critical infrastructure (as defined by the Department of Homeland Security) to provide services such as satellite-based communications, position, navigation, and timing (PNT), remote sensing, weather monitoring, and imaging. The components within an HSN are likely to have varying levels of trust among different components, requiring frameworks for establishing confidentiality and integrity of individual components while still enabling availability of required shared services.

The flexibility of HSNs enables rapid integration of new capabilities and technologies. A properly architected HSN can do so in a secure, scalable, responsive, cyber resilient and information-centric manner.

HSNs present opportunities for organizations to leverage existing space-based capabilities and platforms through means such as hosted payloads, ground infrastructure as a service, virtualized satellite operation centers, etc. There is a need to verify that these systems are secure, and that the integration of components is done in a manner acceptable to the participating organizations. In collaboration with subject matter experts including satellite builders, consultants, acquisition authorities, operators (commercial and government), academia, and other interested parties, the National Institute of Standards and Technology (NIST) has developed the HSN Cybersecurity Framework CSF Profile (HSN Profile).

The HSN Profile is voluntary and does not issue regulations, define mandatory practices, provide a checklist for compliance, nor does it carry statutory authority. It is intended to be a foundational set of guidelines.

## 1.1. Purpose and Objectives

The HSN profile provides practical guidance for organizations and stakeholders engaged in the design, acquisition, and operation of satellite buses or payloads in a manner consistent with the organization's risk tolerance.

The HSN profile is suitable for applications that involve multiple stakeholders contributing to imagery, sensing, broadcast, communications, or other space-based architectures. Use of the HSN profile will help organizations:

- Identify systems, assets, data, and risks that pertain to HSN.
- Protect HSN services by performing self-assessments and adhering to cybersecurity principles.
- Detect cybersecurity-related disturbances or corruption of HSN services and data.

- Respond to HSN service or data anomalies in a timely, effective, and resilient manner.
- Recover the HSN to proper working order after a cybersecurity incident.

## 1.2. Scope

The HSN profile describes the salient cybersecurity functions that are part of the HSN and may include examples to highlight cybersecurity dependencies. Different business objectives or mission requirements will require unique relationships between components of the HSN. These requirements will dictate how data exchanges between system components, ranging from routing data to rendering and analyzing data, are procured between components.

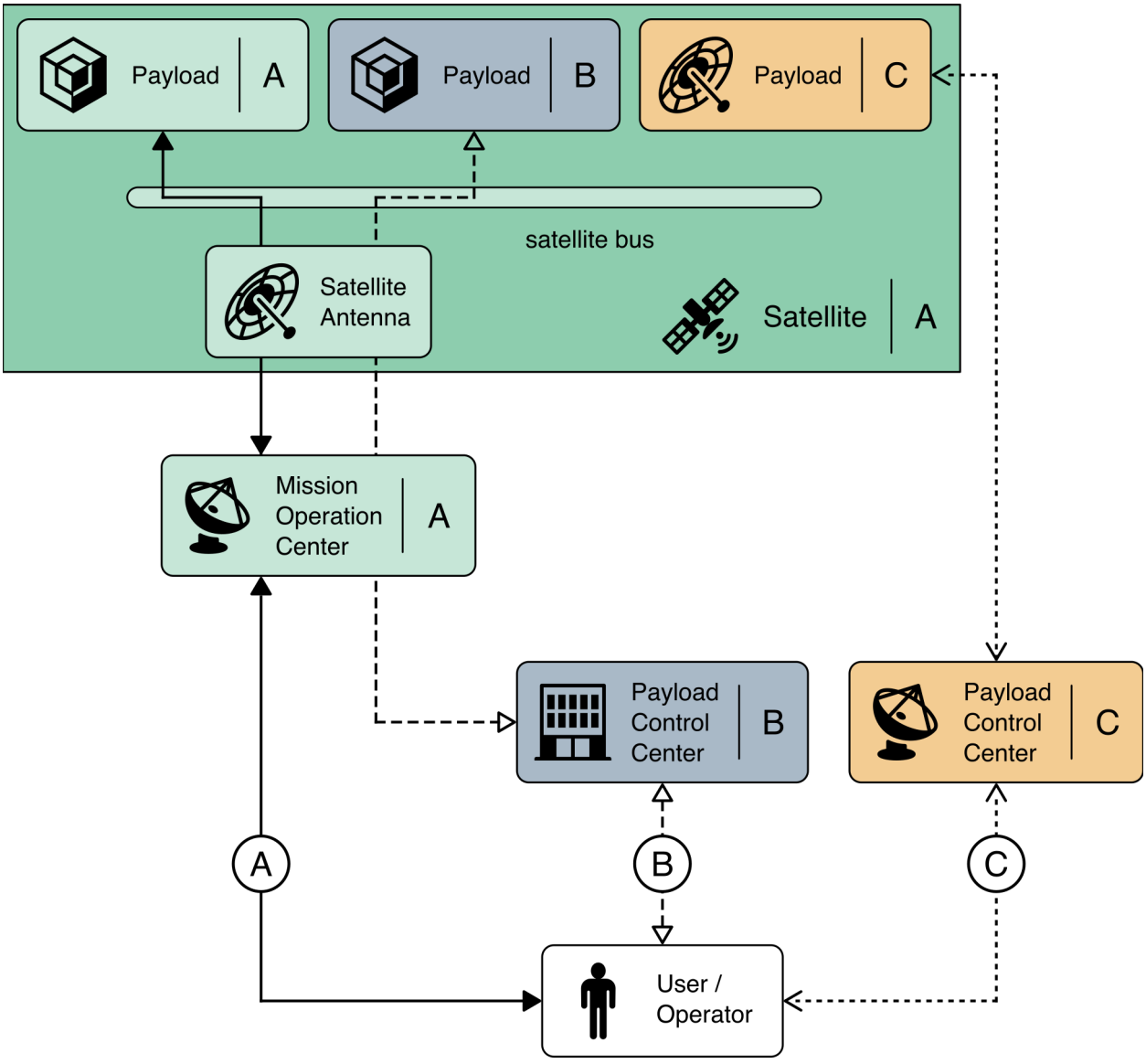


**Fig. 1.** Example of a simple HSN Architecture.

**NOTE:** The solid line in Fig. 1 indicates a normal path while the dashed lines depict communication paths that may be present in an HSN.

A simple satellite architecture is depicted in Fig. 1. Path A shows a typical satellite communications path (non-HSN). In a hybrid environment, the satellite bus and payloads B and C are independently owned and operated. The host system (A) provides different levels of services to the hosted payloads (B and C). Figure 1 shows payload C relies on the host satellite for power and satellite operations while payload B relies on the host system for communications in addition to power and satellite operations.

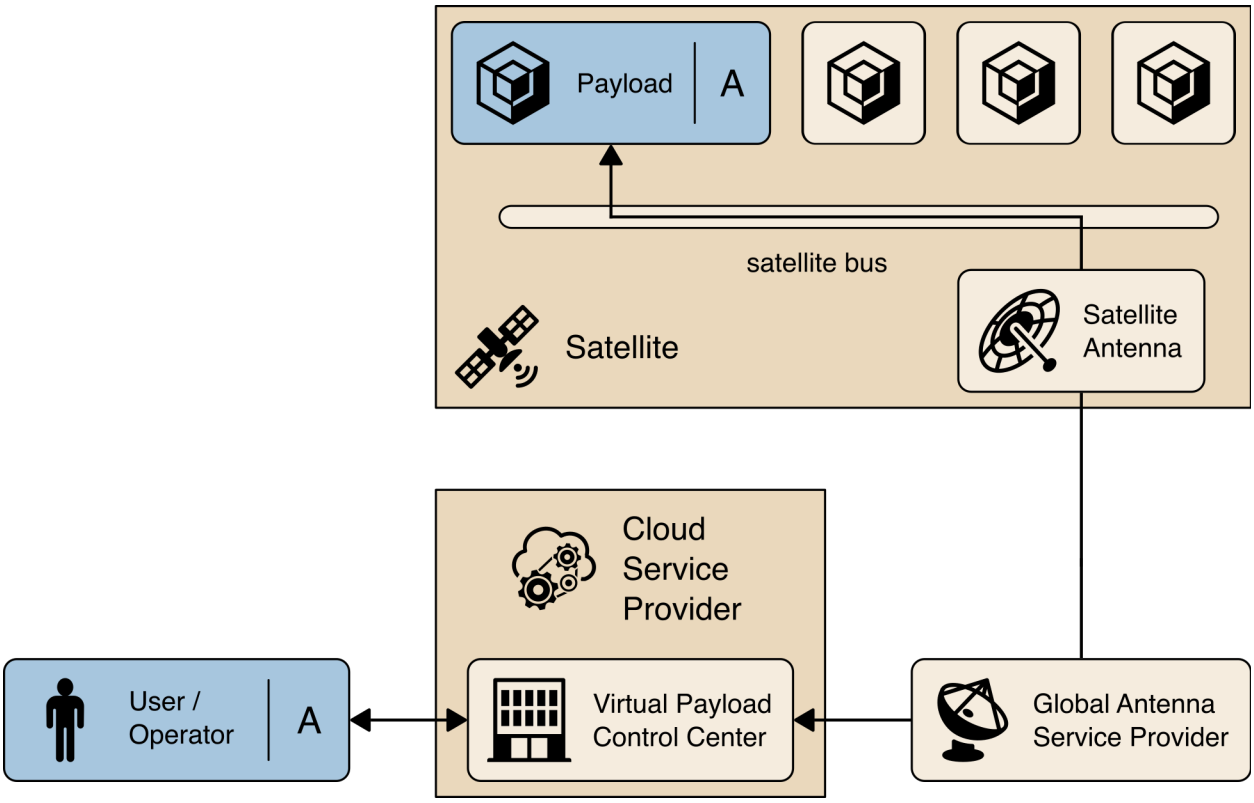


**Fig. 2.** Example of an HSN with virtualized components.

The elements of an HSN may be independently owned, hosted, or virtualized by multiple organizations. While referring to Fig. 2, note that the operator may own the intellectual property that defines the virtualized payload control center (PCC) that is hosted on a third-party cloud service provider (CSP). The virtual PCC interfaces with a physical antenna field independent of the CSP, the operator, and the satellite antenna. All of this is transparent to the operators in organization A when they command, control, communicate or otherwise interact with payload A.

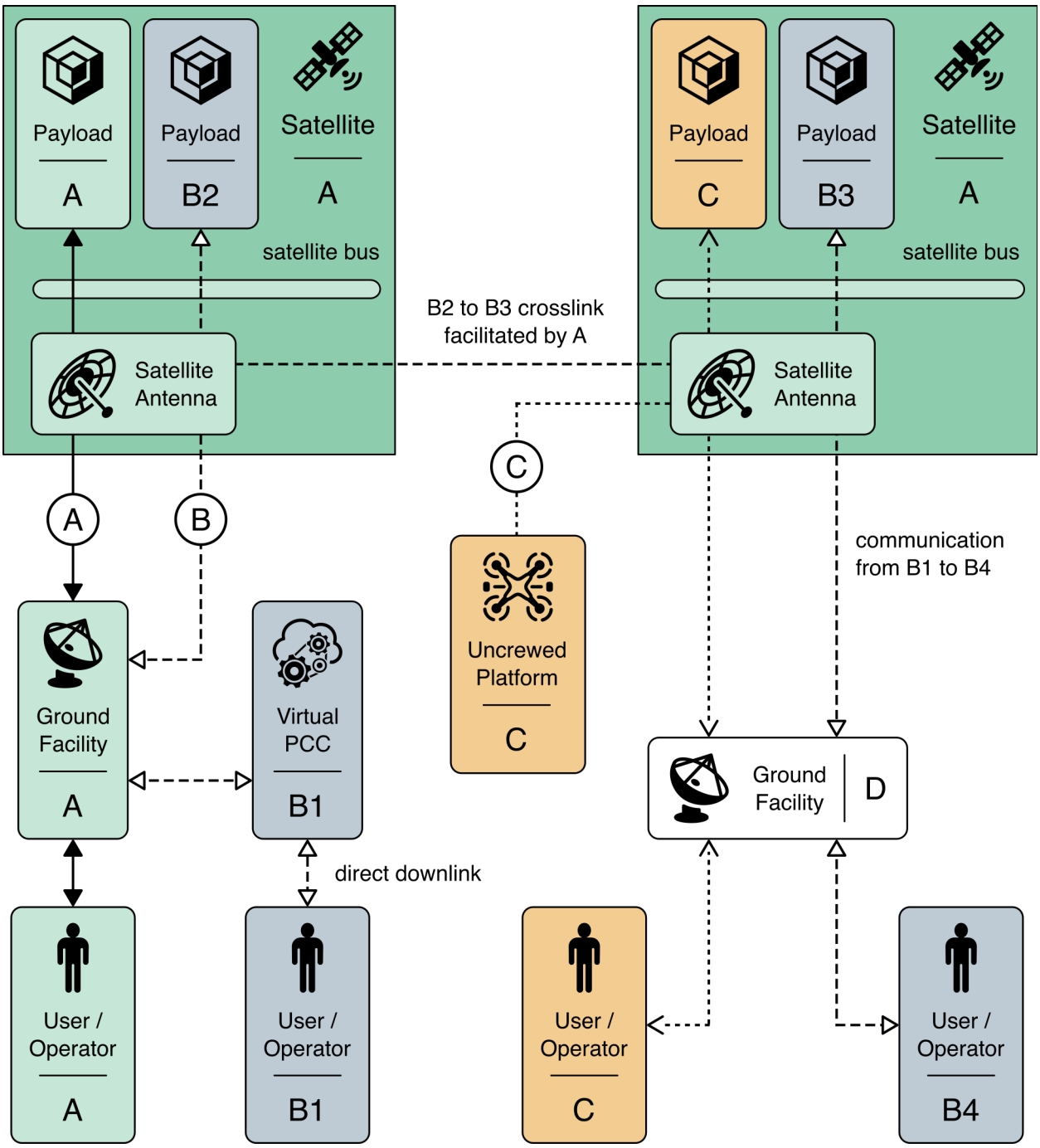


**Fig. 3.** Example of more complex HSN architecture.

HSN architectures may be complex and involve multiple stakeholders. As shown in Fig. 3, the physical and virtual architecture involves multiple independently owned satellites, uncrewed platforms, ground facilities and crosslinks supporting a range of independent HSNs. The organization that owns and operates the host (A) is operating two satellites that are supporting two independent HSNs (B and C). The operators associated with HSN B interface with a virtual payload command center that controls payloads on separate satellites. The crosslink and radio

frequency (RF) interfaces are transparent to HSN B. The host organization may interface with other platforms such as uncrewed vehicles or independently owned antenna fields.

The scope of the HSN profile focuses on physical and virtual interfaces such as:

- Antenna fields
- Virtual Machine-based command formatter
- Software-defined elements hosted on a cloud
- Bus
- Payloads
- User terminals
- Intermediate ground nodes
- Intersatellite cross links for purposes such as linking to a payload hosted on another satellite, higher resolution, greater communication bandwidth, path redundancy, etc.

This HSN profile is intended to:

- Facilitate integration of HSN components thorough consideration of cybersecurity functions, categories, and subcategories.
- Consistently assess and communicate the cybersecurity posture.
- Provide a comprehensive framework to facilitate risk management decisions.
- Facilitate consistent assessments of cyber-risk.

The HSN profile focuses on a subset of CSF subcategories that is directly applicable to the HSN and strategies that should be considered. The HSN profile allows each organization the flexibility to implement selected mitigation strategies based on their risk tolerance or accepted risk management strategy.

The HSN profile focuses on the complex variety of interfaces, data flows, and interactions with third-party services or component providers involved in modern HSNs. Many of these systems require connections to external partners or entities that are not trusted. Interfacing with untrusted systems requires the individual systems to understand and bound the inherited risk and assure their confidentiality, integrity, and availability. The HSN profile addresses concerns unique to HSN, and the reader is referred to other CSF profiles (such as NISTIR 8401, NISTIR 8323 and others) to address concerns to space system segments or components that are beyond this profile's scope.

## 1.3. Audience

This document is intended for those involved in managing, developing, implementing, and monitoring the HSN cybersecurity including:

- Procurement officials responsible for the acquisition of HSN services
- Public and private organizations that provide HSN services

- Managers responsible for the use of HSN services
- Risk managers, cybersecurity professionals, and others with a role in cybersecurity risk management for systems that provide or interface with HSN services
- Mission and business process owners responsible for achieving operational outcomes dependent on HSN services
- Researchers and analysts who study the unique cybersecurity needs of HSN services
- Cybersecurity architects who integrate cybersecurity into the product designs for space vehicle segments and ground segments.

## 2. Intended Use

This profile is part of an overall risk management strategy for satellites operating in hybrid environments. The profile provides actionable practical guidance to assess current posture and inform future decisions.

Decision makers are tasked with determining acceptable risk, and this CSF profile is a tool to help inform decision-makers concerning potential risks. This CSF profile provides an HSN-specific framework that facilitates assessments of the cybersecurity posture of the HSN and can be used as part of a larger security in-depth assessment for the space system. The CSF profile is intended to augment, not replace, the organization's risk management procedures.

NIST recognizes that the HSN profile will be applied to specific organizations with specific needs. To this end, a summary of considerations for customization is provided below.

- Operational considerations
    - What methods can be used to detect potential events of concern?
    - What methods can be used to respond to those detected events?
    - What methods can be employed for post-event recovery?
- Mission considerations
    - What services are mission-critical?
    - What systems and data/assets are vulnerable?
    - What recovery/fail-over strategies can be employed?
    - What measures are available to determine the effectiveness of security controls?
- Engineering Considerations
    - What are the capabilities of the system?
    - What are the capabilities of potential adversaries to the system?
    - Which system attributes are adjustable post-deployment, and which are immutable?
- External considerations
    - What external systems and data are critical?

- What are the impacts of degraded or failed external services?

## 3. Overview

This section contains an overview of risk management and the NIST CSF. A profile provides information on risk management and applies the NIST CSF to assist with specific security implications. The HSN profile will include informative references to existing standards, guidelines, and best practices.

### 3.1. Risk Management Overview

Risk management is the ongoing process of identifying, assessing, and managing the residual risk related to an organization's objectives. To manage risk, organizations should understand the likelihood of an event and its potential impacts. With this information, the acceptable level of risk to the data and services can be determined.

As an organization analyzes its objectives as they relate to reliance on or use of HSNs, there are a series of guiding questions that inform the process to include:

- What are the threats to achieving mission objectives?
- What damages can result when those mission objectives are disrupted?
- What are the most important assets for a given mission objective?
- Where does physical infrastructure affect cybersecurity infrastructure and vice versa?

An organization should also be aware of statutory and policy requirements that may have a security or safety dimension. These can be affected by cybersecurity risks or have downstream effects.

The profile supports, and is informed by, cybersecurity risk management processes. Using the profile, organizations can make more informed decisions to select and prioritize cybersecurity activities and expenditures that help identify systems dependent on HSN, identify appropriate HSN sources, detect disturbances and manipulation of HSN services, manage the risk to these systems, and bolster resilience. The HSN profile provides a starting point from which organizations can customize—based on need and risk tolerance—to develop the most appropriate processes to manage cybersecurity posture of their HSN.

Organizations can use a profile in conjunction with existing cybersecurity risk management processes. Examples of cybersecurity risk management processes include International Organization for Standardization (ISO) 31000:2018, ISO/International Electrotechnical Commission (IEC) 27005:2018, and NIST Special Publication 800-39. A full list of helpful resources will be listed in an Annex of the HSN profile.

### 3.2. Cybersecurity Framework Overview

Created through collaboration between industry and government, the Cybersecurity Framework [NIST-CSF] provides prioritized, flexible, risk-based, and voluntary guidance based on existing standards, guidelines, and practices to help organizations better understand, manage, and communicate cybersecurity risks.

The Cybersecurity Framework consists of three main components:

1. The Framework Core provides a catalog of desired cybersecurity activities and outcomes using common language. The Core guides organizations in managing and reducing their cybersecurity risks in a way that complements their existing cybersecurity and risk management processes.
2. The Framework Implementation Tiers provide context for how an organization views cybersecurity risk management. The Tiers help organizations understand whether they have a functioning and repeatable cybersecurity risk management process and the extent to which cybersecurity risk management is integrated with broader organization risk management decisions.
3. The Framework Profiles are customized to the outcomes of the Core to align with an organization's requirements. Profiles are primarily used to identify and prioritize opportunities for improving organizational cybersecurity.

The Framework Core presents standards, guidelines, and practices within five concurrent and continuous Functions, which are described below:

1. Identify – Develop organizational understanding to manage cybersecurity risk to systems, assets, data, and capabilities. The activities in the Identify Functions are foundational to the effective use of the Cybersecurity Framework, enabling an organization to focus and prioritize its efforts consistent with its risk management strategy and business needs.
2. Protect – Develop and implement the appropriate safeguards to ensure the delivery of critical infrastructure services. The activities in the Protect Function support the ability to limit or contain the impact of a potential cybersecurity event.
3. Detect – Develop and implement the appropriate activities to identify the occurrence of a cybersecurity event. The activities in the Detect Function enable the timely discovery of cybersecurity events.
4. Respond – Develop and implement the appropriate activities to react to a detected cybersecurity incident. The activities in the Respond Function support the ability to contain the impact of a potential cybersecurity incident.
5. Recover – Develop and implement appropriate activities to maintain resilience and to restore capabilities or services that were impaired due to a cybersecurity event. The activities in the Recover Function support timely recovery to normal operations, reduce the impact or recurrence of a cybersecurity event, and provide insight and guidance for overall improvement.

When considered together, these Functions provide a high-level, strategic view of the life cycle of an organization's cybersecurity risk management.

The Framework Core then identifies underlying Categories and Subcategories for each Function. The 108 Subcategories are discrete cybersecurity outcomes that are organized into 23 Categories, such as "Asset Management" and "Protective Technology". Fig. 4 depicts the basic structure of the Framework Core.


**Fig. 4.** Structure of the Framework Core

The Cybersecurity Framework is outcome-based and focuses on the cybersecurity functions rather than the components. A Cybersecurity Framework Profile is not intended to provide specific implementation guidance. However, a Profile will supply Informative References to existing standards, guidelines, and practices that provide practical guidance to help an organization achieve the desired outcome of each Subcategory. An example of two Subcategories and their Informative References within the Asset Management Category is shown in Fig. 5.

| Function | Category | Subcategory | Informative References |
|---|---|---|---|
| **IDENTIFY** (ID) | **Asset Management (ID.AM):** The data, personnel, devices, systems, and facilities that enable the organization to achieve business purposes are identified and managed consistent with their relative importance to organizational objectives and the organization's risk strategy. | **ID.AM-1:** Physical devices and systems within the organization are inventoried | **CIS CSC** 1<br>**COBIT 5** BAI09.01, BAI09.02<br>**ISA 62443-2-1:2009** 4.2.3.4<br>**ISA 62443-3-3:2013** SR 7.8<br>**ISO/IEC 27001:2013** A.8.1.1, A.8.1.2<br>**NIST SP 800-53 Rev. 4** CM-8, PM-5 |
| | | **ID.AM-2:** Software platforms and applications within the organization are inventoried | **CIS CSC** 2<br>**COBIT 5** BAI09.01, BAI09.02, BAI09.05<br>**ISA 62443-2-1:2009** 4.2.3.4<br>**ISA 62443-3-3:2013** SR 7.8<br>**ISO/IEC 27001:2013** A.8.1.1, A.8.1.2, A.12.5.1<br>**NIST SP 800-53 Rev. 4** CM-8, PM-5 |

**Fig. 5.** Cybersecurity Framework Subcategory Example.

A Cybersecurity Framework Profile is an assessment of an organization in the context of the Cybersecurity Framework Core. A "current" Profile is a review of the Core Subcategories in terms of their applicability and current efficacy from the organization's perspective. A "target" Profile is a set of Subcategories that an organization selects as being relevant to achieving the desired cybersecurity state. A gap is identified when a target Subcategory is missing or insufficiently implemented by the current Profile.

The Cybersecurity Framework [NIST-CSF] provides additional guidance regarding its purpose and use.

# 4. The HSN CSF Profile

This section was created using the CSF, as described in Sec. 3.2. The tables summarize the Subcategories within a Category for a Function. The Informative References provide additional guidance to aid risk management practitioners when applying this profile.

While reviewing the tables presented in Sec. 4.1–4.5 of this profile, the term "organization" refers to the entity that is an element of the HSN and is assessing their cybersecurity posture. All other elements of the HSN are referred to as partners, stakeholders, service providers, or external organizations.

By design, the CSF is inherently flexible to accommodate different organizations' unique environments and needs. Users of this document should understand that deviations between their enterprise and the assumptions made in this Profile will impact the applicability of the Subcategories. ***Therefore, organizations are advised to review all Subcategories (including those considered not applicable) in the context of their organization.***

## 4.1. Identify

The Identify Function is foundational to cybersecurity and the risk management process. Cybersecurity assessments and risk management should start with the Identify Function. Consideration of the organization's mission objectives, business objectives, threat environment, assets, and vulnerabilities will have a significant influence on the overall risk management decision and will impact the other four Functions (i.e., Protect, Detect, Respond, Recover).

The objectives of the Identify Function include:

- Identify the business or operational environment and organization's purpose.
- Identify all assets, including hardware, software, personnel, roles, responsibilities, and the assets' criticality.
- Identify infrastructure that provides HSN functionality.
- Identify the current and trending vulnerabilities, threats, and impacts should the threat be realized.

The Identify Function within the CSF defines six Categories that are summarized in subsections 4.1.1 through 4.1.6: Asset Management, Business Environment, Governance, Risk Assessment, Risk Management Strategy, and Supply Chain Risk Management. Each Category has at least one Subcategory that directly applies to HSN.

### 4.1.1. Asset Management Category

The data, personnel, devices, systems, and facilities that enable the organization to achieve its business objectives are identified and managed in a manner that is consistent with their importance to organizational objectives and the organization's risk strategy.

Asset management and prioritization are important factors in other functions and activities, such as contingency planning for future attacks, responding to malware events, emergency responses, and recovery actions. Asset management will assist in prioritizing response and recovery activities.

It is beneficial for HSNs to inventory internal and external devices and their configurations. A working knowledge of the interfaces and data flows between devices and organizations, respectively, will illuminate areas of risk and needed protective measures.

The Asset Management category has six subcategories that apply to HSNs.

**Table 1.** Asset Management Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.AM-1:** Physical Devices and systems within the organization are inventoried. | Focus on the interfaces of the physical devices that interact with external organizations.<br><br>Successful interfaces will depend on a working knowledge of physical systems owned vs leased by external organizations as well as any constraints, performance requirements, and tolerances. Collaboration with external organizations is necessary to execute a physical inventory that spans organization locations and ownership. Be aware that in the HSN ecosystem, there are limits on the ability to execute a physical inventory (relative to an internal inventory). | **NIST SP 800-53r5**<br>CM-8, PM-5<br><br>**3GPP TS 32.690**<br><br>**3GPP TS 36.305** |
| **ID.AM-2:** Software platforms and applications within the organization are inventoried. | Focus on the interface between organizations.<br><br>Understand software configurations and version control to ensure interoperability (internal and external).<br><br>Typically, HSNs have a large and dynamic inventory. Understand the limitations associated with complex inventory processes and procedures. Consider some level of automation. | **NIST SP 800-53r5**<br>CM-8, PM-5 |
| **ID.AM-3:** Organizational communication and data flows are mapped. | Consider policies that limit communication and data flows to only those necessary to fulfill the mission. Verify that data sources and recipients are authorized to send or receive data in accordance with the organization's policies.<br><br>Flows may involve very different nodes such as a satellite, a terrestrial terminal, an operations center, or other platforms.<br><br>In addition to the logical data flows, consider mapping physical ports / interfaces and document whether it is a common bus or somehow segregated. | **NIST SP 800-53r5**<br>CA-3, CA-6, CA-9, PM-10, PL-8, SA-17, AC-20 |
| **ID.AM-4:** External information systems are cataloged. | Applicable, no HSN-specific considerations. | **NIST SP 800-53r5**<br>AC-20, PM-5, SA-9 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.AM-5:** Resources (e.g., hardware, devices, data, time, personnel, and software) are prioritized based on their classification, criticality, and business value. | Prioritization of internal and external assets informs risk assessment to include data and services provided externally. The HSN's prioritization effort often considers third-party relationships, agreements, and understandings between the participants. | **NIST SP 800-53r5** SA-9, CP-2, AC-20, RA-2, RA-9, SA-20, SC-6 |
| **ID.AM-6:** Cybersecurity roles and responsibilities for the entire workforce and third-party stakeholders (e.g., suppliers, customers, partners) are established. | Consider assigning cybersecurity roles and responsibilities to all participating organizations for the software, data, or components they manage. The roles and responsibilities of the external organization to the HSN are typically agreed upon in advance. Identify and resolve any inconsistencies or gaps in advance. | **NIST SP 800-53r5** SA-9, CP-2, PM-2, PM-29, PS-7<br>**ETSI TR 101 984** 5.2 |

### 4.1.2. Identify: Business Environment Category

The organization's mission, objectives, stakeholders, and activities are understood and prioritized; this information is used to inform cybersecurity roles, responsibilities, and risk management decisions.

In the context of HSNs, identify the dependencies, obligations, and relationships between different organizations and their stakeholders to remove ambiguities and resolve any differences.

The Business Environment category has five subcategories that apply to HSNs.

**Table 2.** Business Environment Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.BE-1:** The organization's role in the supply chain is identified and communicated. | Identify the role in the supply chain and consider any partners' role in the supply chain. Clearly communicate any corresponding expectations and requirements. | **NIST SP 800-53r5** SR-1, SR-3<br>**NIST SP 800-161** |
| **ID.BE-2:** The organization's place in critical infrastructure and its industry sector are identified and communicated. | Placement in critical infrastructure is based on the service(s) provided (such as Communication services, Emergency services and others). The determination of critical may be mission specific, orbit-specific or system specific.<br>Understand the role in the critical infrastructure of partner organizations and the corresponding expectations. Capture the partner's requirements in addition to what will be provided to fulfill the operational objectives. | **NIST SP 800-53r5** PM-8<br>**PPD-21** |
| **ID.BE-3:** Priorities for organizational missions, objectives, and activities are established and communicated. | Prioritization of the mission objectives will facilitate the definition and evaluation of performance parameters for the HSN's service providers. | **NIST SP 800-53r5** PM-11 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.BE-4:** Dependencies and critical functions for the delivery of critical services are established. | Functions from external service providers critical to operations of the HSN are classified as such. Identify dependencies between organizations (hardware, software, data) to successfully define and execute the tasks. | **NIST SP 800-53r5** PM-8, RA-9, SA-20, |
| **ID.BE-5:** Resilience requirements to support the delivery of critical services are established. | Especially important for HSNs to provide for the resiliency requirements critical to the HSN (operations or mission). Any Memorandum of Understanding (MOU) or Service Level Agreement (SLA) should spell out performance and resilience requirements in advance. Clear and precise resilience requirements facilitate the definition of minimum performance parameters for HSN service providers. | **IEC 61850-90-4** 12.2, 14.2.4<br>**NIST SP 800-53r5** CP-2, CP-11, CP-12, CP-13, SA-8 |

### 4.1.3. Identify: Governance Category

The policies, procedures, and processes to manage and monitor the organization's regulatory, legal, risk, environmental, and operational requirements are documented, reviewed, and inform the management of cybersecurity risk.

The Governance Category has four subcategories that apply to HSNs.

**Table 3.** Governance Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.GV-1:** Organizational cybersecurity policy is established and communicated. | Identify key functions and assign areas of responsibility (to include service providers and external organizations) to ensure a comprehensive cybersecurity approach. Capture the policy requirements for the mission data and payloads, then apply policy and controls appropriately. | **NIST SP 800-53r5** AC-1, AT-1, AU-1, CA-1, CM-1, CP-1, IA-1, IR-1, MA-1, MP-1, PE-1, PL-1, PM-1, PS-1, PT-1, RA-1, SA-1, SC-1, SI-1, SR-1 |
| **ID.GV-2:** Cybersecurity roles and responsibilities are coordinated and aligned with internal roles and external partners. | Establish agreements in advance to define roles and responsibilities with any third-party, partner or service provider to fulfill the pre-defined policies and performance parameters. | **NIST SP 800-53r5** PM-1, PM-2, PM-29, PS-7, PS-9 |
| **ID.GV-3:** Legal and regulatory requirements regarding cybersecurity, including privacy and civil liberties obligations, are understood and managed. | Privacy and civil liberty concerns are typically addressed within the organization (and beyond the control of the external organizations that provide HSN component/service providers). | **NIST SP 800-53r5** AC-1, AT-1, AU-1, CA-1, CM-1, CP-1, IA-1, IR-1, MA-1, MP-1, PE-1, PL-1, PM-1, PS-1, PT-1, RA-1, SA-1, SC-1, SI-1, SR-1 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.GV-4:** Governance and risk management processes address cybersecurity risks. | Within an HSN, there will be varying levels of risk management rigor for different cybersecurity related components such as data vs bus vs payloads. | **NIST SP 800-53r5** PM-3, PM-7, PM-9, PM-10, PM-11, PM-28, RA-1, RA-2, RA-3, SA-2<br>**NIST SP 800-160v1** 3.3.8 |

### 4.1.4. Identify: Risk Assessment Category

The organization understands the cybersecurity risk to organizational operations (including mission, functions, image, or reputation), organizational assets, and individuals.

The HSN elements may have varying risk tolerance levels, and the level of inherited risk from partners or other components of the HSN may exceed the organization's risk tolerance. Identify cyber risks associated with external service providers and their components as it relates to the overall risk management strategy.

The Risk Assessment category has six subcategories that apply to HSNs.

**Table 4.** Risk Assessment Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.RA-1:** Asset vulnerabilities are identified and documented. | In addition to traditional vulnerability management, consider focusing on the HSN interfaces and be aware of vulnerabilities inherited from the external service provider. | **NIST SP 800-53 Rev. 5** CA-2, CA-5, CA-7, CA-8, PM-15, RA-3, RA-5, SA-5, SA-11, SI-2, SI-4, SI-5 |
| **ID.RA-2:** Cyber threat intelligence is received from information-sharing forums and sources. | Consider joining an organization or forum such as the Space ISAC. | **CISA-ICS**<br>**DHS-NCCIC**<br>**NIST SP 800-53 Rev. 5** PM-15, PM-16, RA-10, SI-5<br>**NIST SP 800-150**<br>**Space-ISAC** |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.RA-3:** Threats, both internal and external, are identified and documented. | Applicable, no HSN-specific considerations. | **DIA-SPACE**<br>**NASIC**<br>**NISTIR 8179**<br>**NIST SP 800-37 Rev. 2**<br>**NIST SP 800-53 Rev. 5** PM-12, PM-16, RA-3, RA-10, SI-5<br>**NIST SP 800-154**<br>**NIST SP 800-160 Vol. 1** 2.3<br>**RTCA-DO-235** 4-12<br>**Li 2020** |
| **ID.RA-4:** Potential Business impacts and likelihoods are identified. | In addition to impacts/likelihood to the HSN, understand the impact/likelihood to partner organizations or HSN service providers and consider any corresponding impact on Memorandum of Agreement (MOA), Memorandum of Understanding (MOU), Service Level Agreement (SLA) or similar document. | **NIST-SP800-53 Rev. 5** CP-2, PM-9, PM-11, RA-2, RA-3, RA-9<br>**RTCA-DO-235** 2.1, 13 |
| **ID.RA-5:** Threats, vulnerabilities, likelihoods, and impacts are used to determine risk. | Applicable, no HSN-specific considerations. | **IETF-RFC8915** 3-9<br>**NIST SP 800-30 Rev. 1**<br>**NIST SP 800-53 Rev. 5** CA-2, CA-7, PM-16, PM-28, RA-2, RA-3<br>**NIST-SP800-160v1** 2.3, 2.4<br>**RTCA-DO-235** 2.1-2.4, 3, 14 |
| **ID.RA-6:** Risk responses are identified and prioritized. | Consider how a risk response may impact a partner organization or HSN component/service providers. The prioritization should be informed by the impact of the response (to the external organization), that could result in a possible failure to fulfill a partner agreement/contract element. | **NIST SP 800-53 Rev. 5** CA-5, PM-4, PM-9, PM-28, RA-7 |

### 4.1.5. Identify: Risk Management Category

The organization's priorities, constraints, risk tolerances, and assumptions are established and used to support operational risk decisions.

In the context of HSNs, the risk management strategy is informed by the tolerances and constraints of the contributing organizations. A level of collaboration and negotiation will be

required across the partners to ensure a consistent and compatible set of risk management processes and procedures.

The Risk Management category has three subcategories that apply to HSNs.

**Table 5.** Risk Management Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.RM-1:** Risk management processes are established, managed, and agreed to by organizational stakeholders. | In addition to the organizational stakeholders, an agreement between the HSN, its partners, and providers is beneficial, especially if a collaborative effort is needed to mitigate an attack, vulnerability, or otherwise manage the residual risk. | **NIST SP 800-53 Rev. 5** PM-9, PM-28 |
| **ID.RM-2:** Organizational risk tolerance is determined and clearly expressed. | In addition to intra-organizational segmentation and risk management, HSNs should consider expressing their risk tolerance to external component and service providers. The HSN's risk tolerance is typically expressed as performance parameters and requirements. | **NIST SP 800-53 Rev. 5** PM-9 |
| **ID.RM-3:** The organization's determination of risk tolerance is informed by its role in critical infrastructure and sector-specific risk analysis. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** PM-8, PM-9, PM-11, RA-9 |

### 4.1.6. Identify: Supply Chain Risk Management

The organization's priorities, constraints, risk tolerances, and assumptions are established and used to support risk decisions associated with managing supply chain risk. The organization has established and implemented processes to identify, assess, and manage supply chain risks.

Supply chain risk management (SCRM) is typically an intra-organization function. In the context of HSNs, organizations may consider the partner's SCRM so that the impacts of any risk inherited by partners are understood and within the level of the organization's tolerance.

The Supply Chain Risk Management category has five subcategories that apply to HSNs.

**Table 6.** Supply Chain Risk Management Category for the Identify Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.SC-1:** Cyber supply chain risk management processes are identified established, assessed, managed, and agreed to by organizational stakeholders. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** PM-30, SA-9, SR-1, SR-2, SR-3, SR-5<br>**NIST SP 800-161** |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **ID.SC-2:** Suppliers and third-party partners of information systems, components, and services are identified, prioritized, and assessed using a cyber supply chain risk assessment process. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** PM-9, RA-3, SA-15, SR-2, SR-3, SR-5, SR-6<br>**NIST SP 800-161** 2.2, 3 |
| **ID.SC-3:** Contracts with suppliers and third-party partners are used to implement appropriate measures designed to meet the objectives of an organization's cybersecurity program and Cyber Supply Chain Risk Management Plan. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** SA-4, SA-9, SR-2, SR-3, SR-5<br>**NIST SP 800-161** 2.2, 3.1 |
| **ID.SC-4:** Suppliers and third-party partners are routinely assessed using audits, test results, or other forms of evaluations to confirm that they are meeting their contractual obligations. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** AU-6, CA-2, CA-7, PS-7, SA-9, SA-11<br>**NIST SP 800-161** 2.2, 3.3, 3.4 |
| **ID.SC-5:** Response and recovery planning and testing are conducted with suppliers and third-party providers. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** CP-2, CP-4, IR-3, IR-4, IR-8, IR-9<br>**NIST SP 800-161** 2.2, 3.5 |

## 4.2. Protect

The Protect Function includes development, implementation, and verification measures to prevent the loss of assurance or functionality within the HSN. Additionally, the Protect Function enables the response to and recovery from cybersecurity events with planning and preparation activities, while the execution of risk mitigation is addressed in the Response and Recovery Functions.

The objectives of the Protect Function include:

- Protecting the systems that format and transmit information to the elements of the HSN at the required level of assurance.
- Protecting the systems that receive and process data from independent organizations within the HSN.

- Should a threat be realized, protect users and applications that depend on HSN data by enabling them to maintain a sufficient level of operations through verified response and recovery plans.

The Protect Function within the CSF defines six Categories that are summarized in subsections 4.2.1 through 4.2.6: Access Control, Awareness and Training, Data Security, Information Protection Processes and Procedures, Maintenance and Protective Technology. Each of these Categories has at least one Subcategory that applies to HSN.

### 4.2.1. Protect: Identity Management, Authentication, and Access Control

Access to physical and logical assets and associated facilities is limited to authorized users, processes, and devices. These assets are managed in a manner consistent with the assessed risk of unauthorized access to authorized activities and transactions.

Relative to other organizations, HSNs should consider providing greater access to external organizations in order to function. Consider more granular levels of identity management, authentication, and access controls balance limiting exposure and allowing sufficient access so that the partner's function can be supplied.

The Identity Management, authentications and access control category has seven subcategories that apply to HSNs.

**Table 7.** Identity Management, Authentication and Access Control Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.AC-1:** Identities and credentials are issued, managed, verified, revoked, and audited for authorized devices, users, and processes. | Emphasize managing credentials of devices, users, and processes identified by external organizations. | **NIST SP 800-63-3**<br>**NIST SP 800-207**<br>**NIST SP 800-53 Rev. 5** IA-1, IA-2, IA-3, IA-4, IA-5, IA-6, IA-7, IA-8, IA-9, IA-10, IA-11, IA-12 |
| **PR.AC-2:** Physical access to assets is managed and protected. | Emphasize managing physical access to assets by external organizations. | **NISTIR 8320**<br>**NIST SP 800-53 Rev. 5** PE-1, PE-2, PE-3, PE-4, PE-5, PE-6, PE-8, PE-9 |
| **PR.AC-3:** Remote access is managed. | Critical for HSNs. In addition to remote access for normal operations, consider access to external operators, users, and other personnel. Consider implementation of agile remote access procedures that are in accordance with the agreements between partners' and the organization's contingency plans. | **NIST SP 800-53 Rev. 5** AC-1, AC-17, AC-19, AC-20, SC-15 |
| **PR.AC-4:** Access permissions and authorizations are managed incorporating the principles of least privilege and separation of duties. | Given the necessity for external entities to interact with the HSN, highly granular authorizations are needed to accommodate the principles of least privilege and separation of duties to limit the impact of potential damage from a particular entity. | **NIST SP 800-53 Rev. 5** AC-1, AC-2, AC-3, AC-5, AC-6, AC-14, AC-16, AC-24<br>**NIST SP 800-160 Vol. 1** Appendix F.1.14 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.AC-5:** Network integrity is protected (e.g., network segregation, network segmentation). | HSNs have a potentially large attack surface due to lack of direct control over external organizations. Measures, such as network segmentation, isolation of flows, etc., are essential for containing the damage. | **NIST SP 800-207**<br>**NIST SP 800-53 Rev. 5** AC-4, AC-10, SC-7, SC-10, SC-20 |
| **PR.AC-6:** Identities are proofed and bound to credentials and asserted in interactions. | Third-party roots of trust or certificate authority credential organizations agreed upon by the HSN participants are beneficial. | **NIST SP 800-63-3**<br>**NIST SP 800-53 Rev.5** AC-16, IA-1, IA-2, IA-3, IA-5, IA-8, IA-9, IA-10 |
| **PR.AC-7:** Users, devices, and other assets are authenticated (e.g., single-factor, multi-factor) commensurate with the risk of the transaction (e.g., individuals' security and privacy risks and other organizational risks). | Consider procedures and controls to authenticate external entities before allowing connections. Given the possibility of many external participants not under the direct control of the organization, preventing unauthenticated communication may be a priority.<br>Evaluate the risks and implement adequate controls in accordance with the diversity of the HSN.<br>Consider controls such as multi-factor authentication. | **NIST SP 800-53 Rev. 5** AC-16, IA-1, IA-2, IA-3, IA-5, IA-8, IA-9, IA-10 |

### 4.2.2. Protect: Awareness and Training Category

The organization's personnel and partners are provided cybersecurity awareness education and trained to perform their cybersecurity-related duties and responsibilities consistent with related policies, procedures, and agreements.

The Awareness and Training category is not unique to HSN or the satellite industry. Consider focusing on privileged users who operate, monitor, and maintain equipment that interfaces with the organization and third-party partners. Within an HSN, third-party and partner relationships vary widely and are coordinated in advance.

The Awareness and Training category has five subcategories that apply to HSNs.

**Table 8.** Awareness and Trainings Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.AT-1:** All users are informed and trained. | HSN operators should consider that staff receive adequate cybersecurity training, especially on assets not internal to the organization. | **NIST SP 800-53 Rev. 5** AT-2, PM-13, PM-14 |
| **PR.AT-2:** Privileged users understand their roles and responsibilities. | Consider providing more specialized training to HSN personnel for the bus and payload in accordance with the granularity of the authorization and policies. | **NIST SP 800-53 Rev. 5** AT-3, PM-13<br>**NIST SP 800-160 Vol. 2 Rev. 1** Appendix E |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.AT-3:** Third-party stakeholders (e.g., suppliers, customers, partners) understand their roles and responsibilities. | Consider agreements in advance with all partners to clearly define roles and responsibilities and performance parameters that are measurable and verifiable. | **NIST SP 800-53 Rev. 5** AT-3, PS-7, SA-9 |
| **PR.AT-4:** Senior executives understand their roles and responsibilities. | The HSN will require shared usage across the elements of the HSN. Senior executives from the different organizations should agree upon and ensure buy-in within their organization so that the terms of the agreements will be met. | **NIST SP 800-53 Rev. 5** AT-3, PM-13 |
| **PR.AT-5:** Physical and cybersecurity personnel understand their roles and responsibilities. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** AT-3, CP-3, IR-2, PM-13 |

### 4.2.3. Protect: Data Security Category

Information and records (data) are managed consistent with the organization's risk strategy to protect the confidentiality, integrity, and availability of information.

External partners may provide HSN data protection requirements or the HSN may have an obligation to provide data security for partner organizations. The tools, techniques, processes, and procedures will require a level of inter-organization access and cooperation that other organizations do not typically encounter.

The Data Security category has eight subcategories, seven of which apply to HSNs.

**Table 9.** Data Security Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.DS-1:** Data at rest is protected. | HSNs should consider data at rest protection in accordance with data retained by external organizations. Protection measures should correlate with sensitivity.<br>Data encryption and storage should be communicated and written into policy. | **NIST SP 800-37 Rev. 2** 3<br>**NIST SP 800-53 Rev. 5** MP-2, MP-3, MP-4, MP-5, MP-6, MP-7, MP-8, SC-28<br>**NIST-SP800-175B Rev. 1**<br>**NIST SP 800-209** |
| **PR.DS-2:** Data in transit is protected. | Data encryption and decryption practices should be discussed with external organizations. Consider measures such as error detection, error correction, bulk link encryption and other transport layer protections. Given that Radio Frequency (RF) is the satellite's main communication conduit, availability protection measures such as Direct Sequence Spread Spectrum, Frequency Hopping Spread Spectrum, or other transmission security measures should be considered. | **NIST SP 800-53 Rev. 5** SC-8, SC-11, SC-12 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.DS-3:** Assets are formally managed throughout removal, transfers, and disposition. | Consider policies and procedures for the removal, transfer, and disposition of assets between internal and external organizations that maintain confidentiality and integrity. | **NIST SP 800-53 Rev. 5** CM-8, MP-6, PE-16, PE-20 |
| **PR.DS-4:** Adequate capacity to ensure availability is maintained. | In addition to the availability requirements for the organization's business needs, determine what level of availability needs to be maintained so that the requirements of the partner organizations are fulfilled in accordance with any MOU, SLA, or other agreements. | **NIST SP 800-53 Rev. 5** AU-4, CP-2, PE-11, SC-5 |
| **PR.DS-5:** Protections against data leaks are implemented. | Shared information between organizations should follow policies on data handling to reduce the potential for data leaks. | **NIST SP 800-53 Rev. 5** AC-4, AC-5, AC-6, PE-19, PS-3, PS-6, SC-7, SC-8, SC-13, SC-31, SI-4 |
| **PR.DS-6:** Integrity checking mechanisms are used to verify software, firmware, and information integrity. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** SI-7, SI-10<br>**NIST SP 800-160 Vol. 1** 2.3, 3.3.6, 3.4.9-3.4.11, Appendix F<br>**NIST SP 800-161**<br>**NIST SP 800-193**<br>**NIST SP 800-218** PO.3.3, PS.1 |
| **PR.DS-7:** The development and testing environments are separate from the production environment. | Not directly applicable to HSN. | **FIPS 140-3**<br>**NISTIR 8320**<br>**NIST SP 800-53 Rev. 5** SA-10, SI -7<br>**NIST SP 1800-34** |
| **PR.DS-8:** Integrity checking mechanisms are used to verify hardware integrity. | Consider verification of the integrity for any hardware required to make the HSN system operational. Be aware of and consider the challenges associated with verifying hardware built by different vendors.<br>Consider the use of independent assessors or third-party verification during the operational phase. | **FIPS 140-3**<br>**NISTIR 8320** 4<br>**NIST SP 800-53 Rev. 5** SA-10, SI-7<br>**NIST SP 1800-34** |

### 4.2.4. Protect: Information Protection Processes and Procedures Category

Security policies (that address purpose, scope, roles, responsibilities, management commitment, and coordination among organizational entities), processes, and procedures are maintained and used to protect information systems and assets.

In the context of HSNs, security policies may be coordinated among external partners and stakeholders in addition to internal coordination.

The Information Protection Processes and Procedures category has twelve subcategories that apply to HSNs.

**Table 10.** Information Protection Processes and Procedures Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.IP-1:** A baseline configuration of information technology/industrial control systems is created, maintained, and incorporates security principles (e.g., concept of least functionality). | Focus on the configuration and maintenance of the entities at the interface to the HSN. Baseline and configuration are internal concerns, and obtaining detailed configuration information from the partners is not practical. | **NIST SP 800-53 Rev. 5** CM-1, CM-2, CM-3, CM-4, CM-5, CM-6, CM-7, CM-9, SA-10<br>**NIST SP 800-137** Section D<br>**NIST SP 800-160V1** 3.4.9, 3.4.10, 3.4.11, Appendix F, Appendix G |
| **PR.IP-2:** A System Development Life Cycle (SDLC) to manage systems is implemented. | An SDLC is an internal responsibility, and third-party components are evaluated prior to integration with the system. The HSN should provide guidance on what may or may not be integrated with the HSN. | **NIST SP 800-53 Rev. 5** SA-3, SA-4, SA-8, SA-10, SA-11<br>**NIST SP 800-137** Section D<br>**NIST SP 800-160V1** 3.3.5, 3.8.3, 3.8.4 |
| **PR.IP-3:** Configuration change control processes are in place. | Organizations should employ configuration change control consistent with the software development life cycle to maintain a functioning baseline for the HSN and its components. Monitor all changes to validate impacts and integrity and conduct impact analyses before deploying a change. | **NIST SP 800-53 Rev. 5** CM-3, CM-4, SA-10<br>**NIST SP 800-137** Section D<br>**NIST SP 800-160v1** 3.3.5, 3.8.3, 3.8.4 |
| **PR.IP-4:** Backups of information are conducted, maintained, and tested. | Usually an internal function; however, is highly dependent on the service provided by the partner. | **NIST SP 800-53 Rev. 5** CP-4, CP-6, CP-9 |
| **PR.IP-5:** Policy and regulations regarding the physical operating environment for organizational assets are met. | Applicable to HSN and complicated by third party owned components (hardware, software, applications, etc.) No HSN-specific concerns. | **NIST SP 800-53 Rev. 5** PE-1 |
| **PR.IP-6:** Data is destroyed according to policy. | Consider third-party data retention and proper disposal. Likewise, external organizations should consider destroying data that are no longer required for HSN operations, according to pre-arranged agreements and policies. | **NIST SP 800-53 Rev. 5** MP-6, SR-12 |
| **PR.IP-7:** Protection processes are improved. | Consider the ramifications of any HSN protection process changes and how they relate to the service providers protection process. | **NIST SP 800-53 Rev. 5** CA-2, CA-7, CA-8, CP-2, CP-4, IR-3, IR-8, PL-2, PM-6 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.IP-8:** The effectiveness of protection technologies is shared. | Effectiveness of protection technologies is shared with partner organizations in a manner that is consistent with pre-existing agreements while protecting the organization's equities. | **NIST SP 800-53 Rev. 5** AC-21, CA-7, CP-2, IR-8, SI-4<br>**NIST SP 800-150** |
| **PR.IP-9:** Response plans (Incident Response and Business Continuity) and recovery plans (Incident Recovery and Disaster Recovery) are in place and managed. | Creating and managing these plans are complicated by the diversity of the partners' information, geographic separation, and interfaces between the HSN and its service providers. | **IEC 61850-90-12** 5.8, 4.12-4.14<br>**NIST SP 800-53 Rev. 5** CP-1, CP-2, CP-7, CP-10, IR-1, IR-7, IR-8, IR-9, PE-17<br>**NIST SP 800-61 Rev. 2**<br>**NIST SP 800-160V1** 6.5, 6.6, Appendix F.2 |
| **PR.IP-10:** Response and recovery plans are tested. | Consider including partner organizations when testing response and recovery plans. Full-scale testing involving the partners requires significant effort and coordination. Given the level of effort (and corresponding costs), modeling and simulation of the partners participation in the test may be the only pragmatic approach. | **IEC61850-90-4** 14.2.4, 5.4.2.5<br>**NIST SP 800-53r5** CP-4, IR-3, PM-14<br>**NIST SP 800-115** |
| **PR.IP-11:** Cybersecurity is included in human resources in its practices (e.g., deprovisioning, personnel screening). | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** PS-1, PS-2, PS-3, PS-4, PS-5, PS-6, PS-7, PS-8, PS-9, SA-21 |
| **PR.IP-12:** A vulnerability management plan is developed and implemented. | Develop and implement a vulnerability management plan. A vulnerability management plan that addresses managing vulnerabilities that are potentially inherited from external organizations and assets can be applicable. | **NIST SP 800-53 Rev. 5** RA-1, RA-3, RA-5, SI-2 |

### 4.2.5. Protect: Maintenance Category

Maintenance and repairs of industrial control and information system components are performed consistently with policies and procedures.

The policies and procedures that pertain to maintenance and repairs within the HSN should be agreed upon in advance across the elements of the HSN.

The Maintenance category has two subcategories that apply to HSNs.

**Table 11.** Maintenance Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.MA-1:** The maintenance and repair of organizational assets are performed and logged with approved and controlled tools. | Directly applicable for HSN firmware and software considerations, but not directly applicable to other assets. | **NIST SP 800-53 Rev. 5** MA-1, MA-2, MA-3, MA-5, MA-6 |
| **PR.MA-2:** Remote maintenance of organizational asset is approved, logged, and performed in a manner that prevents unauthorized access. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** MA-4<br>**NIST SP 800-160v1** Appendix F.1.14 |

### 4.2.6. Protect: Protective Technology Category

Technical security solutions are managed to ensure the security and resilience of systems and assets consistent with related policies, procedures, and agreements.

HSNs require collaboration and cooperation. Consider using protective technologies with standardized interfaces, formats, and protocols to facilitate collaboration and ensure compatibility.

The Protective Technology category has five subcategories that apply to HSNs.

**Table 12.** Protective Technology Category for the Protect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.PT-1:** Audit/log records are determined, documented, implemented, and reviewed in accordance with policy. | Promote standardized event record formats across organizations for easy sharing and event analysis.<br>Consider policies that promote audit log sizing, and aging that meet industry best practices. | **NIST SP 800-53 Rev. 5** AU-1, AU-2, AU-3, AU-6, AU-7, AU-12, AU-13 AU-14, AU- 16 |
| **PR.PT-2:** Removable media is protected, and its use is restricted according to policy. | HSNs may need to support using removable media to exchange data between partners and other organizations. | **NIST SP 800-53 Rev. 5** MP-1, MP-2, MP-3, MP-4, MP-5, MP-7, MP-8 |
| **PR.PT-3:** The principle of least functionality is incorporated by configuring systems to provide only essential capabilities. | Limit the data exchanges and functionality between the organization and the partners as much as practical while maintaining the HSN's mission needs. | **NIST SP 800-53 Rev. 5** AC-3, CM-7 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **PR.PT-4:** Communications and control networks are protected. | Multiple organizations may share a common infrastructure, consider the proper controls to meet organizational policies. | **NIST SP 800-53 Rev. 5** AC-12, AC-17, AC-18, CP-8, SC-5, SC-7, SC-10, SC-11, SC-20, SC-21, SC-22, SC-23, SC- 31, SC-37, SC-38, SC-47 |
| **PR.PT-5:** Mechanism (e.g., failsafe, load balancing, hot swap) are implemented to achieve resilience requirements in normal and adverse situations. | Consider load balancing mechanisms such as alternate data/ service sources in addition to other resiliency measures. | **NIST SP 800-53 Rev. 5** CP-7, CP-8, CP-11, CP-12, CP-13, PE-11, PL-8, SC-6 |

## 4.3. Detect

The Detect Function addresses the development and deployment of appropriate activities to monitor for anomalous events and notify users and applications upon their occurrence. The Detect Function is informed by the Identify Function and is enabled by the Protect Function.

The objectives of the Detect Function include:

- Enabling detection through monitoring and consistency checking
- Establishing a process for deploying detection capabilities and the handling/disposition of detected anomalies and events.

The Detect Function may leverage capabilities such as automation and management tools such as Security Information and Event Management (SIEM) to assist in detecting previously uncovered threats and minimize false positives. These capabilities involved data parsing, analytics, and the sharing of information. In an HSN environment, all the data message formatting and transmission must be compatible. If practical, comply with standards-based solutions for data formatting, message formatting, and message transmission to facilitate interoperability, integration, and sharing.

The Detect Function defines three Categories that are summarized in subsections 4.3.1 through 4.3.3: Anomalies and Events, Security Continuous Monitoring, and Detection Processes. Each Category has at least one Subcategory that directly applies to HSN.

### 4.3.1. Detect: Anomalies and Events Category

Anomalous activity is detected, and the potential impact of events is understood.

HSNs may need to detect anomalous activity and perform analysis on behalf of a partner or, conversely, rely on external organizations for detection and analysis.

The Anomalies and Events category has five subcategories that are applicable to HSNs.

**Table 13.** Anomalies and Event Category for the Detect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.AE-1:** A baseline of network operations and expected data flows for users and systems is established and managed. | It is especially important to focus on the expected (or normal) data and information flow at the ingress and egress of the interfaces (including wired, RF and virtual).<br><br>Operational performance baselines and expected data flows between the elements of the HSN are captured, developed, and maintained at the appropriate interfaces to detect events. | **NIST SP 800-53 Rev. 5** AC-4, CA-3, CM-2, SC-16, SI-4 |
| **DE.AE-2:** Detected events are analyzed to understand attack targets and methods. | Review and analyze detected events within the HSN system to understand the characteristics (e.g., source, data error statistics, duration, frequency, and location) of anomalous events.<br><br>Distinguishing between potentially harmful events and normal operations requires an understanding of attack targets and methods. Be able to predict the level of harm based on event analysis. Consider a common methodology agreed upon by stakeholders to facilitate sharing.<br><br>For RF interference, include environmental monitoring with direction, finding capabilities to locate the source.<br><br>Preserve the raw data, analysis, and characterization to aid in the analysis of future events.<br><br>Emphasize insider attacks due to the access granted to external participants and partner organizations within the HSN. | **NIST SP 800-53 Rev. 5** AU-6, CA-7, IR-4, RA-5, SI-4 |
| **DE.AE-3:** Event data are collected and correlated from multiple sources and sensors. | Data from multiple sources may be used, cross-checked, and compared to detect anomalous behavior. Compile sufficient event data across the different participants using various sources, such as event reports, logs, and audits. Monitor the network, physical access, human-machine interface activity, user reports, and administrator reports. Standards-based data formatting and serialization promotes communication, interoperability, and exchange of HSN data and supporting data.<br><br>Correlate events and cross-check detected anomalies from the different data and service providers.<br><br>Consider including events from external and authoritative shared resources (such as open source, industry forums, user groups and others). | **NIST SP 800-53 Rev. 5** AU-6, CA-7, CP-2, IR-4, IR-5, IR-8, SI-4<br><br>**NIST SP 800-160v1** 3.3.7, Appendix G.2, Appendix G.3 |
| **DE.AE-4:** The impact of events is determined. | In addition to the impact on the organization, consider the impact on the data and service providers participating in the HSN. | **NIST SP 800-53 Rev. 5** CP-2, IR-4, IR-5, IR-8, SI-4 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.AE-5:** Incident alert thresholds are established. | Discussions regarding the setting and review of thresholds should include external stakeholders.<br><br>Attributes such as criticality, sensitivity, and tolerance to false positives will vary among different service providers and their assets.<br><br>Consider and document the required notification or alarm communication time upon nearing and exceeding thresholds. | **NIST SP 800-53 Rev. 5**<br>CP-2, IR-4, IR-5, IR-8, SI-4 |

### 4.3.2. Detect: Security Continuous Monitoring Category

The information system and assets are monitored to identify cybersecurity events and verify the effectiveness of protective measures.

The granularity of the monitoring and the depth of the analysis are consistent with the findings of the risk assessment.

In addition to internal monitoring, HSNs are likely to monitor external partners and elements of the HSN in accordance with prearranged agreements and commitments.

The Security Continuous Monitoring category has eight subcategories, seven of which apply to HSNs.

**Table 14.** Security Continuous Monitoring Category for the Detect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.CM-1:** The network is monitored to detect potential cybersecurity events. | Heighten system monitoring activities when there is an indication of increased risk to the organization or the service providers. Fuse data from multiple sources. Consider using fault detection and exclusion algorithms to analyze data.<br><br>Alert the participating users and organizations when services or data are unavailable within a specified, agreed upon time. | **NIST SP 800-53 Rev. 5**<br>AU-12, CA-7, CM-3, SC-5, SC-7, SI-4 |
| **DE.CM-2:** The physical environment is monitored to detect potential cybersecurity events. | Not directly applicable to HSNs. | **NIST SP 800-53 Rev. 5**<br>CA-7, PE-6, PE-20 |
| **DE.CM-3:** Personnel activity is monitored to detect potential cybersecurity events. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5**<br>AC-2, AU-12, AU-13, CA-7, CM-10, CM-11 |
| **DE.CM-4:** Malicious code is detected. | Given the increased level of access and privileges that may be provided externally, it is essential to detect malicious code. Consider multi-layered detection strategies. | **NIST SP 800-53 Rev. 5**<br>SC-44, SI-3, SI-4, SI-8<br><br>**NIST SP 800-218** |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.CM-5:** Unauthorized mobile code is detected. | Especially important for HSNs to detect and limit unauthorized mobile code to implement the principles of least privilege and least functionality. | **NIST SP 800-53r5** SC-18, SC-44, SI-4 |
| **DE.CM-6:** External service provider activity is monitored to detect potential cybersecurity events. | Detect deviations from HSN service providers' interface specifications, as defined in an SLA with the service provider. | **NIST SP 800-53 Rev. 5** CA-7, PS-7, SA-4, SA-9, SI-4 |
| **DE.CM-7:** Monitoring for unauthorized personnel, connections, devices, and software is performed. | Focus on data flow discrepancies, unauthorized connections, and access points. Monitoring may include RF detection and direction finding. | **NIST SP 800-53r5** AU-12, CA-7, CM-3, CM-8, PE-6, PE-20, SI-4 |
| **DE.CM-8:** Vulnerability scans are performed. | Applicable, no HSN-specific considerations. | **NIST SP 800-53 Rev. 5** RA-5<br>**NIST SP 800-115** |

### 4.3.3. Detect: Detection Processes Category

Detection processes and procedures are maintained and tested to ensure awareness of anomalous events.

Organizations need a level of awareness for the external partners' testing and maintenance to ensure the processes and procedures are within the HSN's specifications.

**Table 15.** Detection Process Category for the Detect Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.DP-1:** Roles and responsibilities for detection are well defined to ensure accountability. | All roles—including data collection, analytics, reporting, and notification—are identified, and performance criteria are defined when feasible.<br>Understand HSN service provider and sector specific roles and responsibilities. For example, Payload Control Centers (PCC)s responsible for hosted payloads should have an agreement on these roles and responsibilities with the host's Mission Operations Center (MOC) and host satellite. | **NIST SP 800-53 Rev. 5** CA-2, CA-7, PM-14 |
| **DE.DP-2:** Detection activities comply with all applicable requirements. | HSNs are likely to have several MOU, SLA, or other agreements. Confirm that detection activities comply with applicable requirements. Organizations with MOCs responsible for hosting third-party payloads should perform detection activities in accordance with predefined agreements for hosted payloads. | **NIST SP 800-53 Rev. 5** AC-1, AU-1, CA-1, CA-2, CA-7, CM-1, CP-1, IR-1, PL-1, PM-1, RA-1, SA-1, SC-1, SI-1, SI-4, SR-1, SR-9, SR-10 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **DE.DP-3:** Detection processes are tested. | Typically, an intra-organization activity.<br>The participating organizations may have agreements in place to test detection processes; however, inter-organization detection processes are atypical. | **NIST SP 800-53 Rev. 5** CA-2, CA-7. PM-14, SI-3, SI-4 |
| **DE.DP-4:** Event detection information is communicated. | Appropriate responses require event detection information in cyber-relevant time at the HSN interfaces. Definition of thresholds and other criteria in advance will facilitate timely detection.<br>When the cause of a HSN service disruption event is suspected to be external, share event detection with the appropriate external stakeholders for further investigation.<br>Consider sharing detected information with regional Computer Emergency Response Teams or industry organizations, such as Information Sharing and Analysis Centers (ISACs). MOCs with buses that host (or PCCs that are hosted by) an independent organization should have prearranged information sharing agreements. | **NIST SP 800-53 Rev. 5** AU-6, CA-2, CA-7, RA5, SI-4 |
| **DE.DP-5:** Detection processes are continuously improved. | Reevaluate the detection processes as the HSN evolves to ensure sufficient robustness.<br>Periodically examine anomaly detection processes to determine if improvements are needed and collaborate with the constituent elements. | **NIST SP 800-53 Rev. 5** CA-2, CA-7, PL-2, PM-14, RA-5, SI-4 |

## 4.4. Respond

The activities in the Respond Function support the ability to contain the impact of an incident by developing and implementing appropriate responses to a detected cybersecurity attack or anomalous incident.

The Respond Function actions are triggered by the outputs generated by the Detect Function. The Protect Function enables the Respond Function to execute the proper response to an event according to a predefined plan.

The objectives of the Response Function are to:

- Contain events using a verified response procedure.
- Communicate the occurrence and impact of the event on satellite operations and stakeholders.
- Develop processes to respond to and mitigate new known or anticipated threats or vulnerabilities.
- Evolve response strategies and plans based on lessons learned.

The Respond Function defines five Categories that are summarized in subsections 4.4.1 through 4.4.5: Response Planning, Communications, Analysis, Mitigation, and Improvements. Each Category has at least one Subcategory that directly applies to HSN.

### 4.4.1. Respond: Response Planning Category

Response processes and procedures are executed and maintained, to ensure response to detected cybersecurity incidents.

HSN response planning requires additional efforts to avoid ambiguities. The response plan should be developed and coordinated prior to an incident to ensure that all participants know what can be expected from the HSN and are aware of their obligations.

The Response Planning category has a single subcategory, which applies to HSNs.

**Table 16.** Response Planning Category for the Respond Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.RP-1:** The response plan is executed during or after an incident. | In accordance with pre-defined thresholds, organizations should coordinate and execute a response plan(s) during or after a cybersecurity event that impacts space systems.<br>Update the response plans to address changes in partners, service providers, and agreements, as well as to the organization itself. | **CISA-CIVR-PB**<br>Appendix B<br>**NIST SP 800-53 Rev. 5**<br>CP-2, CP-10, IR-4, IR-8 |

### 4.4.2. Respond: Communications Category

Response activities are coordinated with internal and external stakeholders (e.g., external support from law enforcement agencies).

In addition to typical intra-communications required for response activities, organizations need to provide additional consideration to external communications between partners, service providers and other elements of the HSN.

The Communications category has five subcategories that apply to HSNs.

**Table 17.** Communications Category for the Respond Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.CO-1:** Personnel know their roles and order of operations when a response is needed. | Consider personnel training that exercised their roles in response to disruptions.<br><br>Understand the expectations and limitations of the roles provided by external partners and service providers.<br><br>Responders should understand recovery time objectives, recovery point objectives, restoration priorities, task sequences, and assigned responsibilities for event response programs and processes in a manner that is consistent with business continuity objectives. | **DHS CISA**<br>1.f, 7.a<br><br>**DHS RCF**<br>5.2, 8.3<br><br>**IMO**<br>1575 C.2.2<br><br>**NIST SP 800-61**<br><br>**NIST SP 800-34 Rev.1**<br>3.2.1, CP-2, CP-3, IR-3, IR-8<br><br>**NIST SP 800-53 Rev. 5**<br>CP-2, CP-3, CP-10, IR-3, IR-8<br><br>**USG FRP**<br>5.1.2.5 |
| **RS.CO-2:** Incidents are reported consistent with established criteria. | Ensure that cybersecurity events that exceed a predetermined threshold are reported across stakeholders. | **DHS-GPS-PR**<br><br>**NERC**<br>CIP-008-6<br><br>**NIST SP 800-53 Rev. 5**<br>AU-6, IR-6, IR-8<br><br>**NIST SP 800-61 Rev. 2**<br>4 |
| **RS.CO-3:** Information is shared consistent with response plans. | Timely information exchange within and between organizations improves the overall efficiency of incident response.<br><br>Exchange information with external stakeholders in accordance with prearranged agreements, thresholds, and formats to ensure that obligations are met. | **FCC-JAMMER**<br><br>**NIST SP 800-53 Rev. 5**<br>AC-21, CP-2, IR-4, IR-8<br><br>**NIST SP 800-61 Rev. 2**<br>2.4 |
| **RS.CO-4:** Coordination with stakeholders occurs consistent with response plans. | If the satellite hosts third-party payloads, incidents that impact satellite bus operations should be reported to the stakeholders in accordance with the response plan and prearranged agreements with the PCC. | **NIST SP 800-53 Rev. 5**<br>CP-2, IR-4, IR-8<br><br>**NIST SP 800-61 Rev. 2**<br>2.4 |
| **RS.CO-5:** Voluntary information sharing occurs with external stakeholders or achieve broader cybersecurity situational awareness. | Use agreed upon common data formats to facilitate information sharing.<br><br>Suspected interference should be reported to stakeholders through the appropriate channels and procedures. | **NIST SP 800-53 Rev. 5**<br>PM-15, SI-5 |

### 4.4.3. Respond: Analysis Category

Analysis is conducted to ensure effective response and support recovery activities. An HSN may require analysis from independent groups or elements within the HSN. Organizations should understand the limitations of external analysis reports and determine the appropriate response for a given analysis.

The Analysis category has five subcategories that apply to HSNs.

**Table 18.** Analysis Category for the Respond Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.AN-1:** Notifications from detection systems are investigated. | Investigate cybersecurity-related notifications generated by the anomaly detection systems. | **CISA-CIVR-PB** 10<br>**CISA-RFI-BPG**<br>**NIST SP 800-53 Rev. 5** AU-6, CA-7, IR-4, IR-5, PE-6, RA-5, SI-4 |
| **RS.AN-2:** The impact of the incident is understood. | Understand impacts that may affect the hybrid user and community, third-party stakeholders (in the case of a MOC that hosts third-party payloads), or the end-user community. | **CISA-CIVR-PB** 10<br>**NIST SP 800-53 Rev. 5** CP-2, IR-4, RA-3<br>**NIST SP 800-61 Rev. 2** 3 |
| **RS.AN-3:** Forensics are performed. | Consider performing forensics on cyber events to aid in root cause analysis and residual effects. Some of the relevant data may be on a host system or service provider and the HSN's forensic team may not have access to all the relevant data. | **CISA-CIVR-PB** [CISA-CIVR-PB] 16<br>**NIST SP 800-53 Rev. 5** AC-20, IR-4, IR-5, RA-5, SA-9<br>**NIST SP 800 61 Rev. 2** 3 |
| **RS.AN-4:** Incidents are categorized consistent with response plans. | Categorize cybersecurity incidents according to the severity and impact consistent with the response plan. Such categorization may include impacts on the hybrid user, community, partners, and third-party stakeholders. | **NIST-SP 800-53 Rev. 5** CP-2, IR-4, IR-5, IR-8, RA-3<br>**NIST SP 800-61 Rev. 2** 2, 3.2 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.AN-5:** Processes are established to receive, analyze, and respond to vulnerabilities disclosed to the organization from internal and external sources (e.g., internal testing, security bulletins, security researchers). | Consider establishing processes for responding to disclosed vulnerabilities. These processes are especially important when the vulnerability affects the HSN interfaces or data flows. | **DHS-NCCIC**<br>**GPS-ICD-240**<br>7.6, 7.7<br>**NIST SP 800-53 Rev. 5**<br>CA-1, CA-5, CA-7, PM-4, PM-15, RA-1, RA-5, RA-7, SI-5<br>**NIST SP 800-61 Rev. 2**<br>3, 3.2<br>**NIST SP 800-160 Vol. 1 Rev.1**<br>3.4.9, 3.4.11 |

### 4.4.4. Respond: Mitigation Category

Activities are performed to prevent the expansion of an event, mitigate its effects, and resolve the incident. Mitigation activities will impact partners, stakeholders, and other elements of the HSN. Organizations need to be aware of any undesirable consequences of mitigation measures, and consider the impact on pre-existing MOUs, SLAs, or similar agreements.

The Mitigation category has three subcategories that apply to HSNs.

**Table 19.** Mitigation Category for the Respond Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.MI-1:** Incidents are contained. | Contain cybersecurity incidents to minimize impacts on the HSN.<br>Containment may also involve rapidly zeroizing processing equipment that contain sensitive data. Some organizations have remote assets in vulnerable locations, and operators may need to disable equipment quickly.<br>Consider processes to enable automated response capabilities to reduce response time for active threats. Consider technologies such as artificial intelligence or machine learning to hasten the response. | **CISA-CIVR-PB**<br>14<br>**NIST SP 800-53 Rev. 5**<br>IR-4<br>**NIST SP 800-61 Rev. 2**<br>3.4.1 |
| **RS.MI-2:** Incidents are mitigated. | Once the effects of the incident are contained, take steps to return to a proper working state. These steps should be performed in a manner that does not impact forensic efforts. | **NIST SP 800-53 Rev. 5**<br>IR-4<br>**NIST SP 800-61 Rev. 2**<br>3.4 |

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.MI-3:** Newly identified vulnerabilities are mitigated or documented as accepted risks. | Risk assessments should be updated with newly identified HSN vulnerabilities.<br>Vulnerabilities should be mitigated, or the residual risks documented as acceptable.<br>Revise protection, monitoring, detection, response, and recovery capabilities as needed to mitigate newly identified vulnerabilities in a timely manner. | **NIST SP 800-53 Rev. 5**<br>CA-2, CA-7, RA-3, RA-5, RA-7<br>**NIST SP 800-61 Rev. 2**<br>3<br>**RTCA DO-235**<br>3.8, 14.1.4, 14.2-14.4 |

### 4.4.5. Respond: Improvements Category

Organizational response activities are improved by incorporating lessons learned from current and previous detection/response activities.

This category is a post-incident analysis activity involving other CSF functions.

HSNs will benefit from sharing lessons learned and collaboration with partners, service providers and other elements of the HSN. Any changes and improvements are usually evaluated in the context of their efficacy and impact on the HSN and partners.

The Improvements category has two subcategories that are applicable to HSNs.

**Table 20.** Improvements Category for the Respond Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RS.IM-1**: Response plans incorporate lessons learned. | Share the lessons learned with the participants of the HSN.<br>The elements of the HSN should incorporate the lessons learned into incident response procedures, training, and testing.<br>Keep plans updated and implement the resulting changes accordingly. | **NIST SP 800-53 Rev. 5**<br>CP-2, IR-4, IR-8<br>**NIST SP 800-61 Rev. 2** |
| **RS.IM-2:** Response strategies are updated. | The response strategies are updated based on the analysis of the event, its corresponding impact to the organization, its impact to the other elements of the HSN and any impacts to the organizations ability to comply with existing MOUs, MOAs, or other agreements. | **NIST SP 800-53 Rev. 5**<br>CP-2, IR-4, IR-8 |

## 4.5. Recover

The Recover Function develops and implements the appropriate activities to maintain resilience and restore any capabilities or services that were impaired due to a cybersecurity event.

The activities in the Recover Function support timely recovery to normal operations and return the organization back to its proper working state after an incident has occurred. The Recover Function's effectiveness depends on the implementation of the previous Functions: Identify, Protect, Detect, and Respond.

The objectives of the Recover Function are to:

- Restore the HSN services to a proper working state using a verified recovery procedure so that systems dependent on those services can function properly.
- Communicate the recovery activities and status of the HSN services to stakeholders.
- Evolve recovery strategies and plans based on lessons learned.

The Recover Function defines three Categories that are summarized in subsections 4.5.1 through 4.5.3: Recovery Planning, Communications, Analysis, Mitigation, and Improvements. Each Category has at least one subcategory that directly applies to HSN.

### 4.5.1. Recover: Recovery Planning Category

Recovery processes and procedures are executed and maintained to ensure the restoration of systems or assets affected by cybersecurity incidents.

In the context of HSN, coordination across the participating organizations in advance of the incident is required to ensure successful recovery. Organizational recovery plans should be coordinated in advance to protect each organization's equities.

The Recovery Planning category has a single subcategory that applies to HSNs.

**Table 21.** Recovery Planning Category for the Recover Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RC.RP-1:** The recovery plan is executed during or after a cybersecurity incident. | The recovery plan can include specific actions for the restoration, recalibration, resetting, and test validation of equipment.<br><br>Consider system testing to verify the systems are restored to proper working state. | **NIST SP 800-53 Rev. 5** CP-2, CP-9, CP-10, IR-4, IR-8,<br>**NIST SP 800-61 Rev. 2** 3.4 |

### 4.5.2. Recover: Improvements Category

Recovery planning and processes are improved by incorporating lessons learned into future activities.

In the context of HSN, the efficacy of the recovery actions may include deliberations between the components to capture different perspectives. Proposed improvements are evaluated and agreed upon.

The Improvements category has two subcategories that apply to HSNs.

**Table 22.** Improvements Category for the Recover Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RC.IM-1:** Recovery plans incorporate lessons learned. | Update the recovery plan to incorporate lessons learned, reflect new threats, improve technology, and address changes to the organization, the operating environment, and deficiencies encountered during plan implementation, execution, and testing. | **NIST SP 800-53 Rev. 5** CP-2, CP-10, IR-4, IR-8<br>**NIST SP 800 612** 3.4 |
| **RC.IM-2:** Recovery strategies are updated. | Evaluate the incident's characteristics and impact to determine if the recovery strategy was sufficient or appropriate (i.e., proportional to the impact) and revise the recovery strategy and corresponding plan accordingly.<br>HSNs share lessons learned and after-action reports among partner organizations in a format and level of detail agreed upon in advance.<br>Consider participation and sharing of lessons learned in forums such as Space ISAC. | **NIST SP 800-53 Rev. 5** IR-3, IR-4, IR-8 |

### 4.5.3. Recover: Communications Category

Restoration activities are coordinated with internal and external parties (e.g., coordinating centers, internet service providers, owners of attacking systems, victims, other CSIRTs, and vendors).

In the context of HSN, organizations should compare and communicate post event public relations policies/procedures to plan for after incident response.

The Communications category has three subcategories that apply to HSNs.

**Table 23.** Communications Category for the Recover Function.

| Subcategory | Applicability to HSNs | Informative References |
|---|---|---|
| **RC.CO-1:** Public relations are managed. | Coordination among stakeholders should be planned to ensure consistent and accurate messaging from all the partner organizations. | **NIST SP 800-53 Rev. 5** IR-4, PM-1<br>**ISO/IEC 27001:2022** A.6.1.4, Clause 7.4 |
| **RC.CO-2:** Reputation is repaired after an incident. | Compare post-event public relations policies/procedures to plan for after-incident response. | **NIST SP 800-53 Rev. 5** IR-4<br>**ISO/IEC 27001:2022** Clause 7.4 |
| **RC.CO-3:** Recovery activities are communicated to internal and external stakeholders as well as executive and management teams. | Communicate recovery activities to all relevant internal and external stakeholders, executive, and management teams. Then, execute in a manner that is consistent with the recovery plan. | **ISO/IEC 27001:2022** Clause 7.4<br>**NIST SP 800-53 Rev. 5** CP-2, IR-4 |

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## Appendix A. List of Acronyms

Selected acronyms and abbreviations used in this document are defined below:

**CSF**
Cybersecurity Framework

**CSIRT**
Computer Security Incident Response Team

**HSN**
Hybrid Satellite Network

**IEC**
ISO/International Electrotechnical Commission

**ISAC**
Information Sharing and Analysis Center

**ISO**
International Organization for Standardization

**ITL**
Information Technology Laboratory

**IR**
Intra-agency or Internal

**MOA**
Memorandum of Agreement

**MOC**
Mission Operations Center

**MOU**
Memorandum of Understanding

**NIST**
National Institute of Standards and Technology

**NIST IR**
NIST Interagency Report

**PCC**
Payload Control Center

**PNT**
Positioning, Navigation and Timing

**RF**
Radio Frequency

**SCRM**
Supply Chain Risk Management

**SDLC**
Software Development Lifecycle

**SIEM**
Security Information and Event Management

**SLA**
Service Level Agreement

# Appendix B. Glossary

**attack**
Any kind of malicious activity that attempts to collect, disrupt, deny, degrade, or destroy information system resources or the information itself. [NIST-SP-800-30r1]

**availability**
Any kind of malicious activity that attempts to collect, disrupt, deny, degrade, or destroy information system resources or the information itself. [NIST-SP-800-30r1]

**bus**
The primary spacecraft structure containing power, temperature control, and directional thrusters of the satellite that provides locations for the payloads. [NASA-smallsat]

**component**
A hardware, software, or firmware part or element of a larger system with well-defined inputs and outputs and a specific function. [DHS-RCF, Adapted]

**confidentiality**
Preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information. [NIST-FIPS-200]

**hybrid satellite network**
An integrated terrestrial and space infrastructure comprised of independently owned and operated segments, parts, or systems that collectively create or perform as a singular space system.

**integrity**
A measure of the trust that can be placed in the correctness of the information supplied by an HSN service provider. Integrity includes the ability of the system to provide timely warnings to users when the HSN data should not be used. [USG-FRP]

**payload**
Elements of the spacecraft that provide (commercial, scientific, or other) services to end-users. [NASA-smallsat, Adapted]

**payload control center**
A facility that provides C2 for satellite payloads.

**resilience**
The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. [PPD-21]

**risk**
A measure of the extent to which an entity is threatened by a potential circumstance or event, and typically a function of: (i) the adverse impacts that would arise if the circumstance or event occurs; and (ii) the likelihood of occurrence. [NIST-SP-800-37]

**risk assessment**
The process of identifying, estimating, and prioritizing risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation, resulting from the operation of an information system. Part of risk management incorporates threat and vulnerability analyses, and considers mitigations provided by security controls planned or in place. Synonymous with risk analysis. [NIST-SP-800-30]

**risk management**
The program and supporting processes to manage information security risk to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation and

includes (i) establishing the context for risk-related activities, (ii) assessing risk, (iii) responding to risk once determined, and (iv) monitoring risk over time. [NIST-SP-800-39]

**secure**
To reduce the risks of intrusions and attacks as well as the effects of natural or manmade disasters on critical infrastructure by physical means or defensive cyber measures. [PPD-21]

**threat**
Any circumstance or event with the potential to adversely impact organizational operations, organizational assets, individuals, other organizations, or the Nation through a system via unauthorized access, destruction, disclosure, modification of information, or denial of service. [NIST-SP-800-53]

**verification**
Process of producing objective evidence that sufficiently demonstrates that the system satisfies its security requirements and security characteristics with the level of assurance that applies to the system. [NIST-SP-800-160v1r1 (§3.4.9), adapted]

**vulnerability**
A weakness in an information system, system security procedures, internal controls, or implementation that could be exploited or triggered by a threat source. [NIST-SP-800-30]