How to develop Security Case by combining real life security experiences (evidence) with D-Case.

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Abstract

In this paper we present a new reasonable method for writing security cases. A security case is one form of assurance case as there are other forms such as safety case, reliability case, dependability case and so on. Assurance case is a technique to structure assurance requirements concerning a system. It contains argumentation structure and evidence to convince a stakeholder that a certain concern on whether it is safety, reliability or security is being assured by the implementation of proper and appropriate actions that counters the risks or vulnerabilities raised by the concerned stakeholder. A security case is somehow very unpopular if we compare it to a safety case. And therefore, it is safe to say that so far; safety cases are better versed than security cases. However, due to the ever-growing concerns of the area of Cyber-Security, it is extremely crucial to produce effective and accurate security cases for cyber-systems.

1. Introduction

Security does not appear on the list of dependability attributes. Instead, the terms that are related to security are best defined in terms of integrity, confidentiality, and availability. The reason why security does not appear as an individual term is because it is very difficult to define what a secure system will mean because concerns in the security area are too diverse to deal with. For example, some systems are more concerned with unauthorized access to information while some are more concerned with denial-of-service attacks and so on. Nevertheless, our daily life reliance on information and software systems is ever increasing for the purpose of convenience, efficiency, and security. We all know that modern systems runs for long periods of time and are being constantly improved in service objectives and stakeholders’ requirements under evolving technologies and changing regulations or standards. At the same time, these systems have become extremely complex and hence the high demand for dependable systems. And in order to achieve dependable systems, assurance cases are becoming indispensable.
Conventional technologies such as software processes and/or formal methods alone cannot guarantee the dependability of present-day complex systems anymore. Such complex systems are required to have proper written assurance cases in order for the system stakeholders to admit to its (complex system) dependability. There are many well-written documents on how to write safety cases and reliability cases but very few on security cases. The reason for this is not the concern of this paper but to propose a sensible method of how to write a security case by looking at previous and current systems with (1) similar functionalities (not necessarily an exact match), (2) running under similar environment/s and more important; (3) suspected of encountering similar risks. This paper is limited to networking and information systems such as our global networking e-learning system named KISSEL or Knowledge Integrated Server System for E-Learning.

2. Introducing our new method

From the current method, the decision of what aspect of the system (whether its safety, reliability or availability) to be assured via assurance case is usually directly or indirectly comes from its (the system under review) risk assessment results and report, system expert’s previous experience (lessons learnt) and so forth. However in our new method, since we are getting all these risk assessment results and reports plus the lessons learnt from similar systems, we can actually use these gathered information into our advantage. For example, in Table 1 below, we show a list of the most popular security vulnerabilities that most information sharing and information storage system have to overcome. And of this list of security vulnerabilities also known to us as claims, we built and derived from it a list of solutions evidence for the construction of a security case.

Table 1. List of the most common security vulnerabilities with possible solution to help by limiting the risk causal factors

<table>
<thead>
<tr>
<th>Network Component at Risk</th>
<th>Security Vulnerabilities (- Claims)</th>
<th>Proposed Solution / Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boarder Router</td>
<td>Inadequate router access control. Misconfigured router ACLs can allow information leakage through ICMP, IP, NetBIOS and lead to unauthorized access to services on your DMZ servers.</td>
<td>All Router ACLs configurations should be checked and monitored constantly for accuracy.</td>
</tr>
<tr>
<td>Remote Access Server</td>
<td>Unmonitored remote access points provide one of the easiest means of access to your corporate network. Telecommuters often connect to the Internet with little protection, exposing sensitive files to attack.</td>
<td>(i) Limit the number of Remote Access Servers within the system. (ii) All Remote Access Servers should be under monitoring continuously.</td>
</tr>
<tr>
<td>Firewall</td>
<td>Misconfigured firewall ACLs can allow access to internal systems directly or once a DMZ server is compromised.</td>
<td>(i) Firewall ACLs configurations should be checked and monitored constantly for accuracy. (ii) Backup the completed configurations into a secure separate location.</td>
</tr>
<tr>
<td>Internet / DMZ Server</td>
<td>Information leakage can provide the attacker with operating system and application versions, users, groups, shares, DNS information via some transfers and running services like SNMP, finger, SMTP, telnet, rsh, rlogin, NetBIOS.</td>
<td>&lt;Undeveloped&gt;</td>
</tr>
<tr>
<td>Hosts running unnecessary services such as RPC, FTP, DNS, SMTP are easily compromised.</td>
<td>Limit the use of services such as RPD, FTP, DNS and SMTP.</td>
<td></td>
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<tr>
<td>Misconfigured Internet servers, especially CGI and ASP scripts on web servers, anonymous FTP with world-readable directories and XSS vulnerabilities.</td>
<td>(i) All CGI and ASP scripts should be double checked by a second party for accuracy before the system is deployed. (ii) The use of FTP with anonymous accounts and passwords on the system should be limited.</td>
<td></td>
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<tr>
<td>Inadequate logging, monitoring and detection capabilities at the network and host level. (i) Continuous monitoring of the full system log-files in a daily or weekly bases to up the security threats early detection capability of the system.</td>
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</table>
To put things into perspective, it is more sensible if we show the strategy node of our security case diagram shown in Figure 1. From Table 1, we derived from it 7 sub-goals for our security case labelled Goal: G_2, G_3, G_4 up to Goal: G_7.

This decomposition supports the strategy node Strategy: S_1 with an argument for security vulnerability.

2.1 Essential documentations that is required to be inserted into the security case diagram

During the development of the security assurance case, it is very important to understand what sort of documents one should use to show as evidence inside the security case and what documents is necessary to be inserted into the security case diagram. The following list is called Security Requirement Documentations List. In our new method, we used this list as a checklist of documentations that are required to be inserted into the “context” node and so as the solution node if found suited.

Table 2: Security Requirement Documentations List

<table>
<thead>
<tr>
<th>Security Awareness</th>
<th>Identification Authentication</th>
<th>Authorization</th>
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<tr>
<td>Have you ensured that the corporate security policies and guidelines to which you are designing are the latest versions? Have you read them? Are you aware of all relevant computing security compliance and risk acceptance processes? (Interviewer should list all relevant policies and guidelines.)</td>
<td>Diagram the process flow of how a user is identified to the application and how the application authenticates that the user is who they claim to be. Provide supporting documentation to the diagram explaining the flow from the user interface to the application/database server(s) and back to the user. Are you compliant with corporate policies on accounts, passwords, etc.?</td>
<td>Provide a process flow from beginning to end showing how a user requests access to the application, indicating the associated security controls and separation of duties. This should include how the request is approved by the appropriate data owner, how the user is placed into the appropriate access-level classification profile, how the user ID, password, and access is created and provided to the user. Also include how the user is informed of their responsibilities associated with using the application, given a copy of the access agreement, how to change password, who to call for help, etc.</td>
</tr>
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3. Building the Security D-Case

In this section of the paper, we briefly explain the steps of how we build our security case structured diagram using the D-Case technique. Our security case diagram is derived from the information provided by the list (refer to Table 1) of the most common security vulnerabilities that are often encountered by corporate information sharing systems or networking systems. But before the building of the security dependability case, we'd like to explain about what a dependability case is.

3.1. Building the Security Case

This new method was used and tested as an experimental research application to provide assurance to the security aspect of our networking E-learning system called KISSEL (Knowledge Integrated Server System for E-Learning). More work, experiment and tests (trail and error) are still needed in order to take our work into the next stage. But as all great ideas and great technologies of today, it all started from a simple vision.

The security domain is not new to networking and information sharing systems. Therefore, such systems have been associated with security factors for as long as networking and information systems existed. What is really new here is the urge to associate the networking system with assurance case that assured the networking system will behave as predicted, function well under pressure from future security vulnerabilities and attacks and so on.

Since we are building a security case, therefore our top goal or the main claim that we are going to argue about our system should be the “System is reasonably secure”. To support this top goal or claim, the context nodes should provide whichever sort of environmental information about the system or any sort of attachment that helps to make the main argument truthful or convincing; like for example, documents like the system requirements which tells of what kind of security requirements that the system has in order to secure the system from unwanted attacks, or any kinds of security design architecture diagram if any, and so forth. Figure 2 is to provide a visualized view of what this paragraph is trying explain. Figure 2 shows only the top most part of our security case diagram.

![Figure 2](image.png)

After the top goal is set with all the necessary contexts. What follows is the decomposition step or stage of
the main argument or the ‘main goal’ into two or more sub-goals. However, prior to the decomposition stage, where the ‘sub-goal nodes’ comes into the picture, the node called ‘strategy’ is inserted between the main goal and the sub-goals. The strategy node should explain or give a sense of justification or reason to why we the security case builders decided to decompose the main goal into such and such number of sub-goals. In figure 6, the strategy links us to some of the identified security vulnerabilities displayed in table 1. In this example, we take 6 identified security vulnerabilities as sub-goals. And the strategy is to argue over each of the 6 identified security vulnerabilities. Figure 6 is to provide a visualized view of what this paragraph is trying explain.

No matter what the assurance case or the D-Case is, whether it is a safety case, reliability case or a security case, they all follow a kind of pattern. For example, [9] security case patterns are claims-argument-evidence structures that can be reused in many different security cases. The security case method offers the opportunity for security and domain experts to organize security knowledge and mitigation strategies in the form of security case patterns. Such patterns can then be shared among the security community and other stakeholder communities and continually built upon, refined, and improved. A growing repository of security case patterns is a huge possibility for a variety of domains and operational contexts that not only would provide greater opportunities for reuse and standardization of assurance arguments, but also could allow the security community to associate an historical record of security performance and return on investment with particular security case patterns.

In the last measure to our security case, we would see that some of the sub-goals got themselves a straightforward evident or solution that satisfy the final objective in supporting of the main goal, while in some sub-goals, they have to be expanded more widely in order to get to the heart of where the evident truly exist. Figure 7 shows how sub-goals one, two and three are decomposed until the evident that satisfy all the objectives of the security case main goal.

Our next figure; Figure 5 shows how we decomposed sub-goal Goal: G_4 into four more sub-goals of sub-goal G_4.1, sub-goal G_4.2, sub-goal G_4.3 and sub-goal G_4.4. Note that for sub-goal G_4.1, we added one property of D-Case called node = undeveloped which means this sub-goal G_4.1 is yet to be completed. Many
factors could contribute to be the reason why a sub-goal is labelled undeveloped. For example, one of the factors could be that the evident or evidence provided to satisfy the objective of sub-goal G_4.1 is not well defined by both the stakeholders, system engineers and the security case builders.

Fig. 5. This figure shows how sub-goal 4 is decomposed into 4 more sub-goals of 4.1, 4.2, 4.3 and 4.4

4. Evaluation and Conclusion

We proposed a new and sensible method of how we should write security cases. This security case though may only be suited for information networking systems with small budgets. The current method is still working however it is too costly and therefore not suited for projects with small budgets. By assessing similar systems (similar in functionalities, running under similar environment and gathered previous encountered risks reports), we the security case developers could easily managed and discuss all the necessary actions prior to the development of the security case. This step helped to limit the cost of having experts to do all the preliminary jobs for you. We have a complete manual of security cases developed for our e-learning system. And so far, it has helped us to limit the threats we already faced and threats that are yet to be faced.

5. Acknowledgement

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6. Reference