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(Second Draft) NIST Special Publication 800-150

Guide to Cyber Threat Information Sharing

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C O M P U T E R S E C U R I T Y



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122

Abstract

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125 Cyber threat information is any information that can help an organization identify, assess, monitor, and
126 respond to cyber threats. Cyber threat information includes indicators of compromise; tactics, techniques,
127 and procedures used by threat actors; suggested actions to detect, contain, or prevent attacks; and the
128 findings from the analyses of incidents. Organizations that share cyber threat information can improve
129 their own security postures as well as those of other organizations. This publication provides guidelines
130 for establishing and participating in cyber threat information sharing relationships. This guidance helps
131 organizations establish information sharing goals, identify cyber threat information sources, scope
132 information sharing activities, develop rules that control the publication and distribution of threat
133 information, engage with existing sharing communities, and make effective use of threat information in
134 support of their overall cybersecurity practices.

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Keywords

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138 cyber threat; cyber threat information sharing; indicators; information security; information sharing

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199 **Executive Summary**

200 Cyber attacks have increased in frequency and sophistication, resulting in significant challenges for
201 organizations in defending their data and systems from capable threat actors (“actors”). These actors
202 range from individual, autonomous attackers to well-resourced groups operating in a coordinated manner
203 as part of a criminal enterprise or on behalf of a nation-state. These actors can be persistent, motivated,
204 and agile, and they employ a variety of tactics, techniques, and procedures (TTPs) to compromise
205 systems, disrupt services, commit financial fraud, and expose or steal intellectual property and other
206 sensitive information. Given the risks these threats present, it is increasingly important that organizations
207 share cyber threat information and use it to improve their cyber defenses.

208 Cyber threat information is any information that can help an organization identify, assess, monitor, and
209 respond to cyber threats. Examples of cyber threat information include indicators (system artifacts or
210 observables associated with an attack), TTPs, security alerts, threat intelligence reports, and
211 recommended security tool configurations. Most organizations already produce multiple types of cyber
212 threat information that are available to share internally as part of their information technology and
213 security operations efforts.

214 Through the exchange of cyber threat information with other sharing community participants,
215 organizations can leverage the collective knowledge, experience, and capabilities of a sharing community
216 to gain a more complete understanding of the threats they may face. Using this knowledge, an
217 organization can make threat-informed decisions regarding defensive capabilities, threat detection
218 techniques, and mitigation strategies. By correlating and analyzing cyber threat information from multiple
219 sources, an organization can enrich existing information and make it more actionable. This enrichment
220 may be achieved by independently confirming the observations of other community members, and by
221 improving the overall quality of the threat information through the reduction of ambiguity and errors.
222 Members of a sharing community who receive information and subsequently remediate a threat also
223 confer a degree of protection to other community members (even those who may not have received or
224 acted upon the cyber threat information) by impeding the threat’s ability to spread. Additionally, sharing
225 of cyber threat information allows organizations to better detect campaigns that target particular industry
226 sectors, business entities, or institutions.

227 This publication assists organizations in establishing and participating in cyber threat information sharing
228 relationships. The publication describes the benefits and challenges of sharing, clarifies the importance of
229 trust, and introduces specific data handling considerations. The goal of the publication is to provide
230 guidelines that improve cybersecurity operations and risk management activities through safe and
231 effective information sharing practices, and that help organizations plan, implement, and maintain
232 information sharing.

233 NIST encourages greater sharing of cyber threat information among organizations, both acquiring threat
234 information from other organizations and providing internally-generated threat information to other
235 organizations. Implementing the following recommendations enables organizations to make more
236 efficient and effective use of information sharing capabilities.

237 **Establish information sharing goals and objectives that support business processes and security** 238 **policies.**

239 An organization’s information sharing goals and objectives should advance its overall cybersecurity
240 strategy and help an organization more effectively manage cyber-related risk. An organization should use
241 the combined knowledge and experience of its own personnel and others, such as members of cyber threat

242 information sharing organizations, to share threat information while operating in accordance with its
243 security, privacy, regulatory, and legal compliance requirements.

244 **Identify existing internal sources of cyber threat information.**

245 Organizations should identify the threat information they currently collect, analyze, and store. As part of
246 the inventory process, organizations should determine how the information is used. This inventory can
247 help an organization identify opportunities for improving decision-making processes through the use of
248 cyber threat information, develop strategies for acquiring threat information from alternative (possibly
249 external) sources or through the deployment of additional tools or sensors, and identify threat information
250 that is available for sharing with outside parties.

251 **Specify the scope of information sharing activities.**

252 The breadth of an organization's information sharing activities should be consistent with its resources,
253 abilities, and objectives. Information sharing efforts should be focused on activities that provide the
254 greatest value to an organization and its sharing partners. The scoping activity should identify types of
255 information that an organization's key stakeholders authorize for sharing, the circumstances under which
256 sharing of this information is permitted, and those with whom the information can and should be shared.

257 **Establish information sharing rules.**

258 Sharing rules are intended to control the publication and distribution of threat information, and
259 consequently help to prevent the dissemination of information that, if improperly disclosed, may have
260 adverse consequences for an organization, its customers, or its business partners. Information sharing
261 rules should take into consideration the trustworthiness of the recipient, the sensitivity of the shared
262 information, and the potential impact of sharing (or not sharing) specific types of information.

263 **Join and participate in information sharing efforts.**

264 An organization should identify and participate in sharing activities that complement its existing threat
265 information capabilities. An organization may need to participate in multiple information sharing forums
266 to meet its operational needs. Organizations should consider public and private sharing communities,
267 government repositories, commercial cyber threat intelligence feeds, and open sources such as public
268 websites, blogs, and data feeds.

269 **Actively seek to enrich indicators by providing additional context, corrections, or suggested
270 improvements.**

271 When possible, organizations should produce metadata that provides context for each indicator that is
272 generated, describing how it is to be used and interpreted and how it relates to other indicators.
273 Additionally, sharing processes should include mechanisms for publishing indicators, updating indicators
274 and associated metadata, and retracting submissions that are incorrect or perhaps inadvertently shared.
275 Such feedback plays an important role in the enrichment, maturation, and quality of the indicators shared
276 within a community.

277 **Use secure, automated mechanisms to publish, consume, analyze, and act upon cyber threat
278 information.**

279 The use of standardized data formats and transport protocols to share cyber threat information makes it
280 easier to automate threat information processing. The use of automation enables cyber threat information
281 to be rapidly shared, transformed, enriched, and analyzed with less need for manual intervention.

282 **Proactively establish cyber threat sharing agreements.**

283 Rather than attempting to establish sharing agreements during an active cyber incident, organizations
284 should plan ahead and put such agreements in place before incidents occur. Such advanced planning helps
285 ensure that participating organizations understand their roles, responsibilities, and information handling
286 requirements.

287 **Protect the security and privacy of sensitive cyber threat information.**

288 Sensitive information such as personally identifiable information (PII), intellectual property, and trade
289 secrets may be encountered when handling cyber threat information. The improper disclosure of such
290 information could cause financial loss; violate laws, regulations, and contracts; be cause for legal action;
291 or damage an organization's reputation. Accordingly, organizations should implement the necessary
292 security and privacy controls and handling procedures to protect this information from unauthorized
293 disclosure or modification.

294 **Provide ongoing support for information sharing activities.**

295 Each organization should establish an information sharing plan that provides for ongoing infrastructure
296 maintenance and user support. The plan should address the collection and analysis of threat information
297 from both internal and external sources and the use of this information in the development and
298 deployment of protective measures. A sustainable approach is necessary to ensure that resources are
299 available for the ongoing collection, storage, analysis, and dissemination of cyber threat information.

300

301 **1. Introduction**

302 **1.1 Purpose and Scope**

303 This publication provides guidance to help organizations exchange cyber threat information. The
304 guidance addresses consuming and using cyber threat information received from external sources and
305 producing cyber threat information that can be shared with other organizations. The document also
306 presents specific considerations for participation in information sharing communities.

307 This publication expands upon the information sharing concepts introduced in Section 4, Coordination
308 and Information Sharing, of NIST Special Publication (SP) 800-61, *Computer Security Incident Handling*
309 *Guide* [1].

310 **1.2 Audience**

311 This publication is intended for computer security incident response teams (CSIRTs), system and network
312 administrators, security staff, privacy officers, technical support staff, chief information security officers
313 (CISOs), chief information officers (CIOs), computer security program managers, and others who are key
314 stakeholders in cyber threat information sharing activities.

315 Although this guidance is written primarily for Federal agencies, it is intended to be applicable to a wide
316 variety of other governmental and non-governmental organizations.

317 **1.3 Document Structure**

318 The remainder of this document is organized into the following sections and appendices:

- 319 • **Section 2** introduces basic cyber threat information sharing concepts, describes the benefits of sharing
320 information, and discusses the challenges faced by organizations as they implement sharing
321 capabilities.
- 322 • **Section 3** provides guidelines on establishing sharing relationships with other organizations.
- 323 • **Section 4** discusses considerations for participating in sharing relationships.
- 324 • **Appendix A** contains scenarios that show how sharing cyber threat information increases the
325 efficiency and effectiveness of the organizations involved and enhances their network defenses by
326 leveraging the cyber experience and capabilities of their partners.
- 327 • **Appendix B** contains a list of terms used in the document and their associated definitions.
- 328 • **Appendix C** provides a list of acronyms used in the document.
- 329 • **Appendix D** identifies resources referenced in the document.

330

331 2. Basics of Cyber Threat Information Sharing

332 This section introduces basic concepts of cyber threat information sharing. It discusses types of cyber
333 threat information and defines common terminology. It also examines potential uses for shared cyber
334 threat information and explores benefits and challenges of threat information sharing.

335 2.1 Threat Information Types

336 A *cyber threat* is “any circumstance or event with the potential to adversely impact organizational
337 operations (including mission, functions, image, or reputation), organizational assets, individuals, other
338 organizations, or the Nation through an information system via unauthorized access, destruction,
339 disclosure, or modification of information, and/or denial of service.” [2] For brevity, this publication uses
340 the term *threat* instead of “cyber threat”. The individuals and groups posing threats are known as “threat
341 actors” or simply *actors*.

342 *Threat information* is any information related to a threat that might help an organization protect itself
343 against a threat or detect the activities of an actor. Major types of threat information include the
344 following:

- 345 • **Indicators** are technical artifacts or observables¹ that suggest an attack is imminent or is currently
346 underway, or that a compromise may have already occurred. Examples of indicators include the
347 Internet Protocol (IP) address of a suspected command and control server, a suspicious Domain Name
348 System (DNS) domain name, a Uniform Resource Locator (URL) that references malicious content, a
349 file hash for a malicious executable, or the subject line text of a malicious email message.
- 350 • **Tactics, techniques, and procedures (TTPs)** describe the behavior of an actor. *Tactics* are high-level
351 descriptions of behavior, *techniques* are detailed descriptions of behavior in the context of a tactic,
352 and *procedures* are even lower-level, highly detailed descriptions in the context of a technique. TTPs
353 could describe an actor’s tendency to use a specific malware variant, order of operations, attack tool,
354 delivery mechanism (e.g., phishing or watering hole attack), or exploit.
- 355 • **Security alerts**, also known as advisories, bulletins, and vulnerability notes, are brief, usually human-
356 readable, technical notifications regarding current vulnerabilities, exploits, and other security issues.
357 Security alerts originate from sources such as the United States Computer Emergency Readiness
358 Team (US-CERT), Information Sharing and Analysis Centers (ISACs), the National Vulnerability
359 Database (NVD), Product Security Incident Response Teams (PSIRTs), commercial security service
360 providers, and security researchers.
- 361 • **Threat intelligence reports** are generally prose documents that describe TTPs, actors, types of
362 systems and information being targeted, and other threat-related information that provides greater
363 situational awareness to an organization. Threat intelligence is threat information that has been
364 aggregated, transformed, analyzed, interpreted, or enriched to provide the necessary context for
365 decision-making processes.
- 366 • **Tool configurations** are recommendations for setting up and using tools (mechanisms) that support
367 the automated collection, exchange, processing, analysis, and use of threat information. For example,
368 tool configuration information could consist of instructions on how to install and use a rootkit
369 detection and removal utility, or how to create and customize intrusion detection signatures, router
370 access control lists (ACLs), firewall rules, or web filter configuration files.

¹ An *observable* is an event (benign or malicious) on a network or system.

371 Many organizations already produce and share threat information internally. For example, an
372 organization's security team may identify malicious files on a compromised system when responding to
373 an incident and produce an associated set of indicators (e.g., file names, sizes, hash values). These
374 indicators are then shared with system administrators who configure security tools, such as host-based
375 intrusion detection systems, to detect the presence of these indicators on other systems. Likewise, the
376 security team may launch an email security awareness campaign in response to an observed rise in
377 phishing attacks within the organization. These practices demonstrate information sharing within an
378 organization.

379 The primary goal of this publication is to foster similar threat information sharing practices across
380 organizational boundaries – both acquiring threat information from other organizations, and providing
381 internally-generated threat information to other organizations.

382 **2.2 Benefits of Information Sharing**

383 Threat information sharing provides access to threat information that might otherwise be unavailable to an
384 organization. Using shared resources, organizations are able to enhance their security posture by
385 leveraging the knowledge, experience, and capabilities of their partners in a proactive way. Allowing
386 “one organization's detection to become another's prevention”² is a powerful paradigm that can advance
387 the overall security of organizations that actively share.

388 An organization can use shared threat information in many ways. Some uses are operationally oriented,
389 such as updating enterprise security controls for continuous monitoring with new indicators and
390 configurations so they can detect the latest attacks and compromises. Others are strategically oriented,
391 such as using shared threat information as inputs when planning major changes to an organization's
392 security architecture.

393 Threat information exchanged within communities organized around industrial sector (or some other
394 shared characteristic) can be particularly beneficial because the member organizations often face actors
395 that use common TTPs that target the same types of systems and information. Cyber defense is most
396 effective when organizations collaborate successfully to deter and defend against well-organized, capable
397 actors. By working together, organizations can also build and sustain the trusted relationships that are the
398 foundation of secure, responsible, and effective information sharing.

399 Benefits of information sharing include:

- 400 • **Shared Situational Awareness.** Information sharing enables organizations to leverage the collective
401 knowledge, experiences, and analytic capabilities of their sharing partners within a community of
402 interest, thereby enhancing the defensive capabilities of multiple organizations. Even a single
403 contribution—a new indicator or observation about a threat actor—can increase the awareness and
404 security of an entire community.
- 405 • **Enhanced Threat Understanding.** By developing and sharing threat information, organizations gain
406 a better understanding of the threat environment and are able to use threat information to inform their
407 cybersecurity and risk management practices. Using shared information, organizations are able to
408 identify affected platforms or systems, implement protective measures, enhance detection capabilities,
409 and more effectively respond and recover from incidents based on observed changes in the current
410 threat environment.

² This phrase, which has been used in numerous presentations and discussions, was formulated by Tony Sager, Senior VP and Chief Evangelist, Center for Internet Security.

- 411 • **Knowledge Maturation.** When seemingly unrelated observations are shared and analyzed by
412 organizations, they can be correlated with data collected by others. This enrichment process increases
413 the value of information by enhancing existing indicators and by developing knowledge of threat
414 actor TTPs that are associated with a specific incident, threat, or threat campaign. Correlation can also
415 impart valuable insights into the relationships that exist between indicators.
- 416 • **Herd Immunity.** The principle of herd or community immunity comes from biology, where it refers
417 to protecting a community from a disease by vaccinating many, but not all, of its members. Similarly,
418 organizations that act upon the threat information they receive by remediating threats to themselves
419 afford a degree of protection to those who are yet unprotected (i.e., who have either not received or
420 acted upon the threat information received) by reducing the number of viable attack vectors for threat
421 actors, thus reducing vulnerability.
- 422 • **Greater Defensive Agility.** Actors continually adapt their TTPs to attempt to evade detection,
423 circumvent security controls, and exploit new vulnerabilities. Organizations that share information are
424 often better informed about changing TTPs and can rapidly detect and respond to threats, thereby
425 reducing the probability of successful attack. Such agility creates economies of scale for network
426 defenders while increasing the costs of actors by forcing them to develop new TTPs.

427 2.3 Challenges to Information Sharing

428 While there are clear benefits to sharing threat information, there are also a number of challenges to
429 consider. Some challenges that apply both to consuming and to producing threat information are:

- 430 • **Establishing Trust.** Trust relationships form the basis for information sharing, but require effort to
431 establish and maintain. Ongoing communication through regular in-person meetings, phone calls, or
432 social media can help accelerate the process of building trust.
- 433 • **Achieving Interoperability.** Standardized data formats and transport protocols are important
434 building blocks for interoperability and help enable the secure, automated exchange of structured
435 threat information among organizations, repositories, and tools. Adopting specific formats and
436 protocols, however, can require significant time and resources, and the value of these investments can
437 be substantially reduced if sharing partners require different formats or protocols.
- 438 • **Protecting Sensitive but Unclassified Information.** Disclosure of sensitive information, such as
439 personally identifiable information (PII), intellectual property, trade secrets, or other proprietary
440 information can result in financial loss, violation of sharing agreements, legal action, and loss of
441 reputation. Sharing information could expose the protective or detective capabilities of the
442 organization and result in threat shifting by the actor.³ The unauthorized disclosure of information
443 may impede or disrupt an ongoing investigation, jeopardize information needed for future legal
444 proceedings, or disrupt response actions such as botnet takedown operations. Organizations should
445 apply handling designations to shared information and implement policies, procedures, and technical
446 controls to actively manage the risks of disclosure of sensitive but unclassified information.

³ NIST SP 800-30, *Guide for Conducting Risk Assessments* [2], defines threat shifting as “the response of adversaries to perceived safeguards and/or countermeasures (i.e., security controls), in which adversaries change some characteristic of their intent/targeting in order to avoid and/or overcome those safeguards/countermeasures. Threat shifting can occur in one or more domains including: (i) the time domain (e.g., a delay in an attack or illegal entry to conduct additional surveillance); (ii) the target domain (e.g., selecting a different target that is not as well protected); (iii) the resource domain (e.g., adding resources to the attack in order to reduce uncertainty or overcome safeguards and/or countermeasures); or (iv) the attack planning/attack method domain (e.g., changing the attack weapon or attack path).”

447 • **Protecting Classified Information.** Information received from government sources may be marked
448 as classified, making it difficult for an organization to use. It is also expensive and time-consuming
449 for organizations to request and maintain the clearances needed for ongoing access to classified
450 information sources. In addition, many organizations employ non-U.S. citizens who are not eligible to
451 hold security clearances and are not permitted access to classified information. [3]

452 Some challenges to information sharing apply only to consuming others' threat information:

453 • **Accessing External Information.** Organizations need the infrastructure to access external sources
454 and incorporate the information retrieved from external sources into local decision-making processes.
455 Information received from external sources has value only to the extent that an organization is
456 equipped to act on the information.

457 • **Evaluating the Quality of Received Information.** Before an organization takes security-relevant
458 actions (such as reconfiguring protection devices) based on information received from an information
459 sharing community, an organization needs to validate that the received information addresses an
460 identified need, and that the costs or risks of using the information are understood.

461 Several challenges are only applicable if an organization wants to provide its own information to other
462 organizations:

463 • **Complying with Legal and Organizational Requirements.** An organization's executive and legal
464 teams may restrict the types of information that the organization can provide to others. Such
465 restrictions may include limits on the types of information and the level of technical detail provided.
466 These safeguards are appropriate when they address legitimate business, legal, or privacy concerns,
467 but the imposition of unwarranted or arbitrary restrictions may diminish the utility, availability,
468 quality, and timeliness of shared information.

469 • **Limiting Attribution.** Organizations may openly participate in information sharing communities, but
470 still require that their contributions remain anonymous. Sharing unattributed information may allow
471 organizations to share more information while controlling risks to an organization's reputation. The
472 lack of attribution may, however, limit the usefulness of the information because users may have less
473 confidence in information that originates from an unknown source. If the original sources of
474 information cannot be identified, organizations may be unable to confirm that information has been
475 received from multiple independent sources, and thus reduce an organization's ability to build
476 confidence in received information.

477 • **Enabling Information Production.** Organizations seeking to produce information should have the
478 necessary infrastructure, tools, and training to do so, commensurate with the types of information to
479 be produced. While basic threat information (e.g., indicators) is relatively easy to collect and publish,
480 information such as an actor's motives and TTPs generally requires greater analysis effort.

481 **3. Establishing Sharing Relationships**

482 When launching a threat information sharing capability, the following planning and preparation activities
483 are recommended:⁴

- 484 • Define the goals and objectives of information sharing (section 3.1)
- 485 • Identify internal sources of threat information (section 3.2)
- 486 • Define the scope of information sharing activities (section 3.3)
- 487 • Establish information sharing rules (section 3.4)
- 488 • Join a sharing community (section 3.5)
- 489 • Plan to provide ongoing support for information sharing activities (section 3.6)

490 Throughout this process, organizations are encouraged to consult with subject matter experts both inside
491 and outside their organization. Such sources include:

- 492 • Experienced cybersecurity personnel
- 493 • Members and operators of established threat information sharing organizations
- 494 • Trusted business associates, supply chain partners, and industry peers
- 495 • Personnel knowledgeable about legal issues, internal business processes, procedures, and systems

496 An organization should use the knowledge and experience from these experts to help shape a threat
497 information sharing capability that supports its mission and operates in accordance with its security,
498 privacy, regulatory, and legal compliance requirements. Due to constantly changing risks, requirements,
499 priorities, technology, and/or regulations, this process will often be iterative. Organizations should
500 reassess and adjust their information sharing capabilities as needed based on changing circumstances.
501 Such a change may involve repeating some or all of the planning and preparation activities listed above.

502 **3.1 Define Information Sharing Goals and Objectives**

503 At the outset, an organization should establish goals and objectives that describe the desired outcomes of
504 threat information sharing in terms of the organization's business processes and security policies. These
505 goals and objectives will help guide the organization through the process of scoping its information
506 sharing efforts, selecting and joining sharing communities, and providing ongoing support for information
507 sharing activities. Due to technological and/or resource constraints, it may be necessary to prioritize goals
508 and objectives to ensure the most critical ones are addressed.

509 **3.2 Identify Internal Sources of Cyber Threat Information**

510 A key step in any information sharing effort is to identify potential sources of threat information within an
511 organization. Sources of threat information include sensors, tools, data feeds, and information
512 repositories. Specific steps that may be helpful are:

⁴ Although an order for these activities is described, in practice the sequence of these activities can vary, and activities can even be performed concurrently. For example, when joining an established sharing organization, it may make sense to address information sharing rules as part of joining the community.

- 513 • Identify sensors, tools, data feeds, and repositories that produce threat information, and confirm that
514 they produce the information with sufficient frequency, precision, and accuracy to support
515 cybersecurity decision-making
- 516 • Identify threat information that is collected and analyzed as part of an organization’s continuous
517 monitoring strategy
- 518 • Locate threat information that is collected and stored, but not necessarily analyzed or reviewed on an
519 ongoing basis (e.g., operating system default audit log files)
- 520 • Identify threat information that is suitable for sharing with outside parties and that could help them
521 more effectively respond to cyber threats

522 This inventory process also includes identifying the owners and operators of threat information sources
523 within an organization. Ideally, personnel would possess an in-depth knowledge of the sensors, tools, data
524 feeds, and repositories that they operate and be able to contribute to the process of developing data export,
525 transformation, and integration capabilities in support of information sharing initiatives. When developing
526 such capabilities, it is important to understand how the information is natively stored; what formats are
527 available for data export; and which query languages, protocols, and services are available to interact with
528 the information source. Some sources may store and publish structured, machine-readable data, while
529 others may provide unstructured data with no fixed format (e.g., free text or images). Structured data
530 based on open, machine-readable, standard formats can generally be more readily accessed, searched, and
531 analyzed by a wider range of tools. Thus, the format of the information plays a significant role in
532 determining the ease and efficiency of information use, analysis, and exchange.

533 During the inventory process, an organization should also take note of any information gaps that may
534 prevent realization of the organization’s goals and objectives. By identifying these gaps, an organization
535 will be better able to prioritize investments into new capabilities, and identify opportunities to fill gaps by
536 acquiring threat information from alternate, possibly external, sources or through the deployment of
537 additional tools or sensors.

538 Table 3-1 describes common sources of cybersecurity-related information found within organizations and
539 provides examples of data elements from these sources that may be of interest to security operations
540 personnel.

541 **Table 3-1: Selected Internal Information Sources**

Source	Examples
Network Data Sources	
Router, firewall, remote services (such as remote login or remote command execution), and Dynamic Host Configuration Protocol (DHCP) server logs	Timestamp Source and destination IP address TCP/UDP port numbers Media Access Control (MAC) address Hostname Action (deny/allow) Status code Other protocol information

Source	Examples
Diagnostic and monitoring tools (network intrusion detection and prevention system, packet capture & protocol analysis)	Timestamp IP address, port, and other protocol information Packet payloads Application-specific information Type of attack (e.g., SQL injection, buffer overflow) Targeted vulnerability Attack status (success/fail/blocked)
Host Data Sources	
Operating system and application configuration settings, states, and logs	Bound and established network connections and ports Processes and threads Registry settings Configuration file entries Software version and patch level information Hardware information User and groups File attributes (e.g., name, hash value, permissions, timestamp, size) File access System events (e.g., startup, shutdown, failures) Command history
Antivirus products	Hostname IP address MAC address Malware name Malware type (e.g., virus, hacking tool, spyware, remote access) File name File location (i.e., path) File hash Action taken (e.g., quarantine, clean, rename, delete)
Web browsers	Browser histories and caches including: <ul style="list-style-type: none"> • Sites visited • Objects downloaded • Objects uploaded • Extensions installed or enabled • Cookies

Source	Examples
Other Data Sources	
Security Information and Event Management (SIEM)	Summary reports synthesized from a variety of data sources (e.g., operating system, application, and network logs)
Email systems	Email messages: Email header content <ul style="list-style-type: none"> • Sender/recipient email address • Subject line • Routing information Attachments URLs Embedded graphics
Help desk ticketing systems, incident management/tracking system, and people from within the organization	Analysis reports and observations regarding: <ul style="list-style-type: none"> • TTPs • Campaigns • Affiliations • Motives • Exploit code and tools • Response and mitigation strategies • Recommended courses of action User screen captures (e.g., error messages or dialog boxes)
Forensic toolkits and dynamic and/or virtual execution environments	Malware samples System artifacts (network, file system, memory)

542 An organization’s inventory should be updated when new sensors, repositories, or capabilities are
 543 deployed. Additionally, significant changes to a device’s configuration, ownership, or administrative
 544 point of contact should be documented.

545 **3.3 Define the Scope of Information Sharing Activities**

546 Organizations should specify the scope of their information sharing activities by identifying the types of
 547 information available to share, the circumstances under which sharing this information is permitted, and
 548 those with whom the information can and should be shared. Organizations should review their
 549 information sharing goals and objectives while scoping information sharing activities to ensure that
 550 priorities are addressed. When defining these activities, it is important to ensure that the information
 551 sources and capabilities needed to support each activity are available. Organizations should also consider
 552 pursuing sharing activities that will address known information gaps. For example, an organization might
 553 not have an internal malware analysis capability, but it may gain access to malware indicators by
 554 participating in a sharing community.

555
 556 The breadth of information sharing activities will vary based on an organization’s resources and abilities.
 557 By choosing a narrow scope, an organization with limited resources can focus on a smaller set of
 558 activities that provides the greatest value to the organization and its sharing partners. An organization may
 559 be able to expand the scope as additional capabilities and resources become available. Such an
 560 incremental approach helps to ensure that information sharing activities support an organization’s
 561 information sharing goals and objectives, while at the same time fitting within available resources.
 562 Organizations with greater resources and advanced capabilities may choose a larger initial scope,
 563 allowing for a broader set of activities in support of their goals and objectives.

564
565 The degree of automation available to support the sharing and receipt of threat information is a factor to
566 consider when establishing the scope of sharing activities. Less automated approaches or manual
567 approaches, which involve humans directly in the loop, may increase human resource costs and limit the
568 breadth and volume of information processed. The use of automation can help reduce human resource
569 costs, allowing an organization to choose a larger scope of activities. Automated threat information
570 sharing concepts are discussed more in section 4.

571 **3.4 Establish Information Sharing Rules**

573 Before sharing threat information, it is important to:

- 574 • List the types of threat information that may be shared
- 575 • Describe the conditions and circumstances when sharing is permitted
- 576 • Identify approved recipients of threat information
- 577 • Describe any requirements for redacting or sanitizing information to be shared
- 578 • Specify if source attribution is permitted
- 579 • Apply information handling designations that describe recipient obligations for protecting
580 information

581 These steps express rules that control the publication and distribution of threat information, and
582 consequently help to prevent the dissemination of information that, if improperly disclosed, may have
583 adverse consequences for the organization or its customers or business partners. Information sharing rules
584 should take into consideration the trustworthiness of the recipient, the sensitivity of the shared
585 information, and the potential impact of sharing (or not sharing). For example, an organization may
586 express rules that limit the exchange of highly sensitive information to internal individuals or groups, that
587 allow the sharing of moderately sensitive information with specific trusted partners, that permit
588 information having a low sensitivity to be published within a closed sharing community, and that allow
589 for the free exchange of non-sensitive information within public information sharing forums.

590
591 When establishing and reviewing information sharing rules, organizations should solicit input from their
592 legal and privacy officials, information owners, the management team, and other key stakeholders to
593 ensure that the sharing rules align with the organization's documented policies and procedures. An
594 organization may choose to codify sharing rules through Memoranda of Understanding (MOUs), Non-
595 Disclosure Agreements (NDAs), Framework Agreements⁵, or other agreements. Organizations are
596 encouraged to proactively establish cyber threat information sharing agreements as part of their ongoing
597 cybersecurity operations rather than attempting to put such agreements into place while under duress in
598 the midst of an active cyber incident.

599
600 An organization's information sharing rules should be reevaluated on a regular basis. Some of the events
601 that can trigger reevaluation are:

⁵ An example of such an agreement is the Defense Industrial Base (DIB) Cyber Security/Information Assurance (CS/IA) Program standardized Framework Agreement [4] which implements the requirements set forth in Title 32 Code of Federal Regulations, Part 236, Section 236.4 through 236.6.

- 602 • Changes to regulatory or legal requirements
- 603 • Updates to organizational policy
- 604 • Introduction of new information sources
- 605 • Risk tolerance changes
- 606 • Information ownership changes
- 607 • Changes in the operating/threat environment
- 608 • Organizational mergers and acquisitions

609

610 **3.4.1 Information Sensitivity and Privacy**

611 Many organizations handle information that, by regulation, law, or contractual obligation, requires
612 protection. This includes PII and other sensitive information afforded protection under the Sarbanes-
613 Oxley Act (SOX), the Payment Card Industry Data Security Standard (PCI DSS), the Health Information
614 Portability and Accountability Act (HIPAA), the Federal Information Security Modernization Act of 2014
615 (FISMA), and the Gramm-Leach-Bliley Act (GLBA). It is important for organizations to identify and
616 appropriately protect such information. An organization's legal team, privacy officers, auditors, and
617 experts familiar with the various regulatory frameworks should be consulted when developing procedures
618 for identifying and protecting sensitive information.

619

620 From a privacy perspective, one of the key challenges with threat information sharing is the potential for
621 disclosure of PII⁶. Education and awareness activities are critical to ensure that individuals responsible for
622 handling threat information understand how to recognize and safeguard PII when it is encountered.⁷
623 Internal sharing of information may result in disclosure of PII to people who, by virtue of their job
624 functions, would not typically have routine access to such information. For example, a forensic analyst or
625 incident responder may encounter PII while searching a hard drive for malware indicators, reviewing
626 emails related to suspected phishing attacks, or inspecting packet captures. The analyst has a legitimate
627 need to review this information in order to investigate an exploit, develop detection strategies, or develop
628 defensive measures. If the result of such an analysis is shared with others, steps should be taken to protect
629 the confidentiality of PII.

630 An organization should have information sharing policies and procedures in place that provide guidance
631 for the handling of PII. These policies and procedures should include steps for identifying incident data
632 types that are likely to contain PII. Policies should describe appropriate safeguards for managing the
633 privacy risks associated with sharing such data. A common practice is to focus on the exchange of

⁶ OMB Memorandum 07-16 [5] defines PII as “information which can be used to distinguish or trace an individual’s identity, such as their name, social security number, biometric records, etc. alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother’s maiden name, etc.” OMB Memorandum 10-22 [6] further states that “the definition of PII is not anchored to any single category of information or technology. Rather, it demands a case-by-case assessment of the specific risk that an individual can be identified. In performing this assessment, it is important for an agency to recognize that non-PII can become PII whenever additional information is made publicly available — in any medium and from any source — that, when combined with other available information, could be used to identify an individual.” NIST SP 800-122 [7] includes a slightly different definition of PII that is focused on the security objective of confidentiality and not privacy in the broad sense. Definitions of PII established by organizations outside of the federal government may vary based on the consideration of additional regulatory requirements. The guidance in this document applies regardless of how organizations define PII.

⁷ For additional guidance and examples of privacy controls, see NIST SP 800-53, Rev 4, Appendix J, Privacy Control Catalog, Privacy Controls, Enhancements, and Supplemental Guidance [8].

634 indicators to the maximum extent possible. Some indicators, such as file hashes, network port numbers,
 635 registry key values, and other data elements, are largely free of PII. Where PII is identified, however,
 636 organizations should redact fields containing PII that are not relevant to investigating or addressing cyber
 637 threats before sharing.⁸ The type and degree of protection applied should be based on the intended use of
 638 the information, the sensitivity of the information, and the intended recipient.

639 Where practical, organizations are encouraged to use automated methods rather than human-oriented
 640 methods to identify and protect PII. Manual identification, extraction, and obfuscation of PII can be a
 641 slow, error-prone, and resource-intensive process. Automated methods may include checking the contents
 642 of data fields against a list of permitted values, searching for PII using pattern matching techniques such
 643 as regular expressions, and performing operations that de-identify, mask, and anonymize data containing
 644 PII. The degree of automation that can be achieved will vary based on factors such as the structure and
 645 complexity of the data, the sensitivity of the information, and the capabilities of the tools being used.

646 Organizations should also implement safeguards to protect intellectual property, trade secrets, and other
 647 proprietary information from unauthorized disclosure. The disclosure of such information could result in
 648 financial loss, violate NDAs or other sharing agreements, be cause for legal action, or damage an
 649 organization’s reputation.

650 Table 3-2 introduces selected types of threat information, provides examples of sensitive data that may be
 651 present in these types of threat information, and offers general recommendations for handling such data
 652 when it is encountered.

653 **Table 3-2: Handling Recommendations for Selected Types of Sensitive Data**

Type of Threat Information	Examples of Sensitive Data Elements ⁹	Recommendations
Network Indicators	Any single network indicator can be sensitive, but network indicators in the aggregate are often more sensitive because they can reveal relationships between network entities. By studying these relationships it may be possible to infer the identity of users, gather information about the posture of devices, perform network reconnaissance, and characterize the security safeguards and tools that an organization employs.	Focus on the exchange of network indicators such as destination IP addresses associated with a threat actor’s command and control infrastructure, malicious URLs/domains, and staging servers. Before sharing, anonymize or sanitize network indicators that contain IP or MAC addresses of target systems or addresses registered to your organization. Also anonymize or sanitize indicators that may reveal the structure of internal networks, or ports or protocols that identify particular products.

⁸ NIST SP 800-122 [7] describes a process called “de-identification” which entails the removal or obfuscation of PII, such that the remaining information cannot be used to identify an individual.

⁹ The PII confidentiality impact level as discussed in NIST SP 800-122 [7] is a useful tool for gauging sensitivity of PII.

Type of Threat Information	Examples of Sensitive Data Elements ⁹	Recommendations
<p>Packet Capture (PCAP)</p>	<p>In addition to the network indicators previously discussed, unencrypted or decrypted packets may contain authentication credentials and sensitive organization information, such as PII and intellectual property.</p>	<p>PCAP files can be challenging because network indicators may be present within both the packet header and the payload. For example, PCAP files may show protocols (e.g., DHCP, Address Resolution Protocol (ARP), File Transfer Protocol (FTP), DNS) and applications operating at multiple layers within the network stack. These protocols and applications generate network information that may be captured within PCAP files and may require sanitization or anonymization to prevent sensitive information leakage.</p> <p>Filter PCAP files before sharing by extracting only those packets that are related to the investigation of a specific incident or pattern of events:</p> <ul style="list-style-type: none"> • Related to a particular network conversation (i.e., exchange of information between specific IP addresses of interest) • Occurring during a designated time period • Destined for, or originating from, a specific port • Employing a particular network protocol <p>Redact payload content that contains PII or other sensitive information or that is not relevant for characterizing the incident or event of interest.</p> <p>When anonymizing or redacting network information, it is important to use a strategy that preserves enough information to support meaningful analysis of the resulting PCAP file contents.</p>
<p>Network Flow Data</p>	<p>Network flow data contains information such as:</p> <ul style="list-style-type: none"> • Source IP address (i.e., the sender) • Destination IP address (i.e., the recipient) • Port and protocol information • Byte counts • Timestamps <p>If not effectively anonymized, network flow data may make identification of specific users possible, provide insights into user behavior (e.g., web sites visited), expose application and service usage patterns, or reveal network routing information and data volumes.</p>	<p>Before sharing network flow data, organizations should consider redacting portions of session histories using cryptography-based, prefix-preserving, IP address anonymization techniques to prevent network identification or to conceal specific fields within the session trace (e.g., time stamps, ports, protocols, or byte counts). To gain the greatest value from the information, it is important to use a tool that transforms network flow data without breaking referential integrity. Network flow analysis and correlation operations often require that IP address replacement and transformation operations are performed consistently within and sometimes across multiple files. Anonymization techniques that do not employ a consistent replacement strategy may reduce or eliminate the value of sharing this type of information.</p>

Type of Threat Information	Examples of Sensitive Data Elements ⁹	Recommendations
Phishing Email Samples	Email headers may contain information such as: <ul style="list-style-type: none"> • Mail agent IP addresses • Host or domain names • Email addresses An email message body may also contain PII or other types of sensitive information.	Organizations should anonymize email samples and remove any sensitive information that is not necessary for describing an incident or event of interest.
System, Network, and Application Logs	Log files may contain PII or other types of sensitive information. Log data may reveal IP addresses, ports, protocols, services, and URLs, as well as connection strings, logon credentials, portions of financial transactions, or other activities captured in URL parameters.	Organizations should perform IP address, timestamp, port, and protocol anonymization and remove any sensitive information that is not necessary for describing an incident or event of interest. Before sharing log data, it may also be necessary to sanitize URLs that contain identifying information such as session or user IDs. Application logs may require redaction and anonymizing operations that are specific to particular application log formats.
Malware Indicators and Samples	Although organizations are unlikely to encounter PII in malware indicators or samples, it is possible that PII or other sensitive information may be present depending on how targeted the malware is and what collection methods were used to gather a sample.	Organizations should remove PII or other sensitive information that is not necessary for describing an incident or event of interest.

654

655 **3.4.2 Sharing Designations**

656 A variety of methods exist to designate handling requirements for shared threat information. These
 657 designations identify unclassified information that may not be suitable for public release and that may
 658 require special handling. A designation applied to threat information can communicate specific handling
 659 requirements and identify data elements that are considered sensitive and should be redacted prior to
 660 sharing. Organizations are encouraged to provide clear handling guidance for any shared threat
 661 information. Likewise, recipients of threat information should observe the handling, attribution,
 662 dissemination, and storage requirements expressed in the source organization’s handling guidance.

663 The Traffic Light Protocol (TLP), depicted in Table 3-3, provides a framework for expressing sharing
 664 designations. [9]

665

666

Table 3-3: Traffic Light Protocol

Color	When should it be used?	How may it be shared?
RED	Sources may use TLP:RED when information cannot be effectively acted upon by additional parties, and could lead to impacts on a party's privacy, reputation, or operations if misused.	Recipients may not share TLP:RED information with any parties outside of the specific exchange, meeting, or conversation in which it is originally disclosed.
AMBER	Sources may use TLP:AMBER when information requires support to be effectively acted upon, but carries risks to privacy, reputation, or operations if shared outside of the organizations involved.	Recipients may only share TLP:AMBER information with members of their own organization who need to know, and only as widely as necessary to act on that information.
GREEN	Sources may use TLP:GREEN when information is useful for the awareness of all participating organizations as well as with peers within the broader community or sector.	Recipients may share TLP:GREEN information with peers and partner organizations within their sector or community, but not via publicly accessible channels.
WHITE	Sources may use TLP:WHITE when information carries minimal or no foreseeable risk of misuse, in accordance with applicable rules and procedures for public release.	TLP:WHITE information may be distributed without restriction, subject to copyright controls.

667
668 The TLP specifies a color-coded set of restrictions that indicate which restrictions apply to a particular
669 record. In the TLP, red specifies the most restrictive rule, with information sharable only in a particular
670 exchange or meeting, not even within a participant's own organization. The amber, green, and white color
671 codes specify successively relaxed restrictions.

672
673 The Anti-Phishing Working Group (APWG) has also proposed a schema for expressing sharing
674 designations [10]. The APWG schema describes an extensible, hierarchical tagging system that can be
675 used to express distribution restrictions on shared information. The tags can be used to indicate with
676 whom the information may or may not be shared (e.g., recipient only, with affected parties only, no
677 restrictions) and to express other caveats (e.g., that no attribution is permitted).

678 For some threat information, collection methods may be considered confidential or proprietary, but the
679 actual indicators observed may be shareable. In such cases, an organization may want to use *tear line*
680 *reporting*, an approach where reports are organized such that information of differing sensitivity is not
681 intermingled (e.g., the indicator information is presented in a separate part of the document than the
682 collection methods). Organizing a report in this manner allows an organization to readily produce a report
683 containing only information that designated recipients are authorized to receive.

684 An organization should carefully choose, or formulate, an approach for expressing sharing designations.
685 Regardless of how an organization expresses sharing designations, it should ensure that the procedures for
686 applying designations to threat information are documented and approved, and that the personnel
687 responsible for assigning such designations are appropriately trained.

688 3.4.3 Cyber Threat Information Sharing and Tracking Procedures

689 Over time, an organization's cybersecurity activities can result in the accumulation of large quantities of
690 threat information from various sources, both internal and external. Though challenging, tracking of data
691 sources is important both for protecting information owners and for ensuring that consuming
692 organizations are able to meet their legal or regulatory commitments for data protection. Additionally,
693 preserving the provenance of data is important for analytic purposes to yield insights into who provided

694 the information and how the information was collected, transformed, or processed. This kind of
695 information is important for drawing conclusions from shared information.

696 An organization should formulate procedures that allow prompt sharing of threat information while at the
697 same satisfying its obligations for protecting potentially sensitive data. The procedures should, to the
698 extent possible, balance the risks of possibly ineffective sharing against the risks of possibly flawed
699 protection. An organization's information sharing and tracking procedures should:

- 700 • Identify threat information that can be readily shared with trusted parties.
- 701 • Establish processes for reviewing, sanitizing, and protecting threat information that is likely to
702 contain sensitive information.
- 703 • Automate the processing and exchange of threat information where possible.
- 704 • Describe how information handling designations are applied, monitored, and enforced.
- 705 • Accommodate non-attributed information exchange, when needed.
- 706 • Track internal and external sources of threat information.

707 The procedures should enumerate the roles, responsibilities, and authorities (both scope and duration) of
708 all stakeholders. The procedures should allow for the effective transfer of authority and flow of shared
709 information to key decision makers and should enable collaboration with approved external communities
710 when needed.

711 **3.5 Join a Sharing Community**

712 When evaluating potential sharing partners, an organization should look to sources that complement its
713 existing threat information resources or that offer actionable information that addresses known gaps in an
714 organization's situational awareness. Since sharing communities may focus on the exchange of a specific
715 type of cyber threat information, an organization may need to participate in multiple information sharing
716 forums to meet its information sharing objectives.

717 Threat information can be acquired from public and private sharing communities, government
718 repositories, commercial cyber threat intelligence feeds, and open sources. Sharing communities often
719 organize around a shared characteristic or interest. The composition of a community may be based on
720 geographic region, political boundary, industrial sector, business interest, or threat space (e.g., focused on
721 phishing attacks). Many of these communities have multinational constituencies and global reach.
722 Examples of potential sharing partners are ISACs, domestic and foreign Computer Emergency Readiness
723 Teams (CERTs) or CSIRTs, threat and vulnerability repositories, law enforcement agencies, product
724 vendors, managed security service providers, internet service providers, supply chain partners, industry
725 sector peers, business partners, and customers.

726 Some communities are informal, open, self-organizing groups that largely operate through voluntary
727 cooperation. The membership of these communities is often mutable (i.e., no formal fixed membership),
728 sometimes anonymous, and the members may maintain full autonomy with minimal central coordination.
729 These communities generally operate under basic rules of conduct rather than formal agreements. In such
730 communities, members publish threat information to the community on a voluntary, ad hoc basis and are
731 individually responsible for ensuring that the content that they provide to the community is suitable for
732 sharing. Organizations wishing to consume information can subscribe to or access various delivery
733 mechanisms offered by a community such as web services, email or text alerts, and RSS feeds. Such
734 sharing communities generally make no assertions regarding the quality and accuracy of data provided by

735 their members, and the degree to which the information should be trusted depends on the reputation of
736 submitters (if known).

737 In contrast, formal sharing communities may define specific membership rules such as:

- 738 • Eligibility requirements for institutions (e.g., must operate within a specific industry sector)
- 739 • Eligibility requirements for individuals (e.g., must have enterprise-wide security responsibilities)
- 740 • Nomination or sponsorship requirements (i.e., brokered trust)
- 741 • Probationary membership period requirements
- 742 • Membership fee structures
- 743 • Types of threat information the community provides/accepts
- 744 • Standard delivery mechanisms, formats, and protocols supported by the community
- 745 • Required organizational cybersecurity capabilities

746 Formal communities may recruit members by invitation or through sponsorship, and, as such, members
747 are vetted. Membership rosters in formal communities are generally more stable than those of informal
748 communities. The exchange of information in a formal community is often governed through service
749 level agreements (SLAs), NDAs, and other agreements that enumerate the responsibilities of its members
750 and participating organizations. Some communities collect an annual membership fee to cover the
751 services and administrative costs of the community. These fees vary by community and the fee structure
752 is sometimes tiered, providing for different levels of membership and service.

753 Before entering into information sharing agreements, it is important to obtain approval from an
754 organization's:

- 755 • Leadership team that is responsible for oversight over information sharing activities and for
756 controlling the resources necessary to support the organization's information sharing goals
- 757 • Legal team or those with the authority to enter into commitments
- 758 • Privacy officers and other key stakeholders that have a role in the collection, ingest, storage, analysis,
759 publication, or protection of threat information

760 When choosing a sharing community, consideration should be given to the types of information that are
761 shared within the community, the structure and dynamics of the community, and the cost of entry and
762 sustainment of membership. When evaluating how information is shared within a community, an
763 organization should consider the following questions:

- 764 • Is the threat information shared within the community relevant and does it complement existing threat
765 information by providing meaningful insights in the context of an organization's threat environment?
- 766 • Is the threat information exchanged within the community actionable?
- 767 • Does the community have mechanisms in place to accept non-attributed cyber threat submissions and
768 the ability to protect a submitter's identity?
- 769 • Is the disseminated threat information timely, reliable, and of known good quality?

770 • Are the information exchange formats used by the community compatible with the infrastructure and
771 tools used in an organization?

772 • Given the frequency and volume of data disseminated by a community, does an organization have the
773 capacity to ingest/analyze/store the information?

774 In addition to the information shared within a community, consideration should also be given to the
775 dynamics of the community and its participants, including:

776 • What is the size and composition of the community? (e.g., number of participants, information
777 producers, and information consumers)

778 • How active is the community? (e.g., number of submissions or requests per day)

779 • Are community members recruited and vetted? If so, how?

780 • What are the technical skills and proficiencies of the community members?

781 • What is the community's governance model?

782 • What are the initial and sustained costs of membership?

783 • What type of sharing agreement does the community use?

784 • Is the sharing agreement well-aligned with an organization's goals, objectives, and business rules?

785 When researching sharing communities, organizations are encouraged to have conversations with current
786 or former members regarding their experiences as a participant in a community. Such conversation can
787 provide additional insight and help an organization assess the trustworthiness of a prospective
788 community.

789 **3.6 Plan to Provide Ongoing Support for Information Sharing Activities**

790 To ensure that information sharing activities have ongoing support, organizations should establish a plan
791 that outlines how their information sharing infrastructure will be maintained, and how its users will be
792 supported. The plan should identify the supporting personnel, infrastructure, and processes needed to:

793 • Collect and analyze the information from both internal and external sources

794 • Acquire and deploy protective measures

795 • Acquire and deploy a monitoring and threat detection infrastructure

796 It is important to ensure that sufficient funding exists for the personnel, infrastructure, and training
797 required for ongoing operational support for data collection, storage, analysis, and dissemination; for
798 technology refreshment; and for membership or service fees required for community participation.

799 Although participation in information sharing activities will require ongoing funding, effective use of
800 threat information may avoid the potentially much larger costs of successful attacks.

801 **4. Participating in Sharing Relationships**

802 An organization's participation in an information sharing community will typically include some or all of
803 the following activities:

- 804 • Engage in ongoing communication (section 4.1)
- 805 • Consume and respond to security alerts (section 4.2)
- 806 • Consume and use indicators (section 4.3)
- 807 • Organize and store indicators (section 4.4)
- 808 • Produce and publish indicators (section 4.5)

809 The following sections describe these activities in greater detail. Organizations just starting their threat
810 information sharing efforts should initially choose one or two activities to focus on and should consider
811 adding additional activities as their information sharing capability matures. Regardless of an
812 organization's information sharing maturity, it is important to understand that information sharing should
813 augment, but not replace, an organization's fundamental cybersecurity capabilities.

814 **4.1 Engage in Ongoing Communication**

815 Information sharing communities use a variety of communications methods to share threat information
816 with their members. Most organizations are able to receive threat information via email lists, text alerts,
817 and web portals without infrastructure investments specific to information sharing, although the content
818 received through these delivery channels may need to be manually processed (e.g., "cut and paste" into
819 tools). For recipients that have security tools that support standard data formats, the use of standards-
820 based data feeds can enable semi-automated ingest, processing, and use of threat information. Other
821 information sharing methods, such as conferences and workshops, require dedicated staff and travel.
822 Organizations that actively produce and share threat information are likely to incur higher communication
823 costs. Communications may be event-driven (i.e., in response to the actions or behavior of an actor) or
824 periodic, such as bi-weekly reviews, teleconferences, and annual conferences.

825 The level of detail, volume, and frequency of messages delivered in human-readable formats varies
826 widely across information sharing communities. Some communities seek to deliver the most current
827 threat information with minimal latency. In contrast, some recipients using threat information for trending
828 and analysis may prefer summary data and may have no need for near real-time delivery of detailed
829 information. To reduce the number of messages generated, sharing communities sometimes provide the
830 option of subscribing to digests (i.e., compilations of messages over time intervals) rather than receiving
831 individual messages.

832 An organization that has recently joined an information sharing community may require time to integrate
833 new threat information sources into its existing cybersecurity practices, configure security tools, and train
834 decision makers on how to interpret and act upon the threat information. During this ramp-up period, an
835 organization should consult any best practices guidance offered by a community, observe and learn from
836 the interactions of more experienced members, and query community support resources (e.g., community
837 knowledgebase, FAQs, blogs). Community-sponsored training events also provide opportunities for less
838 mature organizations and inexperienced employees to gain practical insights from skilled practitioners.
839 Organizations should also establish recruitment and retention processes that reduce personnel turnover
840 and foster the formation of trusted professional relationships between sharing communities and
841 organizations. Retention of skilled staff mitigates the loss of institutional knowledge, and preserves
842 investments in training.

843 Ongoing participation in a sharing community is essential for fostering stronger ties to other members and
844 continuously improving practices. Organizations that actively participate in community-sponsored
845 conference calls and face-to-face meetings are better able to establish trust with other members and
846 consequently to effectively collaborate over time.

847 **4.2 Consume and Respond to Security Alerts**

848 An information sharing community may publish security alerts notifying community members of
849 emerging vulnerabilities, exploits, and other security issues. Fields that commonly appear in security
850 alerts such as US-CERT alerts, NVD vulnerability advisories, and vendor security bulletins include¹⁰:

- 851 • Brief overview/executive summary and detailed description, which would include indicators
- 852 • Platforms affected (e.g., operating system, application, hardware)
- 853 • Estimated impact (e.g., system crash, data exfiltration, application hijacking)¹¹
- 854 • Severity rating (e.g., Common Vulnerability Scoring System (CVSS) [11])
- 855 • Mitigation options, including permanent fixes and/or temporary workarounds
- 856 • References for more information
- 857 • Alert metadata (e.g., alert creation and modification dates, acknowledgments)

858 Upon receipt of a security alert, an organization should first determine if the alert came from a trusted,
859 reliable source. When alerts originate from unknown or untrusted sources, it may be necessary to subject
860 them to additional scrutiny and/or seek independent confirmation before taking action. If an alert is
861 deemed credible, an organization should determine if it owns or operates any of the affected systems,
862 applications, or hardware identified in the alert; if so, the organization should craft an appropriate
863 response.

864 When crafting a response, an organization should characterize the overall impact of an alert by assessing
865 factors such as the severity of the alert, the number of affected systems within the organization, the effects
866 an attack might have on the organization's mission-critical functions, and the operational impact of
867 deploying mitigating security controls. This assessment should inform the prioritization and approach for
868 response actions. Response actions include activities such as identifying and extracting indicators from an
869 alert, using indicators to develop and deploy detection signatures, making configuration changes,
870 applying patches, notifying personnel of threats, and implementing or enhancing security controls. The
871 indicator extraction and response actions are largely manual processes today but there are clear incentives
872 for automating these activities. Manual processing of indicators can be time-consuming, tedious, error-
873 prone, and slow; automation of the activities allows analysts to focus on the interpretation of information,
874 rather than routine data manipulations.

875 **4.3 Consume and Use Indicators**

876 The consumption and use of indicators from external feeds is often a multi-step process that includes
877 some, if not all, of the following activities:

¹⁰ Source: United States Computer Emergency Readiness Team (US-CERT)

¹¹ A more extensive list of potential effects is given in the MITRE Common Weakness Enumeration (<http://cwe.mitre.org/>) and Common Vulnerabilities and Exposures (<http://cve.mitre.org/>) listings.

- 878 • **Validation:** verifying the integrity of indicator content and provenance through the use of digital
879 signatures, cryptographic hashes, or other means.
- 880 • **Decryption:** transforming encrypted indicator files or data streams back to their original format.
- 881 • **Decompression:** unpacking compressed indicator files, archive files (e.g., zip, tar), or data streams.
- 882 • **Prioritization:** processing indicators based on relative importance, the perceived value of a data
883 source, the overall confidence in the data, any operational requirements that specify that data sources
884 be processed in a particular order, the amount of effort required to transform the data into actionable
885 information, or other factors.
- 886 • **Content extraction:** parsing indicator files and extracting indicator information of interest to an
887 organization.
- 888 • **Categorization:** reviewing indicator metadata to determine its security designation and handling
889 requirements. Sensitive information may require encrypted storage, more stringent access control, or
890 limitations on distribution. Content like malware samples may require special handling precautions to
891 prevent inadvertent introduction of malicious code onto production networks.

892 These activities are typically performed in the order described above, but the order may vary based on
893 specific operational or security requirements. Where feasible, organizations are encouraged to automate
894 these activities to expedite use of indicators and minimize manual effort. In cases where indicators are
895 being informally shared, such as through email, indicator prioritization and categorization are still
896 important and should be performed by the recipient.

897 Ideally, indicators are:

- 898 • **Timely.** Indicators that are delivered with minimal latency maximize the time recipients have to
899 prepare suitable responses. The time criticality of indicators depends on the characteristics of the
900 threats, including their severity, speed, and ease of propagation, the infrastructure being targeted, the
901 TTPs being employed, and the capabilities of the actor (or actors). Some decision cycles may require
902 that indicators be delivered within seconds or minutes to counter a fast-moving actor; other threats
903 may effectively be addressed using indicators that are hours, days, or even months old.
- 904 • **Relevant.** Indicators that are applicable to a recipient's operating environment and that address
905 threats the organization is likely to face are much more useful to recipients and allow them to more
906 effectively analyze risks associated with particular threats.
- 907 • **Accurate.** Indicators that are correct, complete, and unambiguous are most useful. Inaccurate or
908 incomplete information introduces uncertainty and may prevent critical action, stimulate unnecessary
909 action, result in ineffective responses, or instill a false sense of security.
- 910 • **Specific.** Indicators should provide clear descriptions of observable events that recipients can use to
911 detect threats while minimizing false positives/negatives.
- 912 • **Actionable.** Indicators should provide sufficient information and context to allow recipients to
913 develop a suitable response.

914 In practice, an indicator may exhibit some, but not all, of these characteristics. For example, indicators
915 might not be actionable because the recipient has no means of detection, information is missing, or the
916 threat has changed. However, this does not mean that such indicators are of no value to an organization.

917 Such indicators can be enriched through aggregation, correlation with other threat information, and
918 additional analysis. As indicators mature, it is important for organizations to share any new insights so
919 that an entire community may benefit.

920 Organizations may use externally and internally-generated indicators in a variety of ways, e.g., to:

- 921 • Reconfigure firewalls, intrusion detection systems, data loss prevention systems, and/or other security
922 controls to block or alert on activity matching the indicators (for example, connections involving IP
923 addresses on a blacklist)
- 924 • Configure security information and event management solutions or other log management-related
925 systems to help with analysis of security log data
- 926 • Scan security logs, systems, or other sources of information, using indicators as search keys, to
927 identify systems that may have already been compromised
- 928 • Find matching records when investigating an incident or potential incident to learn more about a
929 threat, and to help expedite incident response and recovery actions
- 930 • Inform human security analyses
- 931 • Educate staff on threat characteristics
- 932 • Identify threat trends that may necessitate long-term changes to security controls

933 Typically, an organization's willingness to use indicators from external sources is strongly affected by the
934 level of trust the organization has in the. Indicators received from a trusted source might be put to
935 immediate use to detect and respond to a threat. In contrast, indicators originating from an untrusted
936 source may require independent validation, additional research, or testing before use. Indicator use might
937 also be affected by other factors, such as an organization's tolerance for service disruptions. For some
938 organizations, security is paramount and occasionally blocking benign activity is considered acceptable.
939 For other organizations, service availability may be so important that possibly malicious activity might
940 only trigger monitoring.

941 An organization should carefully consider the characteristics of indicators that it receives and should take
942 a risk-based approach to determining how indicators can be most effectively used. An organization may
943 find that a specific indicator is useful in some situations but not in others. Ultimately it is up to each
944 organization to decide how to best use indicators.

945 **4.4 Organize and Store Indicators**

946 Organizations may collect indicators from a variety of sources, including open source repositories,
947 commercial threat feeds, and external partners. Depending on how indicators are being used, there may be
948 a need to organize them in a knowledgebase. Free-form methods such as wikis can be quite flexible and
949 suitable for developing working notes and indicator metadata. Structured databases are also useful for
950 storing, organizing, tracking, querying, and analyzing collections of indicators.

951 Information commonly recorded in a knowledgebase includes the following, when known:

- 952 • Source of an indicator
- 953 • Rules governing the use of, or sharing of, an indicator

- 954 • Date or time an indicator was collected
- 955 • How long an indicator is valid
- 956 • Whether or not attacks associated with an indicator have targeted specific organizations or sectors
- 957 • Any Common Vulnerability Enumeration (CVE), Common Configuration Enumeration (CCE), or
- 958 Common Weakness Enumeration (CWE) records associated with an indicator
- 959 • Groups or actors associated with an indicator
- 960 • Aliases of any associated actors
- 961 • TTPs commonly used by an actor
- 962 • Motives or intent of an associated actor
- 963 • Employees or types of employees targeted in associated attacks
- 964 • Systems targeted in attacks

965 An indicator knowledgebase is an attractive target and may well become a target of attack. Therefore,
966 measures should be taken to ensure that appropriate security practices are followed for a knowledgebase,
967 such as restricting access to authorized personnel only, backing up the knowledgebase regularly,
968 maintaining the knowledgebase systems' operating systems and applications with current patches and
969 secure configurations, and following software development best practices for the production of any in-
970 house software used for the knowledgebase.¹²

971 Organizations should establish policies and procedures that address the disposition of indicators (and
972 threat information in general). Policies and procedures should define data retention requirements for short
973 (online) and long (offline) term availability of indicator information. Information handling and retention
974 requirements may change once threat information is entered into evidence. Evidence acquired during any
975 incident investigations, for instance, should be collected and preserved using best practices for data
976 preservation following chain of custody requirements and other laws pertaining to the submission of
977 evidence. A more detailed treatment of forensic techniques related to chain of custody and preserving
978 information integrity is available in NIST SP 800-86 [12] and Section 3.3.2 of NIST SP 800-61 Revision
979 2 [1].

980 For indicators that are not needed as evidence, organizations should determine appropriate retention
981 policies.¹³ Although retaining threat information has costs, detailed information may provide historical
982 value as well as help new sharing community members and partners understand the persistence and
983 evolution of different actors and attack types. Other considerations, such as financial, legal, contractual,
984 or regulatory issues, may limit data retention to a fixed period of months or years. Once a retention
985 schedule is identified, organizations should either archive or destroy the indicators in accordance with
986 applicable policies.¹⁴

987

¹² The NIST Software Assurance Metrics and Tool Evaluation (SAMATE) project seeks to develop standard evaluation measures and methods for software assurance. http://samate.nist.gov/index.php/SAMATE_Publications.html

¹³ Federal agencies are subject to the National Archives and Records Administration (NARA) General Records Schedule as well as agency-specific retention policies.

¹⁴ NIST SP 800-88 [13] provides guidance to assist organizations in making risk-based decisions regarding the sanitization and disposition of media and information.

988 **4.5 Produce and Publish Indicators**

989 Many organizations only consume indicators. However, some organizations, often those with more
990 advanced security capabilities, choose to produce and publish their own indicators. An organization may
991 benefit substantially by producing threat information. For example, an organization may gain greater
992 expertise, help other organizations more effectively respond to threats in their environments, and foster
993 trust with other community members. These effects are important for building and sustaining the flow of
994 threat information that ultimately benefits a producing organization. A producer of shared threat
995 information must decide what, if any, metadata should accompany shared information, what data formats
996 should be used, how sensitive data should be handled, and how information sharing rules should be
997 maintained over time. The following subsections address these issues.

998 **4.5.1 Indicator Enrichment**

999 When producing and publishing indicators, it is important to include metadata that provides context for
1000 each indicator, describing how it is to be used and interpreted and how it relates to other indicators.
1001 Metadata may also include sensitivity designations and provenance information (e.g., what tool was used
1002 to acquire the data, how the data was processed, who collected the data). As indicators are created,
1003 aggregated, or enriched, their sensitivity and classification should be reevaluated. An aggregation,
1004 association, or enrichment process may enable re-identification (e.g., using data mining techniques) or
1005 elevate the sensitivity of the information, thus necessitating additional data handling restrictions.

1006 The indicator production process should provide a mechanism for publishing indicators, updating
1007 indicators and associated metadata, and retracting submissions that are incorrect or perhaps inadvertently
1008 shared. Any automated mechanisms should be hardened and tested to ensure that they do not become
1009 viable attack vectors for threat actors. Organizations that share indicators should provide a feedback
1010 mechanism that allows sharing partners to submit error reports, suggest improvements, or request
1011 additional information about the indicators. Such feedback plays an important role in the enrichment,
1012 maturation, and quality of the indicators shared within a community.

1013 Some information shared within a community may be marked as “currently under investigation” and may
1014 require that members avoid sharing beyond the collective; such markings may also prohibit members
1015 from performing active information collection (such as retrieving malware samples from a suspect
1016 website, or performing DNS lookups on suspect hostnames) that might tip off a potential actor or
1017 otherwise compromise investigative activities. At some point, such information will probably have its
1018 distribution and investigation restrictions downgraded, so it is useful to have a mechanism to change the
1019 marking or to add a revised marking such as “downgraded to GREEN as of 12/20/2015.”

1020 **4.5.2 Standard Data Formats**

1021 The use of standard data formats for the exchange of indicators enhances interoperability and allows
1022 information to be exchanged with greater speed. Unstructured formats (e.g., text documents, email) are
1023 suitable for high-level threat reports and ad hoc exchanges of indicator information and other materials
1024 intended to be read by security personnel rather than machines. For time-critical exchanges of indicators,
1025 however, such as automatically configuring a firewall to block specified communications, the use of
1026 standard data formats is encouraged because they minimize the need for human assistance. When
1027 evaluating standard formats for data exchange, choose formats that are widely adopted, readily extensible
1028 (i.e., new data elements or features can be incorporated with minimal engineering and design effort), and
1029 scalable, and that provide the requisite data security features.

1030 4.5.3 Protection of Sensitive Data

1031 The indicators that an organization publishes may be sensitive, so it is important to prevent their
1032 unauthorized disclosure or modification. Indicator data can be protected using a variety of methods,
1033 including encrypted network communications, authentication and authorization mechanisms, and storage
1034 in a hardened repository. If a repository is used, an organization should have a written SLA for the
1035 repository that specifies expected availability, security posture requirements, and acceptable use policies.
1036 When producing indicators that may contain sensitive information, appropriate sharing rules (see section
1037 3.4) should be followed, and information should be shared only with community members that are trusted
1038 to follow sharing rules and that have agreed to do so.

DRAFT

1039 Appendix A—Cyber Threat Information Sharing Scenarios

1040 This appendix presents a number of scenarios that describe threat information sharing in real-world
1041 applications. These scenarios seek to show how sharing and coordination can increase the efficiency and
1042 effectiveness of an organization's cybersecurity capabilities. These scenarios represent only a small
1043 number of the possible applications of information sharing and collaboration.

1044 Scenario 1: Nation-State Attacks against a Specific Industry Sector

1045
1046 A nation-state regularly targets companies in a certain industry sector over several months. The attacks
1047 come in the form of targeted emails that carry malicious attachments containing a software exploit that,
1048 upon opening, launches malware on a victim's system. Systems that are successfully compromised by the
1049 malware are then reconfigured by the malware to contact command and control servers and other
1050 infrastructure operated by the threat actor to receive additional instructions, to download additional
1051 malware, and to exfiltrate data.

1052 Many companies within this industry sector participate in a formal threat information sharing
1053 organization in which a central forum is used to post information about observed threats. The posts
1054 describe details relevant to detecting and defending against the threat, such as the sender addresses of
1055 phishing emails, samples of malware collected from the attacks, analysis of exploit code used by the
1056 attackers, the IPs and URLs associated with the attacker's command and control servers, and other
1057 infrastructure involved with attacks.

1058 As soon as one company's security team identifies a new attack, the information is shared with its peers
1059 within the forum. One of the companies (A) that participates in the forum has advanced malware analysis
1060 capabilities and is able to further characterize the threat actor and its command and control infrastructure
1061 using a malware sample shared via the forum by another company (B). Company A then shares back the
1062 information gained through its analysis of the malware. Through B's sharing of the malware sample, the
1063 community benefits from the malware analysis capabilities of company A, and is able to quickly and
1064 efficiently detect and protect against similar attacks against their organizations. In this scenario, an attack
1065 faced by one company contributes to another's defense.

1066 Scenario 2: Campaign Analysis

1067
1068 Cybersecurity analysts from companies in a business sector have been sharing indicators and malware
1069 samples in an online forum over the past few years. Each company performs independent analysis of the
1070 attacks and observes consistent patterns over time, with groups of events often having a number of
1071 commonalities, such as the type of malware used, the DNS domains of command and control channels,
1072 and other technical indicators. These observations lead the analysts to suspect that the attacks are not fully
1073 random, but part of a larger coordinated set of actions.

1074 The forum members participate in technical exchange meetings to share data, insights, and analyses of the
1075 different attacks. Through data aggregation and joint analyses, the members are able to identify activities
1076 that are likely attributable to a common threat actor or to coordination among threat actors. This scenario
1077 demonstrates how data fusion and analysis may help reveal collective action and campaigns by a threat
1078 actor and identify the TTPs that are used by specific threat actors as part of a campaign.

1079 Scenario 3: Distributed Denial of Service Attack against an Industry Sector

1080
1081 A hacktivist group targets a select set of companies for a large-scale distributed denial of service (DDoS)
1082 attack. The group employs a distributed botnet that is loosely coordinated and controlled by members of

1083 the group. By analyzing traffic generated by the botnet, one of the companies targeted in the attack is able
1084 to determine that the attackers are using a variant of a popular DDoS tool.

1085 The targeted companies are members of an ISAC and use the ISAC's discussion portal to establish a
1086 working group to coordinate their efforts to end the attack. The working group contacts the ISAC's law
1087 enforcement liaison, who coordinates with federal and international authorities to aid in the investigation
1088 and to gain court orders to shut down the attacker systems.

1089 The working group contacts various internet service providers (ISPs), and provides information to aid in
1090 identifying abnormal traffic to their network addresses. The ISPs assist both the affected companies and
1091 law enforcement personnel by helping to identify the upstream and downstream traffic sources,
1092 implementing routing changes, and enforcing data rate limits on these sources. Using network traffic
1093 collected by the ISPs, law enforcement agencies are able to identify the command and control servers,
1094 seize these assets, and identify some members of the hacktivist group.

1095 After a technical exchange meeting among the targeted companies, several companies decide to enlist the
1096 aid of content distribution providers to distribute their web presences and make their business systems
1097 more resilient to future DDoS attacks.

1098 **Scenario 4: Financial Conference Phishing Attack**

1099
1100 A cyber crime group makes use of a publicly available conference attendee list to target specific
1101 individuals with a wave of phishing emails. The group is able to identify attendees who are members of
1102 the target organization's corporate accounting team (i.e., individuals who may have the authority to
1103 authorize payments or funds transfers). Through the use of targeted malware, distributed through phishing
1104 attacks, the group attempts to compromise machines and accounts to complete unauthorized electronic
1105 payments and funds transfers to overseas businesses.

1106 One company is able to identify the phishing attack against personnel within its corporate accounting
1107 team and learns, during their investigation, that all the recipients targeted during the attack had attended
1108 the same conference six months earlier. The company's CSIRT contacts the conference organizers, as
1109 well as representatives from other organizations that attended the conference. The affected organizations
1110 arrange a conference call to share specific information (e.g., email header content, attachments, embedded
1111 URLs) regarding the attacks. Using the shared indicators, other conference attendees review their mail
1112 and network traffic logs to identify potentially compromised hosts. These companies agree to ongoing
1113 collaboration and information sharing about future attacks via an informal email list.

1114 **Scenario 5: Business Partner Compromise**

1115
1116 "Company A" and "Company B" are business partners that have established network connectivity
1117 between their organizations to facilitate the exchange of business information. A cyber crime organization
1118 compromises a server at Company B and uses that access as a stepping stone to launch attacks against
1119 internal servers at Company A. Operations personnel at Company A notice the unusual activity and notify
1120 their security team. The security team identifies the source of the activity as coming from a Company B
1121 system. As stipulated in their business partner connectivity agreement, Company A notifies Company B
1122 about the anomalous traffic and the companies initiate a joint response to the incident following
1123 established procedures. Company A's incident response team describes the activity it is seeing, allowing
1124 Company B's team to isolate the compromised server and perform an investigation to identify the source
1125 of the breach and other possible compromises. Their investigation reveals that the attackers exploited a
1126 software flaw in a web-facing application and used it to gain unauthorized access to the server. The
1127 application development team at Company B implements and deploys a code change to close the security

1128 hole, and the security operations team enables additional logging and intrusion detection signatures to
1129 identify any similar future attacks.

1130 Because the security teams of the two companies had agreements and processes in place for a joint
1131 response, had pre-established contacts and existing trust relationships, and had already understood each
1132 other's networks and operations, they were able to quickly respond and recover from the incident.

1133 **Scenario 6: US-CERT Provides Indicators, Receives Feedback**

1134
1135 The US-CERT receives information, from a variety of independent sources, that a number of servers
1136 located in the U.S. are being used to carry out cyber attacks against other U.S. companies. A specific
1137 foreign actor is known to control the compromised servers. The US-CERT identifies the targeted
1138 companies and notes that they are predominantly from the aviation industry. The US-CERT contacts the
1139 security teams of these companies and shares initial threat information, including URLs, malware, and
1140 vulnerabilities being exploited by the threat actor.

1141 Using the indicators, a number of affected companies are able to detect attacks against their
1142 infrastructures and to take the actions necessary to prevent the attacks from being successful. During their
1143 investigation, the affected companies are also able to identify new indicators or provide additional context
1144 regarding the attack to the US-CERT. The US-CERT is able to share these new indicators with other
1145 firms after anonymizing the sources, which leads to a more comprehensive response to the threat.

1146 **Scenario 7: A Retailer Fails to Share**

1147 A large retailer is subject to a cyber attack by a criminal organization. Millions of credit card numbers and
1148 account information are stolen during a breach that goes undiscovered for several weeks. The retailer does
1149 not participate in sharing threat information, so the organization relies on its own security and detection
1150 capabilities. Its internal capabilities prove inadequate in the face of a sophisticated, targeted threat that
1151 uses custom malware.

1152 The breach is discovered by credit card companies investigating a rash of credit card fraud. The
1153 commonality in the credit card fraud was purchases made from this one retailer. The credit card
1154 companies notify law enforcement and the retailer, which begins an investigation.

1155 The damages are extensive. The company notifies its customers of the theft of personal information, but
1156 does not release details of how the attack was carried out. Consequently, several other retailers are
1157 successfully attacked using the same methods in the weeks following the initial breach. The financial
1158 losses realized by the retailers, customers, and credit card issuers could have been avoided, at least in part,
1159 had these companies engaged in active sharing of threat information with one another.

1160 **Appendix B—Glossary**

1161 Selected terms used in the publication are defined below.

Actor	See “threat actor”.
Alert	A brief, usually human-readable, technical notification regarding current vulnerabilities, exploits, and other security issues. Also known as an advisory, bulletin, or vulnerability note.
Cyber Threat	See “threat”.
Indicator	A technical artifact or observable that suggests an attack is imminent or is currently underway, or that a compromise may have already occurred.
Observable	An event (benign or malicious) on a network or system.
Tactics, Techniques, and Procedures (TTPs)	The behavior of an actor. A tactic is the highest-level description of this behavior, while techniques give a more detailed description of behavior in the context of a tactic, and procedures an even lower-level, highly detailed description in the context of a technique.
Threat	Any circumstance or event with the potential to adversely impact organizational operations (including mission, functions, image, or reputation), organizational assets, individuals, other organizations, or the Nation through an information system via unauthorized access, destruction, disclosure, or modification of information, and/or denial of service. [2]
Threat Actor	An individual or a group posing a threat.
Threat Information	Any information related to a threat that might help an organization protect itself against a threat or detect the activities of an actor. Major types of threat information include indicators, TTPs, security alerts, threat intelligence reports, and tool configurations.
Threat Intelligence	Threat information that has been aggregated, transformed, analyzed, interpreted, or enriched to provide the necessary context for decision-making processes.
Threat Intelligence Report	A prose document that describes TTPs, actors, types of systems and information being targeted, and other threat-related information.
Threat Shifting	The response of actors to perceived safeguards and/or countermeasures (i.e., security controls), in which actors change some characteristic of their intent/targeting in order to avoid and/or overcome those safeguards/countermeasures. [2]
Tool Configuration	A recommendation for setting up and using tools that support the automated collection, exchange, processing, analysis, and use of threat information.

1162

1163 **Appendix C—Acronyms**

1164 Selected acronyms used in the publication are defined below.

ACL	Access Control List
ARP	Address Resolution Protocol
CCE	Common Configuration Enumeration
CIO	Chief Information Officer
CISO	Chief Information Security Officer
CSIRT	Computer Security Incident Response Team
CVE	Common Vulnerability Enumeration
CVSS	Common Vulnerability Scoring System
CWE	Common Weakness Enumeration
DDoS	Distributed Denial of Service
DHCP	Dynamic Host Configuration Protocol
DIB	Defense Industrial Base
DNS	Domain Name System
FISMA	Federal Information Security Modernization Act
FTP	File Transfer Protocol
GLBA	Gramm-Leach-Bliley Act
HIPAA	Health Information Portability and Accountability Act
IP	Internet Protocol
IR	Interagency Report or Internal Report
ISAC	Information Sharing and Analysis Center
ISP	Internet Service Provider
IT	Information Technology
ITL	Information Technology Laboratory
MAC	Media Access Control
MOU	Memorandum of Understanding
NDA	Non-Disclosure Agreement
NIST	National Institute of Standards and Technology
NVD	National Vulnerability Database
OMB	Office of Management and Budget
PCAP	Packet Capture
PCI DSS	Payment Card Industry Data Security Standard
PII	Personally Identifiable Information
PSIRT	Product Security Incident Response Team
RSS	Rich Site Summary or Really Simple Syndication
SIEM	Security Information and Event Management
SLA	Service Level Agreement
SOX	Sarbanes-Oxley Act
SP	Special Publication
SQL	Structured Query Language
TCP	Transmission Control Protocol
TLP	Traffic Light Protocol
TTP	Tactics, Techniques, and Procedures
UDP	User Datagram Protocol
URL	Uniform Resource Locator
US-CERT	United States Computer Emergency Readiness Team

1165

1166 **Appendix D—References**

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