



# How Well Do You Know Your Personae Non Gratae?

Jane Cleland-Huang

**IMAGINE THAT YOU'RE** building a software system that collects health-care data and financial information from its users. It might seem obvious that this personal information should be protected from prying eyes through access control mechanisms, audit trails, transaction controls, transmission encryption, and so on—in fact, perhaps so obvious that

tices implemented at the networking and programming levels?

## Finding the Right Fit

In my experience, many requirements specs include a lone security requirement or user story saying something to the effect of, “Only authorized users shall access personal healthcare information.” Or, if we're

ments outweigh its costs. Drawing an analogy from a related field, it's well known that credit card companies, while excellent at detecting fraud and inactivating stolen cards, almost never attempt to track down the actual offenders. Apparently, the cost of bringing them to justice outweighs the benefits, even though such offenders almost definitely pose ongoing security risks.

We clearly need to make informed decisions about how much time and effort to invest in analyzing security needs and specifying product-level security requirements. Performing a rigorous security analysis for a small and unimportant application residing behind an organizational firewall probably doesn't make sense. Similarly, if an organization builds families of Web-based educational tests day in and day out, then it can likely build the next solution by reusing security knowledge. For example, it could simply review existing security requirements, ensure they're suited for the new system, make any necessary customizations, and then reuse them to the fullest extent possible.

If, on the other hand, an organization is branching out into a new domain or building a new kind of

A rigorous security analysis for a small application behind a firewall doesn't make much sense.

in many cases people perform only a cursory security analysis and produce rather generic security requirements.

But is this the right way to build secure software? Are security requirements so similar across projects that we simply don't need to invest the time to explore product-level needs or to document requirements at an individual level for each project? Can we instead rely on business-as-usual, organizational security prac-

even luckier, “An audit log must be maintained of every access to the patient's healthcare information.” Unfortunately, skimping on security analysis can be quite risky.

Perhaps one of the most important questions we should ask is whether specifying security requirements at the individual product level actually leads to more secure systems. We might also ask if the benefits of writing better security require-

system, it simply can't afford to shortchange the security analysis and requirements specification steps. It's important to explore product-level risks and vulnerabilities, design safeguards, and specify them as requirements that are then trackable and testable throughout the entire product life cycle.<sup>1</sup>

## Security Requirements

I recently discussed some of the shortcomings of the Healthcare.gov website, one of which was a failure to secure personal data. David Kennedy, CEO of TrustedSec, reported that his passive reconnaissance of the website allowed him to extract 70,000 personal records without even any attempt to hack into the system. This was particularly alarming, given that the data hub connects to—and integrates information from—the Internal Revenue Service (IRS), the Department of Homeland Security (DHS), third-party verification processes, and insurance companies. The system therefore potentially exposes personal information at a scale not previously experienced in the US and requires a robust analysis of security needs. Building any such public-facing system clearly demands a systematic approach for analyzing security needs and documenting mitigating requirements.

There are several techniques that you might consider adopting for such purposes. None of these replace the need for analyzing security at the networking and code levels to prevent buffer overflows, SQL injection attacks, and so on. But they can be used to create a mindset of defensive thinking early in the requirements elicitation process. As a general rule of thumb, thinking defensively means that for every new requirement or feature, we need to think

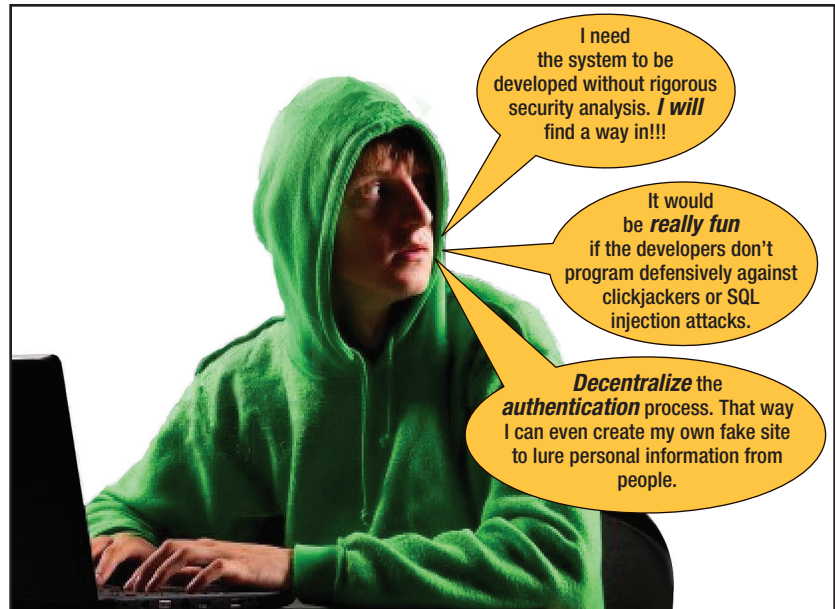


FIGURE 1. An unwanted and malicious intruder is depicted as a persona non grata.

about how it could be either intentionally or unintentionally abused.

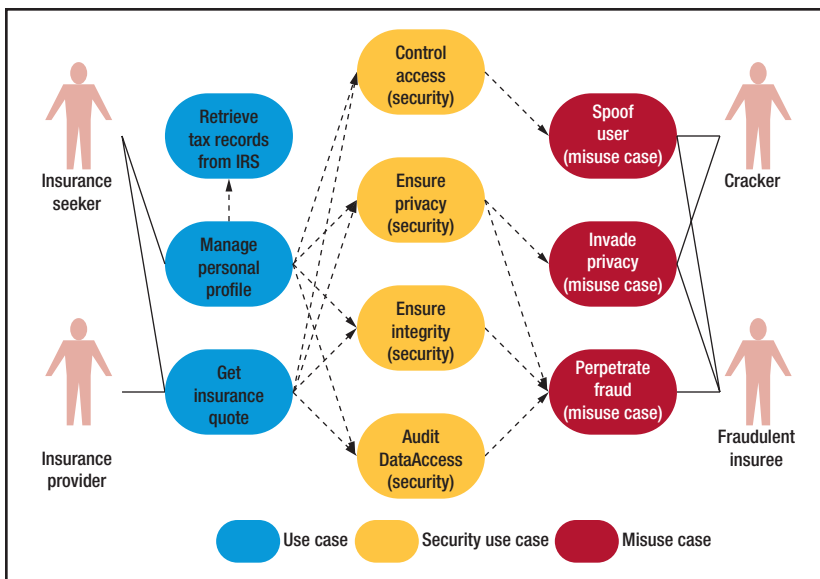
The most obvious technique leverages checklists and regulations. For example, in the US, all systems that involve the use of personal healthcare data are governed by HIPAA's (the Healthcare Information Portability and Accountability Act's) technical safeguards, which stipulate several security-related requirements including access control, automated logout, encryption of stored and transmitted data, and audit logs. Similarly, checklists can be very useful for ensuring that common security issues have been considered. On the other hand, neither of these approaches helps us to think about security risks that might be unique to our application, which means that on their own, they're insufficient.

Three techniques are particularly useful for reasoning about, and defending against, our adversary, the malicious user.

Personae non gratae build on the

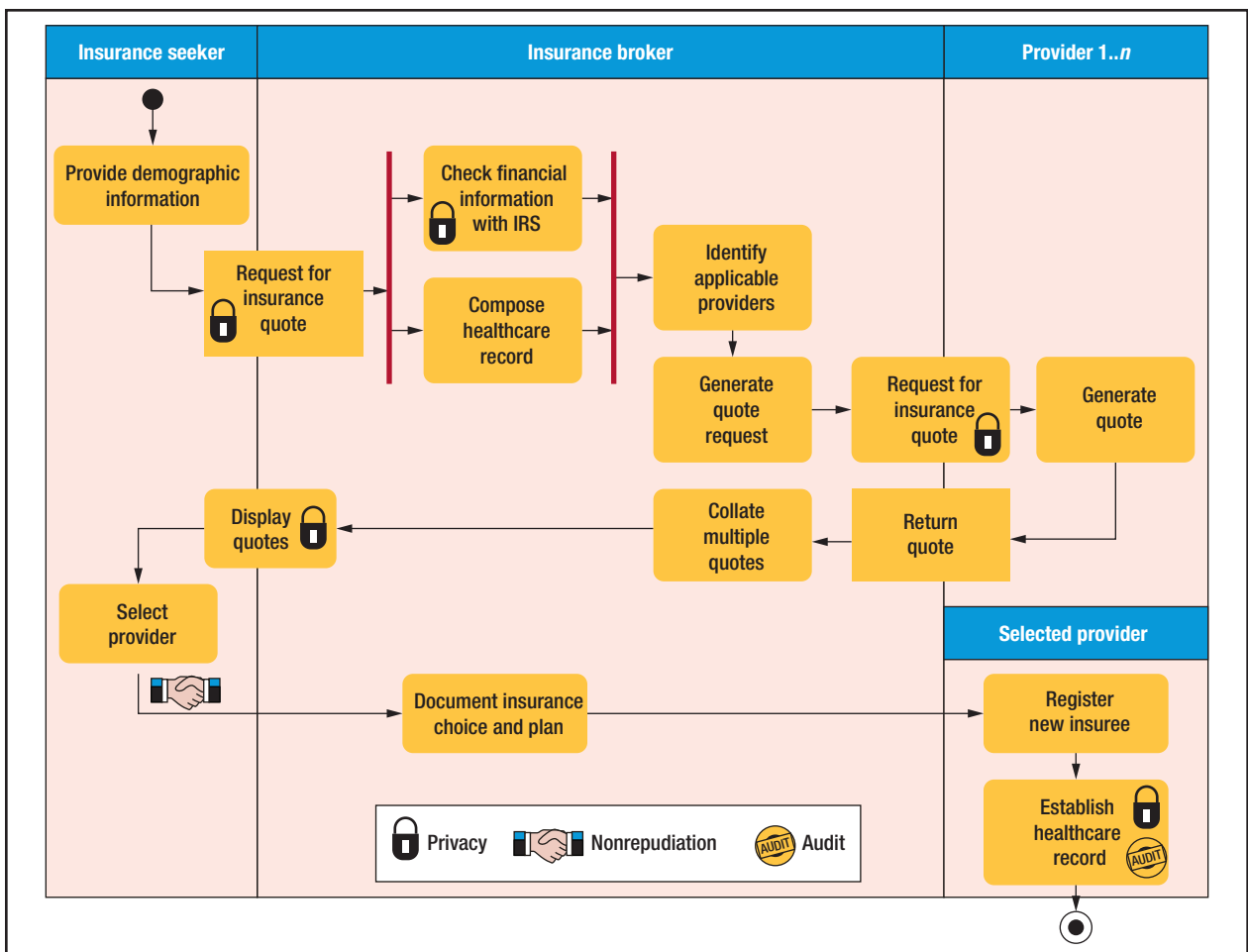
notion of designing for archetypical users and help us think strategically about the kinds of mischief a malicious user might attempt.<sup>2</sup> Figure 1 shows, Hugh, a young man who intends to attack our system. I've kept Hugh's goals quite generic, but we could create a persona non grata with more specific attack strategies to expose vulnerability points of the product. Creating such personas helps us take a more systematic approach to addressing security concerns throughout the project.

A related technique involves misuse cases, which can be used to determine in advance how the software product should respond to unintended, perhaps malicious, use.<sup>3</sup> In Figure 2's simple misuse case, we see two intended actors: an insurance seeker and an insurance provider, along with their related use cases for managing personal data and seeking/providing insurance quotes.<sup>1</sup> We also see security-related use cases that extend the primary



use cases to achieve access control, privacy, integrity, and auditing goals. On the right side, we see two different types of malicious users—the cracker, who attempts to obtain private information for purposes such as identification theft, and the fraudulent insuree. This second actor isn't necessarily technically savvy but intends to trick the system into

**FIGURE 2.** Misuse cases showing the interaction of malicious users with a system for attaining healthcare insurance quotes.



**FIGURE 3.** Activity diagrams model both computational and organizational processes. They can be annotated to depict security concerns.

providing insurance coverage that he's not actually eligible for. While there isn't space to explore these ideas in greater depth, this example illustrates how misuse cases can focus attention on different kinds of abuses, help us explore each of these in depth, determine a suitable set of mitigating requirements, and ultimately design cost-effective countermeasures into the system.

Finally, we could annotate activity diagrams with security concerns.<sup>4</sup> Figure 3 depicts the healthcare insurance seeker's privacy needs, audit capabilities for documenting all official use of the healthcare record, and nonrepudiation requirements related to selecting and signing up for an insurance plan.

**T**hese three simple modeling techniques can help you think more defensively during the requirements elicitation and analysis phases of a project. Instead of focusing solely on the system's intended users, you can also take into consideration their counterparts, who either intentionally or accidentally might undermine your system's integrity. Now is the time to think about how well you know your personae non gratae! ☹

## References

1. D. Firesmith, "Specifying Reusable Security Requirements," *J. Object Technology*, vol. 3, no. 1, 2004, pp. 61–75.
2. J. Cleland-Huang, "Meet Elaine: A Persona-Driven Approach to Exploring Architecturally Significant Requirements,"

*IEEE Software*, vol. 30, no. 4, 2013, pp. 18–21.

3. I. Alexander, "Misuse Cases: Use Cases with Hostile Intent," *IEEE Software*, vol. 20, no. 1, 2003, pp. 58–66
4. E. Fernandez-Buglioni, *Security Patterns in Practice: Designing Secure Architectures Using Software Patterns*, Wiley, 2013

**JANE CLELAND-HUANG** is a professor of software engineering at DePaul University. Her research interests include software traceability, architecture, and requirements engineering. Cleland-Huang received a PhD in computer science from the University of Illinois at Chicago. Contact her at [jhuang@cs.depaul.edu](mailto:jhuang@cs.depaul.edu).



See [www.computer.org/software-multimedia](http://www.computer.org/software-multimedia) for multimedia content related to this article.

## IEEE SOFTWARE CALL FOR PAPERS

### Special Issue on Trends in Systems and Software Variability

Submission deadline: 1 October 2014 • Publication: May/June 2015

Cyber-physical systems (CPS) are systems whose computational elements collaborate to control physical entities. A wide variety of CPS can be found in areas such as aerospace, automotive, energy, healthcare, manufacturing, transportation, entertainment, robots, and consumer appliances. The challenge for building CPS product families relies on new methods able to address more efficiently, dynamically, and intelligently than ever before the context information needed by self-adaptive and CPS systems.

The *IEEE Software* special issue on trends in systems and software variability will present a variety of techniques, tools, and approaches for software variability that support the challenge of adaptation and awareness of CPS systems and its impact on recent software product-line development approaches. We invite contributions related but not limited to the following:

- architectures for cyber-physical systems that effectively support dynamic variability;
- modeling techniques and viewpoints directed to modeling the contextual and physical properties of CPS;
- new software product-line development methods supporting runtime variability models and its impact in the SPL development life cycle;

- case studies on the impact on software evolution of dynamic variability models;
- new variability realization, configuration, and deployment methods;
- tools and models for managing both static and dynamic variability in CPS using context information;
- industry cases and experience reports managing dynamic variability for different types of CPS;
- software variability techniques for self-adaptive and cyber-physical systems;
- self-adaptive and CPS systems viewed as a dynamic software product lines (DSPLs); and
- integration of runtime variability solutions into current SPL/DSPL practice.

#### Questions?

For more information about the focus, contact the guest editors:

- Jan Bosch, [jan@janbosch.com](mailto:jan@janbosch.com)
- Rafael Capilla, [rafael.capilla@urjc.es](mailto:rafael.capilla@urjc.es)
- Rich Hilliard, [richh@mit.edu](mailto:richh@mit.edu)

**Full author guidelines:** [www.computer.org/software/author.htm](http://www.computer.org/software/author.htm)

**Submission details:** [software@computer.org](mailto:software@computer.org)

**Submit an article:** <https://mc.manuscriptcentral.com/sw-cs>