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## A PERSPECTIVE ON TECHNOLOGY EDUCATION FOR LAW STUDENTS

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## A PERSPECTIVE ON TECHNOLOGY EDUCATION FOR LAW STUDENTS

*By Anthony Volini<sup>1</sup>*

*Law schools continue to appreciate the importance of technology awareness for law students practicing in the 21st Century. As law schools have a desire to educate law students on technology, there is a need for focusing curricular priorities in this relatively new endeavor. The need for technology education in law schools is especially urgent, considering so many statutes either directly or indirectly require cybersecurity controls, and lawyers without a foundation in technology struggle to advise on such matters. This essay thus proposes curricular priorities to help law students face the challenges of an increasingly tech-driven legal marketplace and enable them to improve on bridging the communication gap between lawyers and technologists. This essay analogizes learning technology to learning a second language (e.g., Spanish) as a way to conceptualize tech education for law students with no tech background. Conceptually, law schools can enable students to achieve an intermediate level of tech fluency to facilitate further learning outside of law school.*

*I propose a core curricular priority of providing instruction on fundamental concepts in networking and programming with an emphasis on security. To afford law students some depth of insight, the instruction should embrace the back end or under-the-hood concepts as opposed to merely user-side instruction (e.g., merely learning usage of a new software tool). This main curricular priority can be implemented in a variety of ways: (1) providing cross listed IT courses to law students and/or (2) providing customized “for lawyers” courses (e.g., coding for lawyers) and/or (3) providing interdisciplinary law courses that teach and test on technology as an area of competence. As an example of implementing this core priority, one law school could achieve it by offering suitable cross listed Information Technology (IT)*

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*coursework in networking and programming. As another example, a law school might offer a one to two semester blockchain law course having several weeks of instruction on networking and programming, testing students on both the law and the technology concepts.*

*Once the core priority of networking and programming instruction is implemented in some suitable way, I suggest that law schools provide instruction on any other desired tech topics based on factors such as available instructors and student and faculty interest (e.g., AI, disaster recovery, project management, eDiscovery, legal process design, legal practice tools, forensics, etc.)*

*A major emphasis of this essay is that law students can benefit from learning the backend or “under-the-hood” instruction as opposed to merely user side tech education. Law students likely benefit from learning user-side tech (e.g., practice tools), and law schools can and should continue providing this education. However, I propose that a robust tech curriculum for law students prioritizes addressing under-the-hood concepts of networking and programming to facilitate a deeper understanding of IT as opposed to solely user-side tech education. This depth of understanding should facilitate more effective attorney communication on technology issues. A variety of law schools have programming for lawyers courses, which is consistent with my proposal. However, schools could also address networking concepts to provide students a more complete foundational understanding of the OSI layers consistent with Peter Swire’s Cybersecurity Pedagogical Framework. Such knowledge should be a major asset as lawyers will need to work with IT professionals when addressing matters such as cybersecurity/data privacy, tech contracts, legal process design, security by design, and other tech law issues.*

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## INTRODUCTION: ABOUT MY JOURNEY

I have been teaching law school full-time since 2005.<sup>2</sup> In 2016, I wondered how I might make myself more relevant in academia. The answer to me was very clear: obtain a technology degree given the growing need for tech savvy lawyers in the marketplace.<sup>3</sup> So, I started pursuing a Masters in Cybersecurity at DePaul (networking and infrastructure concentration). As of this writing, I have completed twelve courses toward the degree and am nearing completion. Several of the introductory computing courses in the program struck me as potentially a great fit for law students, so I successfully lobbied the faculties of DePaul's law school and computing school to allow any upper level JD student to take up to four selected IT courses and receive JD credit for the same.<sup>4</sup> I believe this is a relatively unique curriculum. While many law schools, including DePaul, offer joint programs (e.g., JD/MS), few law students are willing to simultaneously pursue two graduate degrees. By allowing a few IT courses for JD credit, law students can develop some technology awareness, which may seem like an attractive alternative option.<sup>5</sup> As a side note, I have not observed other law schools marketing a similar educational opportunity to their students, so I suspect the majority of law schools might not allow – or at least do not appear to actively promote – this type of interdisciplinary curriculum.<sup>6</sup>

Besides technology education, I have also obtained several certifications, which I encourage law students to pursue as well. I have obtained the CIPP/US and CIPP/E data privacy certifications as well

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<sup>2</sup> I currently teach a variety of courses, including Data Privacy Law: US & EU, IP Licensing (Drafting), Innovation & the Law at 1871/2112, Patent & Trademark Drafting, first year Legal Research & Writing (specialized IP Legal Writing section), and Legal Responsibilities in IT (co-taught with one of our computing school professors).

<sup>3</sup> I recall meeting with an IT executive around that time who told me that he only hires lawyers who have at least a basic understanding of his company's IT. His small company at the time spent roughly \$50,000 per month on legal services.

<sup>4</sup> Those courses include Intro to Programming; Business Continuity/Disaster Recovery; Information Security Management; and Legal Responsibilities in IT. I worked closely on this initiative with Ellen Gutiontov, Executive Director of DePaul's CIPLIT® (Center for Intellectual Property Law & Information Technology) program at the College of Law.

<sup>5</sup> When I put this curriculum together, I contemplated law students with no tech background and how this curriculum could offer them a basic level of tech fluency.

<sup>6</sup> I should note, however, that Georgetown Law encourages students to take or audit IT courses while in law school. *Privacy Law*, GEO. L., <https://www.law.georgetown.edu/your-life-career/career-exploration-professional-development/for-jd-students/explore-legal-careers/practice-areas/privacy-law/> (last visited Nov. 23, 2019).

as ISACA's (Information Systems Audit and Control Association) CSXF.<sup>7</sup>

With this background, I began teaching Data Privacy Law: US & EU in the spring of 2019 and experienced tremendous enrollment of fifty students with several on the waiting list. While developing the course, I realized that I needed to provide substantial relevant technology education to accompany the statutes and case law in the course (which I discuss in more detail below).

I started my career as a full-time patent attorney, so this chapter in my career seems to be a continuation of my interest in the intersection of technology and the law.

## I. THE NEED FOR TECH-SAVVY LAWYERS IN THE 21ST CENTURY

Much has been written about the need for tech-savvy law graduates, and there seems to be a consensus among legal educators that this is important.<sup>8</sup> In this essay, I will minimize arguing that the need exists. However, continued discussion of which tech topics to teach and how to teach them should be of value to law schools as they pursue this relatively new endeavor.

A few thoughts to consider on the growing need for tech education are (1) most states have adopted American Bar Association (ABA) Rule 1.1 that lawyers have technological competence,<sup>9</sup> (2) as of 2019, North Carolina and Florida now require technology Continuing Legal Education (CLE) for attorneys,<sup>10</sup> and (3) data privacy legislation is growing and current and future statutes, both state and federal, will

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<sup>7</sup> I created a YouTube channel to advise a broad audience on how to prepare for these certifications. Cybersecurity Patent Professor, *Certifications*, YOUTUBE (June 5, 2019), [https://www.youtube.com/playlist?list=PLhAOJU2XD-IuR-R6\\_-8yrENL2glqLEg8s](https://www.youtube.com/playlist?list=PLhAOJU2XD-IuR-R6_-8yrENL2glqLEg8s); see also *CIPP Certification*, IAPP, <https://iapp.org/certify/cipp/> (last visited Nov. 23, 2019); see also *Cybersecurity Fundamentals Certificate*, CSX, <https://cybersecurity.isaca.org/csxcertifications/csxfundamentalscertificate> (last visited Nov. 23, 2019).

<sup>8</sup> See, e.g., Oliver R. Goodenough, *Developing an e-Curriculum: Reflections on the Future of Legal Education and on the Importance of Digital Expertise*, 88 CHI. KENT L. REV. 845 (2013); Mark Cohen, *Law's Looming Skills Crisis*, FORBES (May 21, 2019, 6:56 AM), <https://www.forbes.com/sites/markcohen1/2019/05/21/laws-looming-skills-crisis/#760ea8bd445c>; Mark Cohen, *DXC Is Serious About Legal Digital Transformation*, FORBES (Oct. 8, 2018, 7:16 AM), <https://www.forbes.com/sites/markcohen1/2018/10/08/dxc-is-serious-about-legal-digital-transformation/#2d28b8f33094>.

<sup>9</sup> Robert Ambrogi, *Make That 30 States, As Another Adopts Ethical Duty of Technology Competence*, LAWSITES BLOG (Mar. 14, 2018), <https://www.lawsitesblog.com/2018/03/make-30-states-another-adopts-ethical-duty-technology-competence.html>.

<sup>10</sup> Doug Austin, *A Second State Now Has Approved a Technology CLE Requirement for its Lawyers: eDiscovery Trends*, JDSUPRA (Dec. 7, 2018), <https://www.jdsupra.com/legalnews/a-second-state-now-has-approved-a-87363/>.

have or continue to have express or implied cybersecurity requirements, which lawyers will need to understand.<sup>11</sup>

Renowned privacy law expert Peter Swire has predicted that the future marketplace will have a growing need for a new middle layer of professionals having a combination of law, technology, and business knowledge.<sup>12 13 14</sup> These professionals can be lawyers or nonlawyers, and their job is to liaise between technologists and upper level management.<sup>15</sup> For law schools to produce lawyers to fill this middle layer, they would need to teach both technology and business to aspiring lawyers.<sup>16</sup> Indeed, while most law schools have failed to adopt technology education of any kind, many lawyers have begun to articulate the need for more tech-savvy attorneys.<sup>17</sup>

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<sup>11</sup> Alfred J. Saikali, *The Developing Landscape of Data Protection Laws and Enforcement Actions*, AM. BAR ASS'N (Apr. 9, 2019), <https://www.americanbar.org/groups/litigation/committees/products-liability/practice/2019/the-developing-landscape-of-data-protection-laws-and-enforcement-actions/>.

<sup>12</sup> See generally, Peter Swire, *Privacy and Security: A Pedagogic Cybersecurity Framework*, 81 COMMS. OF THE ACM 23 (Oct. 2018), <http://peterswire.net/wp-content/uploads/Pedagogic-cybersecurity-framework.pdf>.

<sup>13</sup> Evidence of this growing middle layer in legal systems can be seen in the development of alternative business structures in the UK (i.e., nonlawyers sharing fees with lawyers in the provision of legal services). *Alternative Business Structures*, CHAMBERS STUDENT, <https://www.chambersstudent.co.uk/where-to-start/newsletter/alternative-business-structures> (last visited Nov. 24, 2019); see RICHARD SUSSKIND, *TOMORROW'S LAYERS: AN INTRODUCTION TO YOUR FUTURE* 7 (2d ed. 2017).

<sup>14</sup> Cohen discusses the growth of the business of delivering legal services and the need for lawyers to have both business and technological competencies. Mark Cohen, *What's A Lawyer Now? Law's Shift From Practice To Skill*, FORBES (Sept. 23, 2019, 7:20 AM), <https://www.forbes.com/sites/markcohen1/2019/09/23/whats-a-lawyer-now-laws-shift-from-practice-to-skill/#7e7e0276745b>.

<sup>15</sup> Utah's recent procedural adjustment also seems to support Swire's model of a middle layer. See, e.g., UTAH SUP. CT. R. 14-802, <http://www.utcourts.gov/utc/rules-comment/wp-content/uploads/sites/31/2017/08/Redline-14-802-for-Comment.pdf>. (allowing licensed paralegals to give limited-scope advice for temporary situations.)

<sup>16</sup> This essay focuses on the technology aspect and not on the business education aspect (the business education aspect could be addressed in some future essay. As a side note, besides teaching tech to law students, my colleague, Professor Karen Heart (DePaul College of Computing and Digital Media), and I are teaching the law to computing students in IS 482: Legal Responsibilities in IT (accommodating both law and computing students).

<sup>17</sup> See, e.g., Daniel Martin Katz, *The MIT School of Law? A Perspective of Legal Education in the 21st Century*, 2014 U. ILL. L. REV. 1431 (2014) (advocating for a theoretical program that trained students in both technology and law); see also, Janine Ford, *Do lawyers need to learn to code?*, LEGAL TECH WEEKLY (Mar. 19, 2019), <https://suits.contractbook.co/legaltechweekly/do-lawyers-need-to-learn-to-code>; see also Daniel Solove, *Establishing a Robust Law School Educational Program for Privacy Law*, PRIVACY + SECURITY BLOG (Sept. 2019), <https://teachprivacy.com/establishing-robust-law-school-program-privacy-law/> (describing that a robust law school privacy law program should include a "course where law students can learn the basics of technology relevant to privacy issues (knowledge of technology is very sought-after by employers)."

Swire has provided a new cybersecurity pedagogical framework that builds upon the OSI model of computing, adding his layers 8-10 to the OSI model's existing layers 1-7.<sup>18</sup> The OSI model is the Open Systems Interconnection model, and is a conceptual model for understanding how computers operate and communicate with each other.<sup>19</sup> Often, technologists will use these layers to troubleshoot performance problems, checking for issues at each layer, starting with layer 1. Layer 1 is the physical layer (e.g., 1s and 0s traveling across an ethernet cable).<sup>20</sup> Most IT problems are said to occur at layer 1, which is why help desk personnel routinely first ask whether all cables are installed and the power is on as a starting point for troubleshooting. Layer 2 is the data link layer. In an enterprise network, the data link layer might involve an organization's internal PCs and printers connected by switches.<sup>21</sup> Layer 3 is the network layer. A router is commonly referenced as a layer 3 device, and it makes the decision of whether data needs to be sent out to the Internet.<sup>22</sup> Layer 4 is the transport layer and layer 5 is the session layer.<sup>23</sup> These layers establish a communication channel or "session" between two computers. For example, a user's laptop could communicate with a web server, and the two computers could first agree to communicate (i.e., open a "session"), agree on the size of data packets to send each other, and agree on whether to encrypt the data they send to each other (e.g., they may agree to use the https protocol, which provides for encrypting most data sent between a user's computer/browser and a web server, thereby increasing the difficulty of an eavesdropping attack as compared to http/unencrypted communication). Layer 6 is the presentation layer and is often referred to as the syntax layer. Layer 6 essentially translates data into a usable form for layer 7, the application layer, so that the application layer can perform higher level processing on the data.<sup>24</sup> For example, layer 6 might be responsible for decrypting data so that it is usable by a layer 7 software program. Layer 7 is the application layer, which implicates software applications (e.g., Windows 10, Microsoft Word, Internet Explorer, etc.).<sup>25</sup> A general theme of the OSI layers is

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<sup>18</sup> Swire, *supra* note 12, at 23, 24.

<sup>19</sup> See generally, Hubert Zimmermann, *OSI Reference Model - The ISO Model of Architecture for Open Systems Interconnection*, 28 IEEE TRANSACTIONS ON COMM. 425 (Apr. 1980).

<sup>20</sup> See generally, Paul D. Bartoli, *The Application Layer of the Reference Model of Open Systems Interconnection*, 71 PROC. OF THE IEEE 1404 (Dec. 1983).

<sup>21</sup> *Id.*

<sup>22</sup> *Id.*

<sup>23</sup> *Id.*

<sup>24</sup> *Id.*

<sup>25</sup> *Id.*



that the lower layers (e.g., layers 1-5) generally describe transmitting data, while the highest layer (layer 7) uses the data. In a sense, to understand the OSI layers is to understand computing because the core functioning of computers is to either transmit data or to process it.

Swire adds layers 8, 9, and 10 (organization, government, and international layers, respectively) to the existing OSI layers 1-7.<sup>26</sup> The brilliance of Swire's model is that it provides a common framework for technologists and lawyers to use, by simply adding human layers 8-10 on top of the existing IT layers. It would seem that professionals operating in layers in 8-10 would need good awareness of layers 1-7, which supports my proposal of prioritizing basic instruction in programming (layer 7) and networking (layers 1-5).

Swire's model seems useful not only as a pedagogical framework for teaching cybersecurity but really for any area of technology: any professional communicating with technologists would seem to benefit from deepening her understanding of OSI layers 1-7 when engaged in any management involving technology. For example, medical students could benefit from instruction in the OSI layers if their careers later involve communicating with IT on development of new processes or online tools for improved healthcare systems.

Law students who have coursework focused on networking (e.g., layers 1-5) and programming (layer 7) will have a better foundation for understanding future technology developments than a law student whose education focuses exclusively on learning about the most recent legal practice tools from a user perspective or from merely studying the impact of a technology on the legal industry. Essentially, a law school that can provide some level of technical training can provide a liberal arts student with a touch of engineering training, enough to be tech conversant on basic terminology and concepts, which should benefit her.

Melanie Reid notes that students with a computer science (CS) degree may be better prepared for legal practice than other students.<sup>27</sup> This provokes the question of why. The answer is that the CS graduate typically has a deep fluency in technology and therefore has the ability

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<sup>26</sup> Swire, *supra* note 12, at 23, 24.

<sup>27</sup> Melanie Reid, *A Call to Arms: Why and How Lawyers and Law Schools Should Embrace Artificial Intelligence*, 50 U. TOL. L. REV. 477, 483 (2019). "With the advancement of AI, a computer science degree may be a better preparation for legal practice than a liberal arts degree. Similar to a high LSAT score, a highly technical background may be a harbinger of future success in law school. While there is no necessity for future law students to have a computer engineering or coding background, it is essential these future students feel comfortable with advanced technology so they can adapt and innovate as AI programs evolve." *Id.*

to quickly understand a client's technology issues and ask the right questions. Typically, the CS graduate lawyer does not do IT work, but the deep level of tech fluency afforded by the CS degree puts that lawyer in a much better position than other non-CS degree lawyers (because of this communication ability) as she works on legal issues intersecting with tech. Her role as a tech lawyer is not to do the tech work, but instead is to manage the legal tech issues or to perhaps participate on a team in terms of the high level brainstorming of software development (e.g., security by design, legal process design, or other issues).

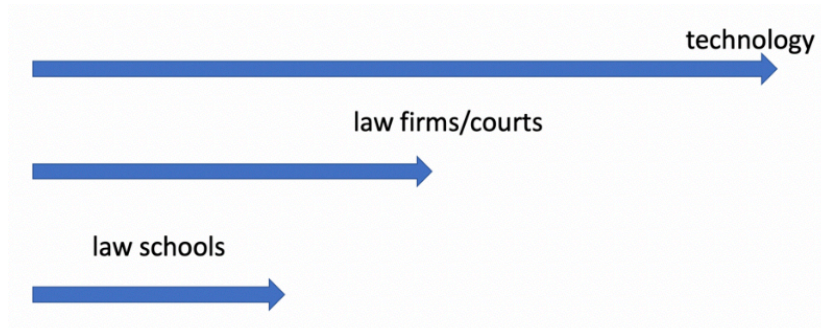
Law schools are unlikely to fill their classrooms with CS or engineering students anytime soon, so my focus is on the typical liberal arts student and assessing what depth of IT education will enable this law student to have some level of working tech fluency. This will probably not be the same level of fluency as the CS graduate, but may be enough fluency to facilitate rapid tech learning outside of law school. Along these lines, a 30,000 foot level of tech education for law students is inadequate (e.g., one lecture or week covering the OSI layers), and instead a ten to fifteen thousand foot level of instruction is more helpful to achieve some of the tech fluency of a CS graduate (e.g., multiple tech courses, such as my proposed range below of three to six tech courses for intermediate fluency implemented in varying ways). At DePaul, the law school's cross listed introductory level IT courses from the computing school have no prerequisites and essentially function like introductory Spanish courses from a tech fluency standpoint, as explained below. These courses, or the combination of courses, seem a good option to offer some level of depth in terms of IT education.

#### *A. Keeping up with Tech*

Law schools will continue to struggle to keep up with the marketplace, and perhaps any school in any discipline will struggle to keep up with the marketplace. This is especially the case with technology given its very rapid growth. In fact, even computing schools struggle to keep up with the rapid changes in technology.<sup>28</sup> The image below represents my perception of the lag that may continue indefinitely as courts, law firms, and schools make efforts to catch up with technology:

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<sup>28</sup> Mike Stucka, *Will Education Ever Keep Up with Technology?*, CTR. FOR DIGITAL EDUC. (Oct. 29, 2014), <https://www.govtech.com/education/Will-education-ever-keep-up-with-technology.html>.



### B. *The Exponential Growth Rate of Technology*

Since its inception, IT has grown and will likely continue to grow at an exponential rate, making it difficult for lawyers, courts, and schools to keep up. Perhaps the best evidence of technology's exponential growth is that we are running out of IPv4 address space.<sup>29</sup> IPv4 (version 4) was developed in the early 1980s to provide every Internet connected computer with a common addressing scheme so that every computer has the same format of address.<sup>30</sup> For example, [www.cnn.com](http://www.cnn.com) has an Internet Protocol (IP) address of 151.101.193.67 and [www.depaul.edu](http://www.depaul.edu) has an IP address of 140.192.5.61. These four numbers separated by periods are often referred to as the dotted quad. Each of the four quads can theoretically have a value of 0-255, thus we could visualize the address space as 0-255.0-255.0-255.0-255.<sup>31</sup> Mathematically, the number of possible addresses is thus  $256^4$  or nearly 4.3 billion possible IP addresses.<sup>32</sup> In the early 1980s, 4.3 billion IP addresses likely seemed suitable, considering the U.S. population in 1980 was only about 225 million (this was prior to cars, refrigerators, and smartphones connecting to the Internet).<sup>33</sup>

<sup>29</sup> Geoff Huston, *The Changing Foundation of the Internet: Confronting IPv4 Address Exhaustion*, INTERNET SOC'Y (Oct. 2018), <http://wattle.apnic.net/papers/isoc/2008-10/v4depletion.pdf>.

<sup>30</sup> B. Carpenter et. al., *IPv4 Address Behaviour Today*, HJP (Feb. 1997), <http://www.hjp.at/doc/rfc/rfc2101.html>.

<sup>31</sup> See *Dot-decimal notation*, WIKIPEDIA, [https://en.wikipedia.org/wiki/Dot-decimal\\_notation](https://en.wikipedia.org/wiki/Dot-decimal_notation) (last visited Dec. 2, 2019).

<sup>32</sup> *Id.* (describing that each quad can have a value between 0 and 255, which is 256 possible numbers (counting 0)).

<sup>33</sup> *1980 United States Census*, WIKIPEDIA, [https://simple.wikipedia.org/wiki/1980\\_United\\_States\\_Census](https://simple.wikipedia.org/wiki/1980_United_States_Census) (last visited Nov. 24, 2019); see also *By Decade*, U.S. CENSUS BUREAU, <https://www.census.gov/programs-surveys/decennial-census/decade.1980.html> (last visited Nov. 24, 2019).

Since the early 1980s, the number of “computers” worldwide has increased exponentially (counting smartphones, tablets, cars, etc.) and is expected to exceed 4.3 billion in the near future. Therefore, IPv6 has been developed, and most computers are now compatible with IPv6 to be ready for future networks relying on IPv6 addressing.<sup>34</sup> (IPv6 addresses are essentially four times longer than IPv4 addresses, and therefore, IPv6 has an astronomical address space of  $3.4 \times 10^{38}$  possible addresses.)<sup>35</sup>

Running out of IPv4 address space is an example of the exponential growth of IT since its early days, and the common consensus is that IT will continue to grow exponentially, not just in terms of additional computers in the Internet of Things (IoT) era but also IT generally, such as increased usage of Artificial Intelligence (AI).<sup>36</sup>

### *C. Law Schools are Unlikely to Keep Up with the Exponential Growth of Tech, but What Can Be Done?*

Legal educators, by necessity, need to look backwards when teaching the law. Rather than addressing novel legal issues presented this week by a client, law faculty wait for developments in case law as one major source of their teaching. Essentially, a typical sequence of analysis is that clients have a new legal technology issue, their lawyers struggle with the new issue, courts eventually might struggle with that issue, and finally law faculty review judicial opinions on the issue and integrate the same into their teaching.

Law schools will need to continue teaching historical case law/traditional legal principles because they are essential for lawyers to understand legal issues in our common law system. Further, a law school cannot turn itself into an IT school and expect students to pass the bar.

All that being said, law schools can do something in terms of allowing students to achieve some basic, foundational understanding of IT prior to graduating. At a minimum, law schools can allow students to take several tech-focused elective courses (as described above) either in the law school, at a computing school, or some combination of the two. In line with Swire’s model, I propose that law

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<sup>34</sup>See *Internet Protocol Version 6: IPv6 for Consumers*, FCC, <https://www.fcc.gov/consumers/guides/internet-protocol-version-6-ipv6-consumers> (last visited Nov. 24, 2019) (noting “most personal computer operating systems support IPv6”).

<sup>35</sup> Stanford L. Levin & Stephen Schmidt, *IPv4 to IPv6: Challenges, solutions, and lessons*, 38 TELECOMM. POL’Y, 1059, 1060 (2014).

<sup>36</sup> See generally Reid, *supra* note 27.

schools look for ways to educate law students on layers 1-7 of the OSI model to provide sufficient awareness for them to manage his layers 8-10. As discussed earlier, this would require a core curricular priority of offering some training on networking (i.e., layers 1-5) and computer programming (mainly layer 7).

In a sense, while IT changes and evolves rapidly, the foundational concepts remain largely the same.<sup>37</sup> Therefore, providing a basic foundation in networking and programming is helpful because the fundamental concepts, most of which were developed decades ago, will stay the same.<sup>38</sup> Thus, learning the fundamentals of networking and programming will likely have usefulness for several decades while learning a particular software tool may be useful for perhaps only a few years

#### *D. Keeping Up: A Side Note on Agile Management*

As law schools consider how to adapt to technology changes in the legal marketplace, they could explore adopting an Agile organizational approach<sup>39</sup> that is popular in a variety of industries.<sup>40</sup>

Gartner predicts that by 2023, Agile Portfolio and Project Management will become the dominant approach for effective enterprise changes and outcomes in the business world.<sup>41</sup> Companies,

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<sup>37</sup> As an example, in the networking context, Dynamic Host Configuration Protocol (DHCP) was developed in the early 1990s and is commonly used today. *Dynamic Host Configuration Protocol*, MCMaster U. ENGINEERING COMPUTER & SOFTWARE, [http://wiki.cas.mcmaster.ca/index.php/Dynamic\\_Host\\_Configuration\\_Protocol](http://wiki.cas.mcmaster.ca/index.php/Dynamic_Host_Configuration_Protocol). As another networking example, the Internet Protocol, still in use today, was established in 1981. See INTERNET PROTOCOL, INFO. SCI. INST. U. OF SOUTHERN CALIFORNIA (Sept. 1981), <https://tools.ietf.org/html/rfc791#section-2.1>.

The very concepts laid out by Chris Strachey in his 1967 lectures still form the core concepts of programming languages today. See Christopher Strachey, *Fundamental Concepts in Programming Language*, 13 HIGHER ORD. AND SYMBOLIC COMPUTATION 11 (2000). Certainly, new languages and programming tools have been created over the years, but the basic principles of programming have remained the same for over fifty years.

<sup>38</sup> See, e.g., Wesley M. Johnston, J.R. Paul Hanna, & Richard J. Millar, *Advances in Dataflow Programming Languages*, 36 ACM COMPUTING SURVEYS 1 (Mar. 2004).

<sup>39</sup> “71 percent of organizations report using agile approaches for their projects sometimes, often, or always.” PROJECT MGMT. INST., PULSE OF THE PROFESSION 4 (2017), <https://www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2017.pdf>.

<sup>40</sup> See TEDxAix, *Scrum: How to do twice as much in half the time | Jeff Sutherland*, YOUTUBE (July 7, 2014), <https://m.youtube.com/watch?v=s4thQcgLCqk>; see also Ray Arell et al., *Characteristics of Agile Organizations*, AGILE ALLIANCE, <https://www.agilealliance.org/characteristics-of-agile-organizations/> (last visited Nov. 25, 2019).

<sup>41</sup> Katie Costello, *Gartner Predicts 3 Digital Business Impacts on PPM*, GARTNER (Mar. 12, 2019), <https://www.gartner.com/smarterwithgartner/gartner-predicts-3-digital-business-impacts-on-ppm/>.

schools, and teams across industries today are differentiating themselves by adopting Agile successfully and making it a competitive advantage.<sup>42</sup> Law schools could explore, likely with assistance from a consultant, how developing an Agile culture could contribute to faster and more efficient adaptation to changes in the marketplace.<sup>43</sup> “Some executives seem to associate agile with anarchy’ [everybody does what he or she wants to].”<sup>44</sup> Therefore, law school leaders might likewise initially view Agile as too radical to implement in a law school. However, if law schools require radical change to adapt to the marketplace, it seems prudent to at least explore the possibility of implementing it in some fashion.<sup>45</sup>

Agile focuses on incrementally and adaptively pursuing a goal rather than having all details spelled out up front.<sup>46</sup> It focuses on facilitating collaborative, empowered teams through adaptive planning and continuous improvement practices, and by trusting teams rather than micro-managing them and by striving to reduce meetings. It is reported that Agile tends to support a high level of employee satisfaction and productivity through its reduction in bureaucracy.<sup>47</sup>

According to the Harvard Business Review, prospective employees of today are demanding Agile ways of working and being engaged with.<sup>48</sup> Achieving the benefits of Agile typically requires a radical cultural change in the way that we think about and perform our work. Pivoting to embrace this Agile way of thinking about and

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<sup>42</sup> Rodolfo J. Prieto, *The Agile Classroom: Embracing an Agile Mindset In Education*, MEDIUM (Aug. 31, 2016), <https://medium.com/laboratoria/the-agile-classroom-embracing-an-agile-mindset-in-education-ae0f19e801f3>.

<sup>43</sup> With many thanks to Elizabeth Volini, Executive Director, EPMO at Jones Lang LaSalle, for contributing many of these sources and suggesting the potential usefulness of using Agile principles to drive law school innovation.

<sup>44</sup> Darrel Rigby & Jeff Sutherland, *Understanding Agile Management*, HARV. BUS. REV. (Apr. 15, 2016), <https://hbr.org/ideacast/2016/04/understanding-agile-management.html>.

<sup>45</sup> See Roland Vogl, *The Coming of Age of Legal Technology*, STAN. L. SCH. BLOGS (Sept. 26, 2016), <https://law.stanford.edu/2016/09/26/184188/>. Vogl describes radical change: “With regard to the legal services industry, some are also predicting a radical disruption and the era of ‘robo-lawyers,’ suggesting that we are facing an AI-driven revolution that will make lawyers obsolete in the not-too-distant future.” *Id.*

<sup>46</sup> See, e.g., Enric Senabre Hidalgo, *Management of a Multidisciplinary Research Project: A Case Study on Adopting Agile Methods*, 14 J. OF RES. PRAC. 1 (2018).

<sup>47</sup> Darrell Rigby, *Bureaucracy Can Drain Your Company’s Energy. Agile Can Restore It.*, HARV. BUS. REV. (May 22, 2018), <https://hbr.org/2018/05/bureaucracy-can-drain-your-companys-energy-agile-can-restore-it>.

<sup>48</sup> Darrell K. Rigby, Jeff Sutherland, & Hirotaka Takeuchi, *Embracing Agile*, HARV. BUS. REV. (May 2016), <https://hbr.org/2016/05/embracing-agile>.

performing work seems worth exploring as many have written about the need for radical change in law schools.<sup>49</sup>

Certainly, adopting a flexible, Agile approach to changing curriculum and other administrative goals would present some challenges to law schools as many law schools have a tendency to make decisions by faculty vote. That being said, exploring the Agile approach with a skilled consultant might produce some potential benefits.

#### *E. A Thought About Study After (or Outside of) Law School*

The focus of this essay is on what law schools can do in terms of tech training for students to prepare them for practicing in the 21st century. However, some thought can also be given to what law students and law school graduates can do outside of law school to increase their tech fluency.

A practicing lawyer can certainly take tech focused CLEs. Also, lawyers and law students could perhaps take an online IT course from a local community college. In fact, I have recently advised a couple of law students to take an online digital forensics course over the summer as a way to increase tech awareness.<sup>50</sup>

Students and attorneys can also consider private certifications as a way to demonstrate technology awareness on their resumes.<sup>51</sup> Two entry level tech certifications that might be attractive are: (1) ISACA's CSXF and (2) International Association of Privacy Professionals' (IAPP) Certified Privacy Technologist Certification (CIPT). Students and lawyers could also explore a basic certification in digital forensics and/or eDiscovery, but I have not explored these in depth. Regarding the CSXF, this is a wonderful starting point to learn about cybersecurity concepts (or it is a good way to supplement and/or reinforce particular concepts from other coursework). This certificate is specifically designed for folks with limited technology background, it has a fairly low cost (roughly \$200 as of this writing), no experience requirement,

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<sup>49</sup> Alice Armitage & Robin Feldman, *A More Practical Model for Law Schools*, HARV. BUS. REV. (Dec. 24, 2015), <https://hbr.org/2015/12/a-more-practical-model-for-law-schools>; Robert J. Derocher, *What's going on in legal education?*, AM. BAR ASS'N, [https://www.americanbar.org/groups/bar\\_services/publications/bar\\_leader/2011\\_12/spring/legal-ed/](https://www.americanbar.org/groups/bar_services/publications/bar_leader/2011_12/spring/legal-ed/).

<sup>50</sup> Forensics is a wonderful area of study for lawyers given its importance in eDiscovery and incident response. *See, e.g.*, Oscar Delatorre, *10 Things Attorneys Should Know About Digital Forensics*, L. TECH. TODAY (July 21, 2015), <https://www.lawtechnologytoday.org/2015/07/10-things-attorneys-should-know-about-digital-forensics/>.

<sup>51</sup> As mentioned earlier, I have a YouTube playlist with videos discussing how to prepare for various certifications). *See* Cybersecurity Patent Professor, *Certifications*, YOUTUBE (June 5, 2019), [https://www.youtube.com/playlist?list=PLhAOJU2XD-luR-R6\\_-8yrENL2glqLEg8s](https://www.youtube.com/playlist?list=PLhAOJU2XD-luR-R6_-8yrENL2glqLEg8s).

and no renewal requirements. I have advised law students that this certification could be eye catching on a resume given that few attorneys have any credentials in cybersecurity. Regarding the CIPT certification, I have started studying for this recently, and it strikes me as very achievable for law students with limited technology background.<sup>52</sup> In this regard, preparation for the test (as of this writing) appears to involve reading a seven chapter book, of roughly 200 pages on technology concepts, and then passing a multiple choice test.

Two legal certifications that are popular in the marketplace (available to both lawyers and nonlawyers) are the IAPP CIPP/US and CIPP/E. These two certifications focus on US and European privacy law, respectively, with some light coverage of relevant technology principles.<sup>53</sup>

## II. AN ANALOGY COMPARING LEARNING IT TO LEARNING SPANISH

Imagine a marketplace where many clients are speaking Spanish, when most legal educators do not speak Spanish. Next, imagine that the number of Spanish speaking clients is expected to continue growing at an exponential rate. Also, imagine significant growth of nonlawyer Spanish speaking professionals to meet the growing need.<sup>54</sup> Imagine the opportunities for Spanish speaking lawyers and the necessity for future law students to learn Spanish (of course, by “Spanish” I mean IT)!

On the surface, a simple solution would seem fairly obvious: teach law students some Spanish! However, while that general goal is simple enough, the execution requires considerable thought.

In the following sections, I explore different language education concepts that could be applied to technology education for law students.

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<sup>52</sup> *CIPT Certification*, IAPP, <https://iapp.org/certify/cipt/> (last visited Nov. 25, 2019).

<sup>53</sup> My data privacy law course at DePaul surveys both US and EU law and is likely helpful background for these certifications.

<sup>54</sup> See *Occupational Outlook Handbook*, BUREAU OF LABOR STATISTICS, <https://www.bls.gov/ooh/computer-and-information-technology/home.htm> (last modified Sept. 4, 2019). “Employment of computer and information technology occupations is projected to grow 12 percent from 2018 to 2028, much faster than the average for all occupations” *Id.*



### A. *Fear of Speaking Foreign Languages*

A common fear among human beings is known as xenoglossophobia, a fear of speaking foreign languages.<sup>55</sup> In my own experience, I have observed lawyers exhibit a sort of fear or anxiety when presented with foreign technology terms, and a desire to back away from the tech or to hand off tech issues to someone else. For example, I have heard stories of lawyers asking tech-savvy executives to draft portions of contracts involving technology requirements as the lawyers were ignorant on those issues.

Providing students with some education in technology would likely reduce the fear of the subject.

### B. *Hiring a Translator*

In January 2019, Georgetown Law School announced that it hired a nonlawyer computer scientist, Professor Matt Blaze, to join its full-time law faculty.<sup>56</sup> According to Professor Paul Ohm, this was the first such hiring of a nonlawyer computer scientist at any law school in the country.<sup>57</sup> Per this announcement, Professor Blaze “will teach innovative, interdisciplinary courses at the law school, including Technology of Surveillance and Electronic Voting Technology and Law,” says Ohm.<sup>58</sup>

### C. *Spanish for Lawyers Courses*

Various law schools provide programming for lawyers courses, with a general focus on learning programming and its application to law.<sup>59</sup> Such courses seem helpful and potentially popular among students. A contrasting idea is to allow students to take introductory programming courses in a computing school and to sit alongside IT students. Both types of courses likely have benefits to law students. On the one hand, a programming for lawyers course may specifically focus on programming in the legal industry. On the other hand, a general

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<sup>55</sup> *Foreign language anxiety*, WIKIPEDIA, [https://en.wikipedia.org/wiki/Foreign\\_language\\_anxiety](https://en.wikipedia.org/wiki/Foreign_language_anxiety) (last visited Nov. 25, 2019).

<sup>56</sup> *One of World's Leading Computer and Network Security Experts Joins Georgetown Faculty*, GEO. L. (Jan. 7, 2019), <https://www.law.georgetown.edu/news/one-of-worlds-leading-cryptographers-to-join-georgetown-faculty/?et=editorial&bu=Law.com&cn=20190128&src=EMC-Email&pt=Ahead%20of%20the%20Curve>.

<sup>57</sup> *Id.*

<sup>58</sup> *Id.*

<sup>59</sup> See, e.g., *Law and Computer Science*, STAN. L. SCH., <https://law.stanford.edu/education/degrees/joint-degrees-within-stanford-university/law-and-computer-science/> (last visited Nov. 25, 2019).

introductory programming course may benefit law students by placing them in the same classroom as IT students and might facilitate learning the language of tech from interaction with technology students (compare to the Spanish Immersion section immediately below).<sup>60</sup>

#### D. Spanish Immersion

“Spanish immersion” could involve law students and faculty attending full day conferences concerning technology issues. This certainly seems common as legal technology issues are hot topics in law schools. Inviting technologists and other nonlawyer IT professionals to such conferences can be a helpful way to improve learning the language of IT.

Another immersion concept might involve placing law students and technology students in the same classroom.<sup>61</sup> This is happening with DePaul’s cross listed computing school courses. The Business Continuity/Disaster Recovery course touches on legal and technology issues inherent in Health Insurance Portability and Accountability Act (HIPAA) compliance. Law students and IT students learn alongside each other that the Office of Civil Rights imposes hefty fines for any data loss.<sup>62</sup> They also learn the related tech concepts that for a backup data center a “hot site” is preferred over warm or cold sites given that a HIPAA compliant organization needs a Recovery Point Objective (RPO) of zero (RPO, recovery point objective, essentially means an acceptable amount of data loss, so an RPO of one day means an organization can accept up to one day’s worth of lost data while an

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<sup>60</sup> *Interdisciplinary Learning*, STAN. L. SCH., <https://law.stanford.edu/education/only-at-sls/interdisciplinary-learning/> (last visited Nov. 26, 2019). “Thinking across disciplines and incorporating diverse perspectives in the search for solutions isn’t taught in the traditional law school classroom. But those abilities are essential to the work of 21st-century lawyers, whatever career they choose. At Stanford Law, even students who do not pursue a formal joint degree can benefit from Stanford University’s interdisciplinary strengths and learn to collaborate in the process. SLS offers a wide variety of *team-oriented, problem-solving courses*, many co-taught by law school faculty and faculty from Stanford’s other highly rated schools and departments. These classes give law students the opportunity to learn with and from Stanford students from a wide variety of disciplines.” *Id.* (emphasis in original).

<sup>61</sup> See Sybille Heinzmann et. al., *The effect of study abroad on intercultural competence: Results from a longitudinal quasi-experimental study*, 26 INTERDISC. J. OF STUD. ABROAD 187, 203 (2015) (finding that participating in an exchange activity “that is culturally and linguistically different from one’s own has a positive influence on the development of one’s [intercultural competence]”). *Id.*

<sup>62</sup> See *OCR Concludes 2018 with All-Time Record Year for HIPAA Enforcement*, U.S. DEP’T OF HEALTH & HUM. SERVICES, <https://www.hhs.gov/hipaa/for-professionals/compliance-enforcement/agreements/2018enforcement/index.html>. (last reviewed Feb. 7, 2019).

RPO of 0 strives for 0 seconds of data loss).<sup>63</sup> They can discuss both the legal and technology issues in the same classroom, sharing their insights and vocabulary.

#### *E. A Semester Abroad*

Another learning tool could be a “semester abroad,” which would involve a student interning for a lawyer or even a nonlawyer working on tech issues. Certainly, law schools could encourage tech-focused internships at law firms, consulting firms, in-house situations, or even technology firms.

#### *F. How Much Spanish?*

A hypothetical undergraduate Spanish curriculum could involve two introductory Spanish courses (e.g., Spanish 101 & 102), followed by two intermediate courses (e.g., Spanish 201, 202), followed by one or more advanced courses. Conceivably, a student who has completed some intermediate coursework may have the ability to not only listen and comprehend but to also respond. Reaching such a threshold could be considered a basic foundation for further learning. In my own experience with IT education, I found that after completing four or five IT courses I was able to have somewhat intelligent conversations with tech executives; I could understand much of what they were describing, and I could respond with a somewhat intelligent comment or question.

Based on this hypothetical Spanish curriculum, and my own experience taking tech courses as a cybersecurity student, I arrived at an estimated range of three to six tech courses as providing students with a basic or low level of tech fluency as a foundation for further learning.

### 1. Law Schools Have Limits on How Much Tech Education They Can Provide

A law school has a core function of preparing students to pass the bar exam, so a law school cannot become an IT school, and the extent of its tech offerings is therefore limited. Therefore, a law school may need to cap the number of JD credits it will allow for a student taking IT courses. Also, law schools may struggle finding law faculty with the requisite technology background to effectively teach technology as a competence within a law course.

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<sup>63</sup> See generally, Barry J. Gillin, *Optimizing Recovery of Critical Systems Through Replication to the Cloud*, U. OF OREGON, APPLIED INFO. MGMT. (2018), [https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/24351/Gillin\\_2018.pdf?sequence=1&isAllowed=y](https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/24351/Gillin_2018.pdf?sequence=1&isAllowed=y).

That being said, my twofold proposal above of providing JD students with perhaps three IT electives from a computing school and offering at least some interdisciplinary law school courses seems feasible and may be a goal that law schools wish to pursue.

## 2. Required Spanish?

Some law schools could impose a requirement consistent with Florida's and North Carolina's mandatory tech CLE; however, imposing such a rigid curricular requirement may burden schools administratively. Therefore, some law schools might initially adopt an elective approach concerning tech/tech law education.

### G. Include "Spanglish"?

My third curricular implementation is that law schools consider offering interdisciplinary law courses that include a blend of law and tech (e.g., perhaps 25% of the law course content embodying tech instruction).<sup>64</sup> Embedding tech instruction in a law course can reinforce concepts learned in IT courses (or supplement them with additional tech concepts). This could be accomplished by law faculty, full-time or adjunct, having sufficient tech background to teach tech, or by having law faculty integrate a technologist guest speaker within perhaps two to three weeks of a course. Law school leadership would need to encourage faculty to teach and *test* on technology, viewing technology *as a competence* to be tested, just as the legal principles in the course are tested as a competence.<sup>65</sup>

My law course Data Privacy Law: US & EU is an example of an interdisciplinary law course. I launched this course in the spring of 2019, and I included the goal of teaching and testing students on technology as a competence alongside the legal principles. I would estimate that 25-30% of the lecture content constituted tech education. On my spring 2019 final exam, I included a traditional essay involving General Data Protection Regulation (GDPR) issues and approximately fifty questions that were either multiple choice or short answer. Of these fifty questions, about thirteen were tech focused. For example, I had short answer technology questions, such as asking students to very briefly explain what a domain name server is/does and another question

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<sup>64</sup> JAMES GRIMMELMANN, INTERNET LAW: CASES AND PROBLEMS (9th ed. 2019) (the first chapter of this casebook discusses technology, indicating schools are taking a step in the direction of blending law and tech in courses).

<sup>65</sup> Victoria Hudgins, *States Require Lawyers to Have Tech Competency, But Observers See Some Struggling*, YAHOO! NEWS (Oct. 25, 2018), <https://www.yahoo.com/news/states-require-lawyers-tech-competency-160028982.html>.

asking them to generally describe how a virtual private network (VPN) functions (concepts I presented in my lecture videos).

When developing the course, my initial instinct, viewing this as a “law” course, was to keep the course siloed by minimizing tech concepts and focusing mainly on the law. However, I abandoned this siloed mentality after delivering two highly tech-focused legal lectures in the fall of 2018 that were well received by both students and practicing attorneys. In the fall of 2018, I guest lectured twice in a traditional privacy law course, and the hosting professor asked me to focus specifically on tech concepts relevant to privacy. In my guest lectures, I discussed several tech-focused cases, including *FTC v. Wyndham*, involving a Federal Trade Commission (FTC) fine for defendant misrepresenting that it had strong cybersecurity controls when in reality it lacked most necessary controls, such as functioning firewalls and encryption of stored data.<sup>66</sup> After discussing the legal concepts, I explored a variety of tech concepts: what firewalls are, how firewall rules function, host based versus network appliance firewalls, formation of a demilitarized zone (DMZ) with one firewall (i.e., three-legged firewall architecture) versus formation of a DMZ with two firewalls (i.e., placing servers in between two firewalls), local encryption versus public key encryption, and a variety of other tech concepts and legal principles. My lectures and presentations addressing these topics as they relate to the law have been very well received by both law students and attorneys.<sup>67</sup>

#### *H. Dialects of IT: Areas of Study*

As noted above, coursework that addresses both networking and programming concepts seems beneficial for law students to get a sense of the OSI layers. Essentially, to understand the OSI layers is to understand computing. However, any variety of tech courses should increase understanding of various OSI layers (e.g., an information security management course). In fact, I could consider digital forensics as another category. Forensics appears to involve both networking and

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<sup>66</sup> *FTC v. Wyndham Worldwide Corp.*, 799 F.3d 236 (3d Cir. 2015).

<sup>67</sup> After my first guest lecture, a British attorney/LLM student approached me to tell me that the lecture was “f---ing awesome” as he was so eager to learn about technology to facilitate his communication with clients. In my nearly fifteen years of teaching law school, this was the most exuberant response I have ever experienced after lecturing. Besides this student experience, a second experience that inspired me to make tech education a goal in my law teaching involved meeting with a HIPAA attorney who had over twenty years of practice experience. I described my guest lecturing experience to her and showed her some of my tech-focused slides, and she explained to me that she would immediately pay for any CLE that had such content and affirmed that my tech focused approach should be a huge help to serving clients.

programming concepts as well as system concepts (e.g., Windows Registry keys, deleted files in unallocated memory space, etc.).<sup>68</sup> Forensics is a wonderful area of study for lawyers because it is so integral to both eDiscovery/litigation and incident response.<sup>69</sup>

IT is a fairly broad subject area with many dialects. However, learning one dialect seems effective in terms of quickly understanding another dialect as any IT course is going to have IT terminology and concepts that relate to one or more OSI layers.<sup>70</sup>

### *I. The Myth That Students Already Know the Language of Tech*

As noted in the Introduction, law students would benefit from some “under-the-hood” instruction as most liberal arts students entering law school lack this awareness. It is a myth that millennials understand technology and therefore do not require tech instruction.<sup>71</sup> While it’s true that millennials have grown up with technology and are likely more adept than prior generations at its usage, this technology usage merely affords some awareness on the user side (e.g., like knowing how to drive a car versus knowing how the engine works regarding a products liability suit).<sup>72</sup> Millennials without tech education are unlikely to have any concept of network architecture, public key encryption, or various other under-the-hood concepts that would be helpful to understand tech with sufficient depth when communicating with clients, courts, or regulators on tech issues. Certainly, any courses involving networking or programming concepts would provide some depth of instruction to better understand the OSI layers as many law students will end up managing in layers 8-10 of Swire’s model. For example, many legal scholars have written about the importance of blockchain. Blockchain technology includes

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<sup>68</sup> See, e.g., Gary C. Kessler et. al., *Pedagogy and Overview of a Graduate Program in Digital Investigation Management*, PROCS. OF THE 41ST ANN. HAW. INT’L CONF. ON SYS. SCIS., Jan. 2008.

<sup>69</sup> Colin Chisholm, *Integrating Forensic Investigation Methodology into eDiscovery*, SANS INST. (Jan. 5, 2010), <https://www.sans.org/reading-room/whitepapers/forensics/integrating-forensic-investigation-methodology-ediscovery-33448>.

<sup>70</sup> See, e.g., J. E. Howland, *It’s All in the Language: Yet Another Look at the Choice of Programming Language for Teaching Computer Science*, TRINITY U. (Mar. 1997), <http://www.cs.trinity.edu/~jhowland/ccsc97/ccsc97/>.

<sup>71</sup> Monica Goyal, *Do Lawyers and Law Students Have the Technical Skills to Meet the Needs of Future Legal Jobs*, SLAW (June 29, 2017), <http://www.slw.ca/2017/06/29/do-lawyers-and-law-students-have-the-technical-skills-to-meet-the-needs-of-future-legal-jobs/> (noting the misconception that “[s]enior industry professionals invariably believe that young new law school graduates are technologically proficient.”). *Id.*

<sup>72</sup> See Simon Canick, *Infusing Technology Skills into the Law School Curriculum*, 42 CAP. U. L. REV. 663 (2014).

substantial networking and programming concepts,<sup>73</sup> so law students having education in these areas should be in a better position to understand blockchain (both existing features and new developments) than law students lacking such education. Likewise, many legal scholars have written about AI, and it would seem any deep understanding of AI would require a general understanding of programming and networking concepts.

While legal scholars tend to focus on the usage of AI and blockchain and the legal implications of their usage, lawyers could benefit from a deeper understanding of how blockchain and AI work from a programming and networking standpoint in order to better communicate with technologists on legal issues (e.g., security by design issues as they may relate to Gramm-Leach-Bliley Act (GLBA) or HIPAA statutory security regulations) as these areas of IT evolve.

### *J. Linguistics Concepts*

The Spanish learning analogy, while useful, is not a perfect analogy because learning a language could be viewed as substantially a process of word substitution for structures and processes that the student is already familiar with in his or her own language.

Noam Chomsky analyzed languages in the late 1950s when he significantly advanced the field of linguistics.<sup>74</sup> He observed that all languages have nouns (e.g., structures) and verb phrases.<sup>75</sup> When a student learns a new language, he or she likely already has a concept of the structures and verbs in his or her own native tongue, and learning the new language is largely a matter of word substitution.<sup>76</sup> For example, a native English speaker knows how to say “I would like a cup of coffee.” The native English speaker already understands what coffee is and understands commands/requests/verb phrases such as “give me” or “I would like.” Therefore, learning how to request a cup of coffee in Spanish is largely word substitution: “Me gustaría un café.” Un café is “a coffee” and “me gustaría” is “I would like.”

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<sup>73</sup> Toshendra Kumar Sharma, *How Does Blockchain Use Public Key Cryptography?*, BLOCKCHAIN COUNCIL (Jan. 27, 2018) <https://www.blockchain-council.org/blockchain/how-does-blockchain-use-public-key-cryptography/>. Public key encryption is a topic that I teach and test in my Data Privacy Law course.

<sup>74</sup> See generally, James A. McGilvray, *Noam Chomsky: American Linguist*, ENCYCLOPAEDIA BRITANNICA, <https://www.britannica.com/biography/Noam-Chomsky> (last updated Nov 08, 2019).

<sup>75</sup> John Lyons et al., *Linguistics: Chomsky's Grammar*, ENCYCLOPAEDIA BRITANNICA, <https://www.britannica.com/science/linguistics/Chomskys-grammar> (last visited Dec. 21, 2019).

<sup>76</sup> Granted, language learning is not merely word substitution as other syntax issues need to be learned (e.g., word sequence, verb tenses).

While IT is replete with foreign terminology (especially acronyms), developing some level of IT fluency involves more than mere word substitution. In this regard, I assert that IT fluency requires an understanding of basic structures and processes that are also foreign to the novitiate. For example, while the language student understands the structure/noun of coffee and the process of requesting it, she may not adequately understand the basic network structures of switches, routers, web servers, firewall appliances nor the processes of DNS server requests, html requests via an https port, Transmission Control Protocol (TCP) handshake, and cookies within the client server model. Therefore, learning IT involves developing an understanding not only of foreign terminology but also of associated foreign structures and processes. Therefore, learning new structures and processes especially requires usage of visual aids (as noted elsewhere), such as network topologies or the like.<sup>77</sup>

### III. EXAMPLES OF IMPLEMENTING TECH EDUCATION WITHIN A LAW COURSE

This section provides several examples of the integration of technological concepts into law school coursework, applying various concepts explored in Parts I and II.

#### A. *Embedding Network Security Concepts in my Data Privacy Course*

In the first week of my online data privacy law course, I provide several lecture videos. The first lecture, which is available on my YouTube channel, is roughly thirty minutes on how the Internet works, focusing on the back end details of web browsing.<sup>78</sup> I was inspired to create this lecture based on discussions with practicing technology attorneys who explained to me that one of their first tasks with a new associate is to educate him or her about how the Internet works. This background knowledge seems essential for discussions with technologists on data breach or other privacy/cybersecurity issues as the Internet is the common vehicle through which a data breach occurs. A discussion of how web browsing works is a good introduction to networking concepts that may arise in a broad variety of legal contexts, such as a products liability lawsuit or an assessment of network security relative to statutory compliance (perhaps using the National Institute of

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<sup>77</sup> James B. Levy, *Teaching the Digital Caveman: Rethinking the Use of Classroom Technology in Law School*, 19 CHAP. L. REV. 241 (2016).

<sup>78</sup> Cybersecurity Patent Professor, *How the internet works*, YOUTUBE (Sept. 6, 2019), <https://youtu.be/UESJCDX40Wk>.



Standards and Technology (NIST) or another cybersecurity framework as an analytical tool).<sup>79</sup> Another scenario may involve advising a small to medium size business regarding cybersecurity, including network security, in light of FTC guidance.<sup>80</sup>

I begin the first lecture by referencing a few cases involving web browsing features (e.g., cookies, cached browser pages) and explain how an understanding of Internet browsing terminology and concepts could be helpful to a lawyer in a variety of contexts, such as incident response or reviewing an expert witness report in a data breach suit. I provide a variety of granular technical details involved in the process of powering on a laptop through visiting a remote website, such as the motherboard transferring control to the Windows 10 operating system, logging in to the university's network, the university's router or DHCP server dynamically leasing a private IP address to the laptop, use of a domain name server to look up the IP address of the website, and a variety of other details leading up to visiting the website.<sup>81</sup>

This first lecture is a good starting point on technology as the course then continues to survey a variety of legal and technology issues in the context of US and EU privacy. Typically, when a case or other legal source references certain aspects of IT, I use this as an opportunity to teach the relevant IT. For example, I assign *FTC v. Wyndham* within the first few weeks of the course, a case which involves many conceivable cybersecurity shortcomings leading to liability (e.g., lack of firewalls and lack of encryption).<sup>82</sup> After teaching the legal principles in *Wyndham*, I lecture on specific details of firewalls and encryption, as well as other tech topics implicated by this case. (*Wyndham* is a wonderful foundational case for a cybersecurity/data privacy course as defendant had so many cybersecurity shortcomings.)

## 1. Firewalls

Regarding firewalls, these are one of the very important components of network security, critical for any secure network.

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<sup>79</sup> *Glossary: demilitarized zone (DMZ)*, <https://csrc.nist.gov/glossary/term/demilitarized-zone> (last visited Nov. 26, 2019) (discusses usage of DMZs for network security, which implicates firewall usage).

<sup>80</sup> *Data Security*, FED. TRADE COMMISSION, <https://www.ftc.gov/tips-advice/business-center/privacy-and-security/data-security> (last visited Nov. 26, 2019).

<sup>81</sup> Various granular details addressed in my first lecture include http versus https, ports (well-known ports and random ephemeral ports), an introduction to the client-server model and OSI model, network address translation, dynamic IP addressing/DHCP, private IP addresses, Network Address Translation (NAT) and Port Address Translation (PAT), physical MAC addresses, Domain Name Service (DNS) poisoning attacks, and the Transmission Control Protocol (TCP) handshake to initiate a session between a user computer and remote website.

<sup>82</sup> See *Wyndham*, 799 F.3d 236.

Understanding various details of how firewalls work would seem helpful when evaluating reasonable security, such as blocking malicious sites, host based versus network based firewalls, rule order of firewalls, rule exceptions, formation of a demilitarized zone with one firewall (i.e., three legged architecture) versus sandwiching servers between two firewalls. The 2019 Capital One breach involved an apparent mismanagement of firewall rules, with Amazon Web Service (AWS) asserting that Capital One failed to properly manage the rules.<sup>83</sup> In theory, Capital One could respond that AWS was negligent by failing to inform Capital One of this vulnerability. In any event, a lawyer hoping to advise either party would greatly benefit from an understanding of how firewalls work.

As discussed previously, teaching firewall and other tech concepts is often facilitated by visual aids rather than from words alone as noted by James Levy.<sup>84</sup> This seems particularly helpful when assessing a network's architecture and components therewithin. Therefore, my lectures include visuals of network architecture to facilitate students' understanding. Some of my firewall visuals appear in my YouTube video "Tech Education for Law Students."<sup>85</sup>

## 2. Encryption

Regarding encryption, an understanding of encryption is critical for understanding cybersecurity, and students will likely benefit from understanding encryption in a variety of contexts (e.g., used defensively versus used in a ransomware attack). Encryption is essentially the conversion of plain text to gibberish so that an eavesdropper cannot easily decipher it.<sup>86</sup> Local encryption applies to stored data and is useful for protecting data stored on a thumb drive or laptop when it is powered off or logged off.<sup>87</sup> Instructing students that

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<sup>83</sup> Brian Krebs, *What We Can Learn from the Capital One Hack*, KREBSONSECURITY (Aug. 2, 2019), <https://krebsonsecurity.com/2019/08/what-we-can-learn-from-the-capital-one-hack/>.

<sup>84</sup> Levy, *supra* note 77, at 274, 275 (2016) ("[t]he best way to teach and learn any subject is to employ the methods that are most compatible with the desired outcome . . . Vision is by far the brain's most dominant sense . . .").

<sup>85</sup> Cybersecurity Patent Professor, *Tech education for law students*, YOUTUBE (Aug. 12, 2019), <https://youtu.be/Bkcl8MvEWhY>.

<sup>86</sup> For a general discussion about encryption, *see*, *Encryption*, WIKIPEDIA, <https://en.wikipedia.org/wiki/Encryption> (last visited Dec. 2, 2019).

<sup>87</sup> For a general discussion about implementing local encryption on Microsoft Windows files and folders, *see*, *How to encrypt Files and folders in Windows 10, 8 or 7*, COMPARITECH (June 5, 2018), <https://www.comparitech.com/blog/vpn-privacy/encrypt-windows-files/>.

password protecting a computer is not necessarily the same as activating local encryption seems helpful.<sup>88</sup>

Encryption can be used for protecting data or can be used as an attack tool as in a ransomware attack. Encryption complexity is an important concept for understanding the need for sufficient password complexity to withstand a brute force attack.<sup>89</sup> Students can also be taught that dictionary attacks are a useful species of brute force attack that a forensic examiner or bad actor can use to speed the brute force attack.<sup>90</sup> For example, rather than attempting entirely random strings of characters to brute force attack a password, a dictionary attack makes use of common words and their variations in an effort to more quickly crack the password. Another encryption scenario could include exploring the debate over whether federal law enforcement should be provided a back door to Apple's iPhone or other computer equipment and various technology details relevant to the debate (e.g., timing delays triggered after failed logins, user options to delete all data after failed login attempts, and various forensic tools to either bypass or brute force encrypted data).<sup>91</sup>

Encryption of data in transit arises in a variety of contexts, such as providing an encrypted email tool for a lawyer's communications with clients, usage of Tor browsers and VPN services.<sup>92</sup> VPNs hide the sender and receiver's identities by encrypting source and destination IP addresses along with the data; the VPN could be described as providing

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<sup>88</sup> Chris Hoffman, *Why a Windows Password Isn't Enough to Protect Your Data*, HOW-TO GEEK (Sept. 22, 2016, 4:02 PM), <https://www.howtogeek.com/161444/htg-explains-why-a-windows-password-doesnt-protect-your-data/>.

<sup>89</sup> For a 2017 general discussion of Microsoft's complexity requirements, see, *Password must meet complexity requirements*, MICROSOFT (Sept. 7, 2017), <https://docs.microsoft.com/en-us/windows/security/threat-protection/security-policy-settings/password-must-meet-complexity-requirements>.

<sup>90</sup> *Dictionary Attack*, TECHOPEDIA <https://www.techopedia.com/definition/1774/dictionary-attack> (last visited Nov. 26, 2019).

<sup>91</sup> Alina Selyukh, *A Year After San Bernardino And Apple-FBI, Where Are We On Encryption?*, NPR (Dec. 3, 2016), <https://www.npr.org/sections/alltechconsidered/2016/12/03/504130977/a-year-after-san-berardino-and-apple-fbi-where-are-we-on-encryption>; William Enck & Adwait Nadkarni, *What if the FBI tried to crack an Android phone? We attacked one to find out*, THE CONVERSATION (Mar. 29, 2016), <http://theconversation.com/what-if-the-fbi-tried-to-crack-an-android-phone-we-attacked-one-to-find-out-56556>; Matt Klein, *How to Erase Your iOS Device After Too Many Failed Passcode Attempts*, HOW-TO GEEK (July 28, 2016, 12:34 PM), <https://www.howtogeek.com/264369/how-to-erase-your-ios-device-after-too-many-failed-passcode-attempts/>.

<sup>92</sup> For a general discussion about encrypting data in transit, see, *Encryption in Transit in Google Cloud*, GOOGLE CLOUD, <https://cloud.google.com/security/encryption-in-transit/> (last visited Dec. 2, 2019).

a VPN encryption tunnel to hide both the sender and receiver, as well as their data in transit, from eavesdroppers on the Internet.<sup>93</sup>

Public key encryption is another important concept that arises in a variety of situations (e.g., Blockchain systems, website certificates, and other digital signatures). In public key encryption, a user is provided with a unique public key that he publishes to the world and a unique private key that only works with the public key.<sup>94</sup> Generally, if the user (Bob) wants others to encrypt communications to him, they may encrypt the messages to Bob using Bob's public key.<sup>95</sup> Mathematically, this is a one way function: once the message is encrypted with Bob's public key it cannot be decrypted with that same public key.<sup>96</sup> Essentially, the only way to unlock or decrypt the message is by Bob using his private key. Public key encryption—also known as asymmetric encryption—is thus a useful way to inhibit eavesdropping just like any other form of encryption, and an understanding of the differences between public key encryption and conventional encryption would certainly enhance a student's understanding of encryption.<sup>97</sup> (For example, as a side note, if Bob were relying upon conventional encryption, rather than public key encryption, he and others communicating with him would use a single key to encrypt/decrypt, and there would be a concern that this key could fall into an eavesdropper's hands to decrypt all of Bob's messages.)<sup>98</sup> Another benefit of public key encryption is that it can be used to authenticate a sender of a message, which is relevant to the legal concept of nonrepudiation.<sup>99</sup>

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<sup>93</sup> This VPN scenario demonstrates an example of “encapsulation,” a fundamental concept in computer networking. In a VPN context, the sender's and receiver's IP addresses are encapsulated within the source and destination IP addresses of perhaps two VPN routers. For a general description of encapsulation, *see generally*, *What is Encapsulation in computer networking*, COMPUTER NETWORK DEMYSTIFIED <http://computernetworkingsimplified.in/category-1/layering/encapsulation-decapsulation/> (last visited Nov. 26, 2019).

<sup>94</sup> *Public-key cryptography*, WIKIPEDIA, [https://en.wikipedia.org/wiki/Public-key\\_cryptography](https://en.wikipedia.org/wiki/Public-key_cryptography) (last visited Dec. 2, 2019).

<sup>95</sup> *See generally*, Jeff Tyson, *How Encryption Works*, HOWSTUFFWORKS, <https://computer.howstuffworks.com/encryption3.htm> (last visited Nov. 26, 2019).

<sup>96</sup> *See generally*, Public Key Encryption, TUTORIALS POINT [https://www.tutorialspoint.com/cryptography/public\\_key\\_encryption.htm](https://www.tutorialspoint.com/cryptography/public_key_encryption.htm) (last visited Nov. 26, 2019).

<sup>97</sup> *Advantages and Disadvantages of Asymmetric and Symmetric Cryptosystems*, U. OF BABYLON, [www.uobabylon.edu.iq/eprints/paper\\_1\\_2264\\_649.pdf](http://www.uobabylon.edu.iq/eprints/paper_1_2264_649.pdf) (last visited Dec. 3, 2019).

<sup>98</sup> *Id.*

<sup>99</sup> Ilja Ponka, *Legal Aspects of Digital Signatures and Non-Repudiation*, U. OF HELSI NKI DEP'T OF COMPUTER SCI. RES. SEMINAR ON SECURITY IN DISTRIBUTED SYS. (Dec. 2000), <https://pdfs.semanticscholar.org/ceda/35b3ac8d680a006dc0aa35fad4321d6227c1.pdf>.

Because of the ubiquity of public key encryption in various IT contexts, an understanding of the basics would seem helpful to technology lawyers (e.g., teaching and testing the one-way function concept, and on which key to use for authenticating sender/non-repudiation versus which key to use for merely providing confidentiality).

### 3. Other Tech Topics in my Data Privacy Course

Other tech topics addressed in the course include layered defense strategies/Defense in Depth, the Confidentiality, Integrity, and Availability (CIA) triad (along with nonrepudiation), cookies (persistent vs. session cookies and 1st party vs. 3rd party cookies), Infrastructure as a Service (IAAS), Platform as a Service (PAAS), Software as a Service (SAAS), VPNs, DNS, and layer 7/Next Generation Firewalls.

#### *B. Embedding Digital Forensics & Software Concepts in a Cybersecurity Litigation Course*

I am working with a colleague (Professor Karen Heart, an attorney and computer programmer at DePaul's computing college) on developing a cybersecurity law course (anticipated spring 2020). In this course, we plan on addressing a variety of digital forensics issues (e.g., metadata, hash values, deleted data) and lecturing on fundamental concepts of computer programming as well as security by design concepts (software and hardware considerations) that relate to those fundamentals.

#### 1. Metadata

Metadata is a very important concept in litigation (civil and criminal) and can have significant legal implications.<sup>100</sup> Metadata is essentially data about a file, such as date created, date modified, author, or GPS data with a photo.<sup>101</sup> It is common knowledge among litigators that a party requesting electronic files in discovery should make sure her requests include the metadata for such files.

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<sup>100</sup> Doug Austin, *Metadata Plays Key Role in \$10.8 Million Whistleblower Lawsuit Verdict*, CLOUD NINE: EDISCOVERY DAILY BLOG (Feb. 14, 2017), <https://ediscovery.co/ediscoverydaily/electronic-discovery/metadata-plays-key-role-10-8-million-whistleblower-lawsuit-verdict-ediscovery-case-law/> (discussing how metadata in a wrongful termination whistleblower suit was used to show that the employee's performance evaluation was created a full month after his termination).

<sup>101</sup> Piotr Kononow, *What is Metadata (with Examples)*, DATAEDO (Sept. 16, 2018), <https://dataedo.com/kb/data-glossary/what-is-metadata>.

Understanding metadata with photos can be important in various legal contexts. For example, most iPhones automatically include GPS location metadata, indicating the time and precise location that the photo was taken. A lawyer advising a dating website or other site allowing pictures might counsel the company to scrub all metadata from the photos before they are posted to reduce potential liability. Otherwise, a site visitor could easily look up the metadata using standard features in Windows or perhaps using a free iPhone app. Interestingly, John McAfee, the creator of McAfee Anti-Virus software, was a fugitive many years ago, hiding in South America.<sup>102</sup> He was traveling with a reporter who posted McAfee's picture online without scrubbing the location metadata, allowing authorities to determine his location.<sup>103</sup>

## 2. Hash Values

The topic of hash values could be explored with regard to digital fingerprinting of files or hard drives or perhaps in other contexts (e.g., the use of hashes to represent passwords).

An MD5 hash value, or other hash value, such as SHA1, may be used as essentially a digital fingerprint of either a file or an entire hard drive.<sup>104</sup> Every file or hard drive is unique in terms of the data stored on it. Therefore, every hard drive produces a unique hash value. Just like a human fingerprint, a hash value of a hard drive produces a value that is distinct from all other computers in the world.<sup>105</sup> Put another way, if one could take a hash value of every computer in the state of Illinois at one moment in time, every computer will likely have a unique value (in a sense, it is "lottery odds" to have two computers with matching hash values).<sup>106</sup>

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<sup>102</sup> Eyder Peralta, *Betrayed By Metadata: John McAfee Admits He's Really In Guatemala*, NPR (Dec. 4, 2012, 12:24 PM), <https://www.npr.org/sections/thetwo-way/2012/12/04/166487197/betrayed-by-metadata-john-mcafee-admits-hes-really-in-guatemala>.

<sup>103</sup> *Id.*

<sup>104</sup> *What is a Hash Value*, PINPOINT LABS, <https://pinpointlabs.com/what-is-a-hash-value/> (last visited Dec. 2, 2019).

<sup>105</sup> Zhao Yong-Xia & Zhen Ge, *MD5 research*, PROCS. OF THE 2010 SECOND INTERNATIONAL CONFERENCE ON MULTIMEDIA AND INFORMATION TECHNOLOGY, Apr. 2010, at 271. "MD5 was developed from MD, MD2, MD3 and MD4. It can compress any length of data into an information digest of 128bits while this segment message digest often claims to be a digital fingerprint of the data." *Id.*

<sup>106</sup> See, e.g., *How many random elements before MD5 produces collisions?*, STACK OVERFLOW, <https://stackoverflow.com/questions/201705/how-many-random-elements-before-md5-produces-collisions> (last visited Dec. 31, 2019).

Another characteristic of MD5 or other hash values is that small changes in data can produce significant changes in the hash value.<sup>107</sup> For example, if I have two nearly identical 3000 word Microsoft Word files, but they differ by one word, the two files will produce two very different MD5 hash values. For example, I generated an MD5 hash value of a word file of “57146D7D4B33EE6FFF78E1A70AB6BC0F.”<sup>108</sup> Next, I changed one word in my fairly long document, and the new value was “11A76A945704BAAE14C751565F933327.”

An MD5 value is legally significant because it is a chain of custody tool to show that a forensic image of a party’s hard drive or file was not altered during litigation.<sup>109</sup> For example, a plaintiff’s forensic expert could make a copy of defendant’s hard drive during discovery and save an MD5 hash value at the time of collection. The plaintiff could then analyze the hard drive looking for evidence relevant to the suit. If the other side alleged that plaintiff or his forensic expert altered the evidence, the plaintiff’s side could produce a copy of the forensic image—which would have the same MD5 hash value as at the time of collection—and plaintiff could invite the other side to repeat the same analytical steps on this copy to locate the same evidence.

### 3. Security by Design

Europe’s GDPR requires security by design and by default when launching a new IT product or service.<sup>110</sup> U.S. companies seem to likewise be moving in this direction based on the general concept that stronger cybersecurity up front is likely to reduce future legal exposure (e.g., civil actions, regulatory actions). Other motivations could include a need for GDPR compliance (e.g., U.S. companies handling EU data) or forward thinking in contemplation of GDPR-like legislation

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<sup>107</sup> *Hash Functions*, CERTMIKE, <https://www.certmike.com/hash-functions/> (last visited Nov. 26, 2019) (discussing “[a] small change in a message should generate large changes in the message value”). *Id.*

<sup>108</sup> I used the website <http://onlinemd5.com/> to calculate the hash values of the original and revised file. See ONLINEMD5, <http://onlinemd5.com/> (last visited Nov. 26, 2019).

<sup>109</sup> Hash values arise in both civil and criminal cases for digital fingerprinting of files. For example, *Babcock Power Inc. v. Kapsalis*, No. 3:13-CV-717-CRS, 2018 WL 314860, at \*1 (W.D. Ky. Jan. 5, 2018) involved an order in a civil case to turn over hash value data during discovery and *United States v. Reddick*, 900 F.3d 636, 636–37 (5th Cir. 2018), *cert. denied*, 139 S. Ct. 1617 (2019) involved use of hash values to identify child pornography.

<sup>110</sup> Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), art. 25, 2016 O.J. (L 119) 78 (“The controller shall implement appropriate technical and organisational measures for ensuring that, by default, only personal data which are necessary for each specific purpose of the processing are processed.”). *Id.*

developing in the United States.<sup>111</sup> An understanding of computer programming and networking would be helpful for security by design.

With regard to software engineering, "secure by design" means that "the software has been designed from the foundation to be secure."<sup>112</sup> In a larger sense however, this concept applies to hardware, as well: "Secure by Design principles are pretty straight forward. Security must be considered from system conception, and this focus must continue through all stages of gestation. A system – including all its component parts and their supply chain – must be assumed vulnerable to cyber-attack, and developers must build in appropriate [defenses] & warnings."<sup>113</sup>

### CONCLUSION

As noted above, I propose that law students may benefit from “under-the-hood” technology instruction in addition to (or rather than solely) user side tech education. In addition, to meet the demands of 21st Century law practice, law schools should adopt a core curricular priority of providing “under-the-hood” instruction on networking and programming fundamentals with an emphasis on cybersecurity, which can be implemented in a variety of ways, such as cross listing of IT courses and/or IT for lawyers type courses and/or interdisciplinary law courses that teach and test students on both legal and IT concepts, with IT concepts as a substantial component of the law course. Finally, I propose that law schools consider a foreign language learning analogy when developing a technology curriculum with the goal of helping law students to achieve an intermediate level of tech fluency as a foundation for further learning outside of law school.

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<sup>111</sup> The California Consumer Protection Act (CCPA) was enacted shortly after the GDPR went into effect, and the GDPR likely influenced the CCPA. *See generally*, Alice Marini et al., *Comparing Privacy Laws: GDPR v. CCPA*, DATAGUIDANCE & FUTURE OF PRIVACY FORUM (last visited Nov. 26, 2019), [https://fpf.org/wp-content/uploads/2018/11/GDPR\\_CCPA\\_Comparison-Guide.pdf](https://fpf.org/wp-content/uploads/2018/11/GDPR_CCPA_Comparison-Guide.pdf).

<sup>112</sup> *Secure by design*, WIKIPEDIA, [https://en.wikipedia.org/wiki/Secure\\_by\\_design](https://en.wikipedia.org/wiki/Secure_by_design) (last visited Nov. 26, 2019). *See also*, Hannah Williams, *Secure by design: All you need to know about the consumer IoT security legislation*, COMPUTERWORLD (May 2, 2019 6:50 AM), <https://www.computerworld.com/article/3428047/secure-by-design--all-you-need-to-know-about-the-consumer-iot-security-legislation.html>.

<sup>113</sup> John Palfreyman, *Secure by Design*, IBM GOV'T INDUS. BLOG (Oct. 16, 2015), <https://www.ibm.com/blogs/insights-on-business/government/secure-by-design/>.