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Securing Electronic Health Records on Mobile Devices

Volume E:
Risk Assessment and Outcomes

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FEEDBACK

As a private-public partnership, we are always seeking feedback on our Practice Guides. We are particularly interested in seeing how businesses apply NCCoE reference designs in the real world. If you have implemented the reference design, or have questions about applying it in your environment, please email us at hit_nccoe@nist.gov.

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

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NATIONAL CYBERSECURITY CENTER OF EXCELLENCE

The National Cybersecurity Center of Excellence (NCCoE), a part of the National Institute of Standards and Technology (NIST), is a collaborative hub where industry organizations, government agencies, and academic institutions work together to address businesses' most pressing cybersecurity issues. This public-private partnership enables the creation of practical cybersecurity solutions for specific industries, as well as for broad, cross-sector technology challenges. Through consortia under Cooperative Research and Development Agreements (CRADAs), including technology partners—from Fortune 50 market leaders to smaller companies specializing in IT security—the NCCoE applies standards and best practices to develop modular, easily adaptable example cybersecurity solutions using commercially available technology. The NCCoE documents these example solutions in the NIST Special Publication 1800 series, which maps capabilities to the NIST Cyber Security Framework and details the steps needed for another entity to recreate the example solution. The NCCoE was established in 2012 by NIST in partnership with the State of Maryland and Montgomery County, Md.

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NIST Cybersecurity Practice Guides (Special Publication Series 1800) target specific cybersecurity challenges in the public and private sectors. They are practical, user-friendly guides that facilitate the adoption of standards-based approaches to cybersecurity. They show members of the information security community how to implement example solutions that help them align more easily with relevant standards and best practices and provide users with the materials lists, configuration files, and other information they need to implement a similar approach.

The documents in this series describe example implementations of cybersecurity practices that businesses and other organizations may voluntarily adopt. These documents do not describe regulations or mandatory practices, nor do they carry statutory authority.

ABSTRACT

Healthcare providers increasingly use mobile devices to receive, store, process, and transmit patient clinical information. According to our own risk analysis, discussed here, and in the experience of many healthcare providers, mobile devices can introduce vulnerabilities in a healthcare organization's networks. At the 2012 Health and Human Services Mobile Devices Roundtable, participants stressed that many providers are using mobile devices for healthcare delivery before they have implemented safeguards for privacy and security [1].

This NIST Cybersecurity Practice Guide provides a modular, open, end-to-end reference design that can be tailored and implemented by healthcare organizations of varying sizes and information technology (IT) sophistication. Specifically, the guide shows how healthcare providers, using open-source and commercially available tools and technologies that are consistent with cybersecurity standards, can more securely share patient information among caregivers who are using mobile devices. The scenario considered is that of a hypothetical primary care physician using her mobile device to perform recurring activities such as sending a referral (e.g., clinical information) to another physician or sending an electronic prescription to a pharmacy. While the design was demonstrated with a certain suite of products, the guide does not endorse these products in particular. Instead, it presents the

characteristics and capabilities that an organization's security experts can use to identify similar standards-based products that can be integrated quickly and cost-effectively with a healthcare provider's existing tools and infrastructure.

KEYWORDS

EHR; electronic health records; HIPAA; mobile device security; patient health information; PHI; risk management; standards-based cybersecurity; stolen health records

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Technology Partner/Collaborator	Build Involvement
Cisco	Identity Services Engine (ISE), Adaptive Security Virtual Appliance (ASAv), and RV220W
IBM	MaaS360
Intel	Intel® Identity Protection Technology (Intel® IPT) with Public Key Infrastructure (PKI)
MedTech Enginuity	OpenEHR software
Ramparts	Risk assessment and security testing
RSA	Archer Governance, Risk & Compliance (GRC)
Symantec	Endpoint Protection

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1 Practice Guide Structure

This National Institute of Standards and Technology (NIST) Cybersecurity Practice Guide describes a standards-based reference design and provides users with the information they need to replicate this approach to securing electronic health records transferred among mobile devices. The reference design is modular and can be deployed in whole or in parts.

This Practice Guide is made up of five volumes:

- NIST SP 1800-1A: *Executive Summary*
- NIST SP 1800-1B: *Approach, Architecture, and Security Characteristics* – what we built and why
- NIST SP 1800-1C: *How-To Guides* – instructions to build the reference design
- NIST SP 1800-1D: *Standards and Controls Mapping* – listing of standards, best practices, and technologies used in creating this Practice Guide
- NIST SP 1800-1E: *Risk Assessment and Outcomes* – risk assessment methodology, results, tests, and evaluation **(you are here)**

2 Introduction

NIST SP 1800-1E: Risk Assessment and Outcomes addresses the methodology used to conduct the reference design system risk assessment, the results of that risk assessment, the intended outcomes of implementing the reference design, and the results of the reference design functional test. This volume is broken into six sections:

- Results – the workflow and summary of the security control implementation (Section 3)
- Security Controls Assessment – scenario-based evaluation of the security functionality of the reference design (Section 4)
- Risk Assessment Methodology – the two approaches we took in conducting a system risk assessment of the reference design (Section 5)
- Risk Assessment Results – detailed results of the risk assessments we conducted (Section 6)
- Security Controls Test and Evaluation – security controls and the evidence of their implementation (Section 4)
- Risk Questionnaire for healthcare organizations selecting a cloud-based electronic health record (EHR) provider (Section 8)

3 Results

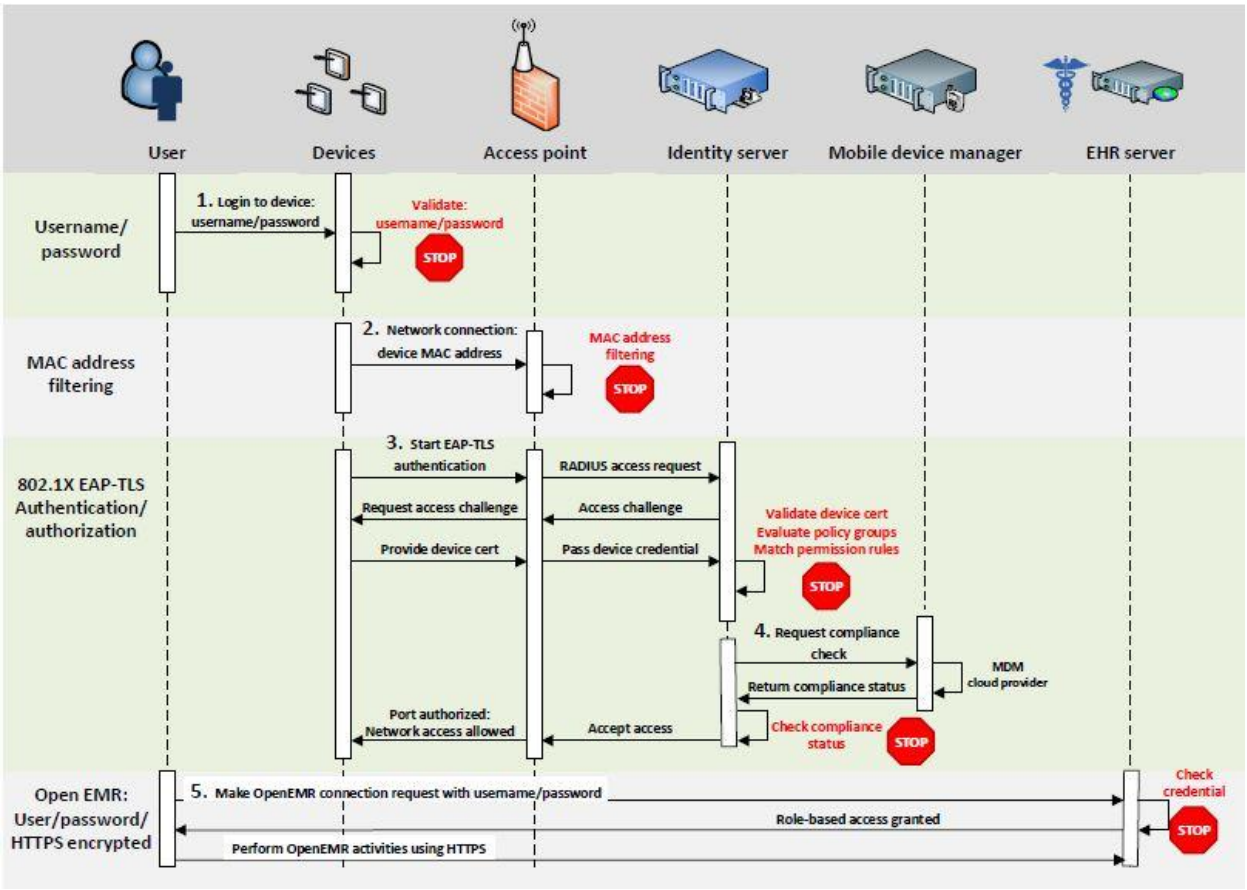
The features in this reference design and our process of continued risk assessment increase the difficulty for an adversary to gain unauthorized access to patient health information. Here the term “patient health information” refers to any information pertaining to a patient’s clinical care. “Protected health information” has a specific definition according to Health Insurance Portability and Accountability Act (HIPAA) that is broader than our scope. We are using “patient health information” so we do not imply

that we are further defining protected health information or setting additional rules about how it is handled.

At the same time, we want to provide authorized users with easy access. The architecture is designed to enhance protection for patient information while minimizing changes to use of systems. As with all components of this reference design, every organization needs to make its own risk-based determinations about which of these capabilities to implement and how.

The security features of the reference design are modeled around the business workflow of a typical user accessing the EHR. This workflow and the relevant security checks are illustrated in Figure 3-1.

Figure 3-1 The Steps Necessary for a User and Device to Gain Access to the Electronic Health Record Server



Prior to being granted access to the EHR, the user must follow the following five steps. However, since ease of use is paramount when it comes to the likelihood of adoption in real-world environments, all but steps 1 (logging on to the device) and 5 (logging into the EHR) are transparent to the user.

Step 1. The user enters a username and password into the device.

Step 2. Communication starts from the mobile devices located in each organization. Each organization minimally provides access points (APs) to facilitate communication to the EHR server located in the Data Center. Each connection to an AP must first be

challenged and responded to by the device with a proper media access control (MAC) address.

A MAC address cannot be changed on the physical device but can be changed in the operating system. This makes security bypass trivial for even a low-level attacker. MAC filtering, therefore, is a first layer of defense for identity and access control.

Step 3. The device is challenged by the AP for a properly signed and trusted certificate. A user who does not have this certificate on his or her device will not be allowed access on the local network to even attempt a connection to the web-based OpenEMR.

In this simulation, the same certificate authority (CA) was used for both the AP and the OpenEMR tool. A hard certification could be a smart card or some other token provided by your IT department. Additional security could be added to this transaction by setting up a separately trusted CA for both and requiring a hard certification for access to either service. This approach would thwart insiders or attackers who have gained access to a lost or stolen device. They may get access to the AP, but not to the OpenEMR.

Step 4. The mobile device manager (MDM) performs a compliance check on the device based on the policy that was assigned. The MDM used in this build has the ability to track the specific location of a device, which can be used to restrict use of the device to a specific medical facility. Devices that are not in compliance will not be admitted to the network.

Step 5. OpenEMR is configured to use mutual authentication when establishing the encrypted connection. This prevents access from any device that does not have a valid certificate. When a device is reported lost or stolen, its certificate is revoked, preventing access from that device.

The user is then challenged by the OpenEMR for the proper username and password credentials. If an attacker attempts what is known as a brute force attack to gain access to the OpenEMR tool, then the likelihood that there will be a trail for an administrator to follow is higher, given that the web server application logs every attempt. The OpenEMR will also lock out the user after several login attempts.

It is important to note that all access to the OpenEMR system uses two different forms of authentication device and user. The certificate needed for mutual authentication is bound to the device, turning the device into a second form of authentication.

In this last step, a user with the right login credentials ultimately logs in to the OpenEMR tool.

4 Security Controls Assessment

To demonstrate that our implementation of the security characteristics meets the business challenge, one of our collaborators, Ramparts, conducted an objective assessment of our reference design. The assessment shows that the architecture and implementation provide enhanced security by ensuring that read and write access to EHRs and patient health information is limited to authorized users.

The assessment was not intended to be a complete test of every aspect of the functionality and security of the architecture or implementation. Such an undertaking would be impractical and resource intensive. Adapting the principles and implementation details of the reference design to an organization's enterprise infrastructure requires customizations that we cannot fully anticipate. Attempting to do so would potentially invalidate test results for organizations without a similar implementation. We expect that organizations that adopt this reference design will build on the material presented here to update their own system security plans and customize as needed to validate the security of their own implementations.

The assessment is organized in three parts:

1. security scenario assessment – provides evidence that the reference design protects the security of the patient health information in the context of several different attack scenarios
2. functional assessment – provides evidence that key functions described in the NCCoE use case document "Secure Exchange of Electronic Health Information" [2], which originally described this challenge, are properly implemented in the build
3. security assessment – provides evidence that the security characteristics specified in the use case are properly implemented in the build

Each assessment is described in further detail below. Section 5 of this volume contains lists of tests relevant to each type of assessment, many of which were run on the build. Some tests, such as those involving policy, procedure, or physical security, have been included in the appendix to provide guidance in the evaluation of real, operational implementations of the architecture. These tests were not performed on this reference design because they are not relevant to a laboratory setting.

4.1 Security Scenario Assessment

The independent evaluator conducted scenario-based security testing of the reference design to provide assurance that the security of health information could be maintained despite four specific attacks, as outlined in the sections below. These scenarios were chosen to bypass specific security controls in order to accelerate the testing of different parts of the defense-in-depth strategy. In the attack-based scenario tests, NCCoE health IT architects and engineers played the roles of system administrators. During the various attack scenarios, the defenders ran the network to mimic the operations of a large healthcare organization with the resources to monitor and respond to any detected threats.

When testing transitioned to a new attacker scenario, the system administrators reset any mitigations (technical and procedural) that were put in place. Mitigations included resetting passwords but did not include blocking virtual private network (VPN) access or the attacker's initial foothold. The test procedure assumed the attacker was able to compromise an internal Windows desktop computer.

The independent evaluator demonstrated that the use case architecture and implementation provide enhanced security with respect to the goal of ensuring that only authorized users are able to gain read and write access to the EHR system and patient health information.

4.1.1 Lost Mobile Device Scenario

In this scenario, an attacker acquired a mobile health device through theft or loss. The device had access to the EHR system at some point in time.

The device did not have any patient health information saved. We examined the device for remnants of patient health information, provided this did not pose a significant risk to the device. In other words, we expected the device to be rooted in order to acquire a forensic image of the device's disk and memory.

Upon discovery of the lost device, the device should be blocked from accessing any resources on the health internet service provider (ISP) network. At a time coordinated with us, the defenders implemented a block. Blocking the device can be accomplished in several ways, depending in the policy within the MDM. Some examples of what blocking does are revoking the digital certificate or wiping specific contents from the mobile device. Wiping can be further defined within your policy to wipe the whole contents or specific contents on the mobile device.

A file or note containing example sensitive information was created and saved on the device. At a time coordinated with us, the defenders initiated a remote wipe. We verified that the sensitive information was removed and the device wiped.

4.1.2 Internal Network Access Scenario

In this scenario, an attacker accessed the internal health ISP network. The attacker obtained access to the network through a phishing campaign and maintained a persistent presence on a Windows desktop computer. This persistent presence is represented by the ability to gain remote access to a desktop by using low-level captured Windows domain credentials. In a real-world scenario, this would typically take the form of a backdoor with a network traffic redirector.

Through this foothold, the attacker obtained a network diagram of the health ISP. In the process of obtaining this network diagram, as well as in several other attacks, the intrusion detection system flagged the attacker's actions.

Testing validated the defense-in-depth strategy and demonstrated that, for many of the weaknesses found, the architecture's security characteristics, such as audit controls, backups, and monitoring, helped limit the damage.

4.1.3 OpenEMR Access Scenario

In this scenario, an attacker accessed the OpenEMR web application with limited privileges (e.g., technician). The attacker was either a malicious insider with limited access to the system or an outsider who captured the user's credentials.

Once the attacker had access to the OpenEMR web application, they attempted to access information for which they were not authorized. This attempt to breach the security of patient health information was thwarted by security characteristics and controls, such as entity authorization and application firewalling, and reduced the amount of patient health information to which the attacker had access.

4.1.4 Physical Access Scenario

In this scenario, an attacker had physical access to a wireless access point used by clinicians to access the OpenEMR web application. We assumed the attacker had unsupervised access to this device for an extended period. The attacker was able to bring in electronics and tools. The attacker connected to the access point, performed packet captures, and monitored network traffic. The test showed that all traffic was encrypted, thereby rendering it unusable by the attacker.

4.2 Functional Assessment

An independent functional test ensured that the build provides key functions described in the use case: A hypothetical primary care physician using a mobile device can securely send

- a referral from one physician to the EHR repository, from which a second physician retrieves the referral
- a prescription to the pharmacy

The subsections below briefly describe the intent of each function and then describe the validation and the results. The procedures used for each functional test are included in Section 5 of this volume.

4.2.1 Send a Referral

This test evaluated the capability of the EHR solution to electronically create and transmit a referral to another physician. In this scenario, the receiving physician was able to access the same EHR application as the referring physician. The receiving physician got the referral and accessed the patient record via a mobile device. When treatment was provided, the receiving physician updated the patient record in the EHR application. The original referring physician was notified of the action and accessed the updated patient record.

4.2.2 Send a Prescription

This test validated the EHR solution's prescription-sending capability. The test simulated a physician using a mobile device and EHR application to send a prescription

- to a pharmacy directly through the EHR application
- outside the application via email or fax

These actions were successfully completed.

4.3 Security Assessment

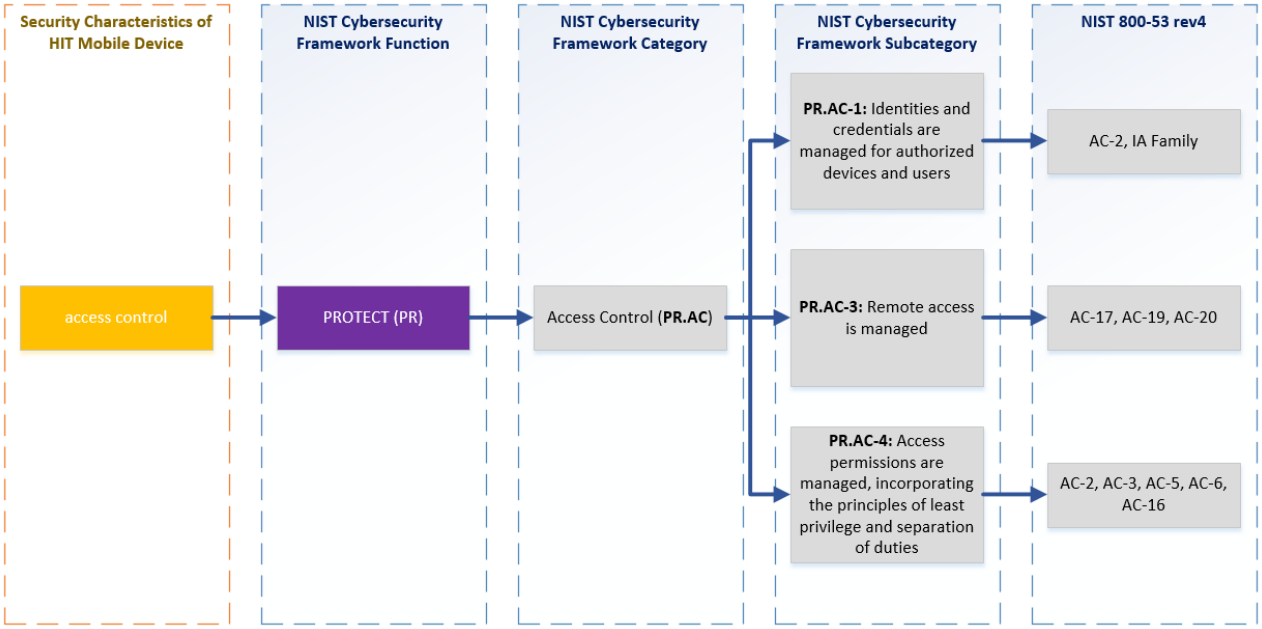
A security assessment evaluated the security characteristics that we thought were satisfied by the architecture. To determine what tests to include, we consulted Table 1, Relevant Standards and Controls, in NIST SP 1800-1D: Standards and Controls Mapping. Five security characteristic requirements are listed:

1. access control
2. audit controls/monitoring
3. device integrity
4. person or entity authentication
5. transmission security

In the table, each of these characteristics is further classified by the NIST Cybersecurity Framework categories and subcategories to which it maps. The NIST Cybersecurity Framework subcategories were used to determine which tests to include in the security assessment by consulting the specific sections

of each standard that were cited in reference to that subcategory. An example of the process is depicted in Figure 4-1.

Figure 4-1 An Example of the Process for Determining Which Tests to Include in the Security Assessment



The security standards that are mapped to the NIST Cybersecurity Framework Subcategories provided additional validation points. By systematically developing tests based on the NIST Cybersecurity Framework Subcategories, we generated a set of reasonably comprehensive tests for the security characteristic requirements we identified when we first identified this challenge [2].

For practical reasons, not all of these tests were run on the example build. All security assessment tests are included in Section 5 of this volume to help users evaluate their own operational implementation of the architecture and provide guidance on testing policy, procedures, and components, and other aspects of security that are relevant in an operational environment. Section 6 of this volume shows which of the tests were run on our example build and which were not.

5 Risk Assessment Methodology

In our solution, we used NIST SP 800-30 as our risk assessment methodology. You may want to consider a methodology that best fits your organization's needs.

As outlined by NIST SP 800-30, organizations conduct risk assessment by executing the following tasks:

- Identify threat source and events.
- Identify vulnerabilities and predisposing conditions.
- Determine likelihood of occurrence.

- Determine magnitude of impact.
- Determine risk.

We offer two methods for conducting a risk assessment:

1. Table-driven method: by following the task list and exemplary tables outlined in NIST SP 800-30: Section 3.2, Conducting the Risk Assessment; and Appendixes D–I. This was the initial risk assessment for this use case, which was conducted prior to the lab architecture design and build.
2. Attack/fault-tree assessment methodology as referenced in NIST 800-30 [3]. The attack/fault-tree methodology was customized for this use case. This was done by decomposing the architecture of the use case. (Note: Ramparts LLC created and used this methodology (Ramparts Risk Assessment Methodology) on the use case. This methodology uses and maps the use case's security characteristics into the NIST Cybersecurity Framework. In addition, it combines techniques pioneered in NIST SP 800-30, SP 800-53 rev4, Mission Oriented Risk and Design Analysis (MORDA) of Critical Information Systems, Risk Analysis Model – Eighth Annual Canadian Computer Security Symposium, and Intelligence-Driven Computer Network Defense informed by Analysis of Adversary Campaigns and Intrusion Kill Chains.)

Both methods performed a risk assessment and an analysis against this use case for all risk factors, and then determined the risks of:

- **Loss of confidentiality –** impact of unauthorized disclosure of sensitive information
- **Loss of integrity –** impact if system or data integrity is lost by unauthorized changes to the data or system
- **Loss of availability –** impact to system functionality and operational effectiveness

The table-driven method provides a technique for assessing the risks without using any software tools. On the other hand, the fault-tree technique, by using a Decision Programing Language tool, allows us to do a graph-based analysis and use specific threat events to generate threat scenarios. The modeling and simulation produces a large number of threat scenarios, which provides us a way to restrict the analysis to a focused subset.

The risk assessments identify a list of the risks and their levels of severity. We used the identified risks as the foundation to validate the security characteristics. The mapping to the NIST Cybersecurity Framework and security controls enable us to provide countermeasures by building the enterprise infrastructure with all necessary components. The organization can take actions to address those risks and protect its health information. This section provides examples on using both assessment methods. The complete assessment results can be found in Section 6 of this volume.

5.1 Table-Driven Risk Assessment Example

This section provides a walk-through for assessing and identifying the following:

- an example of adversarial risk
- an example of non-adversarial risk

During the risk assessment process, we followed the tasks outlined in NIST SP 800-30, Section 3.2, Conducting the Risk Assessment, and used the reference tables, templates, and assessment scale tables outlined in Appendixes D–I.

To recap, we performed the following tasks [4]:

- Task 2-1: Identify and characterize threat sources of concern.
- Task 2-2: Identify potential threat events.
- Task 2-3: Identify vulnerabilities and predisposing conditions.
- Task 2-4: Determine the likelihood.
- Task 2-5: Determine the impact.
- Task 2-6: Determine the risk.

For each task, we produced a number of intermediate tables with the outputs used by the final Task 2-6 for determining the risks. The intermediate tables are omitted from this document as their outputs are aggregated into the final tables. Our assessment results are captured in the following groups, with the risk level sorted from high to low.

- Adversarial Risk (Loss of Confidentiality)
- Adversarial Risk (Loss of Integrity)
- Adversarial Risk (Loss of Availability)
- Non-adversarial Risk (Loss of Confidentiality)
- Non-adversarial Risk (Loss of Integrity)
- Non-adversarial Risk (Loss of Availability)

Refer to Section 6 for the details.

The Adversarial Risk template table and Non-adversarial Risk template table below capture the assessment results for each risk factor. Following each template table, the detailed steps and example walk-throughs are presented. For each step, the column Example Walk-Through/Explanations provides the details on how the sample risk assessment was conducted.

Table 5-1 Adversarial Risk Template [5]

1	2	3	4	5	6	7	8	9	10	11	12	13
Threat Event	Threat Sources	Threat Source Characteristics			Relevance	Likelihood of Attack Initiation	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Initiated Attack Succeeds	Overall Likelihood	Level of Impact	Risk
		Capability	Intent	Targeting								
Exploit known vulnerabilities in mobile systems and devices (e.g., laptops, Personal Digital Assistants (PDAs), smart phones)	Adversarial/Hacker	Moderate	High	Low	Possible	Moderate	Malware — TECHNICAL/ Architectural and Functional	Moderate	Moderate	Moderate	Low	Moderate

Table 5-2 Adversarial Risk Sample Walk-Through [6]

Column	Heading	Content	Example Walk-Through / Explanations
1	Threat Event	Identify threat event	Based on the use case, one example threat event is selected: "Exploit known vulnerabilities in mobile systems and devices (e.g., laptops, PDAs, smartphones)"
2	Threat Sources	Identify threat sources that could initiate the threat event	"Adversarial/hacker" could initiate the exploitation
3	Capability	Assess threat source capability	The adversary has moderate resources, expertise, and opportunities to support multiple successful attacks
4	Intent	Assess threat source intent	The adversary seeks to disrupt the organization's cyber resources, so the source intent is "Moderate"

Column	Heading	Content	Example Walk-Through / Explanations
5	Targeting	Assess threat source targeting	The threat source targeting is low, as attackers can use only publicly available information to target
6	Relevance	Determine relevance of threat event. If the relevance of the threat event does not meet the organization's criteria for further consideration, do not complete the remaining columns	The relevance of this threat event is "possible"
7	Likelihood of Attack Initiation	Determine likelihood that one or more of the threat sources initiates the threat event, taking into consideration capability, intent, and targeting	With the moderate capability and intent and low threat source targeting, the adversary is somewhat likely to initiate the threat event, so "Moderate" is used here
8	Vulnerabilities and Predisposing Conditions	Identify vulnerabilities that could be exploited by threat sources initiating the threat event and the predisposing conditions that could increase the likelihood of adverse impacts	Based on the vulnerabilities related to IT system and vulnerability assessments, the vulnerabilities (malware) can be exploited by hackers by using specific products or product lines, which could increase the likelihood of adverse impacts
9	Severity Pervasiveness	Assess severity of vulnerabilities and pervasiveness of predisposing conditions	The vulnerability is of moderate concern, based on the exposure of the vulnerability and ease of exploitation and/or on the severity of impacts that could result from its exploitation. Relevant security control or other remediation is partially implemented and somewhat effective
10	Likelihood Initiated Attack Succeeds	Determine the likelihood that the threat event, once initiated, will result in adverse impact, taking into consideration threat source capability, vulnerabilities, and predisposing conditions	Based on the moderate treat source capability and severity pervasiveness, if the threat event is initiated or occurs, it is somewhat likely to have adverse impacts, which should be rated as "Moderate"

Column	Heading	Content	Example Walk-Through / Explanations
11	Overall Likelihood	Determine the likelihood that the threat event will be initiated and result in adverse impact (i.e., combination of likelihood of attack initiation and likelihood that initiated attack succeeds)	The overall likelihood is the combination of likelihood of attack initiation (Column 7, Moderate) and likelihood that initiated attack succeeds (Column 10, Moderate). By checking Guide for Conducting Risk Assessments, Table G-5: Assessment Scale — Overall Likelihood, the Overall Likelihood is Moderate
12	Level of Impact	Determine the adverse impact (i.e., potential harm to organizational operations, organizational assets, individuals, other organizations, or the nation) from the threat event	This threat event is potentially harmful to organizational operations. This threat event could be expected to have a serious adverse effect on organization operations, as the mobile system and/or mobile devices might lose availability. The level of impact is Moderate
13	Risk	Determine the level of risk as a combination of likelihood and impact	The level of risk is a combination of likelihood (Column 11, Moderate) and impact (Column 12, Moderate). By checking Guide for Conducting Risk Assessments, Table G-5: Assessment Scale — Overall Likelihood, the Level of Risk is Moderate

Table 5-3 Non-adversarial Risk Template [7]

1	2	3	4	5	6	7	8	9	10	11
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk
Incorrect privilege settings	Accidental (users, admin users)	Moderate	Predicted	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	Moderate	Moderate	Moderate

Table 5-4 Non-adversarial Risk Sample Walk-Through [8]

Column	Heading	Content	Example Walk-Through / Explanations
1	Threat Event	Identify threat event	Based on the use case, one example threat event is selected: "Incorrect privilege settings"
2	Threat Sources	Identify threat sources that could initiate the threat event	"Accidental (users, admin users)" could initiate the exploitation
3	Range of Effects	Identify the range of effects from the threat source	The effects of the accident are wide-ranging, involving a significant portion of the cyber resources of the information systems, including some critical resources. So "Moderate" is used here
4	Relevance	Determine relevance of threat event. If the relevance of the threat event does not meet the organization's criteria for further consideration, do not complete the remaining columns	The relevance of this threat event is "Predicted"

Column	Heading	Content	Example Walk-Through / Explanations
5	Likelihood of Threat Event Occurring	Determine the likelihood that the threat event will occur	Accident is somewhat likely to occur, so "Moderate" is used here
6	Vulnerabilities and Predisposing Conditions	Identify vulnerabilities that could be exploited by threat sources initiating the threat event and the predisposing conditions that could increase the likelihood of adverse impacts	Based on the vulnerabilities related to IT system and vulnerability assessments, the vulnerabilities (related to incorrect privilege settings) can be exploited accidentally by users, which could increase the likelihood of adverse impacts
7	Severity Pervasiveness	Assess severity of vulnerabilities and pervasiveness of predisposing conditions.	The vulnerability is of moderate concern, based on the exposure of the vulnerability and ease of exploitation and/or on the severity of impacts that could result from its exploitation. Relevant security control or other remediation is partially implemented and somewhat effective.
8	Likelihood Threat Event Results in Adverse Impact	Determine the likelihood that the threat event, once initiated, will result in adverse impact, taking into consideration vulnerabilities and predisposing conditions	Based on the moderate threat source capability and severity pervasiveness, if the threat event is initiated or occurs, it is highly likely to have adverse impacts, which should be rated as "High"
9	Overall Likelihood	Determine the likelihood that the threat event will occur and result in adverse impacts (i.e., combination of likelihood of threat occurring and likelihood that the threat event results in adverse impact)	The likelihood that the threat event will occur and result in adverse impacts is the combination of likelihood of threat occurring (Column 5, Moderate) and likelihood that the threat event results in adverse impact (Column 8, High). By checking Guide for Conducting Risk Assessments, Table G-5: Assessment Scale – Overall Likelihood the Overall Likelihood is Moderate.

Column	Heading	Content	Example Walk-Through / Explanations
10	Level of Impact	Determine the adverse impact (i.e., potential harm to organizational operations, organizational assets, individuals, other organizations, or the nation) from the threat event	This threat event is potentially harmful to organizational operations and information-related special-access program. This threat event could be expected to have a serious adverse effect on organization operations, as the mobile system and/or mobile devices might lose availability. The level of impact is Moderate
13	Risk	Determine the level of risk as a combination of likelihood and impact	The level of risk is a combination of likelihood (Column 9, Moderate) and impact (Column 10, Moderate). By checking Table 5-6, Assessment Scale — Level of Risk (Combination of Likelihood and Impact), the Level of Risk is Moderate.

Table 5-5 Assessment Scale – Overall Likelihood [9]

Likelihood of Threat Event Initiation or Occurrence	Likelihood Threat Events Result in Adverse Impacts				
	Very Low	Low	Moderate	High	Very High
Very High	Low	Moderate	High	Very High	Very High
High	Low	Moderate	Moderate	High	Very High
Moderate	Low	Low	Moderate	Moderate	High
Low	Very Low	Low	Low	Moderate	Moderate
Very Low	Very Low	Very Low	Low	Low	Low

Table 5-6 Assessment Scale – Level of Risk (Combination of Likelihood and Impact) [10]

Likelihood (Threat Event Occurs and Results in Adverse Impact)	Level of Impact				
	Very Low	Low	Moderate	High	Very High
Very High	Very Low	Low	Moderate	High	Very High
High	Very Low	Low	Moderate	High	Very High
Moderate	Very Low	Low	Moderate	Moderate	High
Low	Very Low	Low	Low	Low	Moderate
Very Low	Very Low	Very Low	Very Low	Low	Low

5.2 Ramparts' Attack/Fault Tree-Driven Risk Assessment Example

NCCoE worked with Ramparts, LLC to perform a risk assessment by using attack/fault trees. The methodology allowed us to identify and prioritize the impacts of the attack events. Prioritizing the impacts of the attack events focused our attack-based scenario testing, countermeasure implementation, and countermeasure development.

When selecting the analysis approach, graph-based analysis provides an effective way to account for the many-to-many relationships between:

1. threat sources and threat events
2. threat events and vulnerabilities
3. threat events and impacts/assets

The following steps are involved in Ramparts' attack/fault tree risk assessment methodology:

1. Scope the Risk Assessment (define the Potential Harm, Security Characteristics, Critical Data Assets, and map to NIST Cybersecurity Framework)
2. Create Attack Event Trees (Threat Scenarios) that target the Security Characteristics and Critical Data Assets
3. Assign Countermeasures/Safeguards
4. Assign Likelihood of Occurrence of the Security Characteristics being compromised based on the Industry's Primary Adversaries
5. Analyze and Present Results (identify where the greatest relative risk to the system resides and where future efforts to minimize the risk should be placed)

Step 1: Scope the Risk Assessment.

The NIST Cybersecurity Framework is being used to communicate the scope of this risk assessment. The Potential Harm at its highest level has been defined as risk to the confidentiality, integrity, and availability of patient health information. The Security Characteristics as defined in Table 2 are mapped into the NIST Cybersecurity Framework and other standards.

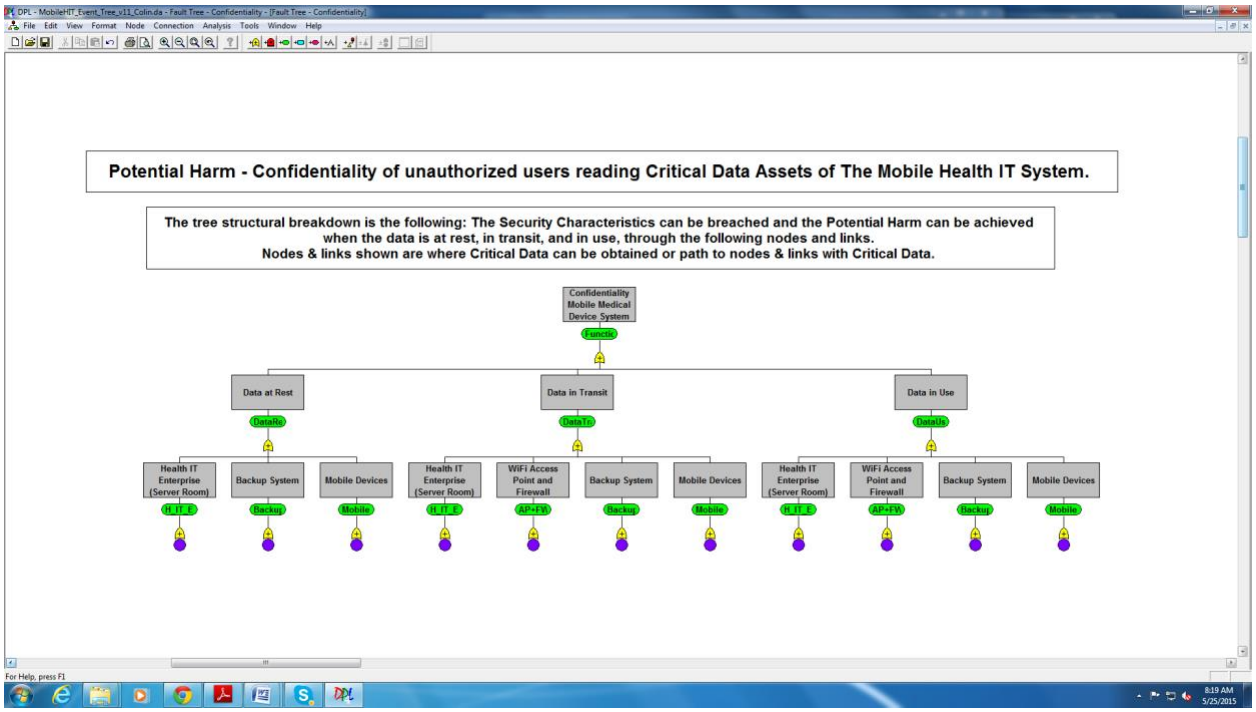
Step 2: Create Attack Event Trees (Attack Scenarios) that target the Security Characteristics and Critical Data Assets.

The potential attack events are developed by using event trees. We define a logical structure where the lower-level events can be given a likelihood of occurrence. A logical structure will also allow security experts with different specialties to review and contribute to the assessment more easily. The event nodes were decomposed to a level where a likelihood of occurrence could be assigned. An attack scenario is considered successful when all parallel events are AND'ed together. Which means, for an attack on a parent event to be considered successful, all parallel child events would need to be compromised. If the attack occurred to any one child event, then the parent event was potentially attacked; therefore, the paralleled events are considered OR'ed together.

The logical structure of the attack event trees chosen for this use case was the following:

1. A separate attack tree was created for three potential harms to confidentiality, integrity, and availability.
2. At the top of each tree, the potential harm was defined as the risk being modeled and measured.
3. The second layer of the tree was modeled as data-at-rest, data-in-transit, and data-in-use.
4. The third layer modeled the devices and data nodes of the system. Reference the confidentiality attack tree below.

Figure 5-1 Confidentiality Attack Tree



Step 3: Assign Countermeasures/Safeguards.

The countermeasures/safeguards detailed in NIST SP 1800-1B: Approach, Architecture, and Security Characteristics, Sections 4 and 5, as appropriate, were assigned to the low-level attack events.

As an example, up-to-date anti-virus software running on the mobile device was assigned when modeling the Install File Copying Malware event. Then this countermeasure was part of the consideration in assigning the Likelihood of Occurrence (step 4).

Step 4: Assign Likelihood of Occurrence of the Security Characteristics being compromised based on the Industry's Primary Adversaries.

The likelihood of occurrence is assigned as Very High, High, Medium-High, Medium, Low-Medium, Low, or Very Low. When getting expert opinions as input, this level of granularity might be too detailed, so a High, Medium, and Low relative qualitative scale could have been used instead.

The following scale of likelihoods was used:

Table 5-7 Scale of Likelihood of Occurrences

Value	Qualitative Numeric Value
Low	.01
Medium Low	.1
Medium	.5
Medium High	.75
High	.9

The qualitative numeric values are used in the event trees to calculate probabilities at the higher levels of the trees. This was done to assess whether particular attack scenarios are more likely to occur.

The following criteria are being used when assigning a likelihood of occurrence values to the low-level event (leaf) of the attack tree:

1. The adversary's likelihood of success. This success criterion considers the protection countermeasures deployed in the system, the complexity of the event, and the availability of known exploits.
2. The adversary's likelihood of not being detected. Not all detections are created equal. Where appropriate, the seven stages in the Kill Chain model are considered. Detection during the Reconnaissance stage (early in the attack) may be much more advantageous than detection during the Actions on Objectives stage (late in the attack). Obviously, when the adversary has been able to access critical data for months or years, and may have established other accesses into the system, the damage could be much greater. The detection countermeasures deployed in the system are considered for the detection criteria.
3. The adversary's resources required. The costs to the adversary in time and money are given a qualitative value for the event. Borrowing from MORDA, the following scale was used:

   Table 5-8 Value/Range Scales

Value	Range
Free	0–$1,000
Very Low	$1,000–$10,000
Low	$10,000–$100,000
Medium	$100,000–$1 Million
High	$1 Million–$10 Million
Very High	>$10 Million

   The assumption we used for this assessment was that the attacks that the potential adversaries would use are in the Very Low to Free resource levels.

4. When coming up with a single qualitative value to assign to the attack tree event, start with the likelihood of success, followed by the likelihood of detection, then the adversary's resources required.

   Understand that if an event is scored with an adversary's Low likelihood of success, it is still important to consider the adversary's likelihood of not being detected. A detection countermeasure(s) can help protect the critical data from zero-day attacks (unknown/unreported/unpatched attacks) and minimize the potential damage from all successful attacks on the critical data.

   This assessment gives equal weight to the adversary's likelihood of success and of not being detected. One goal of any organization providing good security is to make the resources that an adversary would need to accomplish its objective to be cost prohibitive. For this assessment, we have assumed those same low-level resources for all attack scenarios.

   Table 5-9 shows how the three types of Adversary Likelihoods can be combined to come up with a single value for the Assigned Likelihood of Occurrence.

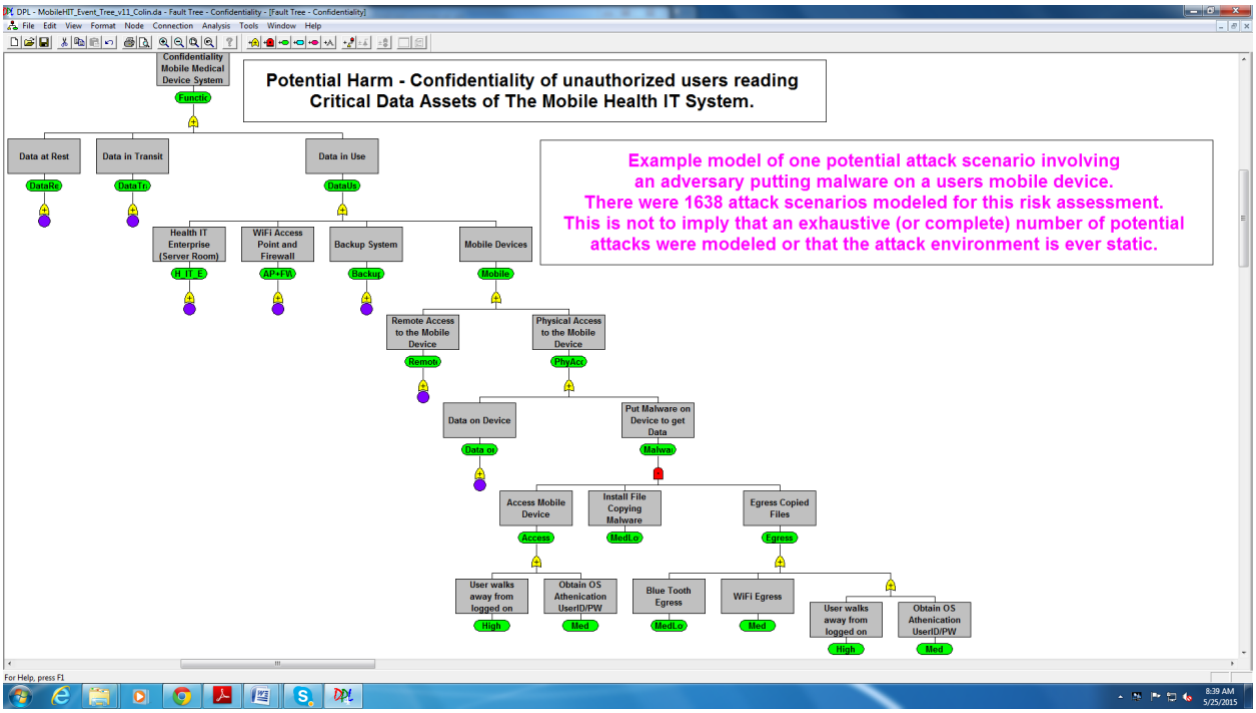
Table 5-9 Assigned Likelihood of Occurrence

Event	Adversary's Likelihood of Success	Adversary's Likelihood of Not Being Detected	Adversary's Resources Required	Assigned Likelihood of Occurrence Value
A	Very Low	Very Low	Free/Very Low	Very Low
B	Very Low	Low	Free/Very Low	Low
C	Very Low	Medium	Free/Very Low	Low-Medium
D	Very Low	High	Free/Very Low	Medium
E	Very Low	Very High	Free/Very Low	Medium-High
F	Low	Very Low	Free/Very Low	Low
G	Low	Low	Free/Very Low	Low
H	Low	Medium	Free/Very Low	Low-Medium
I	Low	High	Free/Very Low	Medium
J	Low	Very High	Free/Very Low	Medium-High
K	Medium	Very Low	Free/Very Low	Low-Medium
L	Medium	Low	Free/Very Low	Low-Medium
M	Medium	Medium	Free/Very Low	Medium
N	Medium	High	Free/Very Low	Medium-High
O	Medium	Very High	Free/Very Low	Medium-High
P	High	Very Low	Free/Very Low	Medium
Q	High	Low	Free/Very Low	Medium
R	High	Medium	Free/Very Low	Medium-High

Event	Adversary's Likelihood of Success	Adversary's Likelihood of Not Being Detected	Adversary's Resources Required	Assigned Likelihood of Occurrence Value
S	High	High	Free/Very Low	High
T	High	Very High	Free/Very Low	Very High
U	Very High	Very Low	Free/Very Low	Medium
V	Very High	Low	Free/Very Low	Medium
W	Very High	Medium	Free/Very Low	Medium-High
X	Very High	High	Free/Very Low	High
Y	Very High	Very High	Free/Very Low	Very High

See below for one complete attack branch (scenario). This branch shows the attack for Data-in-Use, Physical Access to the Mobile Device, and Putting Malware on Device to Get Data.

Figure 5-2 Attack Branch Scenario



Step 5: Analyze and Present Results.

Using established reliability probability theory, the events in the tree structure that are OR'ed together (those that can happen in parallel) can have their probabilities represented as P = 1-(1-p2)(1-p3), which is 1 minus the probability that both event 2 and event 3 have been accomplished by an adversary. Events AND'ed together (those that are sequential) can be represented as P = p4*p5, which is the probability that neither event 4 nor event 5 had been accomplished.

In the complex attack tree structure that was modeled, the following analytics were run and results used:

1. Partial derivatives were used to show where changes to the low-level attack events would have the greatest impact.
2. Calculated minimal cut sets gave the total number of attacks that were modeled.

An in-depth discussion of analytics used can be found in Risk Analysis Model (RAM) – Eighth Annual Canadian Computer Security Symposium.

The risk assessment methodology used here will typically be used to focus the evidence-based vulnerability testing used by system implementers and countermeasure developers, and as shown below, input into a risk management system/framework.

6 Risk Assessment Results

Based on our risk assessment, the major threats to confidentiality, integrity, and availability are:

- a lost or stolen mobile device
- a user who
  - walks away from a logged-on mobile device
  - downloads viruses or other malware
  - uses an insecure Wi-Fi network
- inadequate
  - access control and/or enforcement
  - change management
  - configuration management
  - data retention, backup, and recovery

The detailed risk assessment results for table-driven and fault-tree methods are captured in Appendix A and Appendix B, respectively.

7 Tests Performed in Security Controls Assessment

Table 7-1 summarizes the security controls assessment. We used NIST 800-53 controls for our methodology. You can use security and privacy controls that best fit your organization's needs.

Table 7-1 Security Controls Assessment

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
1	PR.AC-1: Identities and credentials are issued, managed, verified, revoked, and audited for authorized devices, users and processes	AC-2	Architecture accounts for multiple user roles and the access privileges assigned to each role	Log on to OpenEMR as an administrator to verify the account types specified that will allow the least privileged access necessary for users to perform their job function	The solution can allow multiple privilege and role levels
2	PR.AC-1: Identities and credentials are issued, managed, verified, revoked, and audited for authorized devices, users and processes	AC-2	Only currently authorized users are able to access the EHR data	Test that the system applies access controls: a) After verifying roles in OpenEMR, enter credentials for two users and two devices, no users for third device b) show a user can access authorized devices but not the third one c) delete one user's credentials d) show that user can no longer log in	- No EHR information can be accessed unless authorized credentials are used - A mechanism exists for a privileged user to add/modify/remove access
3	PR.AC-3: Remote access is managed	IA-3	Unknown devices are challenged when attempting to connect. Unknown devices are unable to connect to the EHR system	Test: Attempt to access OpenEMR by using a device that does not have a valid certificate	The EHR system recognizes the device as an unknown and either denies access completely or demands additional authentication before establishing connectivity.

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
4	PR.AC-3: Remote access is managed	AC-17	Connection to the EHR system is permitted only through specific secure protocols.	Test: a) Using a mobile device, attempt to connect to the EHR application a) via FTP, port 21; b) via HTTP port 80	The EHR system allows connections but does not allow access via insecure connections. Only secured and appropriate connection protocols are used
5	PR.AC-4: Access permissions and authorizations are managed, incorporating the principles of least privilege and separation of duties	AC-17, AC-6	System components are configured to allow only authorized access to information	Inspect component settings (network access control lists, firewall rules, operating system (OS) permissions, application settings) to verify that mechanisms exist to limit access to only authorized users and services. a)Verify that those restricted settings are in place b)Verify that services have the least privileged settings necessary to perform their function and use a default deny approach	Settings limit access to explicitly allowed systems and users
6	PR.AC-4: Access permissions and authorizations are managed, incorporating the principles of least privilege and separation of duties	AC-6	The system will not allow users greater access than their assigned role permits	Test that the system applies access controls: a) Log in as a privileged user; log out b) Log in as a user with no special privileges, attempt to gain privileged access	The nonprivileged user does not gain additional privileges
7	PR.AC-4: Access permissions and authorizations are	IA-5	Application and system components contain a mechanism to allow the	Within the application, examine settings to identify whether the components used in the solution provide an audit capability	An audit capability exists and can be employed

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
	managed, incorporating the principles of least privilege and separation of duties		auditing of privileged functions	that will indicate when privileged use has been employed	when implemented in a production environment
8	DE.CM-4: Malicious code is detected	SI-3	Malicious code protection (anti-virus software) is installed on mobile devices	a) Examine mobile devices to verify that malicious code protection is installed b) Inspect the signature file to ensure that the code protection software is current	Malicious code/anti-virus software is installed
9	DE.CM-4: Malicious code is detected	SC-35	The EHR application will not permit malicious code to be uploaded	a) Inspect the OS to ensure that malicious code protection is installed b) Test: Attempt to upload a European Institute for Computer Antivirus Research (EICAR) standard anti-virus test file within the application. Verify that the virus scanner responds as if it found a harmful virus c) Attempt to upload an EICAR test file that has been compressed d) Attempt to upload an EICAR test file that has been archived	The application should detect/quarantine all attempts to upload malicious files
10	DE.CM-5: Unauthorized mobile code is detected	SC-18	Verify that only mission-appropriate content may be uploaded within the application	Test: a) Log in to the OpenEMR application b) Identify fields within the application requiring user input c) Attempt to upload multiple file types, including those containing Hypertext Markup Language and JavaScript that contain script code	The application should employ functionality to restrict upload of file types to those expressly required for operations (e.g., TIFF, JPEG, and PDF)

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
11	PR.DS-1: Data-at-rest is protected	SC-28	Data within EHR is accessible only to authorized users and services	Inspect: a) Verify that encryption tools are employed by reviewing configuration settings or available logs or records to confirm that the installed encryption tools or software are operational. Document how it is implemented for the EHR data b) Indicate the encryption type in use and whether it is embedded in the EHR product or a separate mechanism c) Identify any noncryptographic mechanisms employed to protect data (file share scanning, and integrity protection)	Data is protected during storage and processing
12	PR.AC-3: Remote access is managed	AC-17(1)	Remote access to the EHR is monitored and controlled by access type, preventing unauthorized connections	Test: a) Have user A log in via the Internet; log out b) Have user A try to log in via dial-up. This should fail c) Have user B try to log in via the Internet. This should fail d) Have user B log in via dial-up from the authorized source location; log out e) Have user B try to log in via dial-up from an unauthorized source location. This should fail f) Have users A and C log in via Internet. Both users attempt to perform a privileged function. Only user C should be successful g) Have users B and C log in via dial-up from authorized source locations. Both users attempt to perform a privileged function. Only user C should be successful	Attempted logins and use of privileged functions succeed or fail as noted in preceding column. This demonstrates that the mechanisms for restricting access based on remote access type are enforced correctly by the EHR server

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
				h) Have an unauthorized user X attempt to access the EHR server remotely via dial-up from an authorized location (the location from which user B above is authorized to dial in). This should fail	
13	PR.AC-3: Remote access is managed	AC-17	Only devices with authorized MAC addresses will be granted access to the network	a) Use an authorized mobile device to log an authorized user in to the EHR b) Configure that otherwise legitimate mobile device to have a MAC address that is not authorized to access the network, and attempt to log on c) Verify that the login attempt fails	MAC address checking is performed
14	PR.AC-5: Network integrity is protected (e.g., network segregation, network segmentation)	AC-4	Information flow control policy is enforced to control the flow of info between the designated mobile devices and the EHR server	Test: a) Attempt to send EHR information from one mobile device directly to the other via the EHR application b) Attempt to perform Internet Protocol spoofing on the server OS. Command for evaluating on Linux: ls /proc/sys/net/ipv4/conf/*/rp_filter cat /proc/sys/net/ipv4/conf/*/rp_filter grep rp_filter /etc/sysctl.conf	1) EHR information will not be accessible directly from device to device 2) The system is protected from packets transmitted from a masquerading server
15	PR.DS-2: Data-in-transit is protected	SC-8, SC-13	The confidentiality and integrity of EHR information is protected while in transit (SC-8) by using a cryptographic mechanism	Examine transmission settings. Verify that the encryption mechanism is in place when transmitting data. Test: a) Set up Wireshark to eavesdrop on link between mobile device and EHR server and start capturing packets (a hub can be placed between the wireless access point and the wired network and Wireshark run on a computer connected to the hub)	FIPS 140-2-compliant mechanism is used to secure data-in-transit

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
				b) Send EHR info from mobile device to EHR server c) Turn off packet capture d) Examine packet capture to verify that a digital signature was sent with the EHR info transmitted e) Calculate what the digital signature should be for this EHR and verify that it is the same as the value that was transmitted f) Verify that the packets containing health information are encrypted exactly as they should be given the encryption algorithm used	
16	PR.PT-4: Communication and control networks are protected	SC-7	All Wi-Fi-related products in the system conform to IEEE 802.11i and IEEE 802.1X standards	Consult Wi-Fi Alliance online list of Wi-Fi Certified products to verify that all mobile devices and access points used in the system are Wi-Fi Alliance certified in the three security areas of a) WPA2™ (Wi-Fi Protected Access®, b) Extensible Authentication Protocol, and 3) Protected Management Frames	Devices in use are Wi-Fi Certified
17	PR.PT-4: Communications and control networks are protected	SC-7	Wired network is hardened (EHR server is protected by a firewall, anti-virus software, and an intrusion detection system [IDS], and all patching is up-to-date)	Inspect wired network to verify presence of a firewall, anti-virus software, and an IDS. Confirm that all patching is up-to-date	Wired network has listed security components installed
18	PR.PT-4: Communications and control	SC-7	Mobile device (wireless client) is hardened in general	Mobile device has a firewall, anti-virus software, and an IDS installed; its patching is up-to-date; 802.11 ad hoc mode is	Mobile device has listed security components installed

Test ID	NIST Cybersecurity Framework Subcategory	Related NIST 800-53 Control	Evaluation Objective	Evaluation Steps	Evidence of Conformance
	networks are protected			disabled; and Bluetooth is turned off by default	
19	PR.PT-4: Communications and control networks are protected	SC-7	The application accepts connections from only those devices hardened in compliance with security policy	a) Use a mobile device to log in to OpenEMR. Log out b) Turn on Bluetooth on that mobile device and attempt to log in to the EHR c) Verify that the mobile device can no longer log in to the EHR server	Noncompliant mobile devices may not access the OpenEMR application
20	PR.PT-4: Communications and control networks are protected	SC-7	A mobile device's configuration goes out of compliance while logged in	a) Use a mobile device to log in to OpenEMR b) While logged in to OpenEMR, turn on Bluetooth for that mobile device c) Verify that the mobile device is not visible to other devices	Mobile devices outside the EHR application are unable to connect to a mobile device accessing OpenEMR

8 Risk Questionnaire for Healthcare Organizations Selecting a Cloud-Based Electronic Health Record Provider

8.1 Introduction

Healthcare organizations with limited resources and capital may, based on their individual enterprise risk assessment, choose cloud-based services to provide healthcare IT for clinicians and administrators. Because cloud computing resources are often shared by multiple tenants and hosted outside a healthcare organization's perimeters, and data is transmitted through the public internet, healthcare organizations should become educated about the potential risks of using the cloud for their healthcare IT needs.

The functionalities provided, the service levels offered, and the ability to achieve compliance with legal, regulatory, and security-related standards and requirements might differ significantly among different cloud computing vendors. The Office of Civil Rights (OCR) for Health Information Technology provides a questionnaire [11] to help healthcare organizations perform the security risk assessment. On top of utilizing the risk assessment results, an organization can also tailor the OCR's questionnaire to shop for a cloud vendor that provides security for health information and personal privacy along with supports for technical and legal compliance.

The questionnaire should not be viewed as an exhaustive arbiter of security when shopping for a cloud provider. Rather, it is intended to help organizations address security concerns in the early stages so that potential threats and vulnerabilities can be mitigated and minimized in the future. We strongly recommend that each organization performs a thorough risk assessment before moving to cloud-based healthcare IT services, and makes a strategic decision based on the organization's financial, business operation, and legal and regulatory requirements. We also recommend regular reassessments when there are significant changes to the organization's environment.

8.2 Security Questionnaire

1. Vendor Agreements
    a. Is the EHR system vendor willing to sign a comprehensive business service agreement?
    b. Is the EHR system vendor willing to confirm compliance with HIPAA Privacy and Security Rules, and willing to be audited, if requested?
2. Third-Party Application Integration
    a. Does the healthcare organization need to integrate the cloud-based EHR system with other in-house products, such as practice management software, billing systems, and email systems?
    b. If integration of the cloud-based EHR system to in-house applications is needed, what are the implementation procedures and techniques used? What security features protect the data communicated among different systems?
3. Personal or Device Authentication and Authorization
    a. Does the EHR system vendor restrict the type of mobile devices that can access the system?

b. Are mobile devices subject to some kind of mobile device management control for enforcing device security compliance?

c. Are there any security compliance policies for using a client's own device to access the cloud-based EHR system?

d. If a device is lost, stolen, or found to be hacked, are there any countermeasures in place to prevent protected data from becoming compromised?

e. Does the cloud-based EHR system require a user to be authenticated prior to obtaining access to patient health information?

   i. What are the authentication mechanisms used for accessing the system?

   ii. Are user IDs uniquely identifiable?

   iii. Is multifactor authentication used? Which factors?

   iv. If passwords are used, does the vendor enforce strong passwords and specify the life cycle of the password?

f. Does the system offer a role-based access control approach to restrict system access to authorized users to different data sources?

g. Is the least privilege policy used? (A user of a system has only enough rights to conduct an authorized action within a system, and all other permissions are denied by default.)

4. Data Protection

   a. What measures are used to protect the data stored in the cloud?

   b. What measures are used to protect the data from loss, theft, and hacking?

   c. Does the system back up an exact copy of protected data? Are these backup files kept in a different location, well protected, and easily restored?

   d. Does the system encrypt the protected data while at rest?

   e. What happens if the EHR system vendor goes out of business? Will all clinical data and information be retrievable?

   f. Does the EHR system vendor have security procedures and policies for decommissioning used IT equipment and storage devices that contained or processed sensitive information?

5. Security of Data in Transmission

   a. How does the network provide security for data in transmission?

   b. What capabilities are available for encrypting health information as it is transmitted from one point to another?

   c. What reasonable and appropriate steps are taken to reduce the risk that patient health information can be intercepted or modified when it is being sent electronically?

6. Monitoring and Auditing

   a. Are systems and networks monitored continuously for security events?

b. Does the EHR vendor log all the authorized and unauthorized access sessions and offer auditing?

c. Does the system have audit control mechanisms that can monitor, record, and/or examine information system activities that create, store, modify, and transmit patient health information?

d. Does the system retain copies of its audit/access records?

e. How does the EHR system vendor identify, respond to, handle, and report suspected security incidents?

7. Emergencies

    a. Does the EHR system vendor offer the ability to activate emergency access to its information system in the event of a disaster?

    b. Does the EHR system vendor have policies and procedures to identify the role of the individual responsible for accessing and activating emergency access settings, when necessary?

    c. Is the EHR system designed to provide recovery from an emergency and resume normal operations and access to patient health information during a disaster?

8. Customer and Technical Support

    a. What is included in the customer support/IT support contract and relevant service level agreements?

    b. Can the EHR system vendor provide a written copy of its security and privacy policies and procedures (including disaster recovery)?

    c. How often are new features released? How are they deployed?

Appendix A Table-Driven Risk Assessment Results

Table A-1 Table-Driven Results – Adversarial Risk Based on Confidentiality

1	2	3	4	5	6	7	8	9	10	11	12	13	
Threat Event	Threat Sources	Threat Source Characteristics			Relevance	Likelihood of Attack Initiation	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Initiated Attack Succeeds	Overall Likelihood	Level of Impact	Risk	Risk Score
		Capability	Intent	Targeting									
System intrusion and unauthorized system access	Adversarial/ hacker	Moderate	High	High	Possible	Moderate	Possible weak passwords due to lack of password complexity control	High	High	High	Very High	Very High	10
Obtain sensitive information through network sniffing of external networks	Adversarial/ hacker	Low	Moderate	Moderate	Predicted	Moderate	Inadequate incorporation of security into architecture and design	Moderate	High	High	Very High	Very High	10
Stolen mobile devices	Adversarial/ hacker	High	High	High	Confirmed	High	Lack of user training and physical security	High	High	High	High	High	8
Conduct communications interception attacks	Adversarial/ hacker	Low	High	Moderate	Possible	Moderate	Lack of transmission encryption leading to interception of unencrypted data	High	High	High	High	High	8

1	2	3	4	5	6	7	8	9	10	11	12	13	
Threat Event	Threat Sources	Threat Source Characteristics			Relevance	Likelihood of Attack Initiation	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Initiated Attack Succeeds	Overall Likelihood	Level of Impact	Risk	Risk Score
		Capability	Intent	Targeting									
Cause integrity loss by creating, deleting, and/or modifying data on publicly accessible information systems (e.g., web defacement)	Adversarial/ hacker	Moderate	Moderate	Moderate	Predicted	Moderate	Inadequate access control and/or enforcement Inadequate data retention, backup, and recovery	Moderate	Moderate	High	High	High	8
Exploit known vulnerabilities in mobile systems (e.g., laptops, PDAs, smartphones)	Adversarial/ hacker	Moderate	High	High	Possible	High	Malware — TECHNICAL/Architectural and Functional	Moderate	Moderate	Moderate	High	Moderate	5
Deliver/insert/install malicious capabilities	Adversarial/ hacker	Moderate	High	Moderate	Anticipated	Moderate	Inadequate incorporation of security into architecture and design	Moderate	Moderate	Moderate	High	Moderate	5
Conduct an attack (i.e., direct/coordinate attack tools or activities)	Adversarial/ hacker	Moderate	Moderate	Moderate	Anticipated	Moderate	Inadequate incorporation of security into architecture and design	Moderate	Moderate	Moderate	Moderate	Moderate	5

Table A-2 Table-Driven Results – Adversarial Risk Based on Availability

1	2	3	4	5	6	7	8	9	10	11	12	13	
Threat Event	Threat Sources	Threat Source Characteristics			Relevance	Likelihood of Attack Initiation	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Initiated Attack Succeeds	Overall Likelihood	Level of Impact	Risk	Risk Score
		Capability	Intent	Targeting									
Stolen mobile devices	Adversarial/ hacker	High	High	High	Confirmed	High	Lack of user training and physical security	Moderate	Moderate	High	High	High	8
Exploit known vulnerabilities in mobile systems (e.g., laptops, PDAs, smartphones)	Adversarial/ hacker	Moderate	High	High	Possible	High	Malware — TECHNICAL/Architectural and Functional	Moderate	Moderate	Moderate	High	High	8
Cause integrity loss by creating, deleting, and/or modifying data on publicly accessible information systems (e.g., web defacement)	Adversarial/ hacker	Moderate	Moderate	Moderate	Predicted	Moderate	Inadequate access control and/or enforcement Inadequate data retention, backup, and recovery	Moderate	Moderate	High	High	High	8
System intrusion and unauthorized system access	Adversarial/ hacker	Moderate	High	High	Possible	Moderate	Possible weak passwords due to lack of password	Moderate	Moderate	Moderate	High	Moderate	5

1	2	3	4	5	6	7	8	9	10	11	12	13	
Threat Event	Threat Sources	Threat Source Characteristics			Relevance	Likelihood of Attack Initiation	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Initiated Attack Succeeds	Overall Likelihood	Level of Impact	Risk	Risk Score
		Capability	Intent	Targeting									
							complexity control						
Conduct communication interception attacks	Adversarial/ hacker	Low	High	Moderate	Possible	Moderate	Lack of transmission encryption leading to interception of unencrypted data	Moderate	Moderate	Moderate	High	Moderate	5
Deliver/insert/install malicious capabilities	Adversarial/ hacker	Moderate	High	Moderate	Anticipated	Moderate	Inadequate incorporation of security into architecture and design	Moderate	Moderate	Moderate	High	Moderate	5
Obtain sensitive information through network sniffing of external networks	Adversarial/ hacker	Low	Moderate	Moderate	Predicted	Moderate	Inadequate incorporation of security into architecture and design	Moderate	Low	Moderate	Moderate	Moderate	5
Conduct an attack (i.e., direct/coordinate attack tools or activities)	Adversarial/ hacker	Moderate	Moderate	Moderate	Anticipated	Moderate	Inadequate incorporation of security into architecture and design	Moderate	Low	Low	Moderate	Low	2

Table A-3 Table-Driven Results – Non-adversarial Risk Based on Confidentiality

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Spill sensitive information	Accidental (users, admin users)	Moderate	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	Very High	Very High	Very High	Very High	10
Lost mobile device	Accidental (users)	Very Low	Confirmed	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	High	High	High	8
Incorrect privilege settings	Accidental (users, admin users)	High	Predicted	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	Moderate	High	High	8
Mishandling of critical and/or sensitive information by authorized users	Accidental (users, admin users)	High	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	Very High	Moderate	High	High	8
Walks away from logged-on devices	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training	Moderate	High	Moderate	Moderate	Moderate	5

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Downloads viruses or other malware	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training Lack of policy enforcement Inadequate configuration management	Moderate	Moderate	Moderate	Moderate	Moderate	5
Uses an insecure Wi-Fi network	Accidental (users)	Very Low	Confirmed	High	Inadequate user training	Low	Moderate	Moderate	Moderate	Moderate	5
Introduction of vulnerabilities into software products	STRUCTURAL (Software)	High	Expected	Moderate	Inadequate change management and/or configuration management	High	Moderate	Moderate	Moderate	Moderate	5
Weak access control	Accidental (users, admin users)	High	Predicted	Moderate	Inadequate access control and/or enforcement	High	Moderate	Moderate	Moderate	Moderate	5
Disk error	STRUCTURAL (IT equipment)	High	Expected	Moderate	Lack of environmental controls	Moderate	Low	Low	Moderate	Low	2

Table A-4 Table-Driven Results – Non-adversarial Risk Based on Integrity

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Mishandling of critical and/or sensitive information by authorized users	Accidental (users, admin users)	High	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	Very High	Very High	Very High	Very High	10
Spill sensitive information	Accidental (users, admin users)	Moderate	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	Very High	High	High	High	8
Lost mobile device	Accidental (users)	Very Low	Confirmed	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	High	High	High	8
Incorrect privilege settings	Accidental (users, admin users)	High	Predicted	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	Moderate	High	High	8
Walks away from logged-on devices	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training	Moderate	High	Moderate	Moderate	Moderate	5

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Downloads viruses or other malware	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training Lack of policy enforcement Inadequate configuration management	Moderate	Moderate	Moderate	Moderate	Moderate	5
Uses an insecure Wi-Fi network	Accidental (users)	Very Low	Confirmed	High	Inadequate user training	Low	Moderate	Moderate	Moderate	Moderate	5
Introduction of vulnerabilities into software products	STRUCTURAL (Software)	High	Expected	Moderate	Inadequate change management and/or configuration management	High	Moderate	Moderate	Moderate	Moderate	5
Weak access control	Accidental (users, admin users)	High	Predicted	Moderate	Inadequate access control and/or enforcement	High	Moderate	Moderate	Moderate	Moderate	5
Disk error	STRUCTURAL (IT equipment)	High	Expected	Moderate	Lack of environmental controls	Moderate	Low	Low	Moderate	Low	2

Table A-5 Table-Driven Results – Non-adversarial Risk Based on Availability

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Lost mobile device	Accidental (users)	Very Low	Confirmed	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	Very High	Very High	Very High	Very High	10
Mishandling of critical and/or sensitive information by authorized users	Accidental (users, admin users)	High	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	High	High	High	High	8
Spill sensitive information	Accidental (users, admin users)	Moderate	Predicted	Low	Inadequate user training Untraceable user actions	Moderate	Very High	High	High	High	8
Downloads viruses or other malware	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training Lack of policy enforcement Inadequate configuration management	Moderate	Moderate	High	High	High	8

1	2	3	4	5	6	7	8	9	10	11	
Threat Event	Threat Sources	Range of Effects	Relevance	Likelihood of Event Occurring	Vulnerabilities and Predisposing Conditions	Severity and Pervasiveness	Likelihood Event Results in Adverse Impact	Overall Likelihood	Level of Impact	Risk	Risk Score
Introduction of vulnerabilities into software products	STRUCTURAL (Software)	High	Expected	Moderate	Inadequate change management and/or configuration management	High	Moderate	High	High	High	8
Disk error	STRUCTURAL (IT equipment)	High	Expected	Moderate	Lack of environmental controls	Moderate	Low	High	High	High	8
Incorrect privilege settings	Accidental (users, admin users)	High	Predicted	Moderate	INFORMATION-RELATED/Special Access Programs	Moderate	High	Moderate	Moderate	Moderate	5
Walks away from logged-on devices	Accidental (users)	Low	Confirmed	Moderate	Inadequate user training	Moderate	High	Moderate	Moderate	Moderate	5
Uses an insecure Wi-Fi network	Accidental (users)	Very Low	Confirmed	High	Inadequate user training	Low	Moderate	Moderate	Moderate	Moderate	5
Weak access control	Accidental (users, admin users)	High	Predicted	Moderate	Inadequate access control and/or enforcement	High	Moderate	Moderate	Moderate	Moderate	5

Appendix B Fault-Tree Risk Assessment Results

Table B-1 Fault-Tree Results Based on Confidentiality

Partial Derivative	Probability	Maximum Impact	Event
0.0715	0.9	0.0644	User_walks_away_from_logged_on_Mobile_Device1
0.0715	0.9	0.0644	User_walks_away_from_logged_on_Mobile_Device54
0.00732	0.1	0.000732	Install_File_Copying_Malware
0.00732	0.1	0.000732	Install_File_Copying_Malware551
0.000385	0.9	0.000347	User_walks_away_from_logged_on_Mobile_Device443
0.000385	0.9	0.000347	User_walks_away_from_logged_on_Mobile_Device554
0.000604	0.5	0.000302	Mobile_Device_User_Does_Not_Notice
0.00302	0.1	0.000302	Connect_as_OpenEMR2
0.000335	0.9	0.000302	Ask_Receives_Critical_Data_from_the_User1
0.000335	0.9	0.000302	Disconnect_OpenEMR
0.000169	0.9	0.000152	User_walks_away_from_logged_on_Mobile_Device442
0.000169	0.9	0.000152	User_walks_away_from_logged_on_Mobile_Device555
7.22E-05	0.9	6.50E-05	Steal_Media2
0.0065	0.01	6.50E-05	Decrypt_Critical_Data11
7.22E-05	0.9	6.50E-05	Steal_Media40
0.0065	0.01	6.50E-05	Decrypt_Critical_Data440
0.0065	0.01	6.50E-05	Decrypt_Critical_Data554
7.22E-05	0.9	6.50E-05	Steal_Media54
6.51E-05	0.9	5.86E-05	PluginHub
0.00586	0.01	5.86E-05	Decrypt_Critical_Data443
6.51E-05	0.9	5.86E-05	PluginHub54
0.00586	0.01	5.86E-05	Decrypt_Critical_Data534
6.33E-05	0.9	5.70E-05	Laptop_Wireshark2
6.33E-05	0.9	5.70E-05	Laptop_Wireshark54
0.00396	0.01	3.96E-05	Decrypt_Backup_Data_at_Rest25
0.00396	0.01	3.96E-05	Decrypt_Backup_Data_at_Rest544
7.71E-05	0.5	3.85E-05	Obtain_OS_Authentication443
7.71E-05	0.5	3.85E-05	Obtain_OS_Authentication555
0.00359	0.01	3.59E-05	Decrypt_the_Back_up4
0.00359	0.01	3.59E-05	Decrypt_the_Back_up54
7.19E-05	0.5	3.59E-05	During_Physical_Transfer_Obtain_Copy54

Partial Derivative	Probability	Maximum Impact	Event
7.19E-05	0.5	3.59E-05	During_Physical_Transfer_Obtain_Copy1
6.47E-05	0.5	3.24E-05	Obtain_a_copy_of_the_backup
6.47E-05	0.5	3.24E-05	Obtain_a_copy_of_the_backup54
3.37E-05	0.5	1.69E-05	WiFi_Egress442
3.37E-05	0.5	1.69E-05	WiFi_Egress54
3.37E-05	0.5	1.69E-05	Obtain_OS_Authentication442
3.37E-05	0.5	1.69E-05	Obtain_OS_Authentication55
3.23E-05	0.5	1.61E-05	Send_Data_to_New_GW
3.23E-05	0.5	1.61E-05	Acquire_Password2
0.00161	0.01	1.61E-05	Decrypt_Critical_Data16
3.23E-05	0.5	1.61E-05	Acquire_Password54
1.79E-05	0.9	1.61E-05	Capture_Critical_Data2
3.23E-05	0.5	1.61E-05	Send_Data_to_New_GW54
0.00161	0.01	1.61E-05	Decrypt_Critical_Data1554
1.79E-05	0.9	1.61E-05	Capture_Critical_Data554
0.000135	0.1	1.35E-05	Critical_Data_is_Resident_on_the_Mobile_Device
0.000135	0.1	1.35E-05	Critical_Data_is_Resident_on_the_Mobile_Device54
0.00114	0.01	1.14E-05	Decrypt_Critical_Data338
0.00114	0.01	1.14E-05	Decrypt_Critical_Data339
0.00114	0.01	1.14E-05	Decrypt_Critical_Data7
0.00114	0.01	1.14E-05	Decrypt_Critical_Data5
0.00114	0.01	1.14E-05	Decrypt_Critical_Data552
0.00114	0.01	1.14E-05	Decrypt_Critical_Data53
0.00088	0.01	8.80E-06	Decrypt_Critical_Data35
0.00088	0.01	8.80E-06	Decrypt_Critical_Data40
0.00088	0.01	8.80E-06	Decrypt_Critical_Data54
1.02E-05	0.75	7.67E-06	Thumb_Drive40
1.02E-05	0.75	7.67E-06	Thumb_Drive
1.02E-05	0.75	7.67E-06	Thumb_Drive54
0.000716	0.01	7.16E-06	Blue_Tooth_Access
7.16E-05	0.1	7.16E-06	Critical_Data_residue_on_Mobile_device2
7.16E-05	0.1	7.16E-06	Gain_Access_to_the_Backup_System1
0.000716	0.01	7.16E-06	Decrypt_Backup_Data_at_Rest21
0.000716	0.01	7.16E-06	Blue_Tooth_Access454

Partial Derivative	Probability	Maximum Impact	Event
7.16E-05	0.1	7.16E-06	Backup_data_Captured1
7.16E-05	0.1	7.16E-06	Critical_Data_residue_on_Mobile_device454
7.16E-05	0.1	7.16E-06	Gain_Access_to_the_Backup_System54
0.000716	0.01	7.16E-06	Decrypt_Data20
7.16E-05	0.1	7.16E-06	Backup_data_Captured54
0.000716	0.01	7.16E-06	Decrypt_Data54
0.000716	0.01	7.16E-06	Decrypt_Backup_Data_at_Rest54
0.000674	0.01	6.74E-06	Remote_Access_to_the_MDM1
0.000674	0.01	6.74E-06	Physical_Access_to_the_MDM1
0.000674	0.01	6.74E-06	Remote_Access_to_the_MDM54
0.000674	0.01	6.74E-06	Physical_Access_to_the_MDM54
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR339
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR38
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR53
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR52
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR5
6.70E-05	0.1	6.70E-06	Access_to_Health_IT_OpenEMR9
7.16E-06	0.9	6.44E-06	WiFi_Data_Capture2
6.44E-05	0.1	6.44E-06	Decrypt_WiFi_Data_Transfer3
0.000644	0.01	6.44E-06	Decrypt_Critical_Data14
0.000644	0.01	6.44E-06	Decrypt_Critical_Data544
6.44E-05	0.1	6.44E-06	Decrypt_WiFi_Data_Transfer54
7.16E-06	0.9	6.44E-06	WiFi_Data_Capture54
7.13E-06	0.9	6.42E-06	Image_Disk_with_Forensic_Tool1
7.13E-06	0.9	6.42E-06	Image_Disk_with_Forensic_Tool54
0.000625	0.01	6.25E-06	Decrypt_Critical_Data31
0.000625	0.01	6.25E-06	Decrypt_Critical_Data51
0.000625	0.01	6.25E-06	Decrypt_Critical_Data37
5.19E-05	0.1	5.19E-06	Access_to_Health_IT_OpenEMR40
5.19E-05	0.1	5.19E-06	Access_to_Health_IT_OpenEMR45
5.19E-05	0.1	5.19E-06	Access_to_Health_IT_OpenEMR54
1.02E-05	0.5	5.11E-06	Buying_Malware
1.02E-05	0.5	5.11E-06	Buying_Malware37
1.02E-05	0.5	5.11E-06	Buying_Malware51

Partial Derivative	Probability	Maximum Impact	Event
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR7
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR11
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR39
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR338
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR552
4.20E-05	0.1	4.20E-06	Access_to_Health_IT_OpenEMR553
3.68E-05	0.1	3.68E-06	Access_to_Health_IT_OpenEMR2
3.68E-05	0.1	3.68E-06	Access_to_Health_IT_OpenEMR337
3.68E-05	0.1	3.68E-06	Access_to_Health_IT_OpenEMR51
3.60E-05	0.1	3.60E-06	Access_the_Backup_system_on_site1
3.60E-05	0.1	3.60E-06	Access_the_Backup_system_on_site54
3.25E-05	0.1	3.25E-06	Access_to_Health_IT_OpenEMR35
3.25E-05	0.1	3.25E-06	Access_to_Health_IT_OpenEMR440
3.25E-05	0.1	3.25E-06	Access_to_Health_IT_OpenEMR554
5.80E-06	0.5	2.90E-06	Mobile_Device_User_Does_Not_Notice38
0.00029	0.01	2.90E-06	Decrypt_Critical_Data52
0.00029	0.01	2.90E-06	Decrypt_Critical_Data38
2.90E-05	0.1	2.90E-06	Connect_as_OpenEMR38
5.80E-06	0.5	2.90E-06	Mobile_Device_User_Does_Not_Notice52
3.22E-06	0.9	2.90E-06	Ask_Receives_Critical_Data_from_the_User38
3.22E-06	0.9	2.90E-06	Disconnect_OpenEMR38
3.22E-06	0.9	2.90E-06	Disconnect_OpenEMR52
2.90E-05	0.1	2.90E-06	Connect_as_OpenEMR52
3.22E-06	0.9	2.90E-06	Ask_Receives_Critical_Data_from_the_User52
3.58E-06	0.75	2.68E-06	Malicious_Access_Point1
2.68E-05	0.1	2.68E-06	Critical_data_is_resident_on_Mobile_device1
0.000268	0.01	2.68E-06	Access_from_AP_to_Mobile_Device1
5.37E-06	0.5	2.68E-06	Mobile_Device_Attaches_to_Malicious_Access_Point1
0.000268	0.01	2.68E-06	Access_from_AP_to_Mobile_Device54
3.58E-06	0.75	2.68E-06	Malicious_Access_Point54
2.68E-05	0.1	2.68E-06	Critical_data_is_resident_on_Mobile_device54
5.37E-06	0.5	2.68E-06	Mobile_Device_Attaches_to_Malicious_Access_Point54
2.31E-05	0.1	2.31E-06	Access_to_Health_IT_OpenEMR4
2.31E-05	0.1	2.31E-06	Access_to_Health_IT_OpenEMR37

Partial Derivative	Probability	Maximum Impact	Event
2.31E-05	0.1	2.31E-06	Access_to_Health_IT_OpenEMR551
1.87E-05	0.1	1.87E-06	Blue_Tooth_Egress442
1.87E-05	0.1	1.87E-06	Blue_Tooth_Egress54
0.000148	0.01	1.48E-06	Access_from_AP_to_Mobile_Device443
1.97E-06	0.75	1.48E-06	Malicious_Access_Point443
2.95E-06	0.5	1.48E-06	Mobile_Device_Attaches_to_Malicious_Access_Point443
1.48E-05	0.1	1.48E-06	Install_File_Copying_Malware443
2.41E-06	0.5	1.21E-06	WiFi_Egress443
1.13E-05	0.1	1.13E-06	Access_thru_HIT_Server_Room_Firewall
0.000113	0.01	1.13E-06	Decrypt_Critical_Data
1.13E-05	0.1	1.13E-06	Access_thru_HIT_Server_Room_Firewall50
0.000113	0.01	1.13E-06	Decrypt_Critical_Data36
1.13E-05	0.1	1.13E-06	Access_thru_HIT_Server_Room_Firewall36
0.000113	0.01	1.13E-06	Decrypt_Critical_Data50
1.43E-06	0.5	7.13E-07	Obtain_OS_Authentication1
1.43E-06	0.5	7.13E-07	Obtain_OS_Authentication54
6.69E-06	0.1	6.69E-07	Access_to_Health_IT_OpenEMR
6.69E-06	0.1	6.69E-07	Access_to_Health_IT_OpenEMR36
6.69E-06	0.1	6.69E-07	Access_to_Health_IT_OpenEMR50
7.15E-07	0.9	6.44E-07	Capture_Critical_Data54
6.44E-05	0.01	6.44E-07	Breach_Firewall54
6.44E-05	0.01	6.44E-07	Decrypt_Critical_Data154
5.68E-06	0.1	5.68E-07	Coding_Malware
5.68E-06	0.1	5.68E-07	Coding_Malware37
5.68E-06	0.1	5.68E-07	Coding_Malware51
4.19E-06	0.1	4.19E-07	Access_to_Health_IT_OpenEMR30
4.19E-06	0.1	4.19E-07	Access_to_Health_IT_OpenEMR366
4.19E-06	0.1	4.19E-07	Access_to_Health_IT_OpenEMR550
7.15E-07	0.5	3.58E-07	Capture_Critical_Data3
3.58E-05	0.01	3.58E-07	Breach_Firewall
3.58E-05	0.01	3.58E-07	Decrypt_Critical_Data15
2.84E-06	0.1	2.84E-07	Egress_Data_Thru_Firewall40
2.84E-06	0.1	2.84E-07	Egress_Data_Thru_Firewall2
2.84E-06	0.1	2.84E-07	Egress_Data_Thru_Firewall54

Partial Derivative	Probability	Maximum Impact	Event
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management34
2.50E-06	0.1	2.50E-07	VPN_Server32
2.50E-06	0.1	2.50E-07	Risk_Manager32
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners32
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root2
2.50E-06	0.1	2.50E-07	DNS_Server_Ext34
2.50E-06	0.1	2.50E-07	Health_IT_DNS34
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_34
2.50E-06	0.1	2.50E-07	Health_IT_DNS32
2.50E-06	0.1	2.50E-07	DNS_Server_Ext32
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root32
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_32
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management32
2.50E-06	0.1	2.50E-07	Virus_Malware32
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_32
2.50E-06	0.1	2.50E-07	Risk_Manager34
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners34
2.50E-06	0.1	2.50E-07	Virus_Malware34
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_34
2.50E-06	0.1	2.50E-07	VPN_Server34
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_38
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_38
2.50E-06	0.1	2.50E-07	Virus_Malware38
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management38
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners38
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root38
2.50E-06	0.1	2.50E-07	DNS_Server_Ext38
2.50E-06	0.1	2.50E-07	Health_IT_DNS38
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_39
2.50E-06	0.1	2.50E-07	VPN_Server38
2.50E-06	0.1	2.50E-07	VPN_Server39
2.50E-06	0.1	2.50E-07	Risk_Manager39
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners39
2.50E-06	0.1	2.50E-07	Virus_Malware39

Partial Derivative	Probability	Maximum Impact	Event
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_39
2.50E-06	0.1	2.50E-07	Risk_Manager38
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management39
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root39
2.50E-06	0.1	2.50E-07	Health_IT_DNS39
2.50E-06	0.1	2.50E-07	DNS_Server_Ext39
2.50E-06	0.1	2.50E-07	VPN_Server53
2.50E-06	0.1	2.50E-07	Risk_Manager53
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners53
2.50E-06	0.1	2.50E-07	Virus_Malware53
2.50E-06	0.1	2.50E-07	Health_IT_DNS53
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_53
2.50E-06	0.1	2.50E-07	VPN_Server52
2.50E-06	0.1	2.50E-07	DNS_Server_Ext53
2.50E-06	0.1	2.50E-07	Vulnerability_Scanners52
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management53
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root53
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_53
2.50E-06	0.1	2.50E-07	Risk_Manager52
2.50E-06	0.1	2.50E-07	Health_IT_CA_Root52
2.50E-06	0.1	2.50E-07	Mobile_Network_Access_Control__NAC_52
2.50E-06	0.1	2.50E-07	DNS_Server_Ext52
2.50E-06	0.1	2.50E-07	Health_IT_Configuration_Management52
2.50E-06	0.1	2.50E-07	Virus_Malware52
2.50E-06	0.1	2.50E-07	Health_IT_DNS52
2.50E-06	0.1	2.50E-07	Intrusion_Detection_System__IDS_52
1.94E-06	0.1	1.94E-07	Health_IT_CA_Root40
1.94E-06	0.1	1.94E-07	Intrusion_Detection_System__IDS_40
1.94E-06	0.1	1.94E-07	DNS_Server_Ext40
1.94E-06	0.1	1.94E-07	Mobile_Network_Access_Control__NAC_40
1.94E-06	0.1	1.94E-07	Vulnerability_Scanners40
1.94E-06	0.1	1.94E-07	Health_IT_Configuration_Management40
1.94E-06	0.1	1.94E-07	Health_IT_DNS40
1.94E-06	0.1	1.94E-07	VPN_Server40

Partial Derivative	Probability	Maximum Impact	Event
1.94E-06	0.1	1.94E-07	Virus_Malware40
1.94E-06	0.1	1.94E-07	Risk_Manager40
1.94E-06	0.1	1.94E-07	Health_IT_Configuration_Management54
1.94E-06	0.1	1.94E-07	Health_IT_CA_Root54
1.94E-06	0.1	1.94E-07	Vulnerability_Scanners54
1.94E-06	0.1	1.94E-07	Intrusion_Detection_System__IDS_54
1.94E-06	0.1	1.94E-07	Health_IT_DNS54
1.94E-06	0.1	1.94E-07	DNS_Server_Ext54
1.94E-06	0.1	1.94E-07	Health_IT_CA_Root35
1.94E-06	0.1	1.94E-07	Mobile_Network_Access_Control__NAC_54
1.94E-06	0.1	1.94E-07	DNS_Server_Ext35
1.94E-06	0.1	1.94E-07	Health_IT_Configuration_Management35
1.94E-06	0.1	1.94E-07	Health_IT_DNS35
1.94E-06	0.1	1.94E-07	Intrusion_Detection_System__IDS_35
1.94E-06	0.1	1.94E-07	Risk_Manager54
1.94E-06	0.1	1.94E-07	Virus_Malware54
1.94E-06	0.1	1.94E-07	Vulnerability_Scanners35
1.94E-06	0.1	1.94E-07	Risk_Manager35
1.94E-06	0.1	1.94E-07	VPN_Server35
1.94E-06	0.1	1.94E-07	VPN_Server54
1.94E-06	0.1	1.94E-07	Mobile_Network_Access_Control__NAC_35
1.94E-06	0.1	1.94E-07	Virus_Malware35
3.25E-07	0.5	1.62E-07	Mobile_Device_User_Does_Not_Notice443
3.25E-07	0.5	1.62E-07	Ask_Receives_Critical_Data_from_the_User443
1.62E-06	0.1	1.62E-07	Connect_as_OpenEMR443
1.62E-06	0.1	1.62E-07	Connect_as_OpenEMR54
3.25E-07	0.5	1.62E-07	Ask_Receives_Critical_Data_from_the_User54
3.25E-07	0.5	1.62E-07	Mobile_Device_User_Does_Not_Notice54
1.37E-06	0.1	1.37E-07	Virus_Malware37
1.37E-06	0.1	1.37E-07	Health_IT_CA_Root37
1.37E-06	0.1	1.37E-07	Mobile_Network_Access_Control__NAC_37
1.37E-06	0.1	1.37E-07	Health_IT_Configuration_Management37
1.37E-06	0.1	1.37E-07	Vulnerability_Scanners37
1.37E-06	0.1	1.37E-07	Risk_Manager37

Partial Derivative	Probability	Maximum Impact	Event
1.37E-06	0.1	1.37E-07	VPN_Server37
1.37E-06	0.1	1.37E-07	Health_IT_DNS37
1.37E-06	0.1	1.37E-07	Intrusion_Detection_System__IDS_37
1.37E-06	0.1	1.37E-07	Risk_Manager12
1.37E-06	0.1	1.37E-07	Health_IT_CA_Root3
1.37E-06	0.1	1.37E-07	DNS_Server_Ext11
1.37E-06	0.1	1.37E-07	DNS_Server_Ext37
1.37E-06	0.1	1.37E-07	Health_IT_DNS5
1.37E-06	0.1	1.37E-07	Intrusion_Detection_System__IDS_6
1.37E-06	0.1	1.37E-07	VPN_Server13
1.37E-06	0.1	1.37E-07	Virus_Malware9
1.37E-06	0.1	1.37E-07	Vulnerability_Scanners8
1.37E-06	0.1	1.37E-07	Health_IT_Configuration_Management4
1.37E-06	0.1	1.37E-07	Mobile_Network_Access_Control__NAC_7
1.37E-06	0.1	1.37E-07	Health_IT_Configuration_Management51
1.37E-06	0.1	1.37E-07	Health_IT_DNS51
1.37E-06	0.1	1.37E-07	Intrusion_Detection_System__IDS_51
1.37E-06	0.1	1.37E-07	DNS_Server_Ext51
1.37E-06	0.1	1.37E-07	Vulnerability_Scanners51
1.37E-06	0.1	1.37E-07	Risk_Manager51
1.37E-06	0.1	1.37E-07	VPN_Server51
1.37E-06	0.1	1.37E-07	Health_IT_CA_Root51
1.37E-06	0.1	1.37E-07	Mobile_Network_Access_Control__NAC_51
1.37E-06	0.1	1.37E-07	Virus_Malware51
1.34E-06	0.1	1.34E-07	Blue_Tooth_Egress443
2.49E-07	0.1	2.49E-08	Health_IT_Configuration_Management
2.49E-07	0.1	2.49E-08	Health_IT_CA_Root
2.49E-07	0.1	2.49E-08	VPN_Server
2.49E-07	0.1	2.49E-08	Vulnerability_Scanners
2.49E-07	0.1	2.49E-08	Virus_Malware
2.49E-07	0.1	2.49E-08	Risk_Manager
2.49E-07	0.1	2.49E-08	DNS_Server_Ext
2.49E-07	0.1	2.49E-08	Health_IT_DNS
2.49E-07	0.1	2.49E-08	Intrusion_Detection_System__IDS_

Partial Derivative	Probability	Maximum Impact	Event
2.49E-07	0.1	2.49E-08	Mobile_Network_Access_Control__NAC_
2.49E-07	0.1	2.49E-08	Health_IT_DNS36
2.49E-07	0.1	2.49E-08	DNS_Server_Ext36
2.49E-07	0.1	2.49E-08	Health_IT_CA_Root36
2.49E-07	0.1	2.49E-08	Health_IT_Configuration_Management36
2.49E-07	0.1	2.49E-08	Intrusion_Detection_System__IDS_36
2.49E-07	0.1	2.49E-08	Vulnerability_Scanners36
2.49E-07	0.1	2.49E-08	Virus_Malware36
2.49E-07	0.1	2.49E-08	Risk_Manager36
2.49E-07	0.1	2.49E-08	VPN_Server36
2.49E-07	0.1	2.49E-08	Mobile_Network_Access_Control__NAC_36
2.49E-07	0.1	2.49E-08	Vulnerability_Scanners50
2.49E-07	0.1	2.49E-08	Virus_Malware50
2.49E-07	0.1	2.49E-08	DNS_Server_Ext50
2.49E-07	0.1	2.49E-08	Risk_Manager50
2.49E-07	0.1	2.49E-08	Health_IT_Configuration_Management50
2.49E-07	0.1	2.49E-08	Health_IT_DNS50
2.49E-07	0.1	2.49E-08	Intrusion_Detection_System__IDS_50
2.49E-07	0.1	2.49E-08	VPN_Server50
2.49E-07	0.1	2.49E-08	Mobile_Network_Access_Control__NAC_50
2.49E-07	0.1	2.49E-08	Health_IT_CA_Root50
1.97E-08	0.75	1.48E-08	Malicious_Access_Point554
2.95E-08	0.5	1.48E-08	Mobile_Device_Attaches_to_Malicious_Access_Point554
1.48E-06	0.01	1.48E-08	Access_from_AP_to_Mobile_Device554
1.48E-06	0.01	1.48E-08	Blue_Tooth_Access554
1.48E-07	0.1	1.48E-08	Install_File_Copying_Malware554
2.41E-08	0.5	1.21E-08	WiFi_Egress554
1.34E-08	0.1	1.34E-09	Blue_Tooth_Egress554

Table B-2 Fault-Tree Results Based on Integrity

Partial Derivative	Probability	Maximum Impact	Event
0.815	0.9	0.733	Physical_Access___User_walks_away_from_logged_on_Mobile_Device1
0.0855	0.1	0.00855	Install_File_Modifying_Malware
0.0855	0.1	0.00855	Install_File_Modifying_Malware123
0.0045	0.9	0.00405	User_walks_away_from_logged_on_Mobile_Device4433
0.0045	0.9	0.00405	User_walks_away_from_logged_on_Mobile_Device443
0.0009	0.5	0.00045	Obtain_OS_Authentication4433
0.0009	0.5	0.00045	Obtain_OS_Authentication443
0.0307	0.01	0.000307	Access_from_AP_to_Mobile_Device1
0.000613	0.5	0.000307	Mobile_Device_Attaches_to_Malicious_Access_Point1
0.000409	0.75	0.000307	Malicious_Access_Point1
0.0033	0.01	3.30E-05	Changing_Critical_Data4122
0.0033	0.01	3.30E-05	Changing_Critical_Data4
6.60E-05	0.5	3.30E-05	Mobile_Device_User_Does_Not_Notice
3.67E-05	0.9	3.30E-05	Ask_Receives_Critical_Data_from_the_User1
0.00033	0.1	3.30E-05	Connect_as_OpenEMR2
6.60E-05	0.5	3.30E-05	Mobile_Device_User_Does_Not_Notice1221
3.67E-05	0.9	3.30E-05	Ask_Receives_Critical_Data_from_the_User1211
3.67E-05	0.9	3.30E-05	Disconnect_OpenEMR1222
3.67E-05	0.9	3.30E-05	Disconnect_OpenEMR
0.00033	0.1	3.30E-05	Connect_as_OpenEMR2122
0.00306	0.01	3.06E-05	Access_from_AP_to_Mobile_Device554
0.00306	0.01	3.06E-05	Access_from_AP_to_Mobile_Device443
4.07E-05	0.75	3.06E-05	Malicious_Access_Point554
4.07E-05	0.75	3.06E-05	Malicious_Access_Point443
0.000306	0.1	3.06E-05	Install_File_Modifying_Malware554
6.11E-05	0.5	3.06E-05	Mobile_Device_Attaches_to_Malicious_Access_Point554
6.11E-05	0.5	3.06E-05	Mobile_Device_Attaches_to_Malicious_Access_Point443
0.000306	0.1	3.06E-05	Install_File_Modifying_Malware443
0.000204	0.01	2.04E-06	Force_Backup_Online__Critical_System_Failure274
0.000204	0.01	2.04E-06	Decrypt_the_Back_up54
0.000204	0.01	2.04E-06	Force_Backup_Online__Critical_System_Failure27
4.07E-06	0.5	2.04E-06	Replace_with_Modified_Backup1

Partial Derivative	Probability	Maximum Impact	Event
0.000204	0.01	2.04E-06	Decrypt_the_Back_up4
4.07E-06	0.5	2.04E-06	During_Physical_Transfer_Obtain_Copy1
4.07E-06	0.5	2.04E-06	During_Physical_Transfer_Obtain_Copy54
4.07E-06	0.5	2.04E-06	Replace_with_Modified_Backup14
6.60E-07	0.5	3.30E-07	Mobile_Device_User_Does_Not_Notice32
3.30E-05	0.01	3.30E-07	Changing_Critical_Data3212
3.30E-05	0.01	3.30E-07	Decrypt_Critical_Data52
3.30E-06	0.1	3.30E-07	Connect_as_OpenEMR52
3.67E-07	0.9	3.30E-07	Disconnect_OpenEMR52
3.67E-07	0.9	3.30E-07	Ask_Receives_Critical_Data_from_the_User52
6.62E-06	0.01	6.62E-08	Re_Encrypt_Modified_Critical_Data2644
6.62E-06	0.01	6.62E-08	Decrypt_Critical_Data534
6.62E-06	0.01	6.62E-08	Changing_Critical_Data2644
7.35E-08	0.9	6.62E-08	PluginHub
7.35E-08	0.9	6.62E-08	PluginHub54
6.62E-06	0.01	6.62E-08	Decrypt_Critical_Data443
6.62E-06	0.01	6.62E-08	Changing_Critical_Data264
6.62E-06	0.01	6.62E-08	Re_Encrypt_Modified_Critical_Data264
7.15E-08	0.9	6.43E-08	Laptop_Wireshark54
7.15E-08	0.9	6.43E-08	Laptop_Wireshark2
2.04E-08	0.9	1.83E-08	Capture_Critical_Data554
3.67E-08	0.5	1.83E-08	Acquire_Password54
3.67E-08	0.5	1.83E-08	Send_Data_to_New_GW54
1.83E-06	0.01	1.83E-08	Re_Encrypt_Modified_Critical_Data2654
2.04E-08	0.9	1.83E-08	Capture_Critical_Data2
1.83E-06	0.01	1.83E-08	Changing_Critical_Data2654
1.83E-06	0.01	1.83E-08	Decrypt_Critical_Data1554
3.67E-08	0.5	1.83E-08	Acquire_Password2
3.67E-08	0.5	1.83E-08	Send_Data_to_New_GW
1.83E-06	0.01	1.83E-08	Changing_Critical_Data265
1.83E-06	0.01	1.83E-08	Decrypt_Critical_Data16
1.83E-06	0.01	1.83E-08	Re_Encrypt_Modified_Critical_Data265
1.29E-06	0.01	1.29E-08	Changing_Critical_Data6
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data35

Partial Derivative	Probability	Maximum Impact	Event
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data6
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data53
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data552
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data233
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data323
1.29E-06	0.01	1.29E-08	Changing_Critical_Data323
1.29E-06	0.01	1.29E-08	Changing_Critical_Data233
1.29E-06	0.01	1.29E-08	Changing_Critical_Data333
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data7
1.29E-06	0.01	1.29E-08	Changing_Critical_Data3
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data31
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data333
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data5
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data338
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data23
1.29E-06	0.01	1.29E-08	Decrypt_Critical_Data339
1.29E-06	0.01	1.29E-08	Changing_Critical_Data32
1.29E-06	0.01	1.29E-08	Changing_Critical_Data23
1.29E-06	0.01	1.29E-08	Re_Encrypt_Modified_Critical_Data32
1.00E-06	0.01	1.00E-08	Re_Encrypt_Modified_Critical_Data2633
1.00E-06	0.01	1.00E-08	Changing_Critical_Data26
1.00E-06	0.01	1.00E-08	Re_Encrypt_Modified_Critical_Data26
1.00E-06	0.01	1.00E-08	Decrypt_Critical_Data54
1.00E-06	0.01	1.00E-08	Changing_Critical_Data2633
1.00E-06	0.01	1.00E-08	Decrypt_Critical_Data40
1.16E-08	0.75	8.72E-09	Thumb_Drive40
1.16E-08	0.75	8.72E-09	Thumb_Drive54
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR339
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR53
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR52
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR45
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR38
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR9
7.62E-08	0.1	7.62E-09	Access_to_Health_IT_OpenEMR5

Partial Derivative	Probability	Maximum Impact	Event
7.33E-07	0.01	7.33E-09	Re_Encrypt_Modified_Critical_Data2623
7.33E-07	0.01	7.33E-09	Changing_Critical_Data2623
7.33E-07	0.01	7.33E-09	Decrypt_Critical_Data544
7.33E-08	0.1	7.33E-09	Decrypt_WiFi_Data_Transfer3
8.15E-09	0.9	7.33E-09	WiFi_Data_Capture54
7.33E-08	0.1	7.33E-09	Decrypt_WiFi_Data_Transfer54
8.15E-09	0.9	7.33E-09	WiFi_Data_Capture2
7.33E-07	0.01	7.33E-09	Decrypt_Critical_Data14
7.33E-07	0.01	7.33E-09	Re_Encrypt_Modified_Critical_Data262
7.33E-07	0.01	7.33E-09	Changing_Critical_Data262
7.11E-07	0.01	7.11E-09	Decrypt_Critical_Data31
7.11E-07	0.01	7.11E-09	Decrypt_Critical_Data51
7.11E-07	0.01	7.11E-09	Re_Encrypt_Modified_Critical_Data223
7.11E-07	0.01	7.11E-09	Re_Encrypt_Modified_Critical_Data2
7.11E-07	0.01	7.11E-09	Changing_Critical_Data223
7.11E-07	0.01	7.11E-09	Changing_Critical_Data2
7.11E-07	0.01	7.11E-09	Decrypt_Critical_Data37
7.11E-07	0.01	7.11E-09	Re_Encrypt_Modified_Critical_Data22
7.11E-07	0.01	7.11E-09	Changing_Critical_Data22
5.90E-08	0.1	5.90E-09	Access_to_Health_IT_OpenEMR40
5.90E-08	0.1	5.90E-09	Access_to_Health_IT_OpenEMR54
1.16E-08	0.5	5.81E-09	Buying_Malware
1.16E-08	0.5	5.81E-09	Buying_Malware51
1.16E-08	0.5	5.81E-09	Buying_Malware37
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR35
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR7
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR11
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR338
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR39
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR552
4.78E-08	0.1	4.78E-09	Access_to_Health_IT_OpenEMR553
4.19E-08	0.1	4.19E-09	Access_to_Health_IT_OpenEMR337
4.19E-08	0.1	4.19E-09	Access_to_Health_IT_OpenEMR2
4.19E-08	0.1	4.19E-09	Access_to_Health_IT_OpenEMR51

Partial Derivative	Probability	Maximum Impact	Event
3.70E-08	0.1	3.70E-09	Access_to_Health_IT_OpenEMR554
3.70E-08	0.1	3.70E-09	Access_to_Health_IT_OpenEMR440
2.63E-08	0.1	2.63E-09	Access_to_Health_IT_OpenEMR37
2.63E-08	0.1	2.63E-09	Access_to_Health_IT_OpenEMR551
2.63E-08	0.1	2.63E-09	Access_to_Health_IT_OpenEMR4
1.29E-08	0.1	1.29E-09	Access_thru_HIT_Server_Room_Firewall
1.29E-08	0.1	1.29E-09	Access_thru_HIT_Server_Room_Firewall36
1.29E-08	0.1	1.29E-09	Access_thru_HIT_Server_Room_Firewall50
1.29E-07	0.01	1.29E-09	Decrypt_Critical_Data50
1.29E-07	0.01	1.29E-09	Re_Encrypt_Modified_Critical_Data3
1.29E-07	0.01	1.29E-09	Changing_Critical_Data1
1.29E-07	0.01	1.29E-09	Changing_Critical_Data2211
1.29E-07	0.01	1.29E-09	Re_Encrypt_Modified_Critical_Data2211
1.29E-07	0.01	1.29E-09	Decrypt_Critical_Data36
1.29E-07	0.01	1.29E-09	Changing_Critical_Data221
1.29E-07	0.01	1.29E-09	Re_Encrypt_Modified_Critical_Data221
1.29E-07	0.01	1.29E-09	Decrypt_Critical_Data
7.62E-09	0.1	7.62E-10	Access_to_Health_IT_OpenEMR
7.62E-09	0.1	7.62E-10	Access_to_Health_IT_OpenEMR50
7.62E-09	0.1	7.62E-10	Access_to_Health_IT_OpenEMR36
8.15E-10	0.9	7.33E-10	Capture_Critical_Data54
7.33E-08	0.01	7.33E-10	Changing_Critical_Data2634
7.33E-08	0.01	7.33E-10	Re_Encrypt_Modified_Critical_Data2634
7.33E-08	0.01	7.33E-10	Breach_Firewall54
7.33E-08	0.01	7.33E-10	Decrypt_Critical_Data154
6.46E-09	0.1	6.46E-10	Coding_Malware
6.46E-09	0.1	6.46E-10	Coding_Malware51
6.46E-09	0.1	6.46E-10	Coding_Malware37
4.78E-09	0.1	4.78E-10	Access_to_Health_IT_OpenEMR30
4.78E-09	0.1	4.78E-10	Access_to_Health_IT_OpenEMR550
4.78E-09	0.1	4.78E-10	Access_to_Health_IT_OpenEMR366
4.07E-08	0.01	4.07E-10	Changing_Critical_Data263
4.07E-08	0.01	4.07E-10	Re_Encrypt_Modified_Critical_Data263
4.07E-08	0.01	4.07E-10	Breach_Firewall

Partial Derivative	Probability	Maximum Impact	Event
4.07E-08	0.01	4.07E-10	Decrypt_Critical_Data15
8.15E-10	0.5	4.07E-10	Capture_Critical_Data3
3.23E-09	0.1	3.23E-10	Egress_Data_Thru_Firewall54
3.23E-09	0.1	3.23E-10	Egress_Data_Thru_Firewall40
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management35
2.84E-09	0.1	2.84E-10	DNS_Server_Ext35
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_52
2.84E-09	0.1	2.84E-10	Health_IT_DNS52
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root38
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management53
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_52
2.84E-09	0.1	2.84E-10	VPN_Server34
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners52
2.84E-09	0.1	2.84E-10	DNS_Server_Ext53
2.84E-09	0.1	2.84E-10	Risk_Manager52
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root35
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root53
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_32
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management52
2.84E-09	0.1	2.84E-10	VPN_Server52
2.84E-09	0.1	2.84E-10	Virus_Malware52
2.84E-09	0.1	2.84E-10	Health_IT_DNS53
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management38
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_35
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root32
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners53
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management32
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_32
2.84E-09	0.1	2.84E-10	Risk_Manager53
2.84E-09	0.1	2.84E-10	DNS_Server_Ext32
2.84E-09	0.1	2.84E-10	Health_IT_DNS32
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_53
2.84E-09	0.1	2.84E-10	Health_IT_DNS35
2.84E-09	0.1	2.84E-10	DNS_Server_Ext38

Partial Derivative	Probability	Maximum Impact	Event
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_35
2.84E-09	0.1	2.84E-10	Virus_Malware53
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners35
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_53
2.84E-09	0.1	2.84E-10	VPN_Server35
2.84E-09	0.1	2.84E-10	Virus_Malware35
2.84E-09	0.1	2.84E-10	Risk_Manager35
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners38
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_38
2.84E-09	0.1	2.84E-10	VPN_Server39
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_34
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners39
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_39
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_39
2.84E-09	0.1	2.84E-10	Risk_Manager39
2.84E-09	0.1	2.84E-10	Virus_Malware39
2.84E-09	0.1	2.84E-10	Health_IT_DNS39
2.84E-09	0.1	2.84E-10	DNS_Server_Ext34
2.84E-09	0.1	2.84E-10	Virus_Malware32
2.84E-09	0.1	2.84E-10	Intrusion_Detection_System__IDS_34
2.84E-09	0.1	2.84E-10	Risk_Manager32
2.84E-09	0.1	2.84E-10	Health_IT_DNS34
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root2
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners32
2.84E-09	0.1	2.84E-10	VPN_Server32
2.84E-09	0.1	2.84E-10	Health_IT_DNS38
2.84E-09	0.1	2.84E-10	Risk_Manager34
2.84E-09	0.1	2.84E-10	DNS_Server_Ext52
2.84E-09	0.1	2.84E-10	Risk_Manager38
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root52
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management34
2.84E-09	0.1	2.84E-10	Vulnerability_Scanners34
2.84E-09	0.1	2.84E-10	VPN_Server38
2.84E-09	0.1	2.84E-10	Virus_Malware34

Partial Derivative	Probability	Maximum Impact	Event
2.84E-09	0.1	2.84E-10	DNS_Server_Ext39
2.84E-09	0.1	2.84E-10	Health_IT_Configuration_Management39
2.84E-09	0.1	2.84E-10	VPN_Server53
2.84E-09	0.1	2.84E-10	Virus_Malware38
2.84E-09	0.1	2.84E-10	Mobile_Network_Access_Control__NAC_38
2.84E-09	0.1	2.84E-10	Health_IT_CA_Root39
2.20E-09	0.1	2.20E-10	Vulnerability_Scanners54
2.20E-09	0.1	2.20E-10	DNS_Server_Ext54
2.20E-09	0.1	2.20E-10	VPN_Server54
2.20E-09	0.1	2.20E-10	Health_IT_Configuration_Management54
2.20E-09	0.1	2.20E-10	Risk_Manager54
2.20E-09	0.1	2.20E-10	Health_IT_DNS54
2.20E-09	0.1	2.20E-10	Intrusion_Detection_System__IDS_54
2.20E-09	0.1	2.20E-10	Mobile_Network_Access_Control__NAC_54
2.20E-09	0.1	2.20E-10	Virus_Malware54
2.20E-09	0.1	2.20E-10	Health_IT_CA_Root54
2.20E-09	0.1	2.20E-10	Health_IT_DNS40
2.20E-09	0.1	2.20E-10	DNS_Server_Ext40
2.20E-09	0.1	2.20E-10	Health_IT_Configuration_Management40
2.20E-09	0.1	2.20E-10	Intrusion_Detection_System__IDS_40
2.20E-09	0.1	2.20E-10	Vulnerability_Scanners40
2.20E-09	0.1	2.20E-10	Mobile_Network_Access_Control__NAC_40
2.20E-09	0.1	2.20E-10	VPN_Server40
2.20E-09	0.1	2.20E-10	Virus_Malware40
2.20E-09	0.1	2.20E-10	Risk_Manager40
2.20E-09	0.1	2.20E-10	Health_IT_CA_Root40
1.83E-09	0.1	1.83E-10	Connect_as_OpenEMR54
3.67E-10	0.5	1.83E-10	Ask_Receives_Critical_Data_from_the_User54
1.83E-09	0.1	1.83E-10	Connect_as_OpenEMR443
3.67E-10	0.5	1.83E-10	Mobile_Device_User_Does_Not_Notice54
3.67E-10	0.5	1.83E-10	Mobile_Device_User_Does_Not_Notice443
3.67E-10	0.5	1.83E-10	Ask_Receives_Critical_Data_from_the_User443
1.56E-09	0.1	1.56E-10	VPN_Server37
1.56E-09	0.1	1.56E-10	Risk_Manager37

Partial Derivative	Probability	Maximum Impact	Event
1.56E-09	0.1	1.56E-10	Mobile_Network_Access_Control__NAC_37
1.56E-09	0.1	1.56E-10	Virus_Malware37
1.56E-09	0.1	1.56E-10	Intrusion_Detection_System__IDS_37
1.56E-09	0.1	1.56E-10	DNS_Server_Ext11
1.56E-09	0.1	1.56E-10	Health_IT_DNS37
1.56E-09	0.1	1.56E-10	Health_IT_DNS5
1.56E-09	0.1	1.56E-10	Health_IT_Configuration_Management4
1.56E-09	0.1	1.56E-10	Vulnerability_Scanners37
1.56E-09	0.1	1.56E-10	Intrusion_Detection_System__IDS_6
1.56E-09	0.1	1.56E-10	Health_IT_CA_Root3
1.56E-09	0.1	1.56E-10	DNS_Server_Ext37
1.56E-09	0.1	1.56E-10	VPN_Server13
1.56E-09	0.1	1.56E-10	Risk_Manager12
1.56E-09	0.1	1.56E-10	Vulnerability_Scanners8
1.56E-09	0.1	1.56E-10	Health_IT_Configuration_Management37
1.56E-09	0.1	1.56E-10	Virus_Malware9
1.56E-09	0.1	1.56E-10	Health_IT_CA_Root37
1.56E-09	0.1	1.56E-10	Mobile_Network_Access_Control__NAC_7
1.56E-09	0.1	1.56E-10	Health_IT_CA_Root51
1.56E-09	0.1	1.56E-10	DNS_Server_Ext51
1.56E-09	0.1	1.56E-10	Intrusion_Detection_System__IDS_51
1.56E-09	0.1	1.56E-10	Health_IT_DNS51
1.56E-09	0.1	1.56E-10	VPN_Server51
1.56E-09	0.1	1.56E-10	Mobile_Network_Access_Control__NAC_51
1.56E-09	0.1	1.56E-10	Virus_Malware51
1.56E-09	0.1	1.56E-10	Risk_Manager51
1.56E-09	0.1	1.56E-10	Health_IT_Configuration_Management51
1.56E-09	0.1	1.56E-10	Vulnerability_Scanners51
8.15E-09	0.01	8.15E-11	Force_Backup_Online__Critical_System_Failure264
8.15E-10	0.1	8.15E-11	Backup_data_Captured1
8.15E-09	0.01	8.15E-11	Re_Encrypt_Modified_Critical_Data284
8.15E-09	0.01	8.15E-11	Decrypt_Data54
8.15E-09	0.01	8.15E-11	Changing_Critical_Data284
8.15E-10	0.1	8.15E-11	Backup_data_Captured54

Partial Derivative	Probability	Maximum Impact	Event
8.15E-09	0.01	8.15E-11	Decrypt_Data20
8.15E-09	0.01	8.15E-11	Changing_Critical_Data28
8.15E-10	0.1	8.15E-11	Gain_Access_to_the_Backup_System1
8.15E-09	0.01	8.15E-11	Re_Encrypt_Modified_Critical_Data28
8.15E-09	0.01	8.15E-11	Force_Backup_Online__Critical_System_Failure26
8.15E-10	0.1	8.15E-11	Access_the_Backup_system_on_site1
8.15E-09	0.01	8.15E-11	Force_Backup_Online__Critical_System_Failure25
8.15E-09	0.01	8.15E-11	Re_Encrypt_Modified_Critical_Data25
8.15E-09	0.01	8.15E-11	Changing_Critical_Data25
8.15E-09	0.01	8.15E-11	Decrypt_Backup_Data_at_Rest21
8.15E-09	0.01	8.15E-11	Force_Backup_Online__Critical_System_Failure1
8.15E-09	0.01	8.15E-11	Changing_Critical_Data8
8.15E-09	0.01	8.15E-11	Re_Encrypt_Modified_Critical_Data8
8.15E-09	0.01	8.15E-11	Decrypt_Backup_Data_at_Rest25
2.84E-10	0.1	2.84E-11	Health_IT_DNS36
2.84E-10	0.1	2.84E-11	VPN_Server
2.84E-10	0.1	2.84E-11	Risk_Manager
2.84E-10	0.1	2.84E-11	Vulnerability_Scanners
2.84E-10	0.1	2.84E-11	Virus_Malware
2.84E-10	0.1	2.84E-11	Health_IT_CA_Root36
2.84E-10	0.1	2.84E-11	DNS_Server_Ext36
2.84E-10	0.1	2.84E-11	Health_IT_DNS
2.84E-10	0.1	2.84E-11	Health_IT_Configuration_Management
2.84E-10	0.1	2.84E-11	DNS_Server_Ext
2.84E-10	0.1	2.84E-11	Health_IT_CA_Root
2.84E-10	0.1	2.84E-11	Mobile_Network_Access_Control__NAC_
2.84E-10	0.1	2.84E-11	Intrusion_Detection_System__IDS_
2.84E-10	0.1	2.84E-11	Health_IT_Configuration_Management36
2.84E-10	0.1	2.84E-11	Risk_Manager36
2.84E-10	0.1	2.84E-11	Mobile_Network_Access_Control__NAC_36
2.84E-10	0.1	2.84E-11	Virus_Malware36
2.84E-10	0.1	2.84E-11	Vulnerability_Scanners36
2.84E-10	0.1	2.84E-11	VPN_Server36
2.84E-10	0.1	2.84E-11	Intrusion_Detection_System__IDS_36

Partial Derivative	Probability	Maximum Impact	Event
2.84E-10	0.1	2.84E-11	Health_IT_CA_Root50
2.84E-10	0.1	2.84E-11	DNS_Server_Ext50
2.84E-10	0.1	2.84E-11	Virus_Malware50
2.84E-10	0.1	2.84E-11	Vulnerability_Scanners50
2.84E-10	0.1	2.84E-11	Mobile_Network_Access_Control__NAC_50
2.84E-10	0.1	2.84E-11	Intrusion_Detection_System__IDS_50
2.84E-10	0.1	2.84E-11	Health_IT_DNS50
2.84E-10	0.1	2.84E-11	Health_IT_Configuration_Management50
2.84E-10	0.1	2.84E-11	VPN_Server50
2.84E-10	0.1	2.84E-11	Risk_Manager50

Table B-3 Fault-Tree Results Based on Availability

Partial Derivative	Probability	Maximum Impact	Event
0.377	0.9	0.339	Degrade_the_Back_up4
0.678	0.5	0.339	During_Physical_Transfer_Obtain_Copy1
0.0455	0.9	0.041	Degrade_the_Back_Up_Media
0.0455	0.9	0.041	Degrade_Back_Up2
0.41	0.1	0.041	Gain_Access_to_the_Backup_System1
0.41	0.1	0.041	Backup_data_Accessed1
0.41	0.1	0.041	Access_the_Backup_system_on_site1
0.0455	0.9	0.041	Degrade_Back_Up
1.56E-12	0.9	1.40E-12	Unplug_Ethernet_Cables_from_Access_Points3
1.56E-12	0.9	1.40E-12	Unplug_Ethernet_Cables_from_Access_Points1
1.56E-12	0.9	1.40E-12	Traffic___High_Volumes_Sent177
1.56E-12	0.9	1.40E-12	Traffic___High_Volumes_Sent111
1.56E-12	0.9	1.40E-12	Physically_Destroy_Any_Critically_Functional_Devices3
1.56E-12	0.9	1.40E-12	Physically_Destroy_Any_Critically_Functional_Devices1
1.56E-12	0.9	1.40E-12	Traffic___High_Volumes_Sent1
1.56E-12	0.9	1.40E-12	Physically_Destroy_Any_Critically_Functional_Devices66
1.02E-12	0.9	9.17E-13	Install_Device_Degrading_Malware411
1.02E-12	0.9	9.17E-13	Install_Device_Degrading_Malware413
4.83E-13	0.9	4.34E-13	User_walks_away_from_logged_on_Mobile_Device4431

Partial Derivative	Probability	Maximum Impact	Event
4.83E-13	0.9	4.34E-13	User_walks_away_from_logged_on_Mobile_Device4433
3.11E-13	0.5	1.56E-13	WiFI_RF_Jamming_Device_Data_Transfer1
3.11E-13	0.5	1.56E-13	WiFI_RF_Jamming_Device_Data_Transfer3
2.12E-13	0.5	1.06E-13	Acquire_Password21
1.18E-13	0.9	1.06E-13	PluginHub1
1.18E-13	0.9	1.06E-13	Send_Data_to_New_GW_or_Reconfigure1
1.18E-13	0.9	1.06E-13	PluginHub3
2.12E-13	0.5	1.06E-13	Acquire_Password23
1.18E-13	0.9	1.06E-13	Send_Data_to_New_GW_or_Reconfigure3
9.66E-14	0.5	4.83E-14	Obtain_OS_Authentication4433
9.66E-14	0.5	4.83E-14	Obtain_OS_Authentication4431
8.03E-14	0.5	4.01E-14	Buying_Malware22
8.03E-14	0.5	4.01E-14	Buying_Malware9
8.03E-14	0.5	4.01E-14	Buying_Malware
1.73E-13	0.1	1.73E-14	Access_to_HIT_Server_Room_Firewall77
1.73E-13	0.1	1.73E-14	Access_to_HIT_Server_Room_Firewall11
1.73E-13	0.1	1.73E-14	Access_to_HIT_Server_Room_Firewall
1.73E-13	0.1	1.73E-14	Login_3
1.73E-13	0.1	1.73E-14	Connect_as_New_Device0
1.73E-13	0.1	1.73E-14	Login11
1.73E-13	0.1	1.73E-14	Connect_as_New_Device3
1.73E-13	0.1	1.73E-14	Login_66
1.73E-13	0.1	1.73E-14	Connect_as_New_Device55
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall777
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall677
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall277
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall477
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall377
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall311
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall411
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall611
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall711
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall811
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall877

Partial Derivative	Probability	Maximum Impact	Event
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall211
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall8
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall7
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall2
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall3
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall6
1.56E-13	0.1	1.56E-14	Access_thru_HIT_Server_Room_Firewall4
1.71E-14	0.9	1.54E-14	Degrade_Access_Point11
1.71E-14	0.9	1.54E-14	Degrade_Access_Point3
1.54E-13	0.1	1.54E-14	Gain_Access_to_Access_Point13
1.54E-13	0.1	1.54E-14	Gain_Access_to_Access_Point11
1.71E-14	0.9	1.54E-14	DisconnectDevice00
1.71E-14	0.9	1.54E-14	Disconnect_OpenEMR3333
1.71E-14	0.9	1.54E-14	Disconnect_OpenEMR000
1.71E-14	0.9	1.54E-14	DisconnectDevice3333
1.54E-13	0.1	1.54E-14	Connect_as_OpenEMR23333
1.54E-13	0.1	1.54E-14	Connect_as_Device00
1.54E-13	0.1	1.54E-14	Connect_as_OpenEMR2000
1.54E-13	0.1	1.54E-14	Connect_as_Device3333
1.54E-13	0.1	1.54E-14	Connect_as_OpenEMR2
1.54E-13	0.1	1.54E-14	Connect_as_Device
1.71E-14	0.9	1.54E-14	Disconnect_OpenEMR
1.71E-14	0.9	1.54E-14	DisconnectDevice
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent311
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent777
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent877
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent711
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent477
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent377
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent677
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent611
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent411
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent811
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent211

Partial Derivative	Probability	Maximum Impact	Event
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent277
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent3
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent7
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent6
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent4
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent8
1.54E-14	0.9	1.39E-14	Traffic___High_Volumes_Sent2
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall79
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall822
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall39
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall722
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall322
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall89
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall422
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall69
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall622
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall49
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall29
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall222
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall72
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall62
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall82
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall42
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall32
6.36E-14	0.1	6.36E-15	Access_thru_HIT_Server_Room_Firewall22
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent422
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent322
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent622
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent89
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent29
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent39
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent222
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent69
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent822

Partial Derivative	Probability	Maximum Impact	Event
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent79
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent49
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent722
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent62
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent82
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent72
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent32
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent42
6.29E-15	0.9	5.66E-15	Traffic___High_Volumes_Sent22
4.46E-14	0.1	4.46E-15	Coding_Malware9
4.46E-14	0.1	4.46E-15	Coding_Malware22
4.46E-14	0.1	4.46E-15	Coding_Malware
5.27E-14	0.01	5.27E-16	Access_from_AP_to_Mobile_Device4433
5.27E-14	0.01	5.27E-16	Access_from_AP_to_Mobile_Device4431
7.02E-16	0.75	5.27E-16	Malicious_Access_Point4431
5.85E-16	0.9	5.27E-16	Install_Device_Degrading_Malware4433
5.85E-16	0.9	5.27E-16	Install_Device_Degrading_Malware4431
7.02E-16	0.75	5.27E-16	Malicious_Access_Point4433
1.05E-15	0.5	5.27E-16	Mobile_Device_Attaches_to_Malicious_Access_Point4433
1.05E-15	0.5	5.27E-16	Mobile_Device_Attaches_to_Malicious_Access_Point4431
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR411
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR877
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR777
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR811
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR611
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR711
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR111
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR477
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR377
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR311
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR677
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR177
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR3
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR1

Partial Derivative	Probability	Maximum Impact	Event
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR8
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR4
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR7
1.71E-15	0.1	1.71E-16	Access_to_Health_IT_OpenEMR6
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR622
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR822
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR69
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR422
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR322
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR79
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR89
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR39
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR49
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR722
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR19
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR122
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR32
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR82
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR62
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR72
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR42
6.98E-16	0.1	6.98E-17	Access_to_Health_IT_OpenEMR12
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent833
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent81
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent30
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent40
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent60
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent61
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent80
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent333
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent73
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent41
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent83
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent70

Partial Derivative	Probability	Maximum Impact	Event
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent31
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent71
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent63
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent43
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent433
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent33
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent733
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent633
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent766
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent46
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent355
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent66
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent866
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent655
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent855
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent36
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent755
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent455
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent21
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent233
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent20
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent23
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent26
9.19E-20	0.9	8.27E-20	Traffic___High_Volumes_Sent255
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent63333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent43333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent83333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent4000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent3333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent73333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent4333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent33333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent700
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent8333

Partial Derivative	Probability	Maximum Impact	Event
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent8000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent800
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent600
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent300
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent3000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent7333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent7000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent6000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent400
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent6333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent8444
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent6444
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent7444
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent3111
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent8111
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent4444
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent6111
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent7111
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent3444
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent4111
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent200
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent2000
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent2333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent23333
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent2222
8.18E-20	0.9	7.36E-20	Traffic___High_Volumes_Sent2444
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR63
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR833
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR43
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR71
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR733
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR61
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR83
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR41

Partial Derivative	Probability	Maximum Impact	Event
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR31
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR80
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR81
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR60
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR33
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR30
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR73
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR333
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR433
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR633
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR70
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR40
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR355
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR46
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR855
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR655
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR66
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR455
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR866
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR36
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR766
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR755
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR133
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR11
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR10
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR13
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR16
1.02E-20	0.1	1.02E-21	Access_to_Health_IT_OpenEMR155
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR6000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR7000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR83333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR4333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR4000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR6333

Partial Derivative	Probability	Maximum Impact	Event
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR3333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR3000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR8000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR700
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR63333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR800
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR600
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR73333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR400
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR7333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR43333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR300
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR8333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR33333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR8111
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR3111
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR7111
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR4444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR4111
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR6444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR3444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR7444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR8444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR6111
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR13333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR1000
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR1333
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR100
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR1444
9.08E-21	0.1	9.08E-22	Access_to_Health_IT_OpenEMR3222

Appendix C References

[1] K. Marchesini, *Mobile Devices Roundtable: Safeguarding Health Information: Real World Usages and Real World Privacy & Security Practices*, The Office of the National Coordinator for Health Information Technology, U.S. Department of Health & Human Services, March 16, 2012. https://www.healthit.gov/sites/default/files/onc_ocpo_mobile_device_roundtable_slides_3_16_12.pdf [accessed 5/3/18].

[2] *Mobile Devices – Secure Exchange of Electronic Health Information*, Final draft, National Cybersecurity Center of Excellence, National Institute of Standards and Technology, Gaithersburg, Maryland. http://nccoe.nist.gov/sites/default/files/nccoe/NCCoE_HIT_MobileDevices_UseCase.pdf [accessed 5/3/18].

[3] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, 15 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[4] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, 29 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[5] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table I-5: Template – Adversarial Risk, I-3 – I-4 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[6] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table I-4: Column Descriptions for Adversarial Risk Table, I–3 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[7] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table I-7: Template – Non-adversarial Risk, I–4 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[8] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table I-6: Column Descriptions for Non-adversarial Risk Table, I–4 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[9] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table G-5: Assessment Scale – Overall Likelihood, G–2 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[10] *Guide for Conducting Risk Assessments*, NIST Special Publication 800-30 Revision 1, National Institute of Standards and Technology, Gaithersburg, Maryland, September 2012, Table I-2: Assessment Scale – Level of Risk (Combination of Likelihood and Impact), I-1 pp. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf [accessed 5/3/18].

[11] *Security Risk Assessment Tool,* Office of the National Coordinator for Health Information Technology, HealthIT.gov [Website]. http://www.healthit.gov/providers-professionals/security-risk-assessment [accessed 5/3/18].