
Developing a Taxonomic Framework of Security Methods for Security Management and Information Resource Management

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Developing a Taxonomic Framework of Security Methods for Security Management and Information Resource Management

Abstract

People who are concerned with security (such as security professionals) are naturally interested in methods of achieving security. This paper proposes an approach to creating a taxonomic framework of security methods. The taxonomic framework is developed using facet analysis based on a tetra-facet model of security, which identifies four facets of security: subject/scope of security, object of protection, source of insecurity, and method of protection. The taxonomic framework of security methods is created by combining two of the facets: source of insecurity and method of protection. The taxonomic framework of security methods can be integrated with the taxonomic framework of security (which was developed in a previous study), and can be used for security management and the management of information resources related to security and security methods.

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Introduction

The human society has been getting more and more concerned with security. News about security is frequently heard on media. For example, on May 16, 2019, the U.S. Department of Commerce applied export control restrictions to China telecommunications equipment maker Huawei Technology Ltd. and 68 of its affiliates deemed a risk to U. S. national security.¹ This is an example of an attempt to use political and economic methods to achieve national security. On November 1, 2019, Russia passed a new internet sovereignty law that grants the Russian government the ability to disconnect the entire country from the global internet in the event of a national emergency or foreign threat, such as a cyberattack.² This is an example of an attempt to use technological and political methods to achieve national security. These examples raise a question: What methods can be used to achieve security?

Security in this article is a concept related to threat, safety, and protection. People who are concerned with security are probably more interested in methods of protecting security (or security methods). In a previous study, the author collected existing classification snippets of security from knowledge organization systems such as Library of Congress Classification (LCC), Library of Congress Subject Headings (LCSH), and ACM Computing Classification System (ACMCCS).³ The author also inferred classification snippets of security from functional components of major government agencies and international organizations with security management tasks (such as the Department of Homeland Security, the Social Security Administration, and the World Bank), and other sources.⁴ It was found that there is no comprehensive taxonomy of security methods except in the information security sub-domain.⁵ LCC and LCSH contain fragmented taxonomies of security, but do not contain any section of security methods.⁶ The ACM Computing Classification System has a Security and Privacy section, which has the following major sub-categories: Cryptography, formal methods, and theory of security, security services, intrusion/anomaly detection, and malware mitigation, security in hardware, systems security, network security, database and storage security, software, and application security, human and societal aspects of security and privacy.⁷ It includes some information security-related subject terms (such as system security, network security) and some security methods (such as cryptography, formal methods, and security

services, which further include authentication, access control, and authorization). In a previous study, the author identified method of protection as a facet of security, and developed an incomplete, generic list of these methods, including physical method, economic method, financial method, technological method, military method, cultural/psychological method, administrative/legal/political method, and comprehensive method.⁸ These findings and resources lay the foundation for the proposed approach to developing a taxonomic framework of security methods.

The goal of this research is to develop a taxonomic framework of security methods based on the author's previous studies.⁹ The taxonomic framework can be used for the management of security methods and information resources about security methods. The significance of the study is introduced in the next section.

Significance of the Study

Security is an ambiguous term and there is not a precise and universally accepted definition of security.¹⁰ Various aspects of security are studied in various disciplines and application domains, and the community of security studies has greatly expanded the scope of security in the past thirty years.¹¹ As a result, there is no comprehensive classification scheme of security. "Addressing security issues can ultimately boil down to a problem in classification. The goal is to put the problem into general categories ... of threats and then identify the risk factors for each category."¹² A classification scheme of security or threats is needed when addressing security issues. In an earlier article, the author introduced an approach to developing a comprehensive taxonomy of security, and proposed to develop a taxonomy of security methods in a future study.¹³ However, due to the lack of a universal definition or understanding of security, a global taxonomy of security terms or security methods is certain to be inadequate in one way or another. Therefore, this article aims to propose a taxonomic framework of security methods, and any security practitioner or researcher can use this framework to develop a taxonomy of security methods based on their subjective understanding of security.

This research illustrates no comprehensive taxonomy of security methods. Several books can be considered as taxonomic introductions to security methods in government/corporate domains. Hemphill's *Modern Security*

Methods introduces methods for protecting personal and business security.¹⁴ Young's Metrics and Methods for Security Risk Management introduces security methods and standards in government/corporate security domain, including physical security standards for office facilities, standard for fire safety, security standard for the off-site storage of media containing sensitive or proprietary information, and security standard for facilities that process electronic information (data centers).¹⁵ John Fay's Contemporary Security Management introduces all necessary physical and IT security measures in government/corporate environment.¹⁶ James Broder and Eugene Tucker's Risk Analysis and the Security Survey shows how to develop and maintain current business contingency and disaster recovery plans to ensure enterprises are able to sustain loss and recover.¹⁷ It introduces a security survey checklist, including policy and program, organization, control of entry and movement, barriers (fences, gates, walls, etc.), locks and keys, alarms, communications, property control (equipment, material, tools, personal property), emergency planning, and personnel screening.

This study applies facet analysis to the hypernym of a subject term (that is, security) instead of the subject term itself (that is, security methods) in taxonomy development. The taxonomy can be useful for managing information resources about security when security methods are focused, and can be useful for security management since multiple organizations may use certain security methods to manage multiple aspects of security. The users of the taxonomic framework can be organizations (such as government agencies and corporations) that manage all aspects of security, libraries, and information centers that manage information resources about security, and researchers who study security and security methods. Imagine an academic library of a university (such as the National Intelligence University of the United States) that has a special collection of information resources that is related to security methods. A taxonomy of security methods can be useful for the library to organize the collection for information access.

Methodology

In the previous work on developing a taxonomy of security, the author collected 120 journal articles, book chapters, and online documents that are closely related to security definitions, dimensions, features, methods,

taxonomies, and classifications from 102 security-related journals and websites.¹⁸ The author has collected existing classification snippets of security from knowledge organization systems such as Library of Congress Classification (LCC), Library of Congress Subject Headings (LCSH), and ACM Computing Classification System (ACMCCS), or inferred classification snippets of security from functional components of major government agencies and international organizations with security management tasks.¹⁹ These resources are analyzed to create a list of terms related to security methods.

There are many online resources about Internet security, cybersecurity, data security on the Web. For examples, Chakrabarti and Manimaran proposed a taxonomy of Internet infrastructure security attacks and solutions, and Pekin Insurance proposed 10 data security methods for protecting small businesses.²⁰ These small taxonomies are merged into ACMCCS as a sub-category of information security methods.

Facet analysis and a tetra-facet model of security, which was created in the author's previous study, are used to build the taxonomic framework of security methods.²¹ Library scientist S.R. Ranganathan first introduced facet analysis to denote the technique of separating the elements of complex subjects in relation to a set of abstract fundamental concepts.²² Facets are homogeneous or semantically cohesive categories, which are used to create term groupings of a subject discipline with a manageable size.²³ Facet analysis can "provide a framework within which all the various types of terms can be accommodated, together with rules for their combination."²⁴ Facet analysis is conducted based on Ranganathan's five fundamental categories that can be used to demonstrate the facets of a subject:

- Personality (P, the focal subject),
- Matter (M, the substance, properties or materials of the subject),
- Energy (E, including the processes, operations and activities),
- Space (S, which relates to the geographic location of the subject) and
- Time (T, referring to the time of the subject).²⁵

Inspired by the information security section of ACMCCS, the author can work with the experts in various dimensions of security (such as national

security, economic security, human development security, international security, military security, environmental security) to develop a security methods taxonomy for each domain.²⁶ However, these security dimensions have overlaps.²⁷ Therefore, this approach is not flawless. Ranganathan's facet analysis can be used to separate the elements of complex subjects in relation to a set of abstract fundamental concepts.²⁸ The elements are called facets, which are homogeneous or semantically cohesive categories.²⁹ However, performing facet analysis on security methods will get the generic list of security methods (such as physical method, financial method, political method) when the Matter facet is considered, or a list of specific security implementation methods when the Energy facet is considered. Therefore, the author retreated to the facets of security for a possible solution.³⁰

In the previous work, the author found that security is expressed in this pattern: A subject wants to protect objects against sources of insecurity using certain methods, and identified four facets of security:

- Subject/Scope of Security,
- Object of Protection,
- Source of Insecurity, and
- Method of Protection.³¹

Using this tetra-facet model of security to analyze the security methods in the information security domain, the author found that information security methods could be the combination of the Subject/Scope facet of security (which is information) and the technological method facet of Method of Protection. It can also be the combination of the Object of Protection facet of security (which is information or information systems) and the technological method facet of Method of Protection.³² Using the Subject/Scope facet of security to develop the taxonomy of security methods is not ideal because different subjects of security (such as nation, organization, family, and individual) may want to use same security methods. Using the Object of Protection facet (such as body, property, governance, economy, food, environment, job, health, energy, information) to organize security methods is a possible solution, but one would need to make a long list of the objects people have and want to protect, and they can also be overlapped. A better solution is to use the Source of Insecurity facet (that is, various kinds of threats, fears,

vulnerabilities, and risks) to organize security methods because the threats and risks emerging from the Object of Protection are the things that trigger people's security alarms.³³ This solution is consistent with Young's ideas: Since "all security risk issues derive from threats...in analyzing any security problem, the [...] first step is to accurately identify and categorize the set of unique threats."³⁴ "The quest of the security professional is to understand the spectrum of unique threats and to accurately classify them pursuant to assessing their individual components of risk and then applying mitigation."³⁵ "The process of developing a risk mitigation strategy begins with identifying the set of unique threats and associated risk factors for each of those threats."³⁶

The breadth of threats in the modern world of security is wide. "On a high level, these range from the relatively mundane like 'theft' to the more esoteric variety such as chemical, biological, and radiological weapons. If one considers all the variations of each threat, in addition to differences associated with venue, facility type, there are potentially an infinite number of threat scenarios."³⁷ Listing all security risk scenarios "invites complexity and can lead to confusing, duplicative, and/or wasteful mitigation strategies."³⁸ Therefore identifying general categories of risks (or sources of insecurity) based on common features is more efficient and informative than listing all specific security risk scenarios, and each category can be effectively addressed by similar mitigation methods.³⁹ Source of insecurity types is used in the taxonomic framework to represent categories of threats and risks based on common features.

Source of insecurity types includes a wide range of threats, fears, vulnerabilities, and risks, such as war and violence between/within states, weapons proliferation, migration, hunger, infectious disease, environmental degradation, hazards, climate change, poverty, underdevelopment, social inequalities, man-made risks due to modernization (such as financial crisis), and socially-created disasters (such as destruction of water and electricity systems).⁴⁰ Sources of micro-level personal and community insecurity, as well as emotional (vs. physiological) insecurity, can be added in the future.⁴¹

With the bottom-level terms of security methods and top-level facets for security methods (that is, Source of Insecurity, Method of Protection), a combination of top-down and bottom-up approach is used to develop the

taxonomic framework of security methods since it is the best practice in taxonomy construction as discussed in knowledge organization literature.⁴² This approach develops the higher-level categories in the taxonomic framework first, classifies security method terms into lower-level categories, and refines the lower-level categories according to the constraints of the higher-level categories.

The Taxonomic Framework of Security Methods and Connection to the Security Taxonomy

The first four steps of Young's process used to develop a particular security mitigation strategy include the following:

1. "identify the set of unique threats,
2. determine the relevant risk factors that enhance the likelihood or vulnerability components of risk associated with each unique threat [type],
3. establish the full set of controls to address each risk factor,
4. specify the methods necessary to implement each control."⁴³

Young's control is a set of high-level mitigation measures. The first four steps of the security risk mitigation process can be illustrated as this:

Threat (implies→) Risk (mitigated by→) control (applied by→) method.⁴⁴

In this article, Young's threat and risk are integrated into source of insecurity types, Young's control is mapped onto security method type, and Young's method is mapped onto security method instance.

Table 1 shows a small example of the framework of the taxonomy, which is created by combining the Source of Insecurity facet and the Method of Protection facet. The security methods taxonomy can be connected with the security taxonomy framework developed in the author's previous study by adding the Subject/Scope facet and the Object facet.⁴⁵

Table 1. A Snippet of Taxonomic Framework of Security Methods

Source of Insecurity (Type)	Method of Protection	Security Method (Type)	Instance of Security Method
Climate Change	Technological method	Control of emission of greenhouse gases	Renewable energy technology
	Economic method	Carbon emission trade	Chicago Climate Exchange (ceased in 2010)
	Legal/political method	International treaties on greenhouse-gas-emissions mitigation, adaptation, and finance	Kyoto Protocol Paris Agreement
Proliferation of powerful weapons	Physical method	Destruction of weapons	Destruction of missiles and chemical weapons in Soviet Union
	Economic method	Reemployment of weapon scientists	Employment opportunities for former weapons scientists of Soviet Union
	Diplomatic method, military method	Counterproliferation	Convention on conventional weapons
	Legal/political method	International agreements on control of weapon proliferation	Treaty on the Nonproliferation of Nuclear Weapons Chemical Weapons Convention
Illegal immigration	Legal/political method	Immigration laws for reducing illegal immigration	Secure America Through Verification and Enforcement Act of 2011
	Comprehensive methods	Border enforcement	Hiring more border control agents, providing tools for border protection
		Restrictions on illegal employments	Verification of an employee's legal status
	Physical method	Construction of border barriers Increased construction of detention facilities & detention of immigrants	Mexico-United States barrier U.S. President Trump's executive orders on border security
Epidemics of socially dangerous diseases	Legal/political method	Public health law	Laws and regulations governing the control of communicable diseases
	Economic method, Technological method	Cost-effective disease prevention and transmission strategy	Free or affordable immunization
	Physical method	Means of escape Firefighting access & provisions	Fire exits Fire extinguishers, external water hydrants and internal stair risers

Table 1. A Snippet of Taxonomic Framework of Security Methods (continued)

Source of Insecurity (Type)	Method of Protection	Security Method (Type)	Instance of Security Method
Epidemics of socially dangerous diseases	Legal/political method	Public health law	Laws and regulations governing the control of communicable diseases
	Economic method, Technological method	Cost-effective disease prevention and transmission strategy	Free or affordable immunization
Fire threat to people & property	Physical method	Means of escape	Fire exits
		Firefighting access & provisions	Fire extinguishers, external water hydrants and internal stair risers
	Technological method	Fire detection & warning	Fire detection/alarm system
	Administrative method	Emergency response	Staff fire drills
Fire safety management		Fire systems testing & maintenance	
Unauthorized access to office facilities	Physical method	Physical access control	Mechanical/electronic locks
		Authentication/authorization	Authentication via ID picture & guard verification
	Technological method	Visual monitoring	Closed circuit television
Authentication/authorization		Authentication and authorization via two-factor biometric	
Information loss/damage, data breach	Physical method	Physical access restrictions	Mechanical/electronic locks for file cabinets, computers and phones
		Data protection	Encryption of data (including cloud data)
	Technological method	Information access control	Two-factor identification of accessing information
		Administrative method	Background checks

Source: Author

Table 2 shows an example snippet of the integrated taxonomy.

Table 2. Security methods taxonomy connected with security taxonomy (an example)

Source of Insecurity (Type)	Subject/Scope	Object	Security Category/Subcategory
Illegal immigration	Nation	National border	National (border) security
Fire threat to people & property	Organization/Institution	People & property	Business security
	Individual & family	People & property	Family/personal security
Information loss/damage, data breach	Individual & Family	Information	Personal information security
	Organization/Institution	Information	Institutional information security
	Nation	Information	National information security

Source: Author

The Space (S) and Time (T) facets introduced in the author’s previous work can be added to the security methods taxonomic framework when needed.⁴⁶ Table 1 and Table 2 can be used to classify information resources about security. For example, suppose one would like to categorize an article about “President Trump’s executive orders on immigration and refugees.” It can have two categories: U.S. National Security at the United States/Mexico border in 2019 (according to Table 2), and about security method – physical method - increased construction of detention facilities & detention of immigrants – at United States/Mexico border in 2019 (according to Table 1).⁴⁷

Conclusion and Future Work

There is no comprehensive taxonomy of security methods except that the ACM Computing Classification System has a section of Security and Privacy, which includes some security methods. Four books (Hemphill's Modern Security Methods for protecting personal and business security, Young's Metrics and Methods for Security Risk Management in the government/corporate security domain, John Fay's Contemporary Security Management introducing all necessary physical and IT security measures in government/corporate environment, and James Border and Eugene Tucker's Risk Analysis and the Security Survey introducing a security survey checklist) can be considered as taxonomic introductions to security methods.⁴⁸ Based on facet analysis and a tetra-facet model of security developed in the author's previous study, the author developed a taxonomic framework of security methods using two facets of security (that is, Source of Insecurity, and Method of Protection), whereas the Source of Insecurity is the leading facet. The article demonstrates the application of facet analysis to the hypernym concept of a subject term (that is, security) instead of the subject term itself (that is, protection of security, or security methods) in taxonomy development. The taxonomic framework of security methods can be integrated with the security taxonomic framework developed in the author's previous study. The two taxonomic frameworks can be used for security management and the management of information resources related to security and security methods.

In the future, the taxonomic framework of security methods needs to be evaluated by security experts. With this taxonomic framework, the author can study the impacts of certain security methods related to some complicated security events (such as the U.S. Department of Commerce's export control restrictions to Huawei). The relationships between the security methods and the reactions of the stakeholders can be organized and visualized using a topic map, which can be used to facilitate the understanding of the impacts of certain security methods taken for handling certain security concerns.⁴⁹ The cause of insecurity can also be added to Table 1 to categorize Security Method Type further. For example, illegal immigration can have both push reasons (such as poor economy in one's own country) and pull reasons (such as economic opportunities in a

foreign country). The further categorization can enrich not only the Security Method Type but also the instance of Security Method.

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