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Political Science Department

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Perspectives on Cybersecurity:
A Collaborative Study

Massachusetts Institute of Technology:

Nazli Choucri
Chrisma Jackson
Lyla Fischer
Brooke Gier
Vivian Peron
Ben Ze Yuan
Liu Yangyue
Glenn Voelz

Explorations in Cyber International Relations

Massachusetts Institute of Technology Harvard University

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Authors

Chrisma Jackson

Lyla Fischer

Brooke Gier

Vivian Peron

Ben Ze Yuan

Liu Yangyue

Glenn Voelz

Editors

Nazli Choucri

Chrisma Jackson

Department of Political Science

MIT

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4. Cyberspace as the Domain of Content

Lyla Fischer

On the Internet, content is king. This silicon-valley proverb has helped many technologists focus their start-ups on high-impact areas, and might prove useful to policymakers deciding where to focus their efforts on behalf of their stakeholders.

While it is possible to consider cyberspace in terms of its mechanics (eg. networks, sensors, storage devices, algorithms), the constant progress produced by high technology creates a fluidity and complexity that can make it prohibitively difficult for policymakers to know how to influence its activities and hold experts accountable for specific, verifiable objectives.

This paper aims to differentiate between the ends and means of cyberspace so that policymakers can focus on the ends and experts can specialize in the means.

The first step is to define cyberspace as a whole in the same way programs within it are defined: specifying inputs, actions on those inputs, and outputs. Within cyberspace, every input is a bit of information or piece of content, actions on inputs are accomplished using modern technology, and the resulting content outputs an effect on the real world. The longevity of any particular policy can be estimated by its ability to avoid dependence on specific technological implementations.

4.1 Effects of Information and Knowledge

Information and knowledge encoded as digital content is of interest because of effects in the real world. Note that while modern technology can reduce the amount of marginal human intervention for content to have an effect, information and knowledge often produce effects without modern technology. Listed here are common effects that information and knowledge can have.

4.1.1 Entertainment:

Some knowledge is treated like a consumer good. Everyday people enjoy stories, songs, pictures, plays, and games with little regard to usefulness outside of the pleasure that they bring to daily life. Artistic entertainment does not necessarily require modern technology; songs have existed much longer than the microphone. However, people have been able to use modern technology to transform traditional art forms and create new forms of expression that bring joy into people's lives.

Physical Systems:

Knowledge that has historically been trained into humans as skills can be encoded digitally to send electric force through motors. Those motors can move power equipment, control the elevators and climate in buildings, optimize the fuel efficiency in cars, direct current through the power grid, and even automate complex tasks like the flight systems on airplanes.

4.1.2 Technology development:

One of the most concentrated forms of recorded knowledge is a specification or design of high technology. The designs themselves do not produce effects until they have been translated into physical objects through manufacturing and assembly. However, the design is still an extremely valuable asset, and a critical part of the supply chain for those goods.

Note that source code can be considered a subcategory of design. Source code cannot produce effects until it is compiled and deployed on physical computers.

4.1.3 Decision-making:

One of the most familiar and most important effects of knowledge and information is its influence on decision-making. Decision-makers have demonstrated need for high quality knowledge, information, and understanding long before technology developed to its current state, but only in the last century have decision-makers have been unable to personally manage and verify their entire informational supply chain.

4.1.4 Plans:

Information is also quite valuable to non-decision-makers who need to understand the actions that they need to take according to a coordinated plan. A plan by itself cannot produce results without being distributed, contextualized, and executed.

4.2 Capabilities of Modern Technology

Modern technology has four major capabilities that have transformed the effects of information and knowledge.

4.2.1 Speed and Distance of Communication (Networks):

The Morse Telegraph System finished replacing the Pony Express in 1861. That technology eventually became a phone system, and then the hardware basis for the Internet. Electronic communication systems allowed people to conduct commerce, diplomacy, and personal connection at a pace decoupled from the transportation of people and packages. New technological developments continually allow us to transmit more files, larger files, and have those files arrive sooner.

4.2.2 Logic, Patterns, and Simulation (Computation):

Alan Turing built the first non-theoretical computational device in 1941 in order to transform intercepted German communications into a format that allied forces could read. Since then, we have been able to automatically alter information into formats that fit our needs with increasing sophistication. This alteration often requires humans to identify and program mathematical trends and patterns into computers. Computers are useful for quickly translating large numbers of inputs or simulating the results of large numbers of guesses. As technology develops, we can translate more inputs and simulate more guesses in the same amount of time, while making fewer mathematical

simplifications.

4.2.3 Recording and Records (Sensors, Storage):

Bing Crosby popularized the audio recording in 1947 by pioneering the pre-recorded radio show, allowing him to invest highly in production values and use the resulting shows for multiple broadcasts. The work he did while pairing information storage with electronic distribution earned him several stars on the Hollywood Walk of Fame. Since then, technology has made it easier and easier to collect and store larger and larger amounts of information, and has made it easier and faster to alter that stored content using automatic logic.

4.2.4 Human-Computer Interaction (HCI):

The power of sophisticated tools is increasingly used by untrained non-experts because technology has gotten cheaper and easier to use. As desktop computers became affordable around 1983, spreadsheet application Lotus1-2-3 revolutionized small business record keeping and Apple Computer foraged into desktop publishing with What-You-See-Is-What-You-Get (WYSIWYG, pronounced wiss-ee-wig) interfaces. As technology continues to develop, we will see more technological capabilities used with less training and lower capital investment.

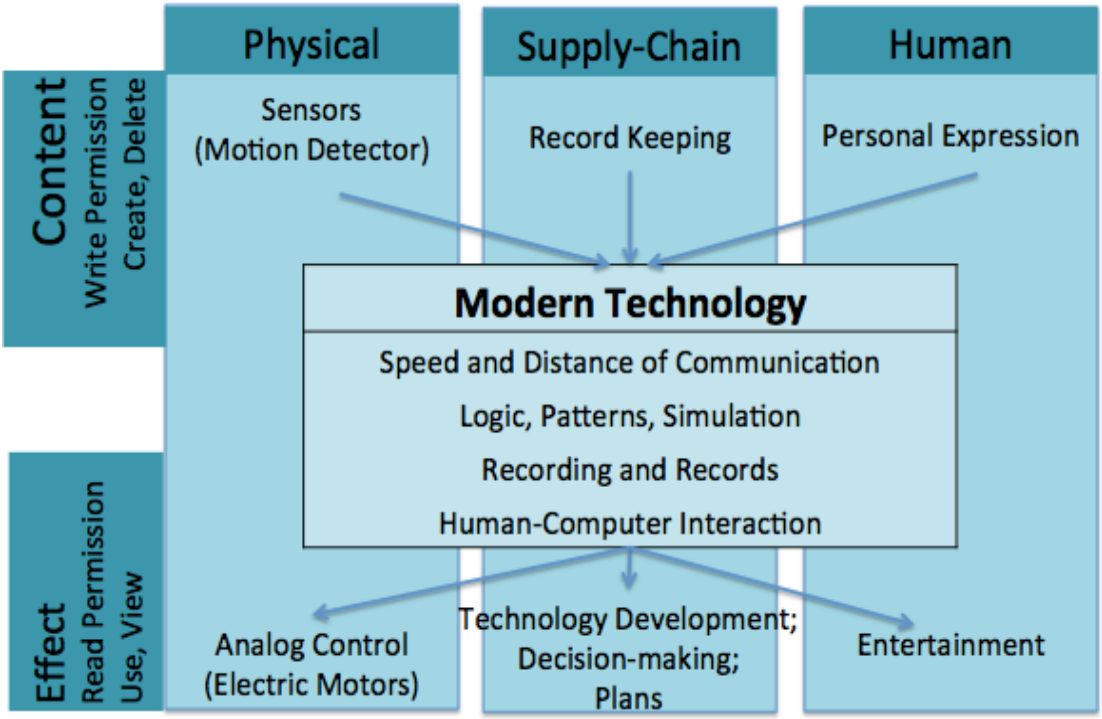

Figure 4.1
The informational domain has a set of capabilities that can take inputs and produce outputs.

4.3 Types of Content

We have outlined some of the major effects that information and knowledge can produce. We

have categorized the advances that modern technology has brought to how we can leverage information and knowledge. However, categorizing information and knowledge remains an underdeveloped area of understanding, in both theory and practice.

Some information is already well controlled because it contributes to important effects in well-known ways, even without the added sophistication of modern technology. Examples include financial records, business accounts, medical records, correspondence, and personal dairies as well as more processed knowledge such as reports, plans, and designs.

Advances of modern technology have allowed us to capture and process information in ways that have augmented the importance of certain assets beyond their historical levels. Without any human intervention, sensors can store facts about the physical world from which logical programs can draw valuable conclusions. Records and reports that used to propagate through paper and human memory are now automatically indexed and searched by metadata, keyword, or other pattern. Social interactions that used to be fleeting and isolated to geographic locations are now international and recorded in perpetuity. Many of these assets are both unregulated and undisputed because they were unable to produce outputs of interest before the application of modern technology.

That is no longer the case.

Policymakers need to understand the impact of information that was previously of minimal value so that they can prioritize and protect their interests from the effects that unclaimed or unprotected information or knowledge might produce for opposing interests.

While it is always better to have a deep understanding of everything one might ever encounter, significant policy guidelines can be produced using only the implications of four main modern technological capabilities. In order to illustrate technology policy using only this limited abstraction of modern technology, I will explain how the music industry was disrupted and how it recovered from the effect of internet-connected desktop computers.

4.4 Case Study: The Recording Industry and the Internet

With the rise of the World Wide Web in the 1990's, many middle class Americans purchased internet-connected desktop computers. Those purchases provided the technical ability for everyday people to upload and make available any information to which they had access.

4.4.1 Status quo:

One particularly interesting type of content is a music file. Before the rise of the internet, a distribution mechanism already existed for recorded music. Specifically, CDs were sold at stores. Common understanding was that after purchasing a CD, the owner could do whatever they wanted with that asset. They could play it at a party. They could lend it to a friend. They could make a mix-tape for their romantic interest. They *owned* the music.

Studios put a significant amount of investment into the development, curation, publicity, and

distribution of music. Studios recuperated that investment from sales made in stores, a well-enforced barrier of access for people to listen to and enjoy the results of a studio's investment.

4.4.2 The effect of technology:

This arrangement worked well until internet-connected personal computers allowed CD owners to give strangers copies of that CD at no cost to themselves. That is: minimally trained users were able to use a communication network to transfer copies of musical content over long distances.

Much of the technical complexity of that sharing ability was handled by yet another piece of technology: the user application called Napster. Most users did not know how a CD was read by a computer, how that computer stored the information read from a CD on a hard drive, how the computer was connected to the internet, how other computers could remotely request copies of content from a hard drive, how a computer could upload content from a hard drive to the internet, how a computer could copy content from the internet to a hard drive, or how content from a hard drive could be transformed into sound. Despite the common lack of knowledge of the mechanics of the music transfer, these activities were able to take place because Napster provided an interface that took care of significant portions of this complexity.

Finally, there was little ethical understanding around the usage of digital content. Most people who bought a CD were under the impression that it was perfectly acceptable to do anything within their power with the asset that they owned. They saw no difference between lending a CD to a friend, allowing that friend to make a copy of the CD, allowing that friend to download a copy of that CD from their computer, and allowing strangers to download a copy of that CD from their computer. Many people thought that if they bought music, and it was theirs to do with as they pleased.

The technological capabilities provided by the internet, desktop computers, and Napster, along with the ethical understanding of acceptable use of musical content after purchase, caused the music industry to temporarily lose the ability to charge money in order to derive enjoyment from their informational assets. It was cheaper and easier to download a song from Napster than to go to a store and purchase a CD.

4.4.3 The resolution:

The music industry was able to use existing legal precedent of copyright to establish that the common understanding of a user's rights after purchasing a CD was incorrect. Armed with that legal judgment, studios were able use legal authority to assert control over a particular piece of information that produced a specific desirable entertaining outcome. They used that authority to prosecute several users, but it soon became clear that the high costs associated with identification and prosecution of violators was prohibitive as long as violations requiring separate lawsuits were small scale. The music industry needed to find other methods of enforcing its control over its property.

The music industry won a key lawsuit against the creators of Napster, the user application that allowed people to violate copyright with minimal technical knowledge. It was not obvious that the

precedents associated with copyright would apply to Napster, but the trail of that specific case established the precedent that information services that allow people to share files with each other bear the legal responsibility for ensuring that people have the right to share those files with each other.

Prosecuting Napster did not solve all of the music industry's problems, because all of the technology that Napster was built on was still readily available. The internet was still free and open. Desktop computers were still in people's houses, providing cheap storage and computation. CDs were still distributed in formats that could be copied and stored on the hard drives of desktop computers. After shutting down Napster, other file-sharing services soon appeared to take Napster's place. There were few enough replacement services that it was possible to also prosecute them and shut them down. Compared to the number of people who used services like Napster, it was still much easier to enforce copyright only against the people who were capable of managing the complexity of putting together interfaces that made it **easy** to illegally download music.

As restrictions on downloading copyrighted music were increasingly enforced and practitioners were driven underground, accessing content illegally meant exposure to other illegal material. It just so happened that computer viruses were distributed on file-sharing sites under the disguise of desirable musical assets. Users who wanted the protection of the law from computer viruses had to abide by the law regarding copyright.

Finally, the music industry offered a legal alternative to file-sharing sites: iTunes. The iTunes software not only offered an online distribution mechanism that included purchasing, it also allowed the music industry to impose technological controls. It was more difficult to copy music stored on an iPod than it was to copy music stored on a CD, and that difficulty was intentionally intensified in various ways. iTunes did not include any ability for an end-user to send purchased music to friends. While untrained users lost a significant amount of control over music files, the iPod still allowed users to enjoy the output of the investment made by the recording studio. For many people, it became better to pay a small fee to legally download a song from iTunes than to understand and traverse an increasingly confusing and dangerous black market for free musical files.

4.4.5 Observations:

The fall of Napster and the rise of iTunes is the story of control over a specific type of content (music files) in order to control and charge for a specific effect (the enjoyment of musical performances). This control was eventually exerted though user-level applications, Napster and iTunes.

The music industry initially tried to apply a legal precedent that most naturally applied to a specific informational asset, but the fact that it was used by such a large set of disperse actors made enforcement difficult. In order to overcome practical implications of enforcement, that legal principle was translated to a smaller set of actors who organized large amounts of activity and who could be held accountable for the activity that it organized.

By focusing its prosecutorial efforts on a small number of specific players in a specific part of

the technological flow, the music industry was able to increase the expertise required to violate the law and to unbundle the acquisition of free musical material from other benefits law enforcement. They also decreased the cost and inconvenience of using a legal alternative so that there was less incentive to acquire expertise or brave danger.

As policymakers consider how different interests will be affected by modern technology, they will repeatedly come across the trend that technology makes information extremely mobile. Historically, it was possible to transfer an informational asset and trust that it would not be transferred further merely due to practical reasons, but technology is pushing those practicalities into irrelevance. The music industry discovered this fact with music files in the 90's, and was forced to adjust both its distribution mechanisms and its price point. Other forms of content are in the process of adjusting to this reality as well.

While applying methods of control to content that has changed in value, policymakers in non-musical fields are unlikely to face exactly the same set of constraints, incentives, costs, or competing interests that the music industry faced. Application of new policies will likely depend on different points in the technological flow where it is easiest to change the cost function of actors pursuing potentially competing interests. Policymakers will likely need to work with specialists to understand which costs will be easiest to adjust, and with other policymakers to understand the impact of potential policies on a wide variety of stakeholders.