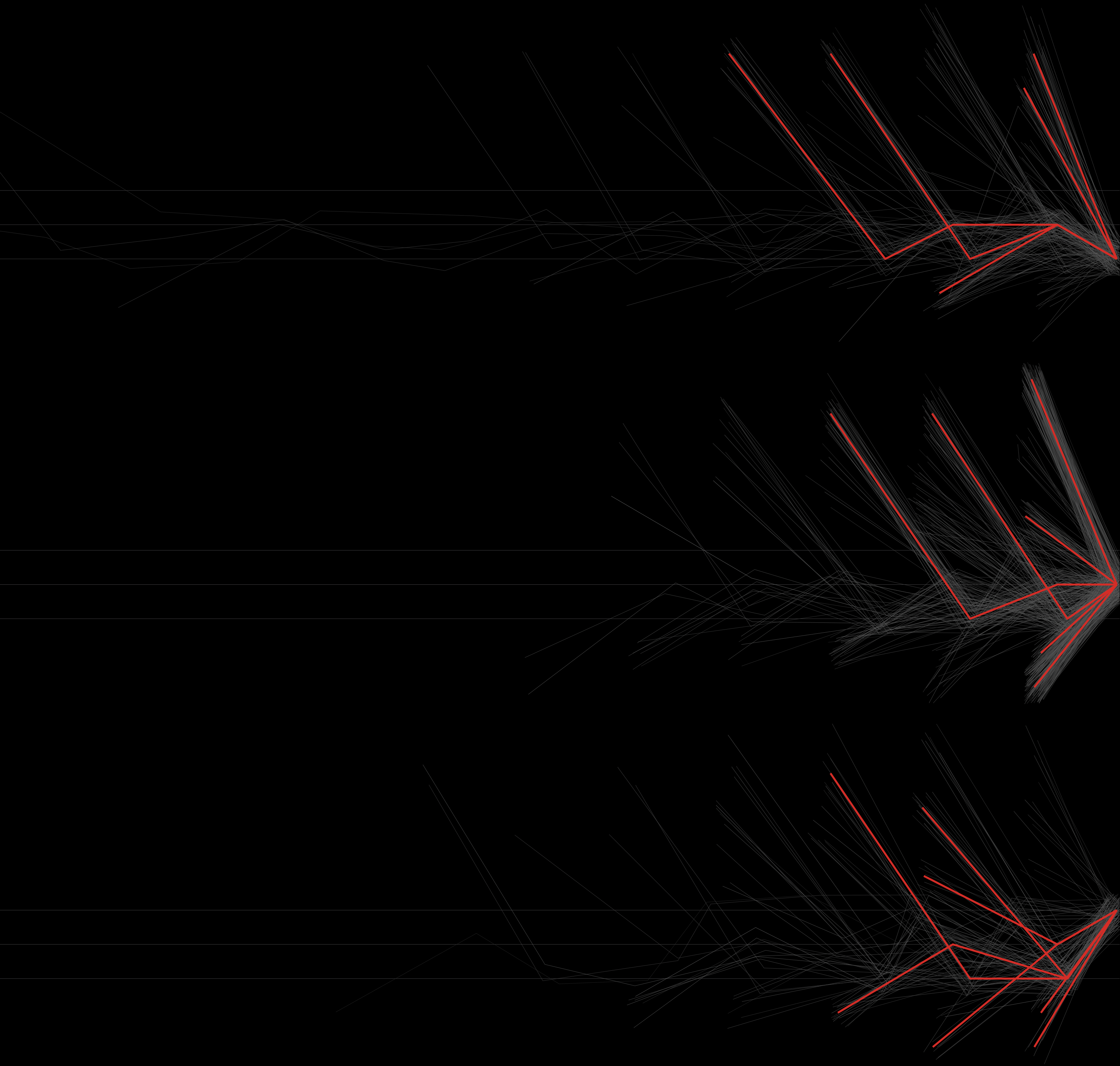
2019 Data Breach Investigations Report



verizon

A couple of tidbits

Before we formally introduce you to the 2019 Data Breach Investigations Report (DBIR), let us get some clarifications out of the way first to reduce potential ambiguity around terms, labels, and figures that you will find throughout this study.

VERIS resources

The terms "threat actions," "threat actors," "varieties," and "vectors" will be referenced a lot. These are part of the Vocabulary for Event Recording and Incident Sharing (VERIS), a framework designed to allow for a consistent, unequivocal collection of security incident details. Here are some select definitions followed by links with more information on the framework and on the enumerations.

Threat actor:
Who is behind the event? This could be the external "bad guy" that launches a phishing campaign, or an employee who leaves sensitive documents in their seat back pocket.

Threat action:
What tactics (actions) were used to affect an asset? VERIS uses seven primary categories of threat actions: Malware, Hacking, Social, Misuse, Physical, Error, and Environmental. Examples at a high level are hacking a server, installing malware, and influencing human behavior.

Variety:
More specific enumerations of higher level categories – e.g., classifying the external "bad guy" as an organized criminal group, or recording a hacking action as SQL injection or brute force.

Learn more here:
- github.com/vz-risk/dbir/tree/gh-pages/2019 – DBIR figures and figure data.
- veriscommunity.net features information on the framework with examples and enumeration listings.
- github.com/vz-risk/veris features the full VERIS schema.
- github.com/vz-risk/vcdb provides access to our database on publicly disclosed breaches, the VERIS Community Database.
- http://veriscommunity.net/veris_webapp_min.html allows you to record your own incidents and breaches. Don't fret, it saves any data locally and you only share what you want.

Incident vs. breaches

We talk a lot about incidents and breaches and we use the following definitions:

Incident:
A security event that compromises the integrity, confidentiality, or availability of an information asset.

Breach:
An incident that results in the confirmed disclosure – not just potential exposure – of data to an unauthorized party.

Industry labels

We align with the North American Industry Classification System (NAICS) standard to categorize the victim organizations in our corpus. The standard uses 2 to 6 digit codes to classify businesses and organizations. Our analysis is typically done at the 2-digit level and we will specify NAICS codes along with an industry label. For example, a chart with a label of Financial (52) is not indicative of 52 as a value. 52 is the NAICS code for the Finance and Insurance sector. The overall label of "Financial" is used for brevity within the figures. Detailed information on the codes and classification system is available here:

https://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2017

New chart, who dis?

You may notice that the bar chart shown may not be as, well, bar-ish as what you may be used to. Last year, we talked a bit in the Methodology section about confidence. When we say a number is X, it's really X +/- a small amount.

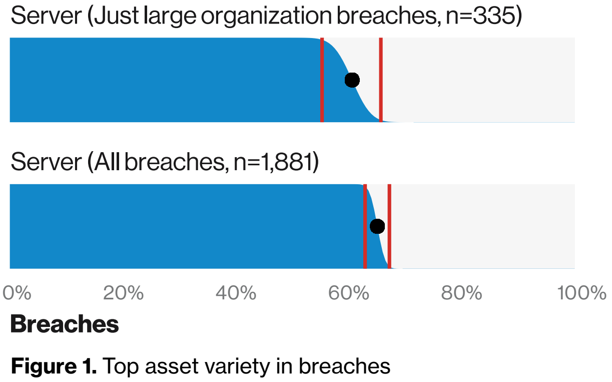


Figure 1. Top asset variety in breaches

This year we're putting it in the bar charts. The black dot is the value, but the slope gives you an idea of where the real value could be between. In this sample figure we've added a few red bars to highlight it, but in 19 bars out of 20 (95%),[1] the real number will be between the two red lines on the bar chart. Notice that as the sample size (n) goes down, the bars get farther apart.
If the lower bound of the range on the top bar overlaps with the higher bound of the bar beneath it, they are treated as statistically similar and thus statements that x is more than y will not be proclaimed.

Questions? Comments? Brilliant ideas?
We want to hear them. Drop us a line at dbir@verizon.com, find us on LinkedIn, tweet @VZEnterprise with the #dbir.
Got a data question? Tweet @VZDBIR!

[1] https://en.wikipedia.org/wiki/Confidence_interval

Table of contents

Introduction

“The wound is the place where the light enters you.”
– Rumi

Welcome! Pull up a chair with the 2019 Verizon Data Breach Investigations Report (DBIR). The statements you will read in the pages that follow are data-driven, either by the incident corpus that is the foundation of this publication, or by non-incident data sets contributed by several security vendors.

This report is built upon analysis of 41,686 security incidents, of which 2,013 were confirmed data breaches. We will take a look at how results are changing (or not) over the years, as well as digging into the overall threat landscape and the actors, actions, and assets that are present in breaches. Windows into the most common pairs of threat actions and affected assets are also provided. This affords the reader with yet another means to analyze breaches and to find commonalities above and beyond the incident classification patterns that you may already be acquainted with.

Fear not, however. The nine incident classification patterns are still around, and we continue to focus on how they correlate to industry. In addition to the nine primary patterns, we have created a subset of data to pull out financially-motivated social engineering (FMSE) attacks that do not have a goal of malware installation. Instead, they are more focused on credential theft and duping people into transferring money into adversary-controlled accounts. In addition to comparing industry threat profiles to each other, individual industry sections are once again front and center.

Joining forces with the ever-growing incident/breach corpus, several areas of research using non-incident data sets such as malware blocks, results of phishing training, and vulnerability scanning are also utilized. Leveraging, and sometimes combining, disparate data sources (like honeypots and internet scan research) allows for additional data-driven context.

It is our charge to present information on the common tactics used by attackers against organizations in your industry. The purpose of this study is not to rub salt in the wounds of information security, but to contribute to the “light” that raises awareness and provides the ability to learn from the past. Use it as another arrow in your quiver to win hearts, minds, and security budget. We often hear that this is “required reading” and strive to deliver actionable information in a manner that does not cause drowsiness, fatigue, or any other adverse side effects.

We continue to be encouraged and energized by the coordinated data sharing by our 73 data sources, 66 of which are organizations external to Verizon. This community of data contributors represents an international group of public and private entities willing to support this annual publication. We again thank them for their support, time, and, of course, DATA.

We all have wounds, none of us knows everything, let’s learn from each other.

Excelsior![2]

[2] If you didn’t expect a Stan Lee reference in this report, then you are certainly a first-time reader. Welcome to the party pal!

Summary of findings

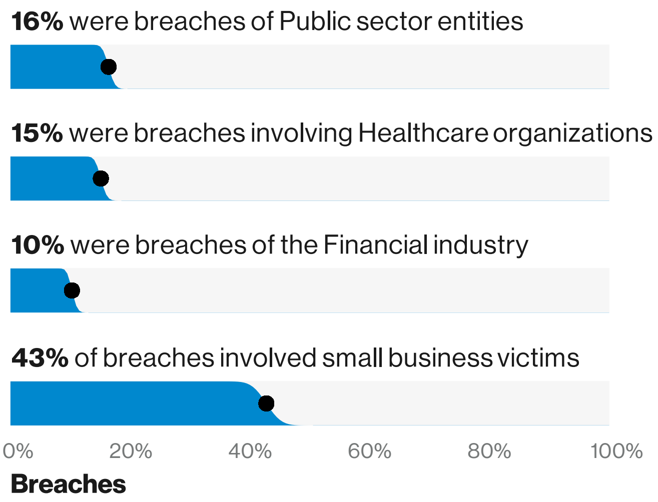


Figure 2.

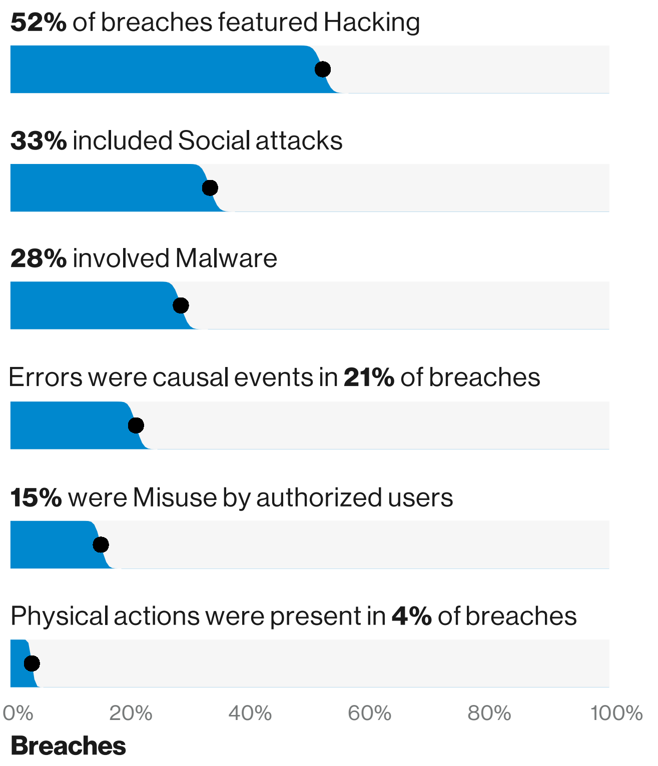


Figure 3.

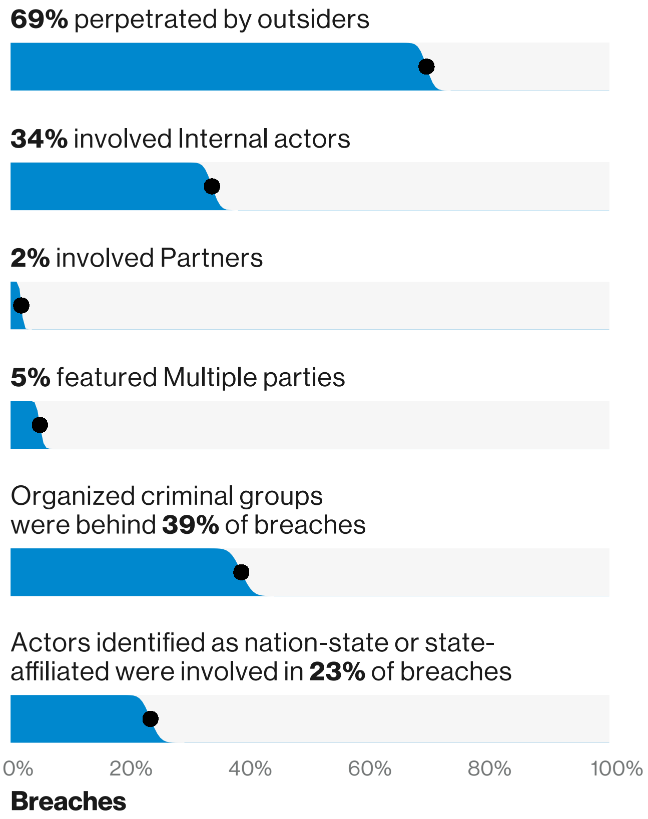


Figure 1.

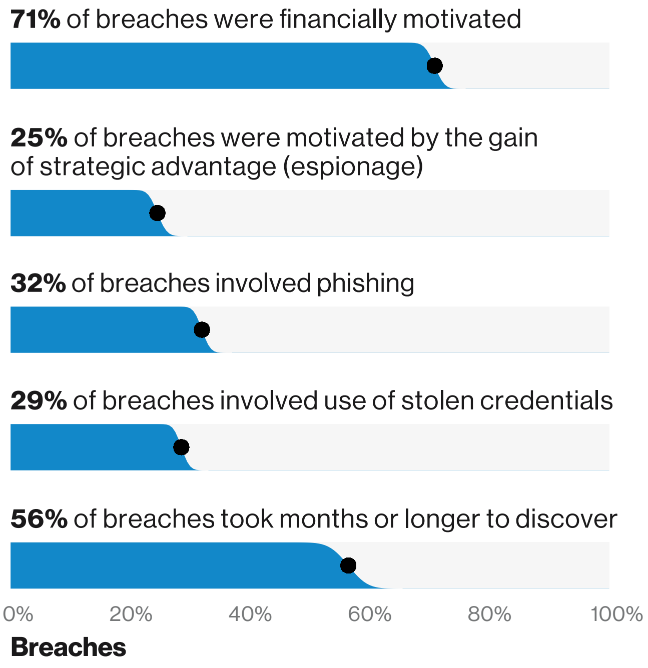


Figure 5. What are other commonalities?

Results and analysis

The results found in this and subsequent sections within the report are based on a data set collected from a variety of sources such as publicly-disclosed security incidents, cases provided by the Verizon Threat Research Advisory Center (VTRAC) investigators, and by our external collaborators. The year-to-year data set(s) will have new sources of incident and breach data as we strive to locate and engage with organizations that are willing to share information to improve the diversity and coverage of real-world events. This is a convenience sample, and changes in contributors, both additions and those who were not able to participate this year, will influence the data set. Moreover, potential changes in their areas of focus can stir the pot o' breaches when we trend over time. All of this means we are not always researching and analyzing the same fish in the same barrel. Still other potential factors that may affect these results are changes in how we subset data and large-scale events that can sometimes influence metrics for a given year. These are all taken into consideration, and acknowledged where necessary within the text, to provide appropriate context to the reader.

With those cards on the table, a year-to-year view of the actors (and their motives),[3] followed by changes in threat actions and affected assets over time, is once again provided. A deeper dive into the overall results for this year's data set with an old-school focus on threat action categories follows. Within the threat action results, relevant non-incident data is included to add more awareness regarding the tactics that are in the adversaries' arsenals.

Defining the threats

Threat actor is the terminology used to describe who was pulling the strings of the breach (or if an error, tripping on them). Actors are broken out into three high-level categories of External, Internal, and Partner. External actors have long been the primary culprits behind confirmed data breaches and this year the trend continues. There are some subsets of data that are removed from the general corpus, notably over 50,000 botnet related breaches. These would have been attributed to external groups and, had they been included, would have further increased the gap between the external and internal threat.

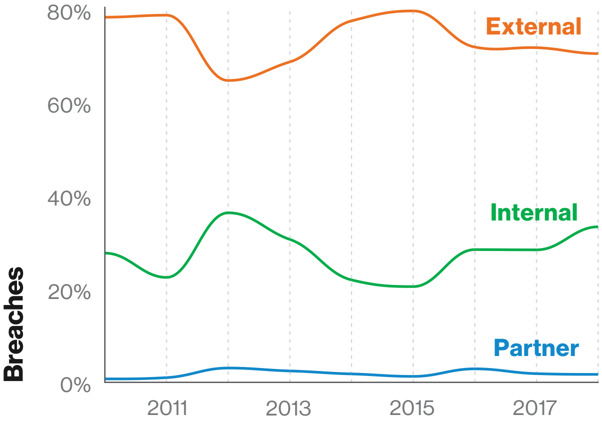


Figure 6. Threat actors in breaches over time

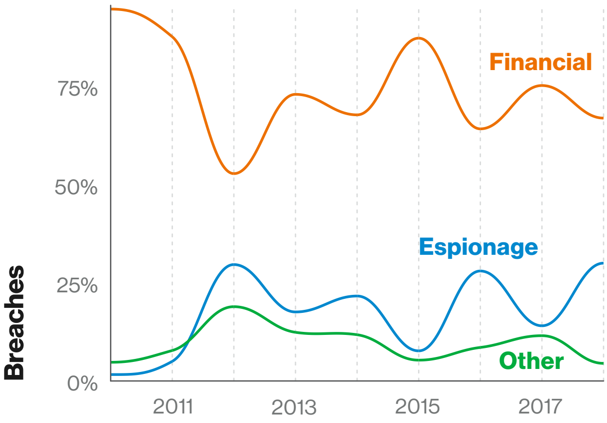


Figure 7. Threat actor motives in breaches over time

[3] And we show the whole deck in Appendix B: Methodology.

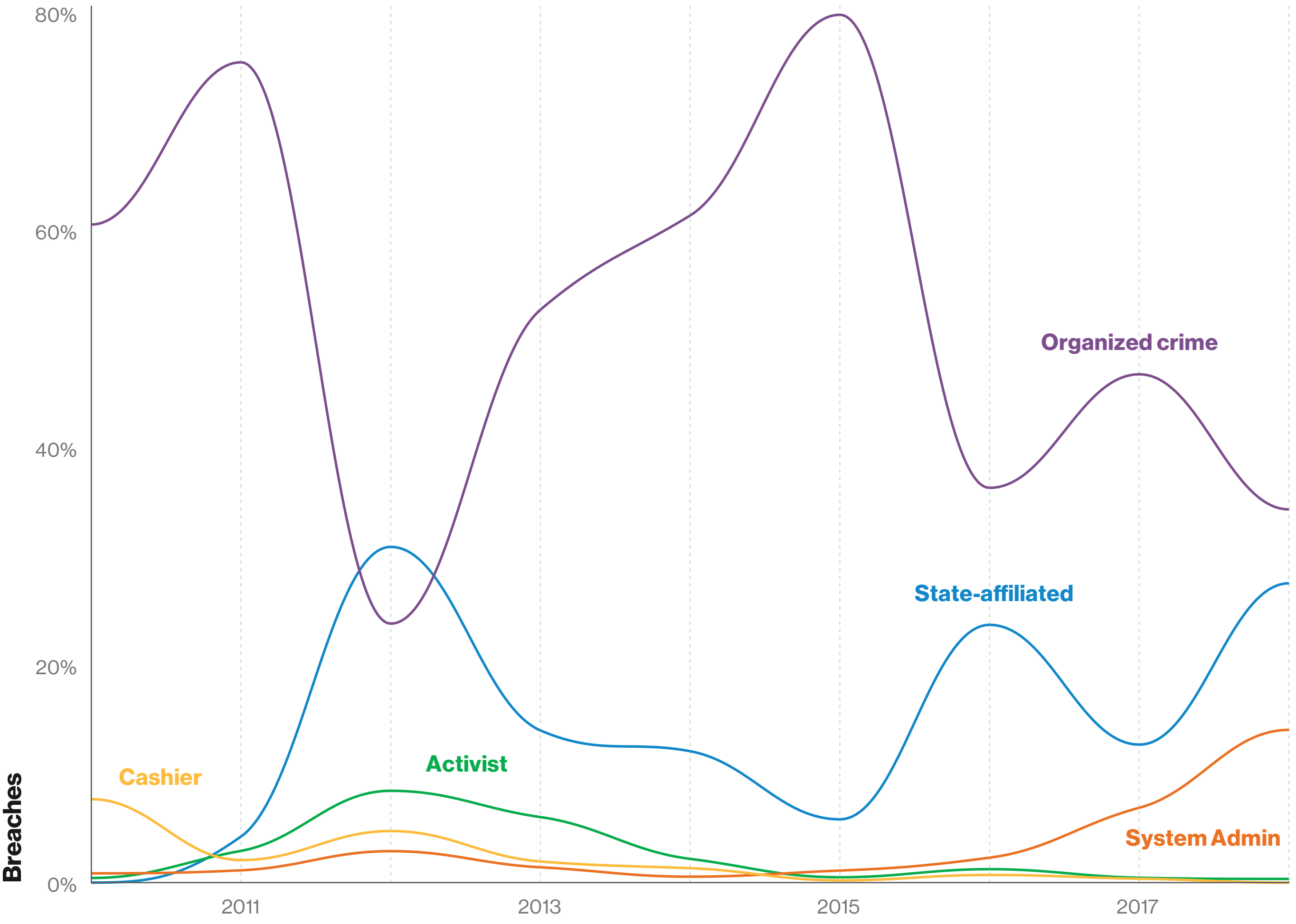


Figure 8. Select threat actors in breaches over time

Financial gain is still the most common motive behind data breaches where a motive is known or applicable (errors are not categorized with any motive). This continued positioning of personal or financial gain at the top is not unexpected. In addition to the botnet breaches that were filtered out, there are other scalable breach types that allow for opportunistic criminals to attack and compromise numerous victims.[4] Breaches with a strategic advantage as the end goal are well represented, with one-quarter of the breaches associated with espionage. The ebb and flow of the financial and espionage motives are indicative of changes in the data contributions and the multi-victim sprees.

This year there was a continued reduction in card-present breaches involving point of sale environments and card skimming operations. Similar percentage changes in organized criminal groups and state-affiliated operations are shown in Figure 8 above. Another notable finding (since we are already walking down memory lane) is the bump in Activists, who were somewhat of a one-hit wonder in the 2012 DBIR with regard to confirmed data breaches. We also don't see much of Cashier (which also encompasses food servers and bank tellers) anymore. System administrators are creeping up and while the rogue admin planting logic bombs and other mayhem makes for a good story, the presence of insiders is most often in the form of errors. These are either by misconfiguring servers to allow for unwanted access or publishing data to a server that should not have been accessible by all site viewers. Please, close those buckets!

[4] In Appendix C: "Watching the Watchers," we refer to these as zero-marginal-cost attacks.

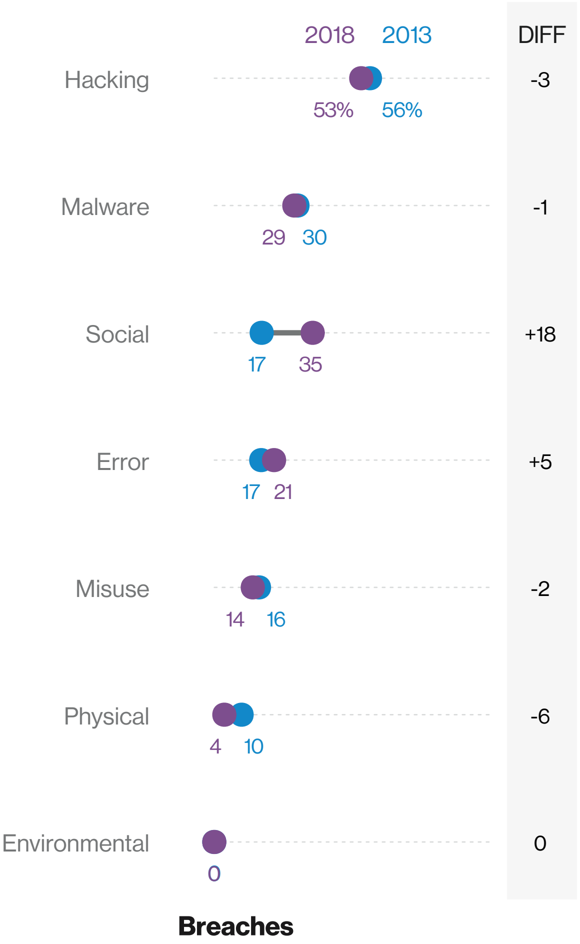


Figure 9. Threat actions in data breaches over time
n=2,501 (2013), n=1,638 (2018)

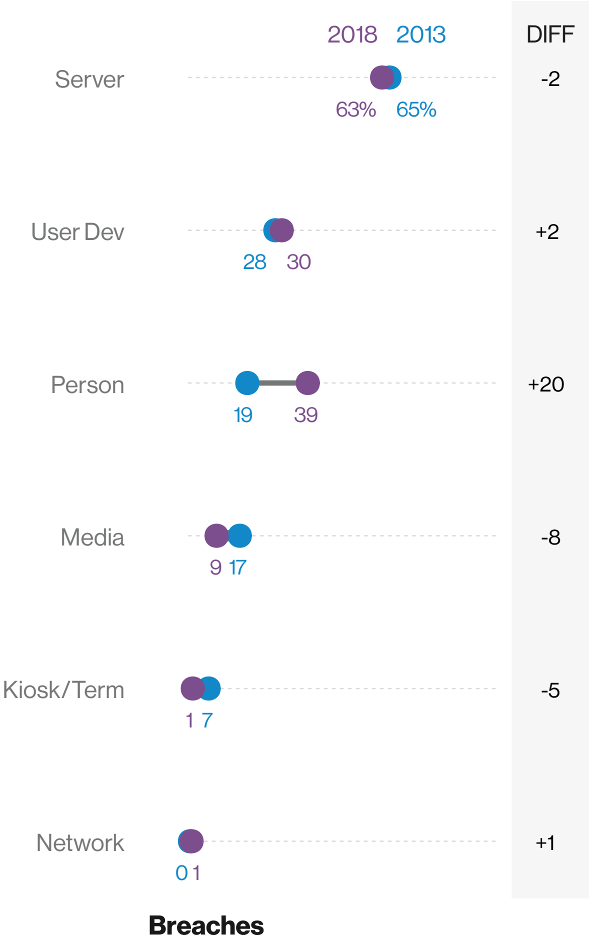


Figure 10. Asset categories in data breaches over time
n=2,294 (2013), n=1,513 (2018)

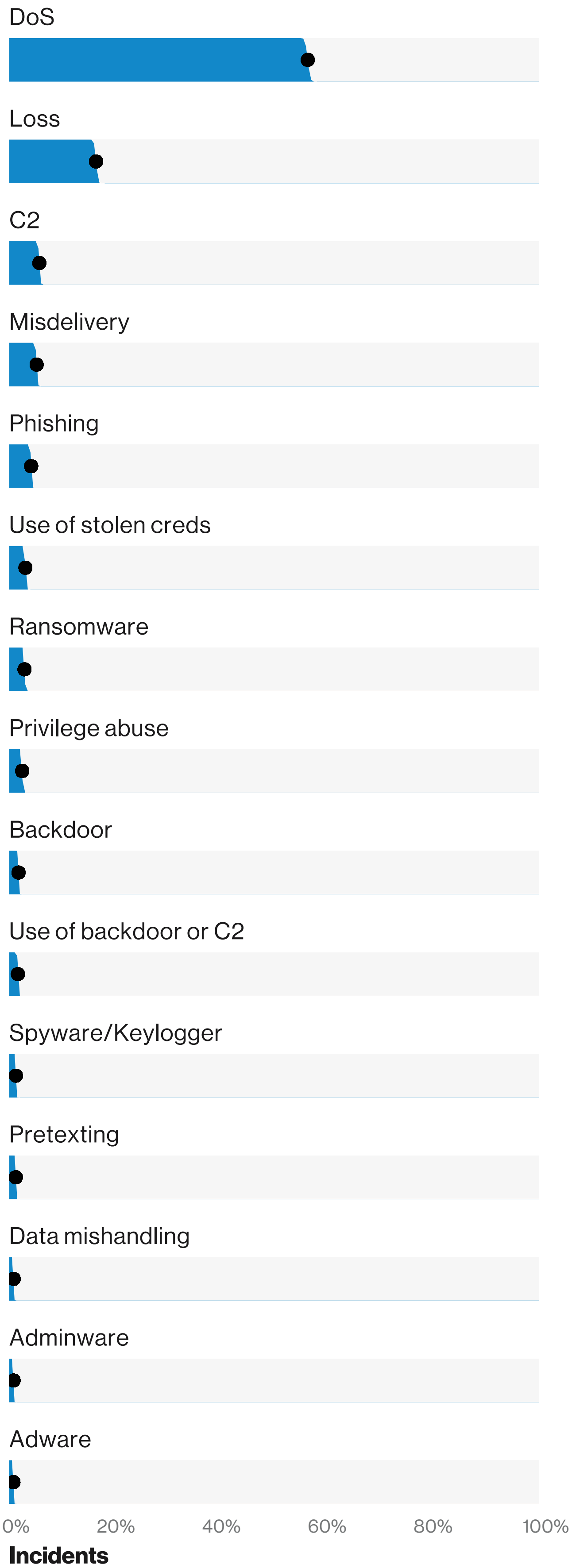
Figures 9 and 10 show changes in threat actions and affected assets from 2013 to 2018.[5,6] No, we don't have some odd affinity for seven-year time frames (as far as you know). Prior years were heavily influenced by payment card breaches featuring automated attacks on POS devices with default credentials, so 2013 was a better representative starting point. The rise in social engineering is evident in both charts, with the action category Social and the related human asset both increasing.

Threat action varieties

When we delve a bit deeper and examine threat actions at the variety level, the proverbial question of "What are the bad guys doing?" starts to become clearer. Figure 11 shows Denial of Service attacks are again at the top of action varieties associated with security incidents, but it is still very rare for DoS to feature in a confirmed data breach. Similarly, Loss, which is short for Lost or misplaced assets, incidents are not labeled as a data breach if the asset lost is a laptop or phone, as there is no feasible way to determine if data was accessed. We allow ourselves to infer data disclosure if the asset involved was printed documents.

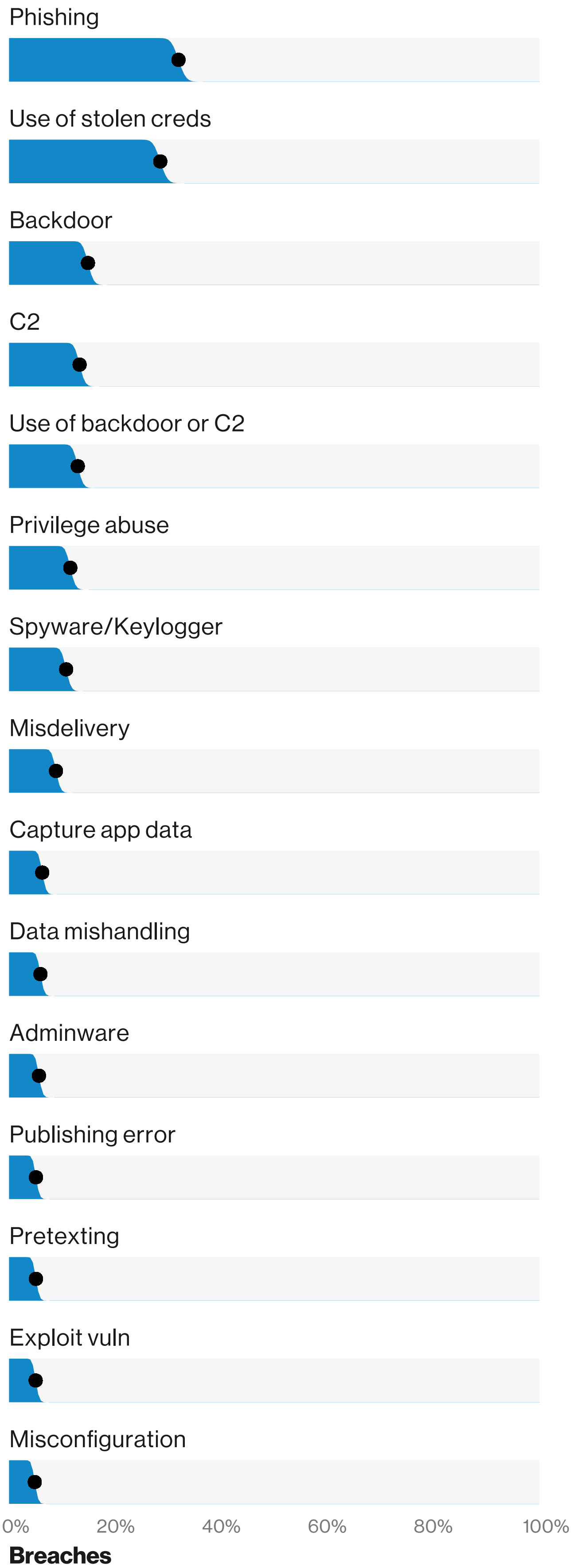
Switching over to breaches in Figure 12, phishing and the hacking action variety of use of stolen credentials are prominent fixtures. The next group of three involves the installation and subsequent use of backdoor or Command and Control (C2) malware. These tactics have historically been common facets of data breaches and based on our data, there is still much success to be had there.

[5] Credit where it's due. These dumbbell charts are based on the design at http://www.pewglobal.org/2016/02/22/social-networking-very-popular-among-adult-internet-users-in-emerging-and-developing-nations/ and code at https://rud.is/b/2016/04/17/ggplot2-exercising-with-ggalt-dumbbells/
[6] Note these are incident years, not DBIR years. All of the 2018 breaches will be represented in this year's data, but a 2012 breach not discovered until 2013 would be part of the 2014 DBIR.



Incidents

Figure 11. Top threat action varieties in incidents, (n=17,310)



Breaches

Figure 12. Top threat action varieties in breaches (n=1,774)

Hacking

A quick glance at the figures below uncovers two prominent hacking variety and vector combinations. The more obvious scenario is using a backdoor or C2 via the backdoor or C2 channel, and the less obvious, but more interesting, use of stolen credentials. Utilizing valid credentials to pop web applications is not exactly avant garde.

The reason it becomes noteworthy is that 60% of the time, the compromised web application vector was the front-end to cloud-based email servers.

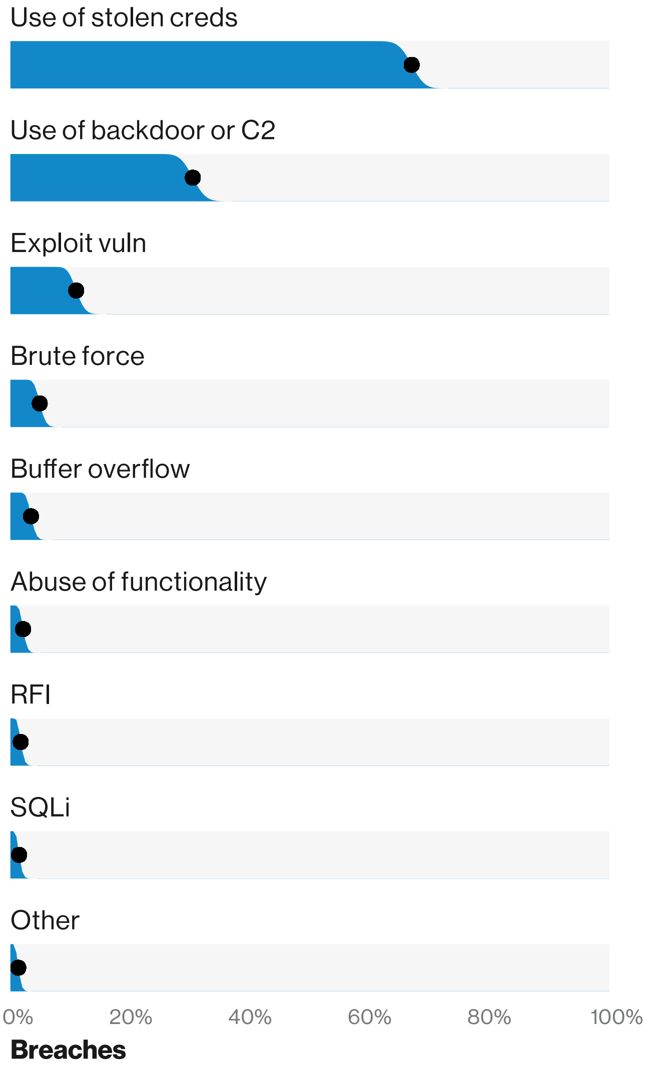


Figure 13. Top hacking action varieties in breaches (n=755)

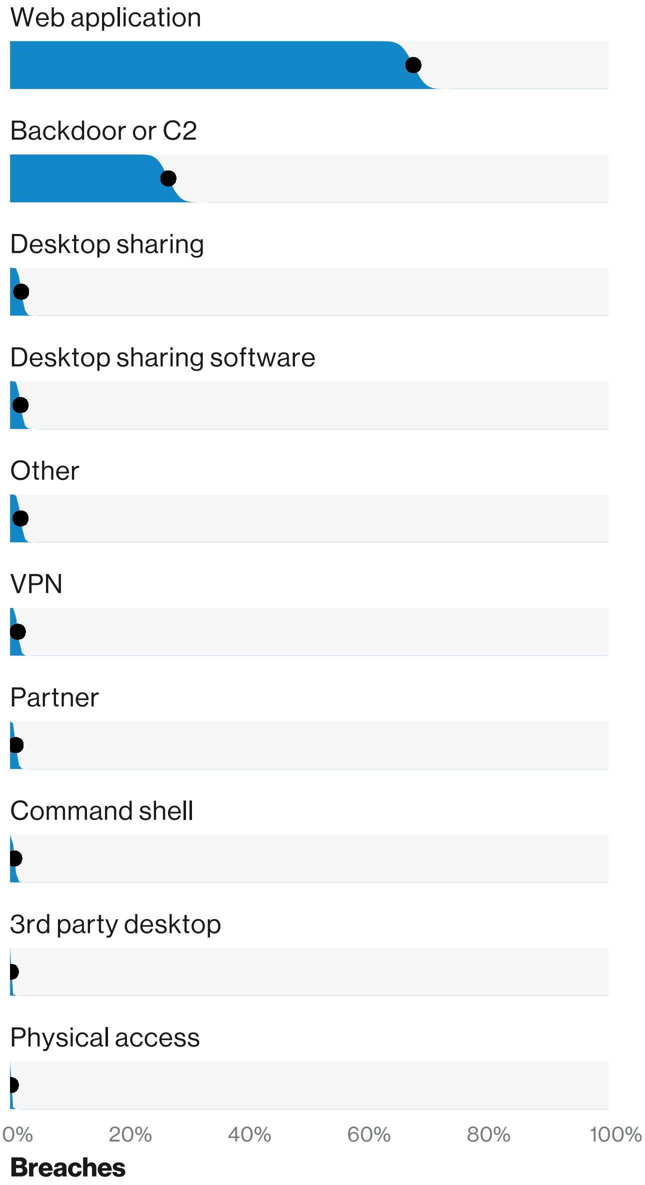


Figure 14. Top hacking action vectors in breaches (n=862)

Even though stolen credentials are not directly associated with patch currency, it is still a necessary and noble undertaking. At most, six percent of breaches in our data set this year involved exploiting vulnerabilities. Remember that time your network was scanned for vulnerabilities and there were zero findings? You slept soundly that night only to be jolted from your drowsy utopia by your alarm radio blaring “I Got You Babe.” Vulnerability scanning always yields findings (even benign informational ones) and it is up to the administrators to determine which are accepted, and which are addressed.

Figure 15 shows the patching behavior of hundreds of organizations from multiple vulnerability scanning contributors. Based on scan history, we determine that organizations will typically have a big push to remediate findings after they are initially discovered and after that there is a steady increase in percentage of findings fixed until it levels out. Not unlike the amount of romance and mutual regard that occurs while dating vs. once married. You get the idea.

The area under the curve (AUC) is how protected you are while you are actively patching. Quick remediation will result in a higher AUC. The percentage completed-on-time (COT) is the amount of vulnerabilities patched at a pre-determined cut-off time; we used 90 days. Your COT metric could be different, and it would make sense to have different COTs for internet-facing devices or browser vulnerabilities, and certainly for vulnerabilities with active exploitation in the wild.

It is important to acknowledge that there will always be findings. The key is to prioritize the important ones and have a plan for the remaining actionable vulnerabilities; and to be able to defend acceptance of unaddressed findings.

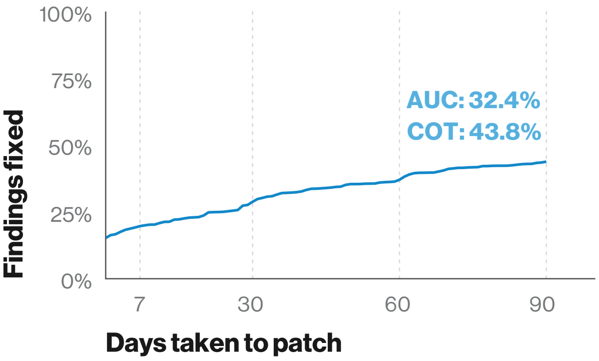


Figure 15. Time to patch

Malware

Malware can be leveraged in numerous ways to establish or advance attacks. Command and Control (C2) and backdoors are found in both security incidents and breaches. Ransomware is still a major issue for organizations and is not forced to rely on data theft in order to be lucrative.

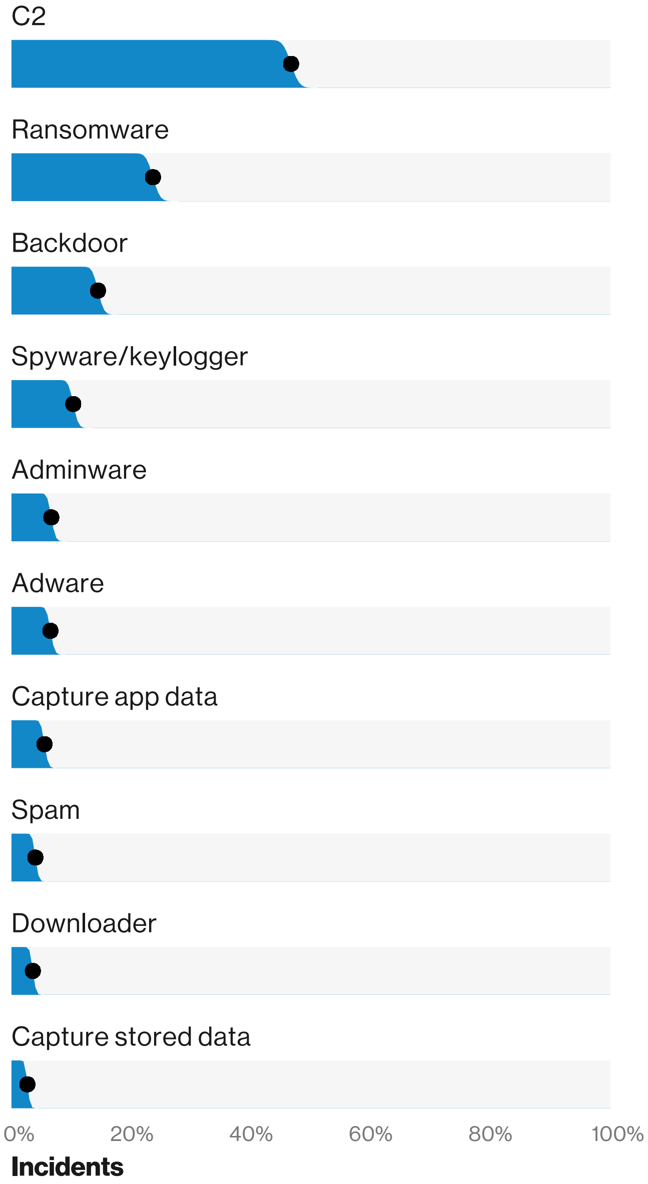


Figure 16. Top malware action varieties in incidents (n=2,103)

We were at a hipster coffee shop and it was packed with people talking about cryptomining malware as the next big thing. The numbers in this year's data set do not support the hype, however, as this malware functionality does not even appear in the top 10 varieties. In previous versions of VERIS, cryptominers were lumped in with click-fraud, but they received their own stand-alone enumeration this year. Combining both the new and legacy enumerations for this year, the total was 39 – more than zero, but still far fewer than the almost 500 ransomware cases this year.

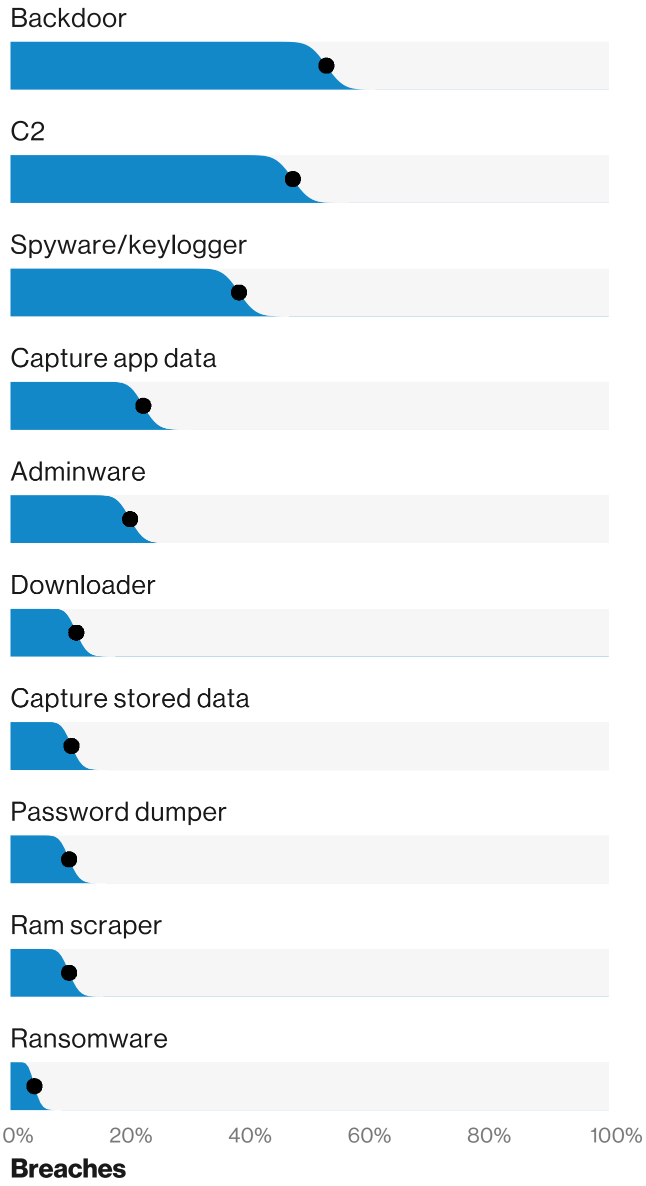


Figure 17. Top malware action varieties in breaches (n=500)

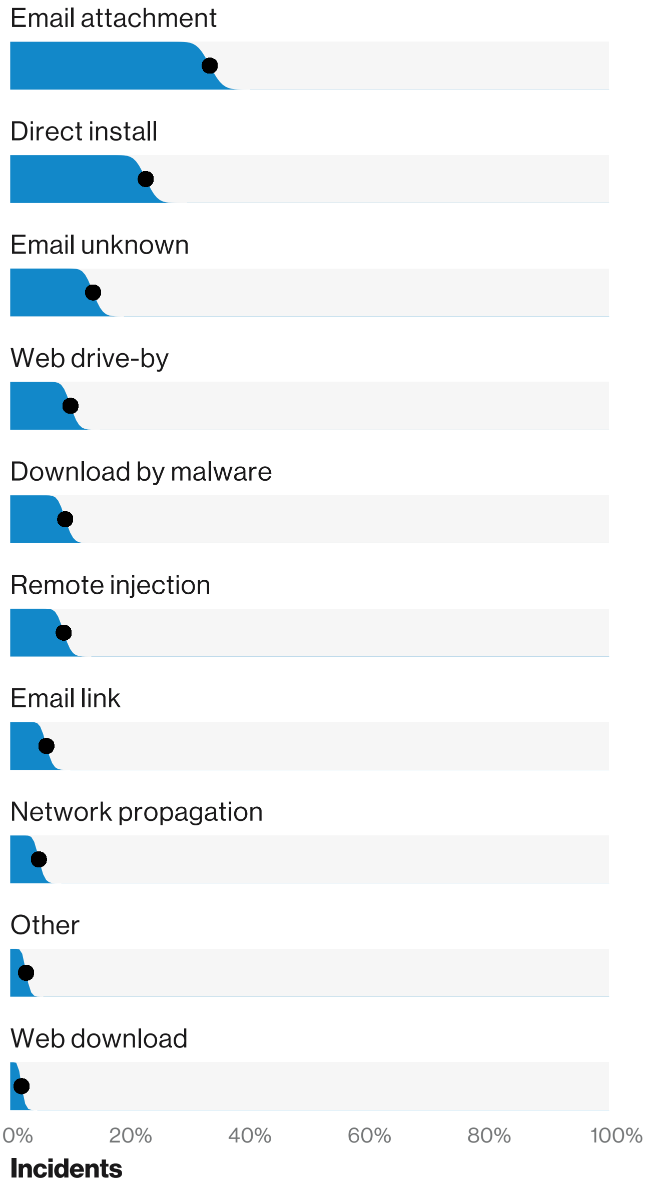


Figure 18. Top malware action vectors in incidents (n=795)

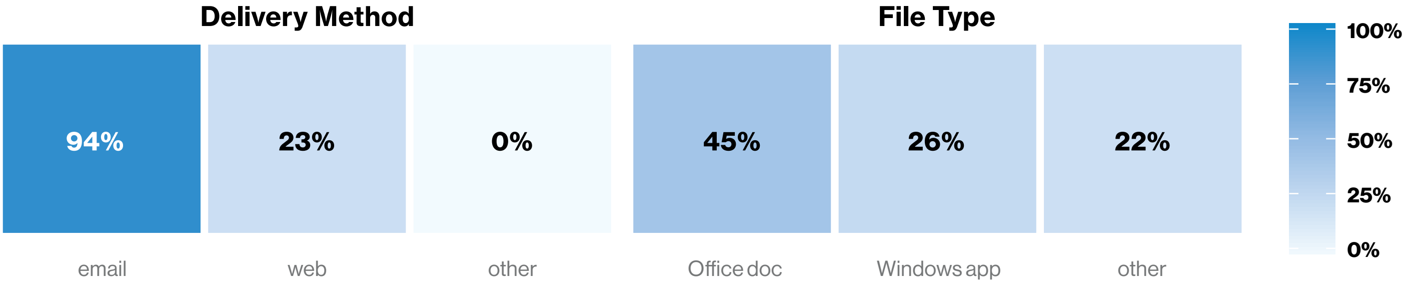


Figure 19. Malware types and delivery methods

Figure 18 displays that when the method of malware installation was known, email was the most common point of entry. This finding is supported in Figure 19, which presents data received from millions of malware detonations, and illustrates that the median company received over 90% of their detected malware by email. Direct install is indicative of a device that is already compromised and the malware is installed after access is established. It is possible for malware to be introduced via email, and once the foothold is gained, additional malware is downloaded, encoded to bypass detection and installed directly. Like most enumerations, these are not mutually exclusive.

Social

While hacking and malicious code may be the words that resonate most with people when the term “data breach” is used, there are other threat action categories that have been around much longer and are still ubiquitous. Social engineering, along with Misuse, Error, and Physical, do not rely on the existence of “cyberstuff” and are definitely worth discussing. We will talk about these “OGs” now, beginning with the manipulation of human behavior.

There is some cause for hope in regard to phishing, as click rates from the combined results of multiple security awareness vendors are going down. As you can see in Figure 21, click rates are at 3%.

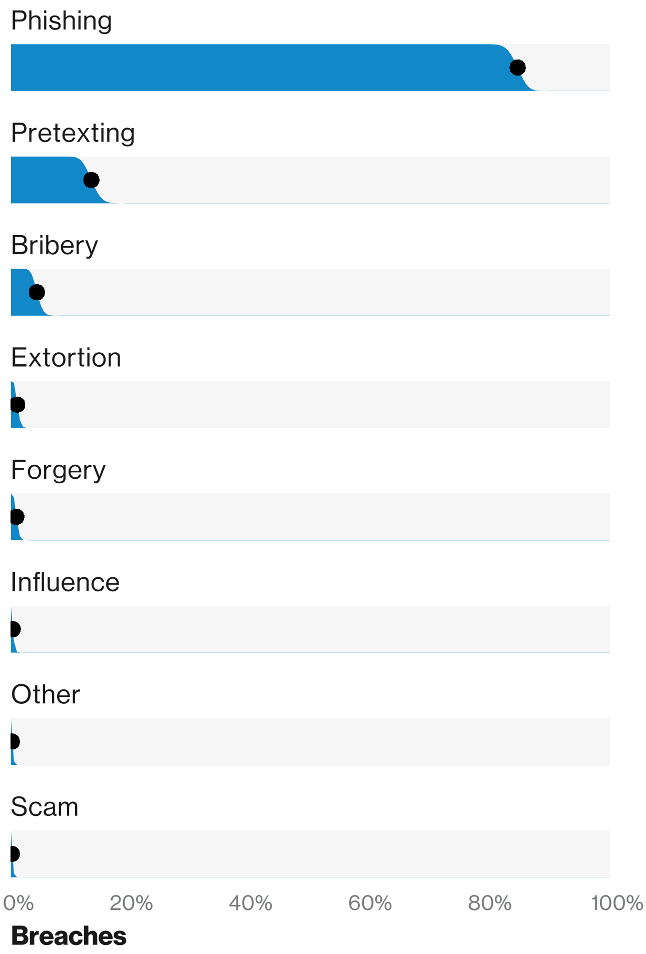


Figure 20. Top social action varieties in breaches (n=670)

With regard to the event chain for these attacks, if the device on which the communication was read and/or interacted with does not have malicious code installed as part of the phish, it may not be recorded as an affected asset. For example, if a user is tricked into visiting a phony site and he/she then enters credentials, the human asset is recorded as well as the asset that the credentials are used to access. To that end, those moments when the user's thoughts are adrift provide an excellent opportunity for criminals to phish via SMS or emails to mobile devices. This is supported by the 18% of clicks from the sanctioned phishing data that were attributed to mobile. Below is a window into mobile devices and how the way humans use them can contribute to successful phishing attacks, provided by researcher Arun Vishwanath, Chief Technologist, Avant Research Group, LLC.

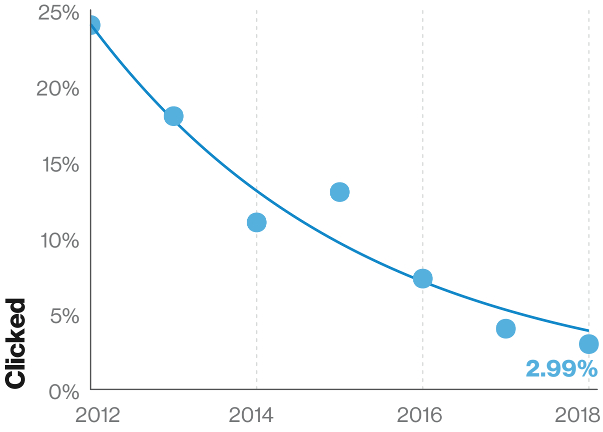


Figure 21. Click rates over time in sanctioned phishing exercises

Research points to users being significantly more susceptible to social attacks they receive on mobile devices. This is the case for email-based spear phishing, spoofing attacks that attempt to mimic legitimate webpages, as well as attacks via social media.[7, 8, 9]

The reasons for this stem from the design of mobile and how users interact with these devices. In hardware terms, mobile devices have relatively limited screen sizes that restrict what can be accessed and viewed clearly. Most smartphones also limit the ability to view multiple pages side-by-side, and navigating pages and apps necessitates toggling between them – all of which make it tedious for users to check the veracity of emails and requests while on mobile.

Mobile OS and apps also restrict the availability of information often necessary for verifying whether an email or webpage is fraudulent. For instance, many mobile browsers limit users' ability to assess the quality of a website's SSL certificate. Likewise, many mobile email apps also limit what aspects of the email header are visible and whether the email-source information is even accessible. Mobile software also enhances the prominence of GUI elements that foster action – accept, reply, send, like, and such – which make it easier for users to respond to a request. Thus, on the one hand, the hardware and software on mobile devices restrict the quality of information that is available, while on the other they make it easier for users to make snap decisions.

The final nail is driven in by how people use mobile devices. Users often interact with their mobile devices while walking, talking, driving, and doing all manner of other activities that interfere with their ability to pay careful attention to incoming information. While already cognitively constrained, on screen notifications that allow users to respond to incoming requests, often without even having to navigate back to the application from which the request emanates, further enhance the likelihood of reactively responding to requests.

Thus, the confluence of design and how users interact with mobile devices make it easier for users to make snap, often uninformed decisions – which significantly increases their susceptibility to social attacks on mobile devices.

[7] Vishwanath, A. (2016). Mobile device affordance: Explicating how smartphones influence the outcome of phishing attacks. Computers in Human Behavior, 63, 198-207.
[8] Vishwanath, A. (2017). Getting phished on social media. Decision Support Systems, 103, 70-81.
[9] Vishwanath, A., Harrison, B., & Ng, Y. J. (2018). Suspicion, cognition, and automaticity model of phishing susceptibility. Communication Research, 45(8), 1146-1166.

Misuse

Misuse is the malicious or inappropriate use of existing privileges. Often, it cannot be further defined beyond that point in this document due to a lack of granularity provided; this fact is reflected in the more generic label of Privilege abuse as the top variety in Figure 22. The motives are predominantly financial in nature, but employees taking sensitive data on the way out to provide themselves with an illegal advantage in their next endeavor are also common.

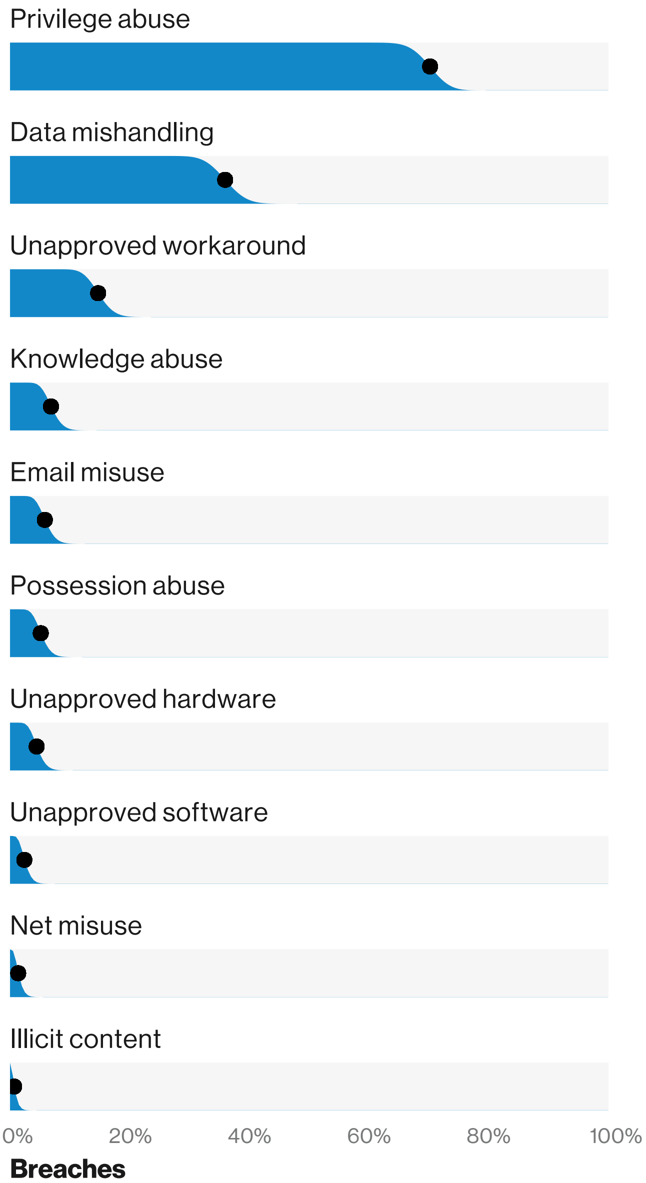


Figure 22. Top misuse varieties in breaches (n=292)

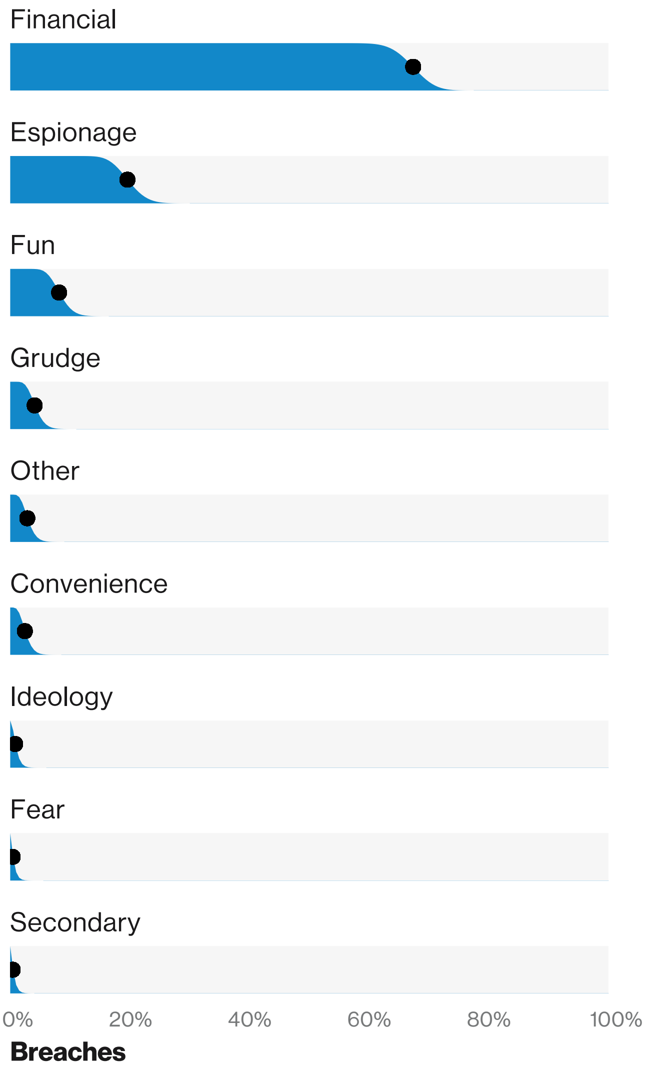


Figure 23. Actor motives in misuse breaches (n=245)

Error

As we see in Figure 24, the top two error varieties are consistent with prior publications, with Misconfiguration increasing at the expense of Loss and Disposal Errors. Sending data to the incorrect recipients (either via email or by mailed documents) is still an issue. Similarly, exposing data on a public website (publishing error) or misconfiguring an asset to allow for unwanted guests also remain prevalent.

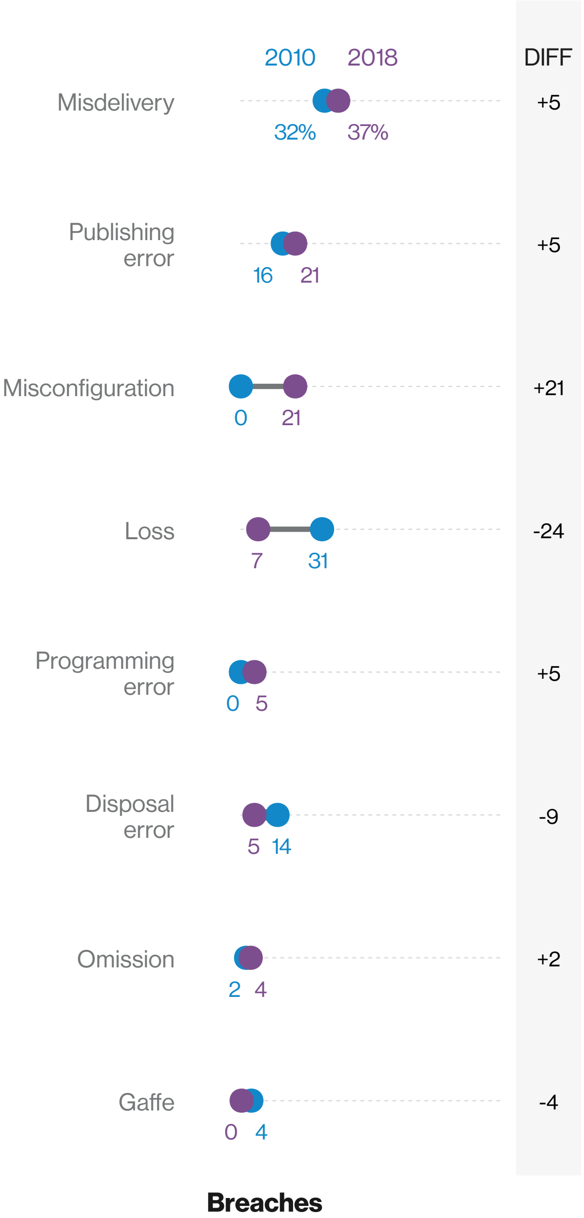


Figure 24. Top error varieties in breaches over time n=100 (2010), n=347 (2018)

Affected assets

Workstations, web applications, and surprisingly, mail servers are in the top group of assets affected in data breaches. There is a great deal to be learned about how threat actions associate with assets within the event chains of breaches. We get down to business in Table 1 to pull out some of the more interesting stories the 2019 DBIR data has to tell us.

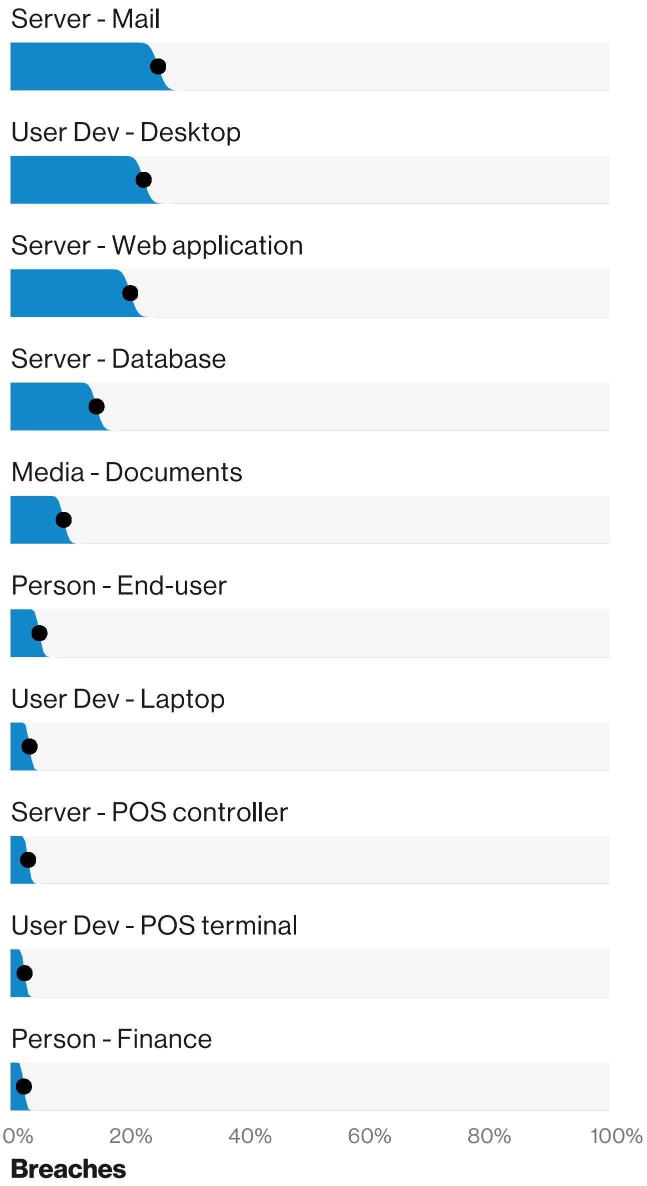


Figure 25. Top asset varieties in breaches (n=1,699)

Action	Asset	Count
Hacking - Use of stolen creds	Server - Mail	340
Social - Phishing	Server - Mail	270
Social - Phishing	User Dev - Desktop	251
Malware - Backdoor	User Dev - Desktop	229
Malware - C2	User Dev - Desktop	210
Hacking - Use of backdoor or C2	User Dev - Desktop	208
Malware - Spyware/Keylogger	User Dev - Desktop	103
Malware - Adminware	User Dev - Desktop	91
Misuse - Privilege abuse	Server - Database	90
Malware - Capture app data	Server - Web application	83

Table 1
Top action and asset variety combinations within breaches, (n= 2,013)

The table above does exclude assets where a particular variety was not known. In the majority of phishing breaches, we are not privy to the exact role of the influenced user and thus, Person - Unknown would have been present. We can deduce that phishing of Those Who Cannot Be Named leads to malware installed on desktops or tricking users into providing their credentials.

Most often, those compromised credentials were to cloud-based mail servers. There was an uptick in actors seeking these credentials to compromise a user's email account. It turns out there are several ways to leverage this newly found access. Actors can launch large phishing campaigns from the account, or if the account owner has a certain degree of clout, send more targeted and elaborate emails to employees who are authorized to pay bogus invoices.

There were also numerous cases where an organization's email accounts were compromised and the adversary inserted themselves into conversations that centered around payments. At this point, the actors are appropriately positioned to add forwarding rules in order to shut out the real account owner from the conversation. Then they simply inform the other recipients that they need to wire money to a different account on this occasion because...reasons.

Another trend in this year's data set is a marked shift away from going after payment cards via ATM/gas pump skimming or Point of Sale systems and towards e-commerce applications. The 83 breaches with the association of web application and the action of type capture application data is one indicator of this change. Figure 26 below illustrates how breaches with compromised payment cards are becoming increasingly about web servers – additional details can be found in the Retail industry section.

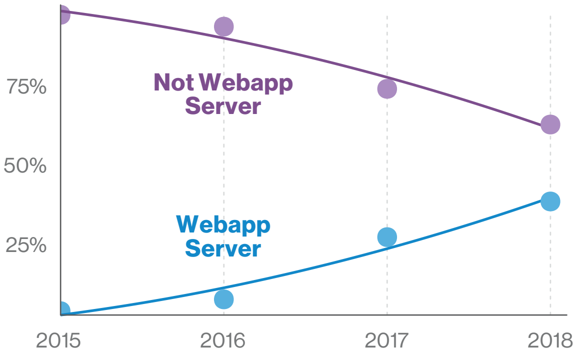


Figure 26. Webapp Server vs. Not Webapp Server assets in payment data breaches over time

Compromised data

Figure 27 details the varieties of data that were disclosed as a result of the data breaches that occurred this year. Personal information is once again prevalent. Credentials and Internal are statistically even, and are often both found in the same breach. The previously mentioned credential theft leading to the access of corporate email is a very common example.

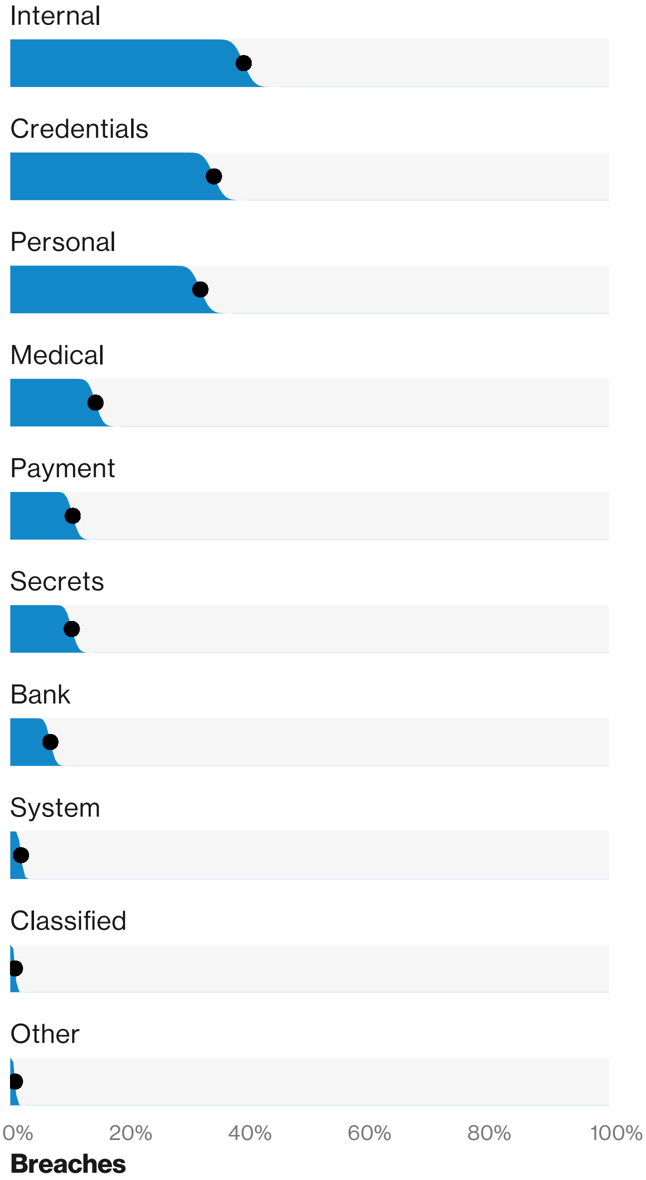


Figure 27. Top data varieties compromised in breaches (n=1,285)

Breach timeline

As we have mentioned in previous reports, when breaches are successful, the time to compromise is typically quite short. Obviously, we have no way of knowing how many resources were expended in activities such as intelligence gathering and other preparations.[10] However, the time from the attacker's first action in an event chain to the initial compromise of an asset is typically measured in minutes. Conversely, the time to discovery is more likely to be months. Discovery time is very dependent on the type of attack in question. With payment card compromises, for instance, discovery is usually based upon the fraudulent use of the stolen data (typically weeks or months), while a stolen laptop will usually be discovered much more quickly because it is relatively obvious when someone has broken the glass out of your car door and taken your computer.

Finally, it goes without saying that not being compromised in the first place is the most desirable scenario in which to find oneself. Therefore, a focus on understanding what data types you possess that are likely to be targeted, along with the correct application of controls to make that data more difficult (even with an initial device compromise) to access and exfiltrate is vital. Unfortunately, we do not have a lot of data around time to exfiltration, but improvements within your own organization in relation to both that metric along with time to discovery can result in the prevention of a high impact confirmed data breach.

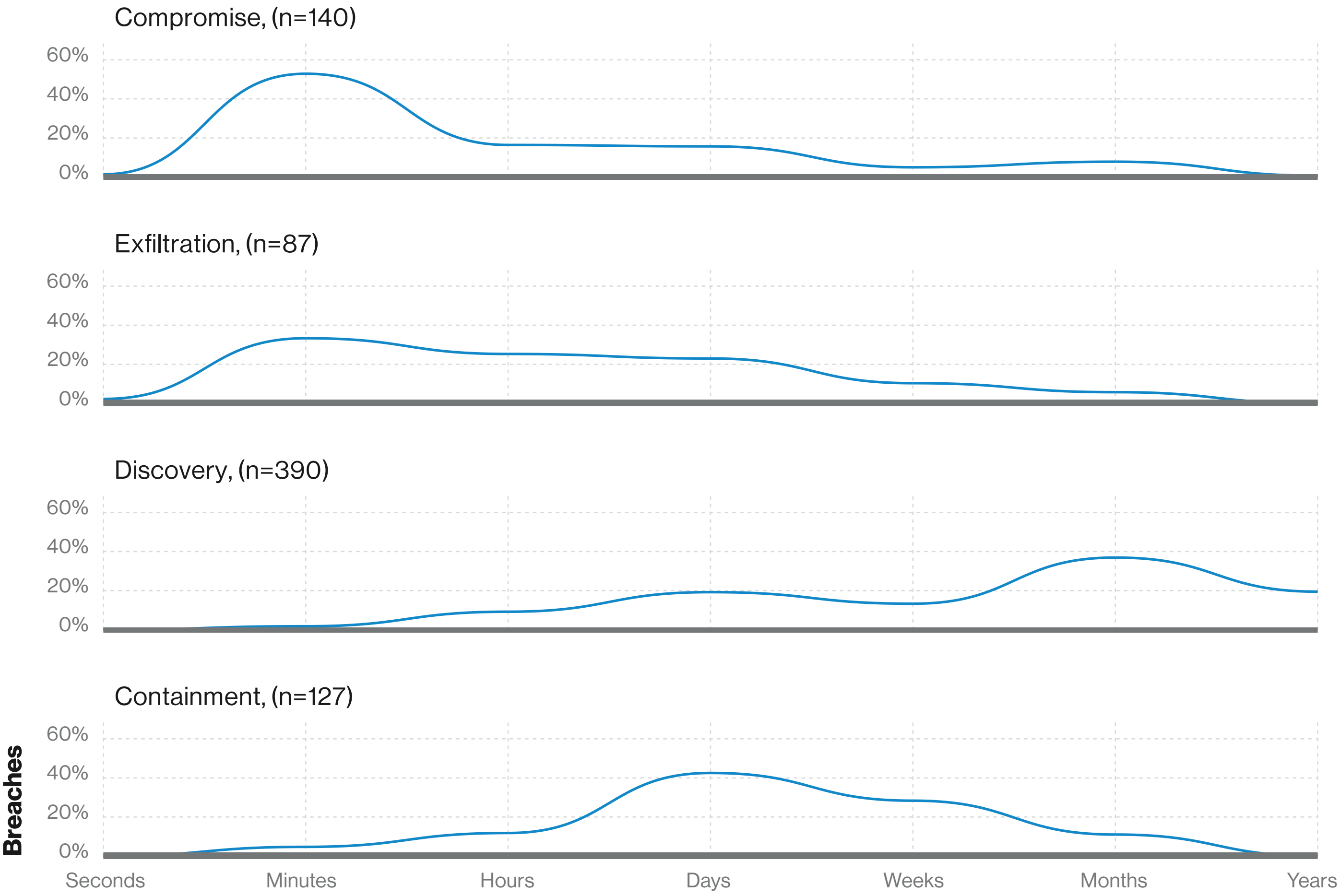


Figure 28. Breach timelines

[10] Though we are starting to look before and after the breach in the Data Breaches, Extended Version section.

Unbroken chains

While it is our belief that this section can be of interest and benefit to our readers, there are a couple of caveats that should be made clear from the beginning. First of all, we have only recently updated the VERIS schema to allow for collection of event chain data. Secondly, not all incident and breach records offer enough details to attempt to map out the path traveled by the threat actor.

We collect an action, actor, asset, and attribute at each step. However, each may be "Unknown" or omitted completely if it did not occur in that particular step of the attack. To create a single path from these factors, we begin by placing the actor at the first step at the beginning of the path. It's followed by the action and then attribute present in the step. For the remaining steps it proceeds from action to attribute to action of the next step, simply skipping over any omitted.

This calls for the old Billy Baroo.

Last year we pointed out how a golfer navigating a golf course is a lot like an adversary attacking your network.[11] The course creator builds sand traps and water hazards along the way to make life difficult. Additional steps, such as the length of grass in the rough and even the pin placement on the green can raise the stroke average for a given hole. In our world, you've put defenses and mitigations in place to deter, detect, and defend. And just like on the golf course, the attackers reach into their bag, pull out their iron, in the form of a threat action, and do everything they can to land on the attribute they want in the soft grass of the fairway.

The first thing to know is that unlike a golfer who graciously paces all the way back to the tees to take his or her first shot, your attackers won't be anywhere near as courteous. In Figure 29 we see that attack paths are much more likely to be short than long. And why not, if you're not following the rules (and which attackers do?) why hit from the tees unless you absolutely have to? Just place your ball right there on the green and tap it in for a birdie or a double eagle, as the case may be. And while your normal genteel golfer will abide (to a greater or lesser degree) by the course rules on the off chance that there is a Marshall watching and start on hole 1, threat actors will invariably take the shotgun start approach. They will begin their round on the hole they are shooting for, whether it's confidentiality, integrity, or availability.

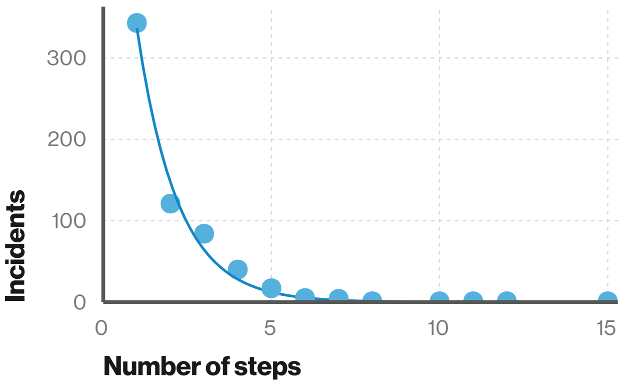


Figure 29. Number of steps per incident (n=1,285) Short attack paths are much more common than long attack paths.

"My ~~golf~~ security is so delicate, so tenuously wired together with silent inward prayers, exhortations and unstable visualizations, that the sheer pressure of an additional pair of eyes crumbles the whole rickety structure into rubble."
– John Updike, with the sympathy of some CISOs.

Figure 30 provides a look at the three holes on our InfoSec golf course. It displays the number of events and threat actions in the attack chains, by last attribute affected. There is a lot to take in, and we do want to point a few things out.

[11] We are not saying hackers have early 90's John Daly mullets. We don't have data to support that. We just imagine that they do, and that this is why they all wear hoodies in clip art.

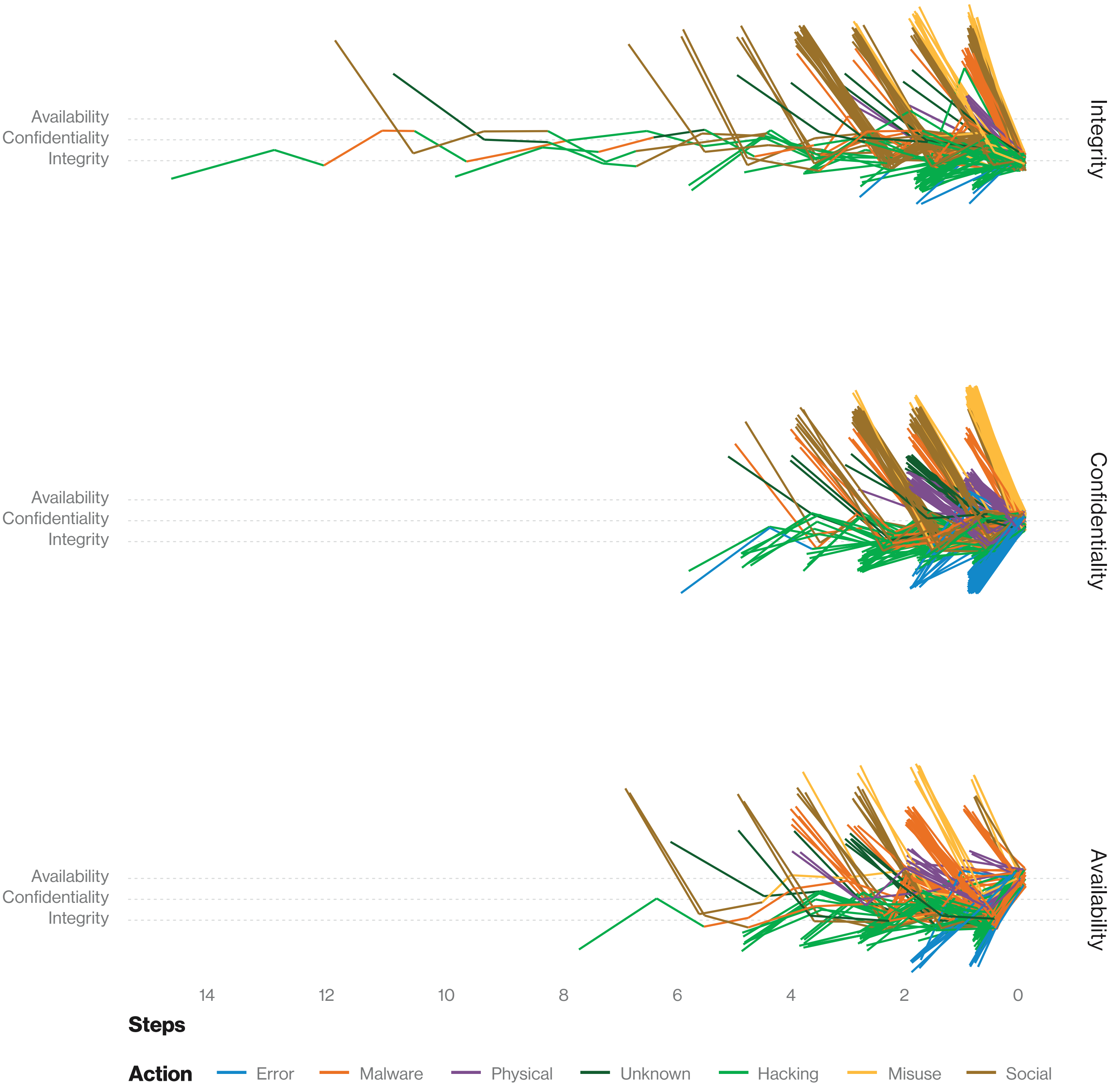


Figure 30. Attack chain by final attribute compromised[12] (n=941)

First, starting with Confidentiality, take a look at just how many short paths result from Misuse and Error, and to a lesser extent from Physical actions. On the other hand, we can see Hacking actions bounding back and forth between attributes for several steps. In Integrity we see an especially long chain beginning with Hacking and going to and fro between that and Malware as it compromises the Confidentiality and Integrity of the target.

Obviously, there's a lot going on in Figure 30. An easier way of looking at it is what actions start (Figure 31), continue (Figure 32), and end (Figure 33) incidents.

[12] There's a lot going on in this figure. Take your time and explore it. For example, notice the differences between short and long attacks.

We see that while Hacking is a little farther ahead, the first action in an incident could be almost anything. The most interesting part is that Malware is at the end of the chart, even behind Physical, which requires the attacker to be, well, physically present during the attack. Malware is usually not the driver you use to get off the tee; remember that most is delivered via social or hacking actions.

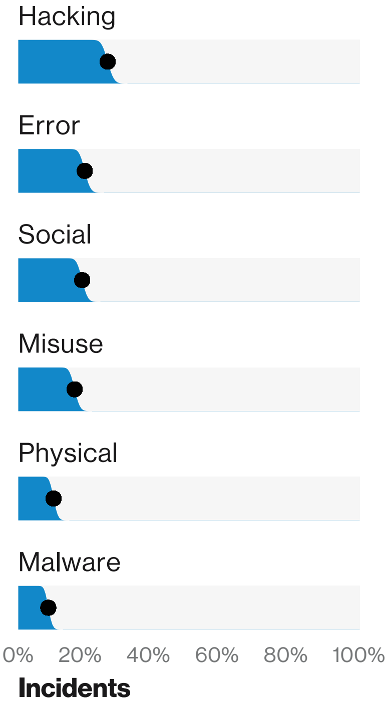


Figure 31. Actions in first step of incidents (n=909). An additional 32 incidents, (3.40% of all paths), started with an unknown action.

Moving on to Figure 32, Malware makes its grand entrance. It may not be the opening shot, but it is the trusty 7-iron (or 3-wood, pick your analogy according to your skills), that is your go-to club for those middle action shots. Interestingly, there are almost no Misuse and Physical middle actions and no Error in our data set. That's primarily because these are short attack paths and to be in the middle you have to have at least three events in the chain.

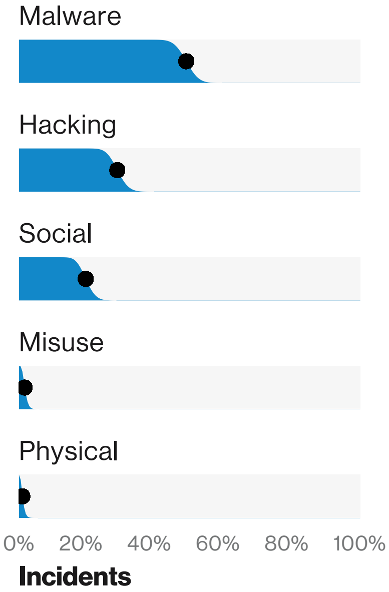


Figure 32. Actions in middle steps of incidents (n=302)

And finally, we get a chance to see where attacks end in Figure 33. The most significant part is how Social is now at the bottom. While social attacks are significant for starting and continuing attacks as seen in Figure 31, they're rarely the three-foot putt followed by the tip of the visor to the sunburned gallery.

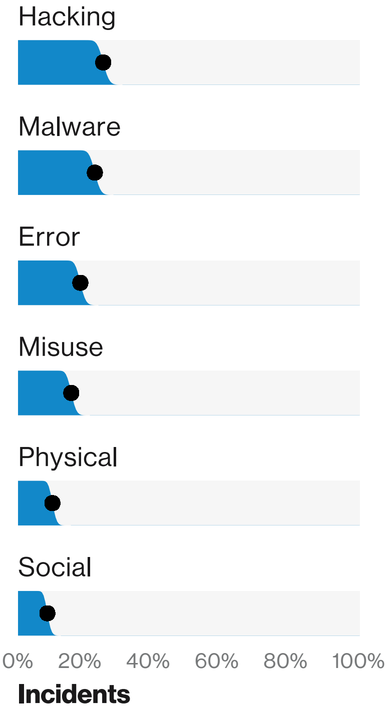


Figure 33. Actions in last step of incidents (n=942)

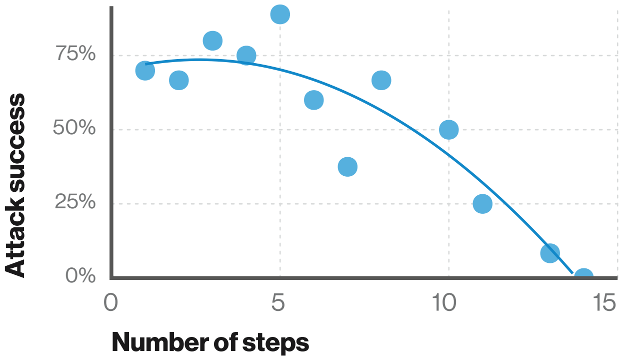


Figure 34. Attack success by chain length in simulated incidents (n=87)

At this point, you may be wondering if your sand traps are sandy enough. Figure 34 comes from breach simulation data. It shows that in testing, defenders fail to stop short paths substantially more often than long paths. So, just in case you were looking on your systems and thinking "it's the other guys that let the attackers start on the putting green," short attacks work.

Attack Paths and Mitigations

Our friends at the Center for Internet Security contributed some thoughts on mitigating attack paths:

Much of security has been founded on catalogues of controls, vague vendor promises, laborious legislation, and tomes of things to do to keep your organization safe. Within this sea of options, we also have to justify our budgets, staff, and meet the business needs of the organization. Leveraging an attack path model is not only an important step towards formalizing our understanding of attacks, but also a means to understanding our defense. Previously, when looking at attack summary data we were presented with a snapshot of an attacker's process which requires us to infer the preceding and proceeding events. Whether we realize it or not, such interpretations impact how we plan our defenses. Defending against malware takes a different approach if the malware is dropped via social engineering, a drive-by download, or brought in by an insider via a USB device.

In addition, while being faced with what seems like an endless list of potential attacks, limiting ourselves to snapshots also hinders our ability to find commonalities between these attacks. Such commonalities may be key dependencies in an attacker's process which represent opportunities for us to disrupt. The more we can understand the sequence of events happening in an attack, the more we as a community can make it harder for adversaries to reuse the same process.

Incident classification patterns and subsets

Beginning with the 2014 report, we have utilized nine basic patterns to categorize security incidents and data breaches that share several similar characteristics. This was done in an effort to communicate that the majority of incidents/breaches, even targeted, sophisticated attacks, generally share enough commonalities to categorize them, and study how often each pattern is found in a particular industry's data set. When we first identified the patterns six years ago, we reported that 92 percent of the incidents in our corpus going back 10 years could be categorized into one of the nine patterns. Fast-forwarding to today, with over 375,000 incidents and over 17,000 data breaches, the numbers reveal that 98.5% of security incidents and 88% of data breaches continue to find a home within one of the original nine patterns. So, it would appear that, as with humans, the "I can change" mantra is false here as well.

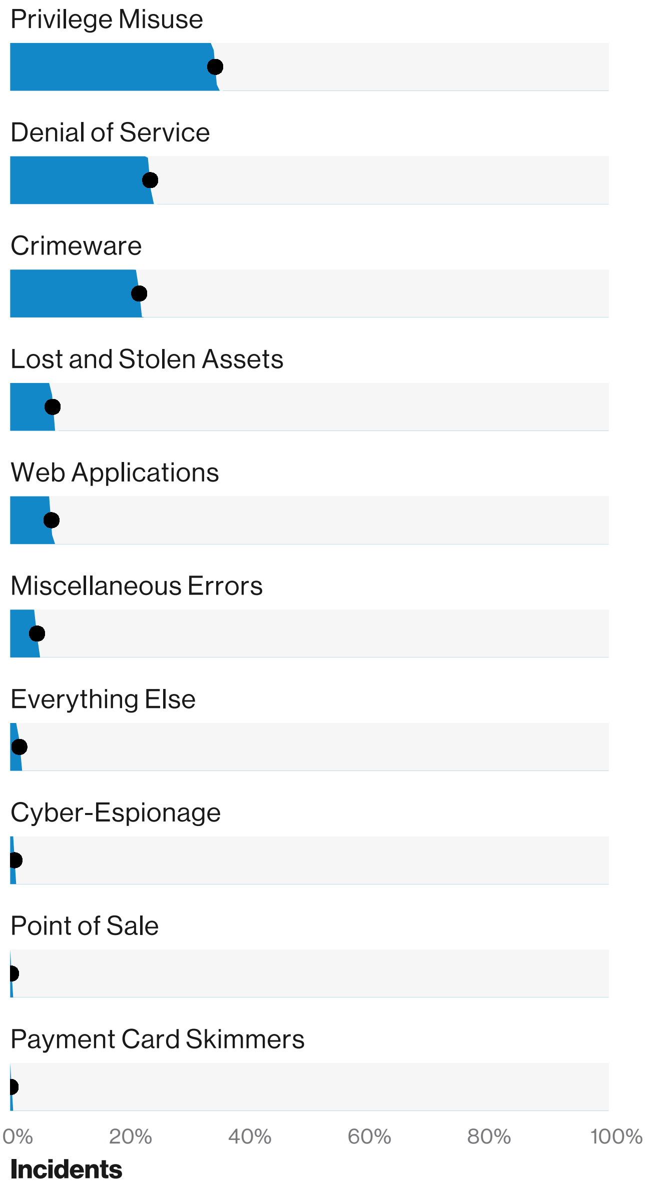


Figure 35. Incidents per pattern (n=41,686)

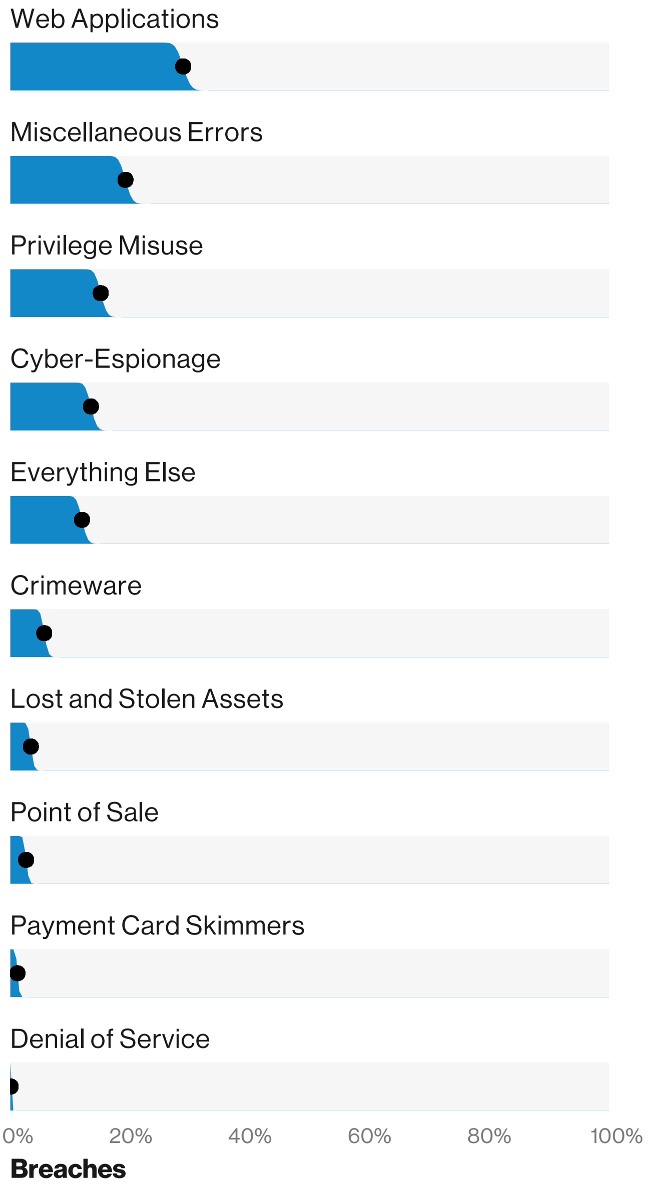


Figure 36. Breaches per pattern (n=2,013)

The patterns will be referenced more in the industry sections, but to get acquainted or rekindle a relationship, they are defined below:

Crimeware:
All instances involving malware that did not fit into a more specific pattern. The majority of incidents that comprise this pattern are opportunistic in nature and are financially motivated.

Notable findings: Command and control (C2) is the most common functionality (47%) in incidents, followed by Ransomware (28%).

Cyber-Espionage:
Incidents in this pattern include unauthorized network or system access linked to state-affiliated actors and/or exhibiting the motive of espionage.

Notable findings: Threat actors attributed to state-affiliated groups or nation-states combine to make up 96% of breaches, with former employees, competitors, and organized criminal groups representing the rest. Phishing was present in 78% of Cyber-Espionage incidents and the installation and use of backdoors and/or C2 malware was found in over 87% of incidents. Breaches involving internal actors are categorized in the Insider and Privilege Misuse pattern.

Denial of Service:
Any attack intended to compromise the availability of networks and systems. This includes both network and application attacks designed to overwhelm systems, resulting in performance degradation or interruption of service.

Notable findings: This pattern is based on the specific hacking action variety of DoS. The victims in our data set are large organizations over 99 percent of the time.

Insider and Privilege Misuse:
All incidents tagged with the action category of Misuse – any unapproved or malicious use of organizational resources – fall within this pattern.

Notable findings: This is mainly insider misuse, but former and collusive employees as well as partners are present in the data set.

Miscellaneous Errors:
Incidents in which unintentional actions directly compromised a security attribute of an asset.

Notable findings: Misdelivery of sensitive data, publishing data to unintended audiences, and misconfigured servers account for 85% of this pattern.

Payment Card Skimmers:
All incidents in which a skimming device was physically implanted (tampering) on an asset that reads magnetic stripe data from a payment card.

Notable findings: Physical tampering of ATMs and gas pumps has decreased from last year. This may be attributable to EMV and disruption of card-present fraud capabilities.

Point of Sale Intrusions:
Remote attacks against the environments where card-present retail transactions are conducted. POS terminals and POS controllers are the targeted assets. Physical tampering of PIN entry device (PED) pads or swapping out devices is covered in the Payment Card Skimmers section.

Notable findings: The Accommodation industry is still the most common victim within this pattern, although breaches were less common this year.

Physical Theft and Loss:
Any incident where an information asset went missing, whether through misplacement or malice.

Notable findings: The top two assets found in Physical Theft and Loss breaches are paper documents, and laptops. When recorded, the most common location of theft was at the victim work area, or from employee-owned vehicles.

Web Application Attacks:
Any incident in which a web application was the vector of attack. This includes exploits of code-level vulnerabilities in the application as well as thwarting authentication mechanisms.

Notable findings: Over one half of breaches in this pattern are associated with unauthorized access of cloud-based email servers.

Everything Else:
Any incident or breach that was not categorized into one of the nine aforementioned patterns.

Notable findings: Of the 241 breaches that fell into the Everything Else pattern, 28% are part of the Financially-Motivated Social Engineering attacks subset discussed later in this section.

Patterns within patterns

There are two subsets of incidents that will be called out when looking at industry breakouts. The increase in mail server (and email account) compromise and the significant dollar losses from social attacks leading to fraudulent payments provided an opportunity to create a Financially-Motivated Social Engineering (FMSE) subset that includes incidents and breaches that would fall into Web Application Attacks or Everything Else. These incidents are included in the main corpus, but we will look at them independently as well. The incidents that comprise the botnet subset are not part of the main data set, due to the sheer volume. These incidents could fall into Crimeware if modeled from the perspective of the malware recipient, or Web applications if the botnet steals credentials from one victim and is used against another organizations' application. Our data is from the latter, organizations whose systems are logged on via stolen user credentials.

Financially-Motivated Social Engineering Subset:
Financially motivated incidents that resulted in either a data breach or fraudulent transaction that featured a Social action but did not involve malware installation or employee misuse. Financial pretexting and phishing attacks (e.g., Business Email Compromise, W-2 phishing) are included in this subset.

Notable findings: 370 incidents, 248 of which are confirmed data breaches populate this subset. The incidents are split almost evenly between parent patterns of Everything Else and Web applications. The breaches are closer to a 3:1 Web Application to Everything Else ratio.

Analysis shows 6x fewer Human Resources personnel being impacted in breaches this year. This finding, as correlated with the W-2 scams, almost disappearing from our data set. While this may be due to improved awareness within organizations, our data doesn't offer any definitive answers as to what has caused the drop.

Botnet Subset:
Comprised of over 50,000 instances of customers as victims of banking Trojans or other credential-stealing malware. These are generally low on details and analyzed separately to avoid eclipsing the rest of the main analysis data set.

Notable findings: 84% of the victims were in Finance and Insurance (52), 10% in Information (51), and 5% in Professional, Scientific, and Technical Services (54). 180 countries and territories are represented in these breaches. Botnets are truly a low-effort attack that knows no boundaries and brings attackers either direct revenue through financial account compromise or infrastructure to work from.

Secondary Subset:
Comprised of 6,527 incidents of web applications used for secondary attacks such as DDoS sources or malware hosting. These are legitimate incidents, but low on details and analyzed separately from the main analysis data set.

Notable findings: Many times, these are light on specifics, but we do know that 39% of the time they involved a malware action, with 70% of those being DDoS, and 30% exploiting a vulnerability and downloading additional malware. Attackers need infrastructure too and just like with the botnet subset, when an attacker takes over your web application, your infrastructure just got converted to multi-tenant.

Data breaches: extended version

There's definitely a feeling in InfoSec that the attackers are outpacing us. They've got all the creds, the vulns, and the shells, not to mention the possibility of huge monetary incentives. We, on the other hand, have a four-year project just to replace the servers on end-of-life operating systems. However, when contemplating this unfair advantage it's sometimes easy for us to overlook the bigger picture. While it is true that attacks typically happen quickly (hours or less) when they are well aimed, and it is also true that when our organizations are successfully breached it often takes us months or more to learn of it, there is still room for optimism. In the paths section, we examined the route that attackers take to get from point A to point B. In this section, we take a look at those events that take place prior to the attack, and those required after the attack has ended in order for the attacker to realize their profit.

"Give me a place to stand and a lever long enough and I will move the world."
– Archimedes

Like all good stories, attackers need somewhere to begin, and whether this starting point is with a list of vulnerable servers, phished emails, or stolen credentials, if the proverbial lever is long enough they will breach your perimeter. Therefore, it is wise to do all that you can to reduce the number of starting points that they are provided. After all, vulns can usually be patched and creds can be better protected with multi-factor authentication. Having said that, we do realize that even the best security departments can only do so much. Sixty-two percent of breaches not involving an Error, Misuse, or Physical action (in other words, wounds that weren't self-inflicted) involved the use of stolen creds, brute force, or phishing. And all that malware doesn't write itself. Admittedly, there's not a lot you can do about the development, preparation, targeting, distribution, and other shenanigans that take place on the part of the bad guy before the breach.[13] However, what goes down after the breach is another story altogether.

Just ask the axis

Let's look at what's being stolen. In Figure 37, we illustrate the analysis of the amount lost to attackers in two types of breaches: business email compromises and computer data breaches. This loss impact data comes courtesy of the Federal Bureau of Investigation Internet Crime Complaint Center (FBI IC3), who have offered some helpful hints in the breakout at the end of this section. When looking at the visualized distribution, the first thing to notice is the spike at zero. Not all incidents and breaches result in a loss. The second piece of good news is that the median loss for a business email compromise is approximately the same as the average cost of a used car. The bad news is that the dollar axis isn't linear. There are about as many breaches resulting in the loss of between zero and the median as there are between the median and $100 million. We are no longer talking about used-car money at this point, unless you happen to be Jay Leno.

As mentioned above, there's a great deal that has to occur even after the breach takes place to make it worth the criminal's while. For example, business email compromises normally involve the fraudulent transfer of funds into an attacker-owned bank account.

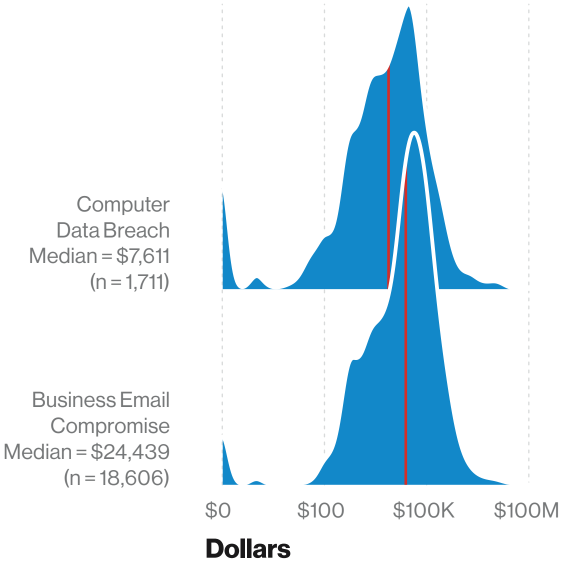


Figure 37. Amount stolen by breach type

[13] Save some large organizations that have gone after dark markets or bullet-proof hosting.

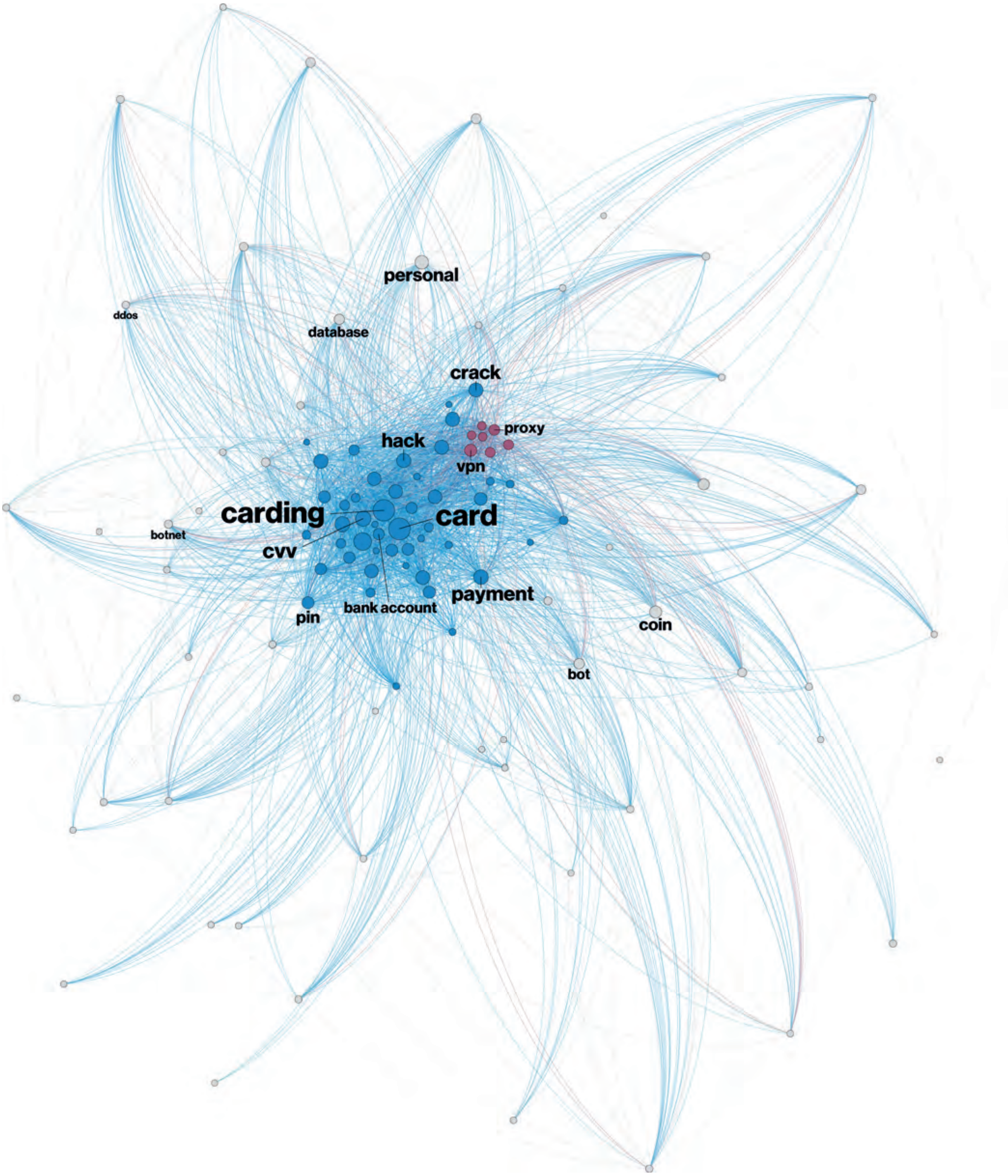


Figure 38. Term clusters in criminal forum and marketplace posts

On this front, we have more glad tidings to impart. When the IC3 Recovery Asset Team acts upon BECs, and works with the destination bank, half of all US-based business email compromises had 99% of the money recovered or frozen; and only 9% had nothing recovered. Let that sink in. BECs do not pay out as well as it initially appears, and just because the attacker won the first round doesn't mean you shouldn't keep fighting.

On the other hand, BECs are still advantageous for the criminal element because they provide a quick way to cash out. Many other types of data breaches require a little more work on the adversaries' part to convert stolen data into accessible wealth. A common solution is to sell what you stole, whether PII, email addresses, creds, credit card numbers, or access to resources you have compromised. Figure 38 provides information about the numerous things for sale in the darker corners of the internet (which surprisingly enough, resemble a 1990s video game message board). In the center we see a large blue cluster. This is comprised primarily of credit card related posts – the buying and selling of credit cards, to make money, to take money, and to cash-out gains. It also includes smaller nodes related to the attacks involved in actually stealing the cards. There's an even smaller cluster in the upper right which is related to credential theft. These may grant access to more lucrative things such as bank accounts, but many times are for consumer services including video games, streaming video, etc., that attackers use directly.

The alternative to posting this data for sale on the dark web is using the data to steal identities and committing direct fraud themselves. Herein lies the appeal of stealing tax and health related information. Filing fraudulent tax returns or insurance claims is a relatively straightforward way to put cash in one's pocket. The problem is that tax returns and insurance claims don't pay out in unmarked bills or wire transfers to South America. This requires another step in the post-breach to-do list: money laundering. Normally, money laundering is an expensive and risky task. If, for example, the money has to go through three separate sets of hands on its way to its final destination, each person needs to take their respective cut. If the third person in the succession says they did not receive it, but the first person insists they sent it, who does the actor believe? "There is no honor among thieves," etc.

This is in large part why attackers often favor cryptocurrency, as is it can be laundered and transferred for relatively low cost and presents negligible risk. However, a distinct drawback is that this type of currency is a bit limited with regard to what one can purchase with it. Thus, at some point it has to be exchanged. For these and other reasons, research into increasing both the risk and cost associated with cryptocurrency laundering and/or exchange for illicit purposes has a good deal of potential as a means of increasing breach overhead and thereby decreasing the relative profit associated with such crimes.

About the IC3

The Federal Bureau of Investigation Internet Crime Complaint Center (IC3) provides the public with a trustworthy and convenient reporting mechanism to submit information concerning suspected internet-facilitated criminal activity.

The IC3 defines the Business Email Compromise (BEC) as a sophisticated scam targeting both businesses and individuals performing wire transfer payments.

The Recovery Asset Team (RAT) is an IC3 initiative to assist in the identification and freezing of fraudulent funds related to BEC incidents.

Regardless of dollar loss, victims are encouraged and often directed by law enforcement to file a complaint online at www.ic3.gov. The IC3 RAT may be able to assist in the recovery efforts.

Victim demographics and industry analysis

Incidents:	Total	Small	Large	Unknown	Breaches: Total	Small	Large	Unknown
Accommodation (72)	87	38	9	40	61	34	7	20
Administrative (56)	90	13	23	54	17	6	6	5
Agriculture (11)	4	2	0	2	2	2	0	0
Construction (23)	31	11	13	7	11	7	3	1
Education (61)	382	24	11	347	99	14	8	77
Entertainment (71)	6,299	6	6	6,287	10	2	3	5
Finance (52)	927	50	64	813	207	26	19	162
Healthcare (62)	466	45	40	381	304	29	25	250
Information (51)	1,094	30	37	1,027	155	20	18	117
Management (55)	4	1	3	0	2	1	1	0
Manufacturing (31-33)	352	27	220	105	87	10	22	55
Mining (21)	28	3	6	19	15	2	5	8
Other Services (81)	78	14	5	59	54	6	5	43
Professional (54)	670	54	17	599	157	34	10	113
Public (92)	23,399	30	22,930	439	330	17	83	230
Real Estate (53)	22	9	5	8	14	6	3	5
Retail (44-45)	234	58	31	145	139	46	19	74
Trade (42)	34	5	16	13	16	4	8	4
Transportation (48-49)	112	6	23	83	36	3	9	24
Utilities (22)	23	3	7	13	8	2	0	6
Unknown	7,350	0	3,558	3,792	289	0	109	180
Total	41,686	429	27,024	14,233	2,013	271	363	1,379

Table 2
Number of security incidents by victim industry and organization size

The data set for this report totals over 100,000 incidents, 101,168 to be exact. After we removed the subsets that were detailed in the prior section, and applied minimum complexity filters, the data set used for core analysis is established. Table 2 is the representation of that data set broken out by industry and organization size, when known.

Our annual statement on what not to do with this breakout will now follow. Do not utilize this to judge one industry over another – so a security staffer from a construction organization waving this in the face of their peer from the financial sector and trash-talking is a big no-no.

		Incidents									Breaches								
		Accommodation (72)	Education (61)	Finance (52)	Healthcare (62)	Information (51)	Manufacturing (31-33)	Professional (54)	Public (92)	Retail (44-45)	Accommodation (72)	Education (61)	Finance (52)	Healthcare (62)	Information (51)	Manufacturing (31-33)	Professional (54)	Public (92)	Retail (44-45)
Pattern	Crimeware	17	31	52	76	206	58	60	4,758	21	3	3	7	1	3	5	8	8	3
	Web Applications	14	30	76	71	75	40	79	93	92	14	24	70	65	45	36	73	33	88
	Privilege Misuse	1	19	100	110	14	36	13	13,021	16	1	9	45	85	7	14	10	40	14
	Everything Else	7	24	29	39	23	23	59	61	14	3	20	12	27	17	8	26	37	8
	Denial of Service		226	575	3	684	163	408	992	54							1		
	Cyber-Espionage	1	6	32	3	22	16	9	143	2	1	5	22	2	20	13	8	140	2
	Miscellaneous Errors	5	37	36	104	69	14	30	1,515	12	2	35	34	97	65	12	28	58	11
	Lost and Stolen Assets	4	9	9	62	4	5	14	2,820	7	1	3	2	28	1	2	5	16	3
	Point of Sale	40			2					10	38			2					9
	Payment Card Skimmers			21		1				10			18		1				4
Action	Malware	61	50	96	85	244	88	91	4,922	90	46	16	33	7	33	26	29	153	70
	Hacking	45	279	699	100	796	233	524	1,279	162	42	42	95	78	75	58	100	205	102
	Misuse	1	19	100	110	14	36	13	13,021	16	1	9	45	85	7	14	10	40	14
	Social	18	43	88	91	38	56	100	201	15	14	38	69	78	32	42	69	173	10
	Error	5	40	38	124	72	16	37	4,317	15	2	37	36	110	67	13	31	66	14
	Physical	5	6	32	47	5	4	8	20	16	2	1	18	17	2	2	3	9	6
Asset	User Dev	40	45	69	71	41	62	58	3,009	30	33	32	38	29	19	26	29	165	16
	Server	68	324	722	225	874	259	559	1,244	184	55	60	117	165	133	64	111	131	118
	Person	18	45	90	93	38	58	104	201	15	14	40	70	80	32	44	73	173	10
	Network		2	1	3	1	1	4	3	1		1	1		1	1	2	1	1
	Media	1	10	16	98	2	2	20	777	8	1	6	13	79	2	2	14	31	7
	Kiosk/Term			24	1	1	1			9			17	1	1				4

0% 25% 50% 75% 100%

Figure 39. Industry Comparison
(left: all security incidents, right: only breaches)

Our community of contributors, disclosure requirements, and the population sizes for the industries all play a major part in the numbers above. The actual threat landscapes for organizations are better depicted in Figure 39. This shows what types of attack patterns are more common to your industry, along with breakouts for threat action categories and affected assets. We will explore deeper into the breach jungle, machete in hand, in the individual industry sections.

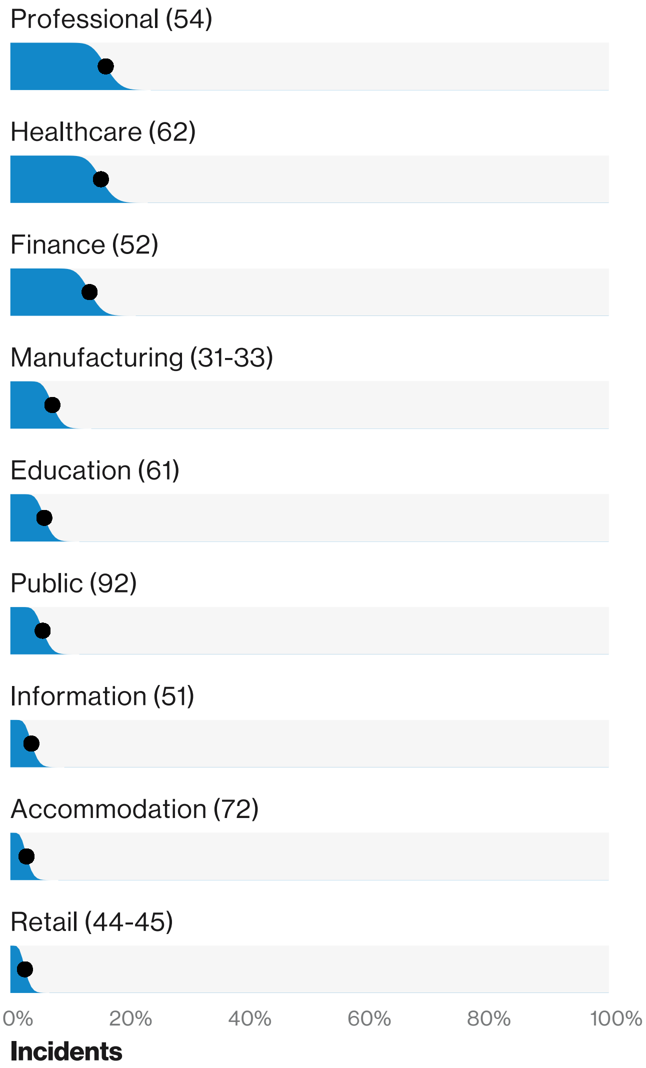


Figure 40. FMSE incidents by industry (n=370)

Before you flip/scroll over to your industry section, we have aligned several non-incident data sources to industry that are worth your while to peruse first.

As we break down industries we see, for example, in Figure 40 how FMSE incidents disproportionately affect Professional Services, Healthcare and Finance, while more point of sale-centric industries appear towards the bottom of the list. However, it's clear that FMSE incidents affect all industries, so all organizations need to be trained and prepared to prevent them.

Phishing

Figure 41 ranks the click rates per industry for sanctioned security awareness training exercises. This data was provided by several vendors in this space, and merged together for analysis. While we realize we were relatively strict earlier about curtailing trash talk on the above Table, feel free to use this for some good-natured banter on an as-needed basis. Just be sure to keep it at an appropriate level. "Not looking so hot anymore for someone who works outside, Construction" is approximately the correct amount of snark (trust us, we are experts). On a positive note, all industries are clocking in with percentages that are less than the overall percentage in this study 2 years ago. So, this calls for much rejoicing.

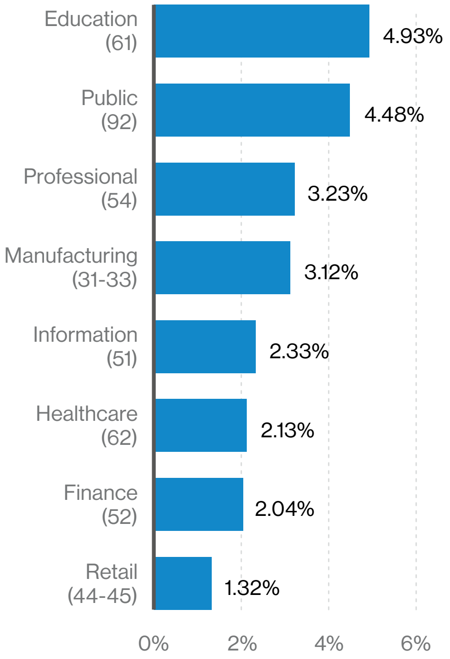


Figure 41. Click rate in phishing tests by industry

Denial of Service

Over time DDoS attacks have been getting much more tightly clumped with regard to size (similar to Manufacturing in Figure 42). However, as other industries illustrate, that is not always the case. Some industries, Information for instance, experience attacks across a much wider range. Another important takeaway is that the median DDoS doesn't change much from industry to industry. The difference between the biggest and smallest industry median is 800Mbps and 400Kpps.

What's your vector, Victor?

Figure 43 takes a look at the median percentage of malware vectors and file types per industry; in other words, it helps you know where to look for the malware that's coming in to your organization and what it will most likely look like. First of all, the majority of initial malware is delivered by email. Secondary infections are downloaded by the initial malware, or directly installed and, as such, are more difficult for network tools to spot. Secondly, though it varies a bit by industry, Office documents and Windows applications are the most common vehicles for the malware along with "Other" (archives, PDFs, DLLs, links, and Flash/iOS/Apple/Linux/Android apps).

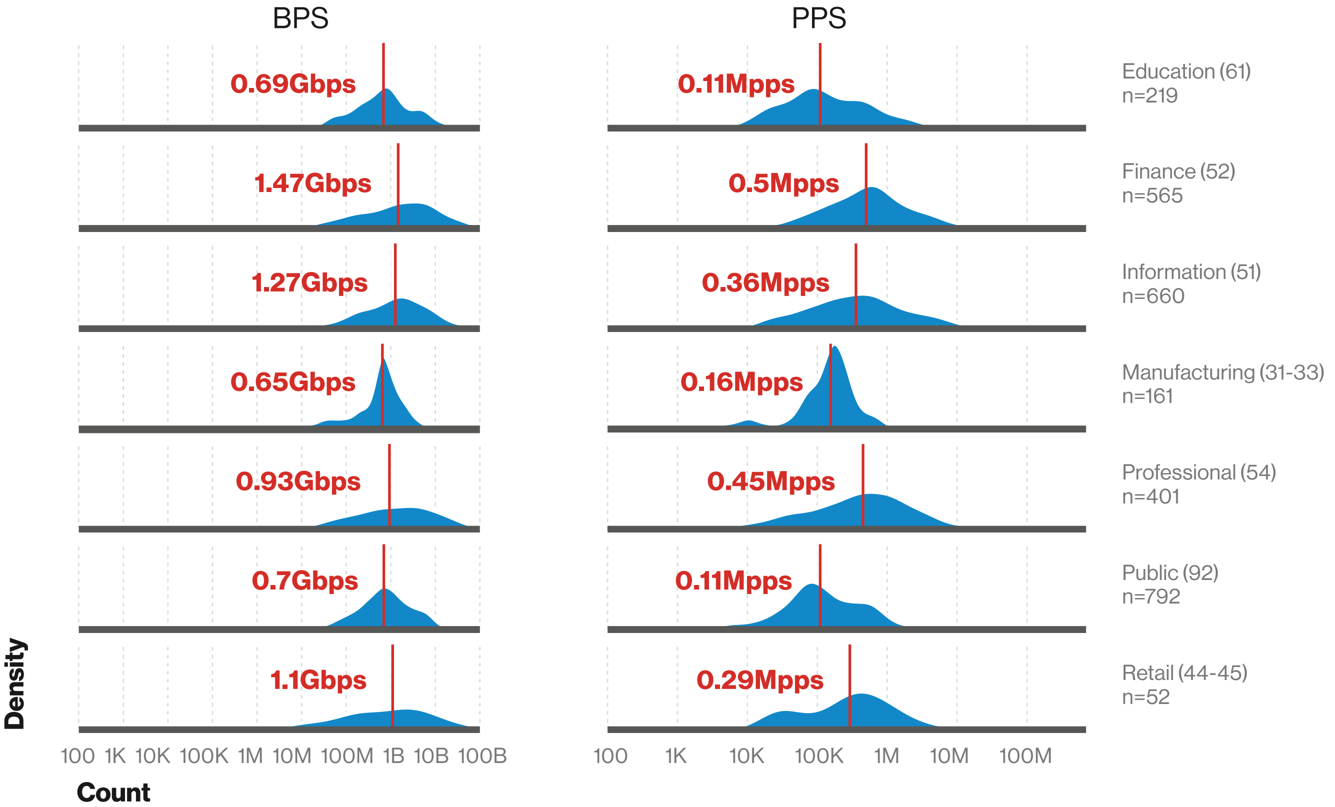
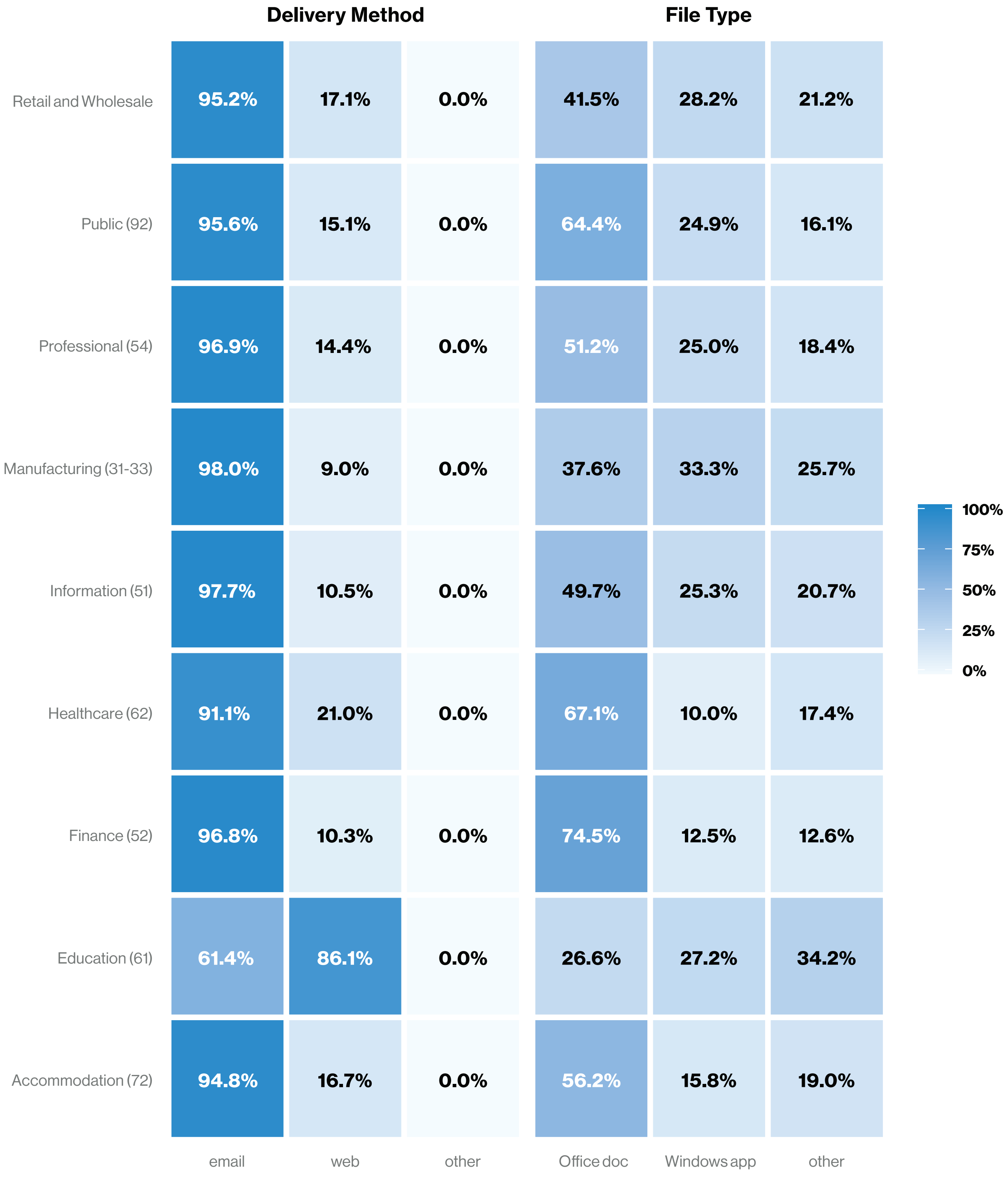


Figure 42. DDoS attack bandwidth and packet counts by industry



	Delivery Method			File Type		
	email	web	other	Office doc	Windows app	other
Retail and Wholesale	95.2%	17.1%	0.0%	41.5%	28.2%	21.2%
Public (92)	95.6%	15.1%	0.0%	64.4%	24.9%	16.1%
Professional (54)	96.9%	14.4%	0.0%	51.2%	25.0%	18.4%
Manufacturing (31-33)	98.0%	9.0%	0.0%	37.6%	33.3%	25.7%
Information (51)	97.7%	10.5%	0.0%	49.7%	25.3%	20.7%
Healthcare (62)	91.1%	21.0%	0.0%	67.1%	10.0%	17.4%
Finance (52)	96.8%	10.3%	0.0%	74.5%	12.5%	12.6%
Education (61)	61.4%	86.1%	0.0%	26.6%	27.2%	34.2%
Accommodation (72)	94.8%	16.7%	0.0%	56.2%	15.8%	19.0%

Figure 43. Malware types and delivery methods by industry

Accommodation and Food Services

The breach totals in our data set have decreased from last year, primarily due to a lack of POS vendor incidents that have led to numerous organizations being compromised with stolen partner credentials.

Frequency	87 incidents, 61 with confirmed data disclosure
Top 3 patterns	Point of Sale intrusions, Web applications and Crimeware patterns represent 93% of all data breaches within Accommodation
Threat actors	External (95%), Internal (5%) (breaches)
Actor motives	Financial (100%) (breaches)
Data compromised	Payment (77%), Credentials (25%), Internal (19%) (breaches)

How can we be of service?

The Accommodation industry prides itself on hospitality, and over the years it has been far too hospitable to criminals. Financially motivated actors are bringing home the bacon by compromising the Point of Sale (POS) environments and collecting customers' payment card data. Table 3 lists the 10 most common combinations of threat action varieties and assets. These are pairings that are found in the same breach, but not necessarily the same event or step in the breach.

As stated above, some of these combinations are indicative of a specific action taken against a specific asset (e.g., RAM Scraping malware infecting a POS terminal). Others show that some actions are conducted earlier or later in event chains that feature a particular asset – you don't phish a laptop, but you may phish a human and install malware on his/her laptop in the next step. In brief, the game has not changed for this industry. POS Controllers are compromised and malware specifically designed to capture payment card data in memory is installed and extended to connected POS Terminals. While these POS intrusions are often a small business issue, large hotel and restaurant chains can learn from this data and, if they use a franchise business model, disseminate this knowledge to their franchisees.

The RAM scrapers may be the specialty of the house, but malware does not spontaneously appear on systems. When the infection vector is known, it is typically a direct installation after the actors use stolen, guessable, or default credentials to gain access into the POS environment.

A cause for optimism?

While attacks against POS environments make up the vast majority of incidents against Accommodation and Food Service organizations, the number has decreased from 307 in last year's report to 40 in this report. Sounds pretty dope so far, but we do not use number of breaches as a solid indicator of "better" or "worse" as there are not only changes in our contributors, but also changes in the types of events our contributors may focus on year over year. Even with such a drastic change, it isn't unprecedented. Figure 44 shows the volatility of breach counts of this ilk. POS breaches are often conducted by organized criminal groups looking to breach numerous targets and there have been sprees of hundreds of victims associated with the same hacking group. Back in 2011, default credentials were used with great success, evidenced by over 400 breaches, and recent sprees have been associated with POS vendors suffering breaches leading to subsequent breaches of their customer base.

Action	Asset	Count
Malware - RAM scraper	Server - POS controller	32
Malware - RAM scraper	User Dev - POS terminal	27
Hacking - Use of stolen creds	Server - Mail	8
Social - Phishing	Server - Mail	8
Hacking - Use of stolen creds	Server - POS controller	7
Hacking - Use of stolen creds	User Dev - POS terminal	7
Malware - Backdoor	Server - POS controller	6
Malware - Backdoor	User Dev - POS terminal	6
Hacking - Brute force	Server - POS controller	5
Hacking - Brute force	User Dev - POS terminal	3

Table 3
Top threat action and asset pairings within Accommodation breaches (n= 61)

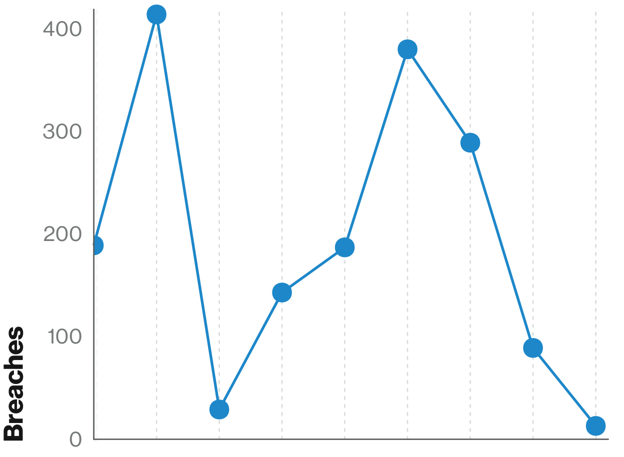


Figure 44. POS intrusions in Accommodation breaches over time

The absence of a large spree in this year's data set is reflected in the drop, but (and it seems like there is always a "but") after our window for data closed and during this writing there has already been a publicly disclosed POS vendor breach affecting multiple food service victims.[14] So, let this be the first ever sneak peek into the 2020 DBIR – POS attacks are not quite an endangered species.

And speaking of delivering bad news

Accommodation data breach victims are informed of their plight the majority of the time via Common Point of Purchase alerts as shown in Figure 45. In fact, 100 percent of POS intrusions in this industry were discovered via external methods. This is a clear indicator that while there is work to be done on preventative controls around POS compromise, there is equal room for improvement in detecting compromise. Being a realist and understanding that many of these victims are "mom and pop" operations asking for sophisticated file integrity software or DLP is not a feasible plan of action for many of these organizations. Working with POS vendors to ensure that someone knows when the environment is accessed via existing remote access methods is a start. A pragmatic process to inform the business owners that legitimate work is being done by the partner would certainly be another simple step up from the current state of affairs.

[14] https://ncbpdataevent.com/

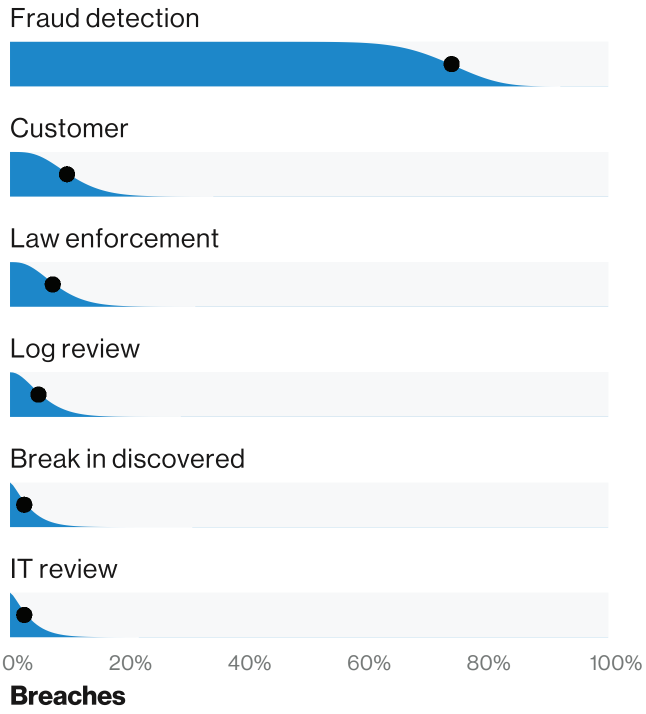


Figure 45. Discovery methods in Accommodation breaches (n=42)

Things to consider:

No vacancy
The numbers from annual breach totals are influenced by smaller food service businesses caught up in what we have described as POS smash-and-grabs. Whether leveraging default credentials or stolen credentials, organized criminal groups often go after numerous little fish – but not always. Several international hotel chains and restaurants have also been hit. While the initial intrusion method may not have been as easy as scanning the internet and issuing a default password, there are some lessons to be learned. Static authentication is circumvented using valid credentials and what follows is installation of RAM scraping malware and adminware such as psexec or PowerShell to facilitate the spread of malware across multiple terminals in multiple locations.

Cover your assets
The data shows year-over-year that there is a malware problem affecting POS controllers and terminals. Implement anti-malware defenses across these environments and validate (and re–validate) the breadth of implementation and currency of controls. Focus on detective controls as well, the external correlation of fraudulent usage of payment cards should not be the sole means of finding out that malware has been introduced into your POS environment. Restrict remote access to POS servers and balance the business needs of interconnectivity between POS systems among your locations with defending against the potential spread of malware from the initial location compromised.

Sleep with one eye open
Since you can't build a perfectly secure system, security operations helps monitor for those weird logins in the middle of the night. If you can justify it in your budget, a security operations team is a must. Even if you can't afford an in-house team, contracting it as a service or requiring it to be a part of your POS or IT contracts will cover you and allow you to benefit from economies of scale.

Chips and Dip
When a chip-enabled card is dipped in a properly configured EMV-enabled POS terminal, the static, reusable magnetic strip information (PAN) is not exposed or stored. This is a good thing and along with contactless payment methods, disrupts the old way of stealing things for the bad guys. The attacks against EMV technology are more theoretical and/or not conducive to real-world use. We know that cyber-criminals are a crafty bunch and nothing is bulletproof, but continue to embrace and implement new technologies that raise the bar to protect against payment card fraud.

Educational Services

Education continues to be plagued by errors, social engineering and inadequately secured email credentials. With regard to incidents, DoS attacks account for over half of all incidents in Education.

Frequency	382 incidents, 99 with confirmed data disclosure
Top 3 patterns	Miscellaneous Errors, Web Application Attacks, and Everything Else represent 80% of breaches
Threat actors	External (57%), Internal (45%), Multiple parties (2%) (breaches)
Actor motives	Financial (80%), Espionage (11%), Fun (4%), Grudge (2%), Ideology (2%) (breaches)
Data compromised	Personal (55%), Credentials (53%), and Internal (35%) (breaches)

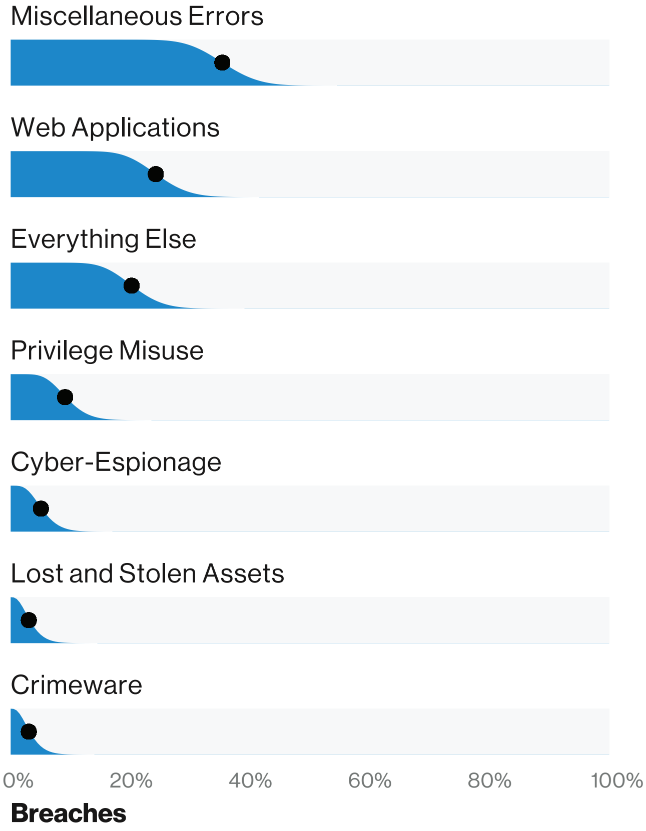


Figure 46. Patterns within Education breaches (n=99)

It's in the syllabus

Anticipating the top pattern for Education each year is a bit like playing the "which shell is it under?" game. You know it's (most likely) under one of three shells, but when you finally point to one, the data proves you wrong with a deft statistical sleight of hand. There were three patterns in a statistical dead heat, and like the Netherlands' women speed skaters in the 3000m, it was a dominant podium sweep. Miscellaneous Errors (35%) had a strong showing, because (spoiler alert) people still have their moments. Most of these errors are of the typical misdelivery and publishing error types that we have all come to know and love.

Web Application Attacks accounted for roughly one quarter of breaches in the Education vertical. This is mostly due to the frequent compromise of cloud-based mail services via phishing links to phony login pages. So, if you use such a service 24/7/...365 you might want to consider tightening up your password security implementing a second authentication factor, and then turning off IMAP.

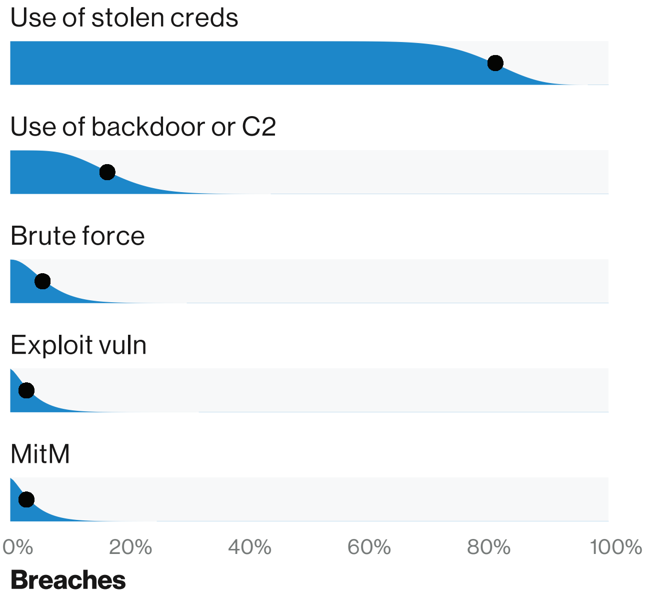


Figure 47. Hacking varieties in Education breaches (n=37)

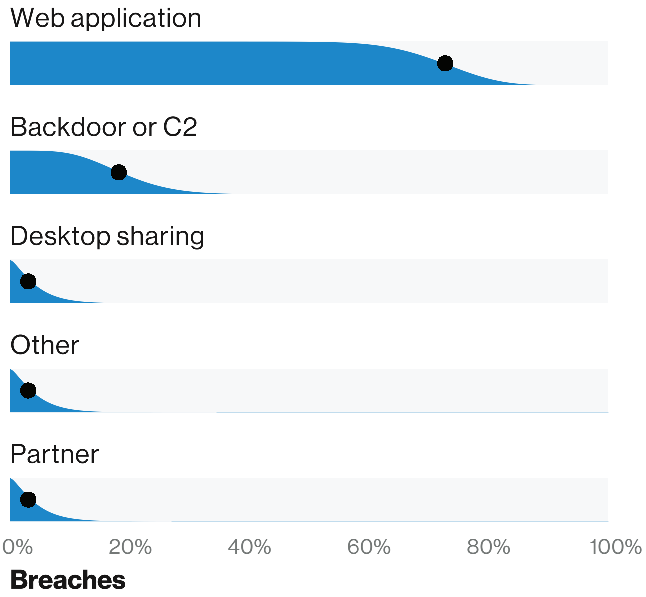


Figure 48. Hacking vectors in Education breaches (n=33)

Everything Else, as previously stated, is more or less the pattern equivalent of a “lost and found” bin. It contains numerous incident types we frequently encounter but that do not provide enough granularity for us to place in one of the other patterns. For example, there are compromised mail servers, but it was undetermined if stolen web credentials were the point of entry. About half or more of these breaches could be attributed to social engineering attacks via phishing.

When known, the motivation is primarily financial, and is carried out mostly by organized criminal groups. There was a smattering of state-affiliated or cyber-espionage cases in this year’s data set, a reduction from the 2017 report as shown in Figure 49. This finding should not convince our readers that attacks seeking research findings and other espionage-related goals have gone the way of Home Economics in this vertical, but is instead more related to the number and type of incidents provided by our partners.

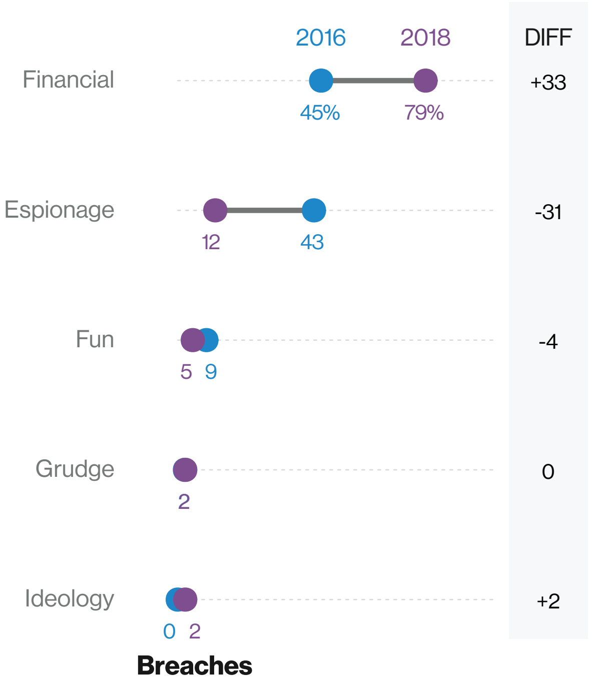


Figure 49. External motives in Education breaches over time n=44 (2016), n=42 (2018) (Secondary motives excluded)

Things to consider:

Clean out your lockers
Many of the breaches that are represented in this industry are a result of poor security hygiene and a lack of attention to detail. Clean up human error to the best extent possible – then establish a baseline level of security around internet-facing assets like web servers. And in 2019, 2FA on those servers is baseline security.

Varsity or JV?
Universities that partner with private Silicon Valley companies, run policy institutes or research centers are probably more likely to be a target of cyber-espionage than secondary school districts. Understand what data you have and the type of adversary who historically seeks it. Your institution of learning may not be researching bleeding-edge tech, but you have PII on students and faculty at the very least.

Security conformity
There are threats that (no matter how individualized one may feel) everyone still has to contend with. Phishing and general email security, Ransomware, and DoS are all potential issues that should be threat modeled and addressed. These topics may not seem new, but we still have not learned our lesson.

Financial and Insurance

Denial of Service and use of stolen credentials on banking applications remain common. Compromised email accounts become evident once those attacked are filtered. ATM Skimming continues to decline.

Frequency	927 incidents, 207 with confirmed data disclosure
Top 3 patterns	Web Applications, Privilege Misuse, and Miscellaneous Errors represent 72% of breaches
Threat actors	External (72%), Internal (36%), Multiple parties (10%), Partner (2%) (breaches)
Actor motives	Financial (88%), Espionage (10%) (breaches)
Data compromised	Personal (43%), Credentials (38%), Internal (38%) (breaches)

Filters are not just for social media photos

We use filters in data analysis to focus on particular industries or threat actors and to pull out interesting topics to discuss. We also exclude certain subsets of data in order to reduce skew and avoid overlooking other trends and findings. This is not to say that we ignore or deny their existence, but rather we analyze them independently in other sections of this study. In this industry, we acknowledge, but filter, customer credential theft via banking Trojan botnets. Their numbers in this year's data set show that they are not inconsequential matters, over 40,000 breaches associated with botnets were separately analyzed for the financial sector. We discuss both of these scenarios in more depth in the Results and Analysis section, but there is not much to say that has not already been said on the subjects. Below is what's left and we will start with the common pairings of action and asset varieties.

Keep in mind that breaches are often more than one event, and sometimes more than one of the combinations above are found in the same breach.

I'd rather be phishing

When we look at the two pairings that share mail servers as an affected asset in Table 4, we can see a story developing. Adversaries are utilizing social engineering tactics on users and tricking them into providing their web-based email creds. That is followed by the use of those stolen credentials to access the mail account. There are also breaches where the method of mail server compromise was not known, but the account was known to have been used to send phishing emails to colleagues. So, while the specific action of phishing is directed at a human (as, by definition, social attacks are), it often precedes or follows a mail server compromise. And there is no law that states that phishing cannot both precede and follow the access into the mail account (there are laws against phishing, however). Phishing is also a great way to deliver malicious payloads.

End of an era?

Physical attacks against ATMs have seen a decline from their heyday of the early 2010s. We are hopeful that the progress made in the implementation of EMV chips in debit cards, influenced by the liability shift to ATM owners, is one reason for this decline. ATM jackpotting is certainly an interesting way to make a buck, but is not a widespread phenomenon. Figure 50 highlights the drop in Payment card data compromise from last year's report.

While payment card breaches are declining, personal data is showing the largest gain from the 2018 report. Focusing on financial breaches where personal data was compromised, social attacks (Everything Else), misdelivery of data and misconfigurations (Miscellaneous Errors), Web Applications and Privilege Misuse are behind over 85 percent.

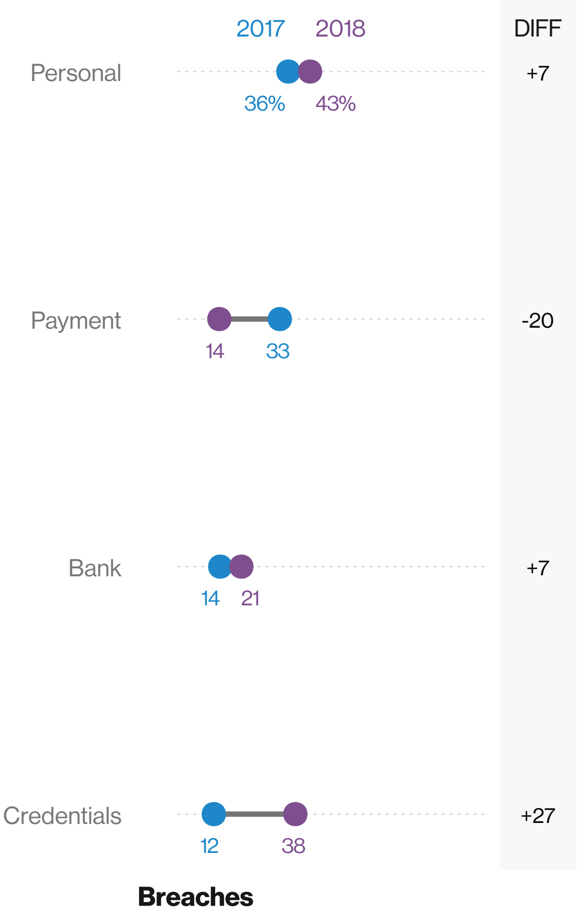


Figure 50. Select data varieties in Financial breaches over time n=144 (2017), n=125 (2018)

Action	Asset	Count
Hacking - Use of stolen creds	Server - Mail	43
Social - Phishing	Server - Mail	41
Hacking - Use of backdoor or C2	User Dev - Desktop	17
Malware - C2	User Dev - Desktop	16
Physical - Skimmer	Kiosk/Term - ATM	16
Misuse - Privilege abuse	Server - Database	14
Hacking - Use of stolen creds	Server - Web application	10
Social - Phishing	User Dev - Desktop	10
Error - Misdelivery	User Dev - Desktop	9
Malware - Backdoor	User Dev - Desktop	9

Table 4
Top combinations of threat actions and assets, (n= 207)

Things to consider:

Do your part
2FA everything. Use strong authentication on your customer-facing applications, any remote access, and any cloud-based email. Contrarians will be quick to point out examples of second authentication factors being compromised, but that does not excuse a lack of implementation.

Squish the phish
There is little that financial organizations can do to ensure that their customers are running up-to-date malware defenses or make them “phish-proof,” but spreading a little security awareness their way can’t hurt. And speaking of security awareness, leverage it to keep employees on their toes when interacting with emails.

Inside job
There were 45 confirmed breaches associated with misuse of privileges. The details were light on most of these but tried and true controls are still relevant. Monitor and log access to sensitive financial data (which we think you are already), and make it quite clear to staff that it is being done and just how good you are at recognizing fraudulent transactions. In other words, “Misuse doesn’t pay.”

Healthcare

Healthcare stands out due to the majority of breaches being associated with internal actors. Denial of Service attacks are infrequent, but availability issues arise in the form of ransomware.

Frequency	466 incidents, 304 with confirmed data disclosure
Top 3 patterns	Miscellaneous Errors, Privilege Misuse and Web Applications represent 81% of incidents within Healthcare
Threat actors	Internal (59%), External (42%), Partner (4%), and Multiple parties (3%) (breaches)
Actor motives	Financial (83%), Fun (6%), Convenience (3%), Grudge (3%), and Espionage (2%) (breaches)
Data compromised	Medical (72%), Personal (34%), Credentials (25%) (breaches)

The doctor can't see you now (that you work for them)

Most people do not enjoy going to the hospital, but once it becomes unavoidable we all need to believe fervently that the good women and men who are providing us care are just this side of perfect. Spoiler alert: they are not. Healthcare is not only fast paced and stressful, it is also a heavily-regulated industry. Those who work in this vertical need to do things right, do things fast, and remain in compliance with legislation such as HIPAA and HITECH (in the US). That in itself is a pretty tall order, but when one combines that with the fact that the most common threat actors in this industry are internal to the organization, it can paint a rather challenging picture.

With internal actors, the main problem is that they have already been granted access to your systems in order to do their jobs. One of the top pairings in Table 5 between actions and assets for Healthcare was privilege abuse (by internal actors) against databases. Effectively monitoring and flagging unusual and/or inappropriate access to data that is not necessary for valid business use or required for patient care is a matter of real concern for this vertical. Across all industries, internal actor breaches have been more difficult to detect, more often taking years to detect than do those breaches involving external actors.

Mailing it in

The Healthcare industry has a multifaceted problem with mail, in both electronic and printed form. The industry is not immune to the same illnesses we see in other verticals such as the very common scenario of phishing emails sent to dupe users into clicking and entering their email credentials on a phony site. The freshly stolen login information is then used to access the user's cloud-based mail account, and any patient data that is chilling in the Inbox, or Sent Items, or other folder for that matter is considered compromised – and its disclosure time.

Misdelivery, sending data to the wrong recipient, is another common threat action variety that plagues the Healthcare industry. It is the most common error type that leads to data breaches as shown in Figure 51. As seen in Table 5 on the next page, documents are a commonly compromised asset. This could be due to errors in mailing paperwork to the patient's home address or by issuance of discharge papers or other medical records to the wrong recipient.

Ransomware "breaches"

Most ransomware incidents are not defined as breaches in this study due to their lack of the required confirmation of data loss. Unfortunately for them, Healthcare organizations are required to disclose ransomware attacks as though they were confirmed breaches due to U.S. regulatory requirements. This compulsory action will influence the number of ransomware incidents associated with the Healthcare sector. Acknowledging the bias, this is the second straight year that ransomware incidents were over 70 percent of all malware outbreaks in this vertical.

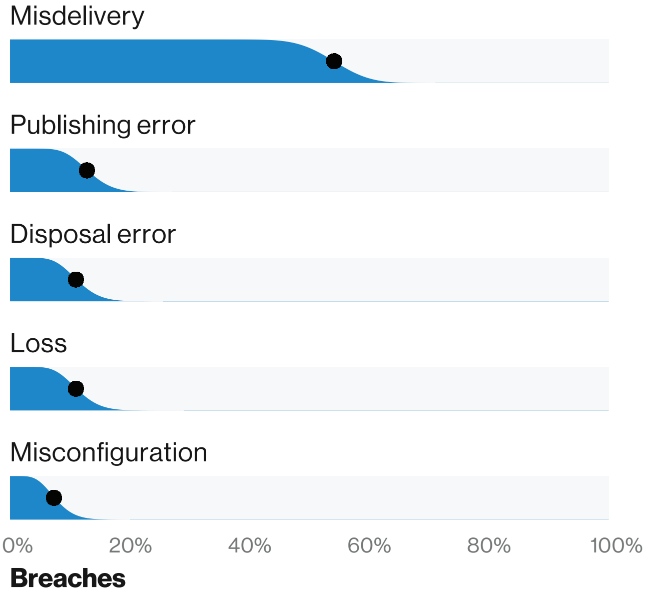


Figure 51. Top error varieties in Healthcare breaches (n=109)

Things to consider:

Easy access
Know where your major data stores are, limit necessary access, and track all access attempts. Start with monitoring the users who have a lot of access that might not be necessary to perform their jobs, and make a goal of finding any unnecessary lookups.

Snitches don't get stitches
Work on improving phishing reporting to more quickly respond to early clickers and prevent late clickers. Think about reward-based motivation if you can – you catch more flies with honey. And you can catch phish with flies. Coincidence?

Perfectly imperfect
Know which processes deliver, publish or dispose of personal or medical information and ensure they include checks so that one mistake doesn't equate to one breach.

Action	Asset	Count
Hacking - Use of stolen creds	Server - Mail	51
Misuse - Privilege abuse	Server - Database	51
Social - Phishing	Server - Mail	48
Error - Misdelivery	Media - Documents	30
Physical - Theft	Media - Documents	14
Error - Publishing error	Server - Web application	13
Error - Disposal error	Media - Documents	12
Error - Loss	Media - Documents	12
Error - Misdelivery	User Dev - Desktop	12
Hacking - Use of stolen creds	Person - End-user	7

Table 5
Top pairs of threat action varieties and asset varieties (n= 304)

Information

Web applications are targeted with availability attacks as well as leveraged for access to cloud-based organizational email accounts.

Frequency	1,094 Incidents, 155 with confirmed data disclosure
Top 3 patterns	Miscellaneous Errors, Web Applications, and Cyber-Espionage represent 83% of breaches within Information
Threat actors	External (56%), Internal (44%), Partner (2%) (breaches)
Actor motives	Financial (67%), Espionage (29%) (breaches)
Data compromised	Personal (47%), Credentials (34%), Secrets (22%) (breaches)

The Information Society

The Information industry is a veritable pantechnicon (look it up) that is chock-full of organizations that have to do with the creation, transmission and storing of information. One might think that with so wide an array of victims, the attacks would be all over the place, but, in fact, it is our duty to inform you that much of what we saw in this category for the 2019 report mirrors last year's results. As was the case in 2018, most of the incidents in this industry consists of DoS attacks (63%). In fact, it is perhaps fitting that this industry covers both TV and motion pictures, since it is in many ways a rerun of last year's programming when viewed from an incident point of view.

With regard to confirmed data disclosure, two of the top three patterns remain the same as last year (albeit in a different order) and we have one newcomer. In order of frequency, the patterns are Miscellaneous Errors (42%), Web App attacks (29%) and Cyber-Espionage (13%). Let's take a quick look at the most common errors below.

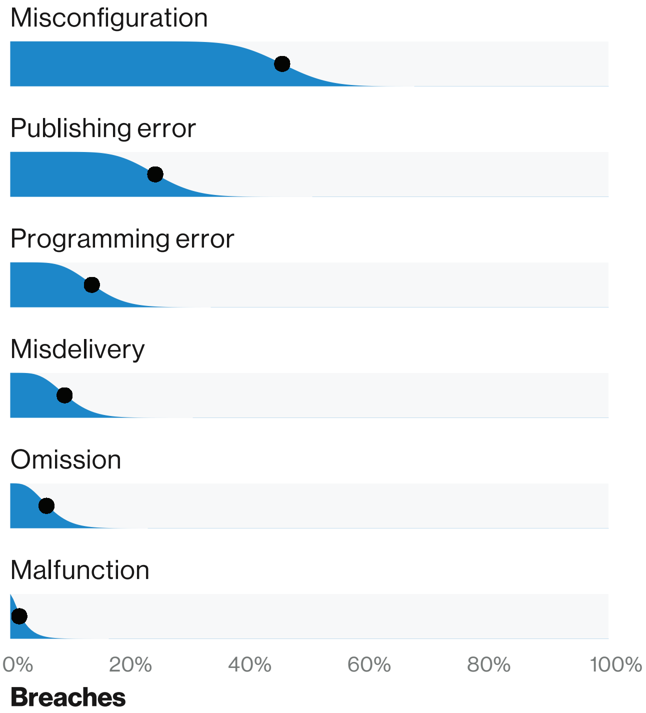


Figure 52. Error varieties in Information breaches (n=66)

Action	Asset	Count
Error - Misconfiguration	Server - Database	24
Social - Phishing	Person - Unknown	22
Hacking - Unknown	Server - Web application	19
Malware - C2	User Dev - Desktop	16
Social - Phishing	User Dev - Desktop	16
Malware - Backdoor	Person - Unknown	15
Malware - Backdoor	User Dev - Desktop	15
Malware - C2	Person - Unknown	15
Error - Publishing error	Server - Web application	14
Hacking - Use of stolen creds	Person - Unknown	14

Table 6
Top pairs of threat action varieties and asset varieties, (n= 155)

Faulty towers

No one is perfect, but when you are a system administrator you are often provided with a better stage on which to showcase that imperfection. Figure 52 illustrates how errors are put in the spotlight. Our data indicates that misconfiguration (45%) and publishing errors (24%) are common miscues that allowed data disclosure to occur. When looking at the relationship between actions and assets in Table 6, 36 percent (24 of 67) of error-related breaches involved misconfigurations on databases, often cloud storage – not good. Obviously, those buckets of data are meant to store lots of information and if your bucket has a (figurative) hole in it, then it may run completely dry before you make it back home from the well and notice. Often these servers are brought online in haste and configured to be open to the public, while storing non-public data. Publishing errors on web applications offer a similar exposure of data to a much wider than intended audience. Just for cmd shift and giggles, we will mention that programming errors were committed on web servers and a couple of databases.

It's not only Charlotte's Web (apps) you can read about

Even if your IT department doesn't make big mistakes like the poor unfortunate souls above, there is no need to worry. You still have more excellent chances to get your data stolen. Criminals do love a tempting freshly baked (or half baked) web application to attack. The illicit use (and reuse) of stolen creds is a common hacking action against web applications regardless of industry. The malware action variety of capture app data is more commonly associated with e-retailers, the application data being captured is the user inputting payment information. While not as common, any internet portals or membership sites that sell content as opposed to a physical product would fall into the Information sector. And payment cards used to purchase content are just as good to steal as ones used to buy shoes online.

I spy with my little eye, something phished

The third pattern in Information breaches we highlight is Cyber-Espionage. An eye opening 36 percent of external attackers were of the state-affiliated variety, statistically even with organized crime. As we have pointed out many times in the past, most Cyber-Espionage attacks begin with a successful phishing campaign and that goes some way to explain why 84 percent of social attacks in this industry featured phishing emails.

Sir Francis Bacon once famously stated "knowledge is power." Perhaps a better definition for 2019 would be "to gain and to control information is power." Therefore, we should probably not be shocked that the organizations that own and distribute that information are the target of such attacks.

Things to consider:

Asset assistance
Whether intentional web attacks or erroneous actions, both databases and web application servers are oft-compromised assets, especially for this industry. Many will complain about "checklist security" but a standard protocol regarding bringing up cloud servers and publishing sensitive data on websites – if implemented and followed – would go a long way to mitigate human error/carelessness.

Scrubbing packets
While breaches were at the forefront of this section, DDoS protection is an essential control for Information entities given the percentage of Denial of Service incidents. Guard against non-malicious interruptions with continuous monitoring and capacity planning for traffic spikes.

It bears repeating
Knowledge is power, and the increase in state-affiliated attacks is a data point we will keep an eye on. It could very well be a spike and not indicative of a trend, but Information organizations have desirable data and these motivations would not be likely to disappear in a year. Understand that these attacks are often "phishy" in nature and start with a compromised workstation and escalate from there.

Manufacturing

Manufacturing has been experiencing an increase in financially motivated breaches in the past couple of years, but espionage is still a strong motivator. Most breaches involve phishing and the use of stolen credentials.

Frequency	352 incidents, 87 with confirmed data disclosure
Top 3 patterns	Web Applications, Privilege Misuse, and Cyber-Espionage represent 71% of breaches
Threat actors	External (75%), Internal (30%), Multiple parties (6%), Partner (1%) (breaches)
Actor motives	Financial (68%), Espionage (27%), Grudge (3%), Fun (2%) (breaches)
Data compromised	Credentials (49%), Internal (41%), Secrets (36%) (breaches)

Uncle Owen, this R2 unit has a financial motivator

For the second year in a row, financially motivated attacks outnumber cyber-espionage as the main reason for breaches in Manufacturing, and this year by a more significant percentage (40% difference). If this were in most any other vertical, it would not be worth mentioning as money is the reason for the vast majority of attacks. However, Manufacturing has experienced a higher level of espionage-related breaches than other verticals in the past few years. So, shall we conclude that James Bond and Ethan Hunt[15] have finally routed their respective nemeses for good? Are we free to buy the world a Coke and teach it to sing in perfect harmony? Probably not. A more likely explanation is that some of our partners who typically provide data around cyber-espionage were either unable to participate this year or simply happened to work other types of investigations. This may have contributed to a bias on those results, meaning the real percentage of cyber-espionage cases was higher in the wild. If the relative percentage of one type of case goes down, the result is an apparent upswing in the other.

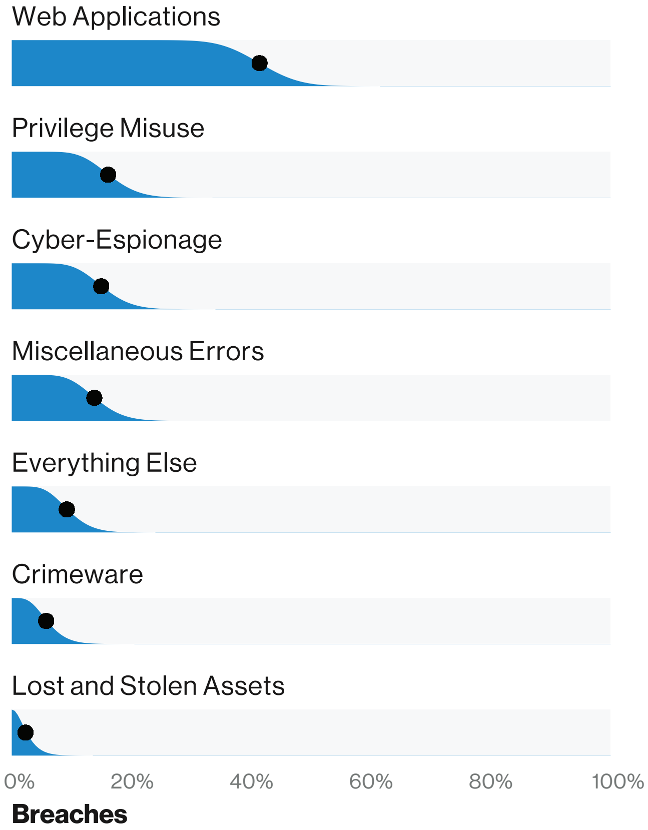


Figure 53. Patterns in Manufacturing breaches (n=87)

[15] Old-school readers, feel free to substitute Rollin Hand as the pop culture reference here if preferred.

Speaking to the web application attacks, this industry shares the same burden of dealing with stolen webmail credentials as other industries. Most breaches with a web application as a vector also featured a mail server as an affected asset. From an overall breach perspective, the use of stolen credentials and web applications were the most common hacking action and vector – see Figures 54 and 55.

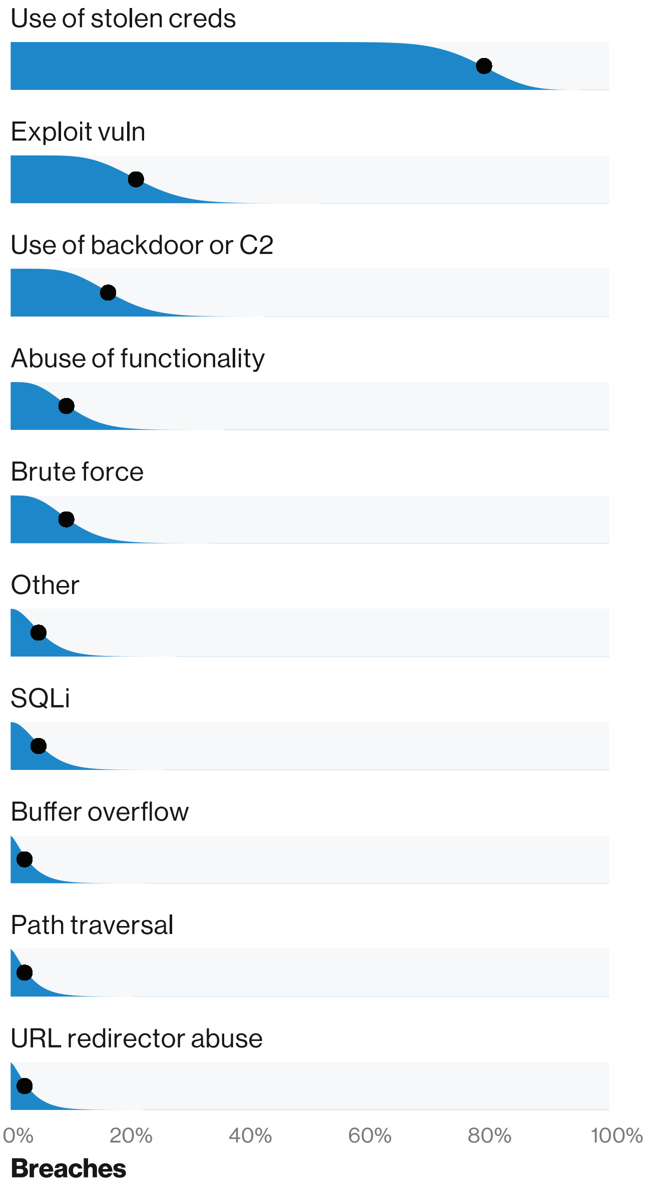


Figure 54. Hacking varieties in Manufacturing breaches (n=43)

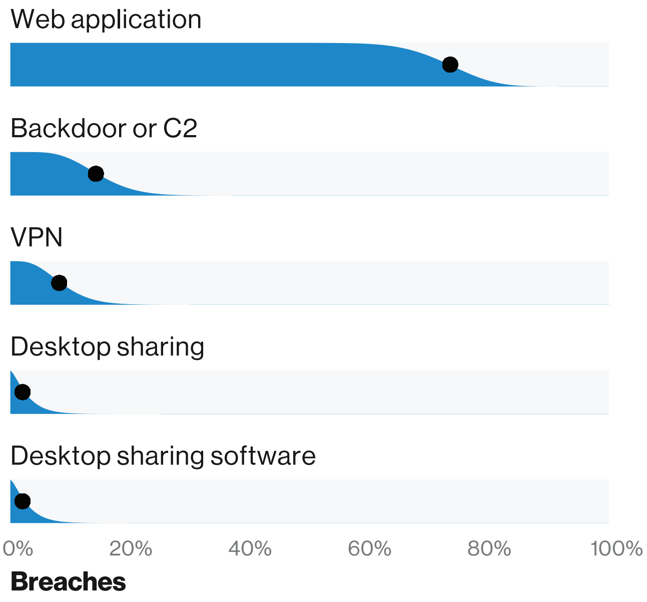


Figure 55. Hacking vectors in Manufacturing breaches (n=49)

Secrets and truths

The Cyber-Espionage pattern, while not as prominent as in past reports, is still an attack type that we recommend the Manufacturing industry defend against. The typical utilization of phishing attacks to convince users to install remote access tools that establish footholds and begin the journey towards stealing important competitive information from victims remains the same.

In keeping with the aforementioned rise in financially motivated attacks, the primary perpetrator when known is organized crime. With regard to data variety, there is a group of four data types that feature prominently in this industry. Credentials (49%) and Internal data (41%), stem from the webmail attacks – if a more specific data type is not known, Internal is used for compromised organizational emails. Secrets (36%) drop from previous heights commensurate to the reduction in espionage as a motive. The fourth amigo is Personal information (25%), a data type that includes employee's W-2 information and other nuggets that can be used for identity theft.

Things to consider:

Multiple factors work better than one
It is a good idea to deploy multiple factor authentication throughout all systems that support it, and discourage password reuse. These actions will definitely help mitigate the impact of stolen credentials across the organization.

Recycling also applies for security
Regardless of motivation, a large number of breaches in this sector started with phishing or pretexting attacks. Providing employees with frequent security training opportunities can help reduce the likelihood they will be reeled in by one of those attacks.

Workers must use safety equipment at all times
Unless inconvenient to do so – due to the prevalence of malware usage in the espionage breaches, it is advisable to deploy and keep up-to-date solutions that can help detect and stop those threats.

Professional, Technical and Scientific Services

Phishing and credential theft associated with cloud-based mail accounts have risen as the prominent attack types.

Frequency	670 incidents, 157 with confirmed data disclosure
Top 3 patterns	Web Applications, Everything Else, and Miscellaneous Errors represent 81% of breaches within Professional Services
Threat actors	External (77%), Internal (21%), Partner (5%), Multiple parties (3%) (breaches)
Actor motives	Financial (88%), Espionage (14%), Convenience (2%) (breaches)
Data compromised	Credentials (50%), Internal (50%), Personal (46%) (breaches)

Wide range of services, narrower range of threats

Professional Services is a broad category even by NAICS standards, and the members of its ranks include law offices, advertising agencies, and engineering and design firms to name only a few. Starting with a focus on the data lost in the 157 Professional Services breaches, Figure 56 gives us an idea of the types of data most commonly involved in these cases.

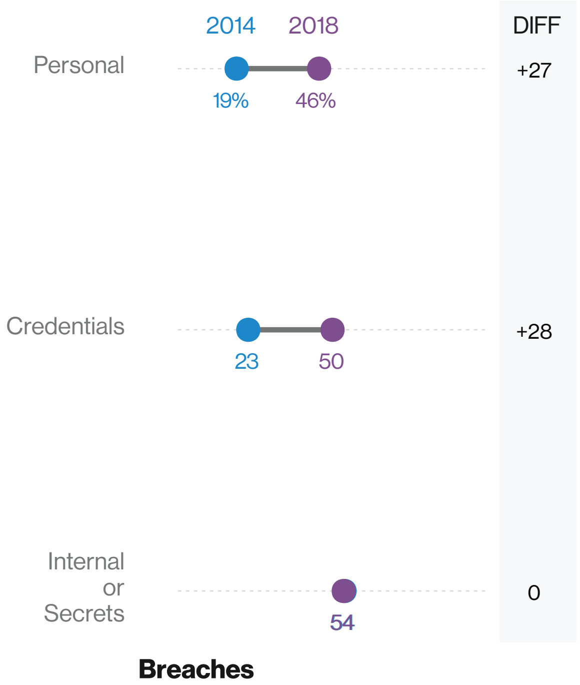


Figure 56. Top error varieties in Professional Services breaches over time, n=105 (2014), n=137 (2018)

We see an overall increase in Personal data and Credentials breached. A lot of this comes from breaches now compromising multiple data types at the same time. Often, credentials are the key that opens the door for other actions. Figure 57 shows that most of the time, it's on the way to compromise Internal and/or Personal data. This is indicative of gaining access to a user's inbox via webmail login using stolen credentials.

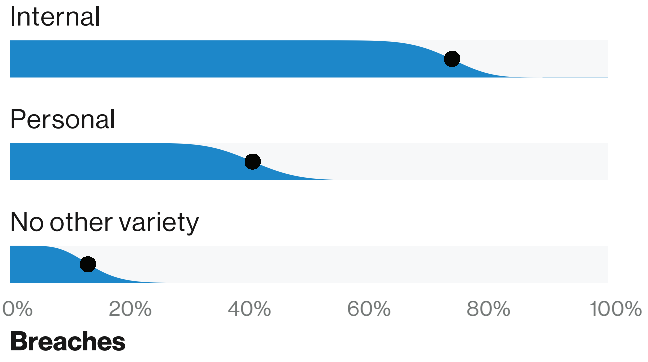


Figure 57. Other data varieties in Professional Services credential breaches (n=69)

Sometimes you just have to ask

Credentials compromising email…sounds a lot like Business Email Compromise doesn't it? Figure 58 provides ample evidence that BECs are an issue for Professional Services. Financial staff were the most likely to be compromised in incidents involving fraudulent transactions, but it should be noted that executives were compromised in 20 percent of the incidents and are 6x more likely to be the asset compromised in Professional Services breaches than the median industry. You have to hand it to the attackers. At some point one must have thought "why don't we skip all the hard hacking and just, you know, ask for the money?"

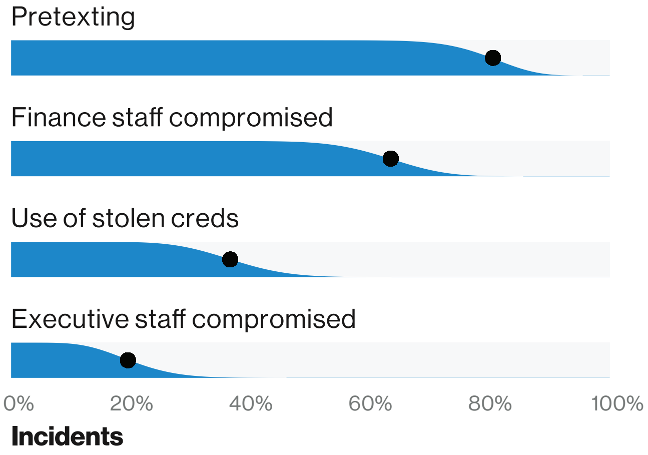


Figure 58. Select enumerations in fraudulent transaction incidents (n=41)

Paths of the unrighteous

To wrap up, Figure 59 illustrates the single step Misuse and Error breaches, but also shows us the Social and Hacking breaches that take slightly longer to develop. All of it provides excellent immediate teaching moments for any organization.

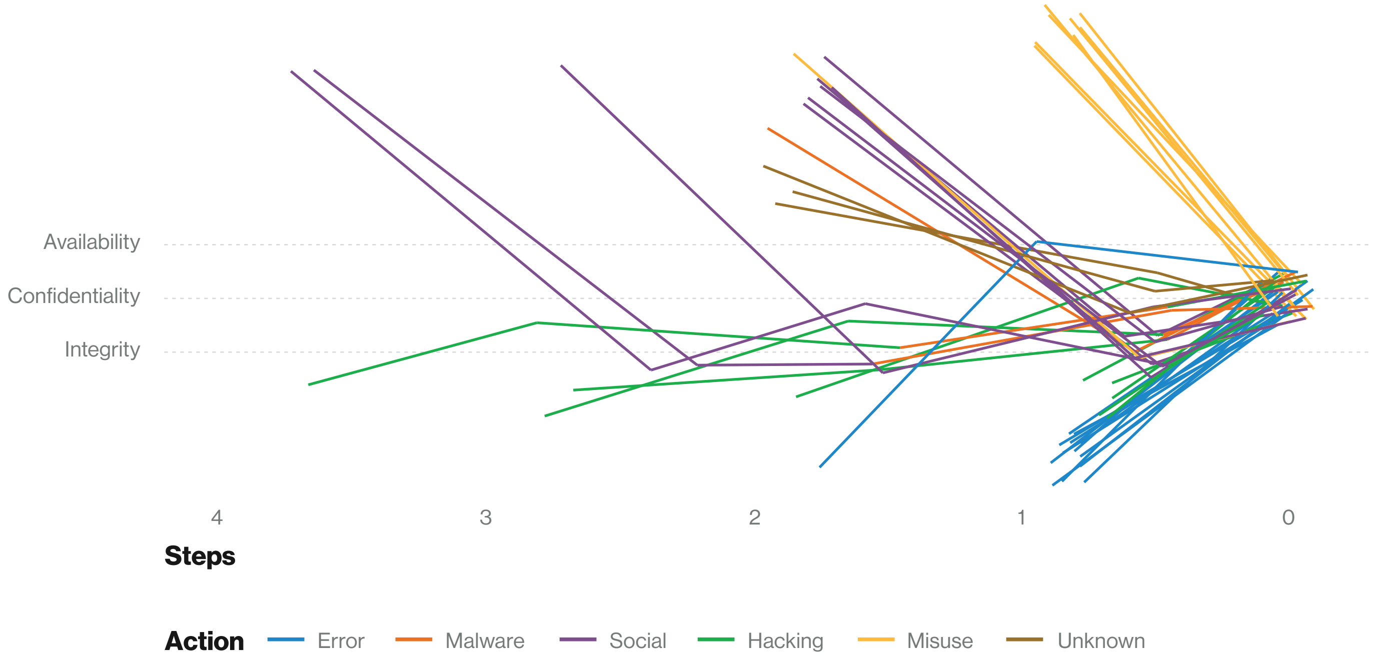


Figure 59. Confidentiality attack chains for Professional Services incidents (n=90)
Misuse and error are short paths while social and hacking take longer.

Things to consider:

One is the loneliest number
We don’t like saying it any more than you like hearing it, but static credentials are the keys. Password managers and two-factor authentication are the spool pins in the lock. Don’t forget to audit where all your doors are. It doesn’t help to put XO-9s on most of your entrances if you’ve got one in the back rocking a screen door.

Social butterflies
You know a great way to capture credentials? A social attack. At least we know where it’s coming from. Monitor email for links and executables (including macro-enabled Office docs). Give your team a way to report potential phishing or pretexting.

To err is human
Set your staff up for success. Monitor what processes access personal data and add in redundant controls so that a single mistake doesn’t result in a breach.

Public Administration

Cyber-Espionage is rampant in the Public sector, with State-affiliated actors accounting for 79 percent of all breaches involving external actors. Privilege Misuse and Error by insiders account for 30 percent of breaches.

Frequency	23,399 incidents, 330 with confirmed data disclosure
Top 3 patterns	Cyber-Espionage, Miscellaneous Errors and Privilege Misuse represent 72% of breaches
Threat actors	External (75%), Internal (30%), Partner (1%), Multiple parties (6%) (breaches)
Actor motives	Espionage (66%), Financial (29%), Other (2%) (breaches)
Data compromised	Internal (68%), Personal (22%), Credentials (12%) (breaches)

Given the sheer number of incidents in this sector, you would think that the government incident responders must either be cape and tights wearing super heroes, or so stressed they're barely hanging on by their fingernails. And while that may yet be the case, keep in mind that we do have very good visibility into this industry, in part due to regulatory requirements that members (at least in the United States) must report their incidents to one of our data sharing partners (the US-CERT). Arguably more interesting is the fact that, with similar breach numbers from last year's report, the makeup of the breaches has seen some change.

Master of whisperers

While the Cyber-Espionage pattern was also the most prominent in this industry in last year's report, the number of breaches in the Cyber-Espionage pattern is 168% of last year's amount. Figure 60 shows how the percentages shifted from last year. The most common pairings of threat actions and assets in Table 7 tells a story that is as easy to follow as "See Spot Send Malicious Attachments and Gain a Foothold." We have a gang of five threat actions found in breaches that had a human asset[16] and a workstation as affected assets. We are seeing the familiar phish > backdoor/C2 > use of the newly acquired channel into the network. Admittedly we do not have as much data as to what is happening beyond the deception and initial device compromise. The inclusion of keylogging malware is a good indicator that additional credential theft and reuse is a likely next step.

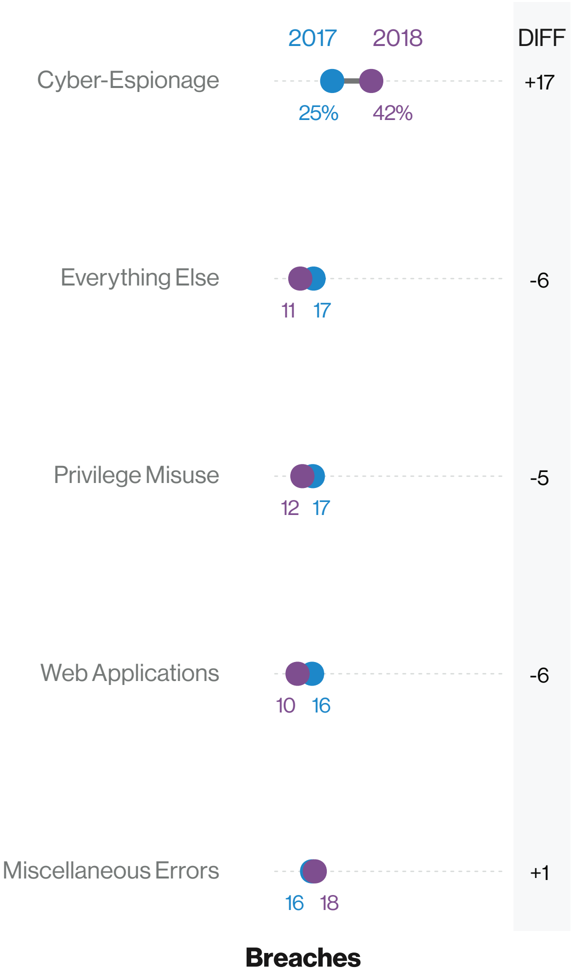


Figure 60. Patterns in Public breaches over time
n=305 (2017), n=330 (2018)

[16] Person – Unknown was not filtered out due to the amount of phishing without a known organizational role associated with the target.

Action	Asset	Count
Social - Phishing	Person - Unknown	155
Social - Phishing	User Dev - Desktop	139
Malware - Backdoor	Person - Unknown	130
Malware - Backdoor	User Dev - Desktop	129
Hacking - Use of backdoor or C2	Person - Unknown	119
Hacking - Use of backdoor or C2	User Dev - Desktop	119
Malware - C2	User Dev - Desktop	100
Malware - C2	Person - Unknown	99
Malware - Spyware/Keylogger	User Dev - Desktop	82
Malware - Spyware/Keylogger	Person - Unknown	81

Table 7
Common threat action and asset combinations within Public breaches, (n=330)

I click, therefore I am

Since we have established a bit of a problem with malicious emails, we wanted to dig more into the security awareness training data provided to us this year. Figure 61 shows how quickly employees in this sector are clicking or reporting on phishing emails. Early on in the training similar percentages of users are clicking and reporting, but reporting drops off after the first hour, where clicking is more active. Not optimal, but since this was sanctioned and not actually malicious, nothing was done after the initial reporting other than an “atta boy.” Having documented, understood, and tested incident response plans to the real thing will allow the containment process to begin during that first hour to limit the effectiveness and impact through quick identification. This should also limit the opportunity for the users who are not KonMari-ing their inboxes to interact with the malicious message days later.

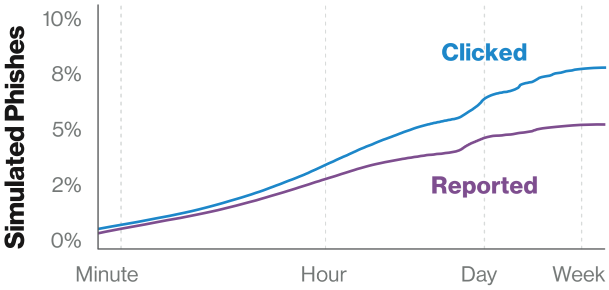


Figure 61. Click and reporting rate in public simulated phishes over time

The wheels of government discover slowly

When there is enough detail to derive breach timeline metrics, the data shows that breaches in the Public sector are taking months and years to be discovered. Public breaches are over 2.5 times more likely to be undiscovered for years. Espionage-related breaches typically do take longer to discover due to the lack of external fraud detection, but we did not have timeline data for those breaches. Privilege Misuse is the most common pattern within breaches that went undiscovered for months or more.

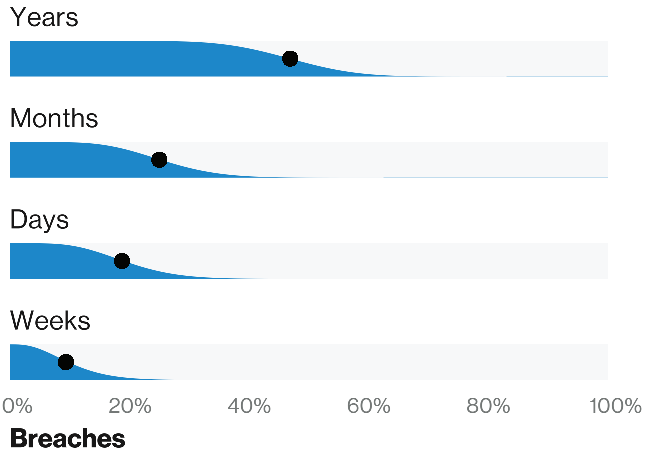


Figure 62. Time-to-discovery in Public breaches (n=32)

Things to consider:

Understand the human factor
Not just from a phishing target standpoint. Errors in the forms of misdelivery and erroneous publishing of data rear their risky heads again. Insider misuse is also still a concern, so ensure efforts are taken to routinely assess user privileges. Limit the amount of damage an employee acting inappropriately or maliciously can do with existing privileges.

Lookin' out my backdoor
While not as obvious as cartwheeling giants, validate there are controls in place to look for suspicious egress traffic that could be indicative of backdoor or C2 malware installation.

The malware conundrum
Large government entities with a massive community of end-points face a challenge in ensuring the breadth of up-to-date malware defenses are implemented. Smaller organizations may lack the budget for additional malware defenses other than desktop AV. Make friends with the desktop security folks and find out what their specific challenges are.

Retail

Card present breaches involving POS compromises or gas-pump skimmers continue to decline. Attacks against e-commerce payment applications are satisfying the financial motives of the threat actors targeting this industry.

Frequency	234 incidents, 139 with confirmed data disclosure
Top 3 patterns	Web Applications, Privilege Misuse, and Miscellaneous Errors represent 81% of breaches
Threat actors	External (81%), Internal (19%) (breaches)
Actor motives	Financial (97%), Fun (2%), Espionage (2%) (breaches)
Data compromised	Payment (64%), Credentials (20%), Personal (16%) (breaches)

Not such a POS anymore

Let's jump in our DBIR time machine and travel all the way back to four years ago. It was the second year that we featured the incident classification patterns and the top pattern for Retail was POS Intrusion, along with remote compromise of point of sale environments, with all of the malware and payment card exfiltration that comes with it. Coming back to the present year's data set in Figure 63, the times they are a-changing.

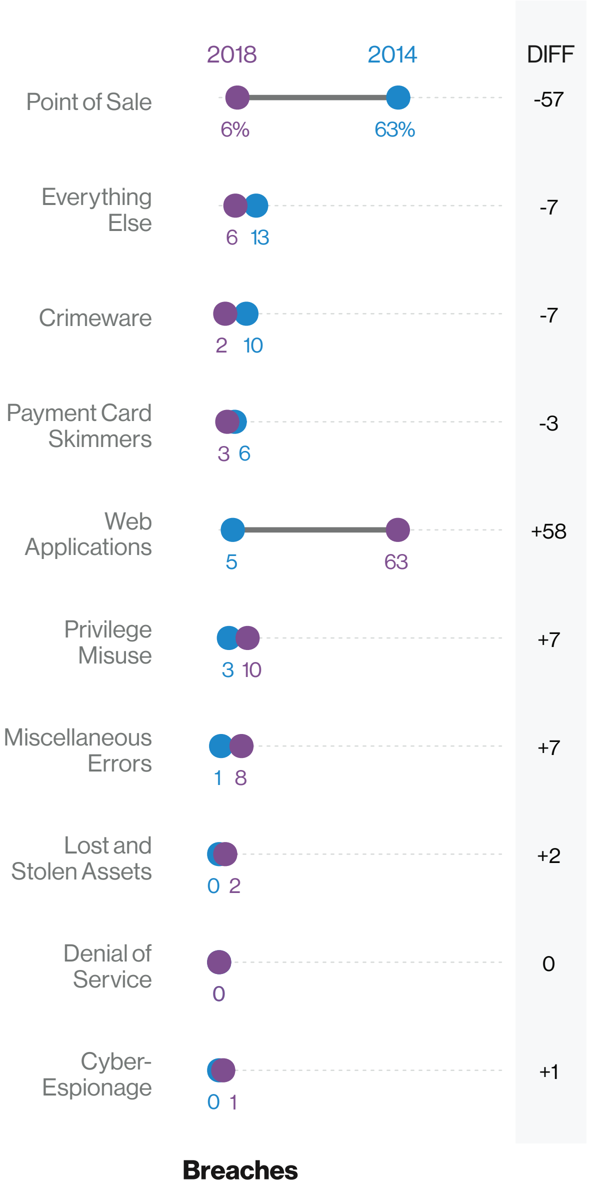


Figure 63. Patterns in Retail breaches over time
n=145 (2014), n=139 (2018)

Essentially, Web application attacks have punched the time clock and relieved POS Intrusion of their duties. This is not just a retail-specific phenomenon – Figure 64 comes courtesy of our friends at the National Cyber-Forensics and Training Alliance (NCFTA) and their tracking of card-present versus card-not-present fraud independent of victim industry.

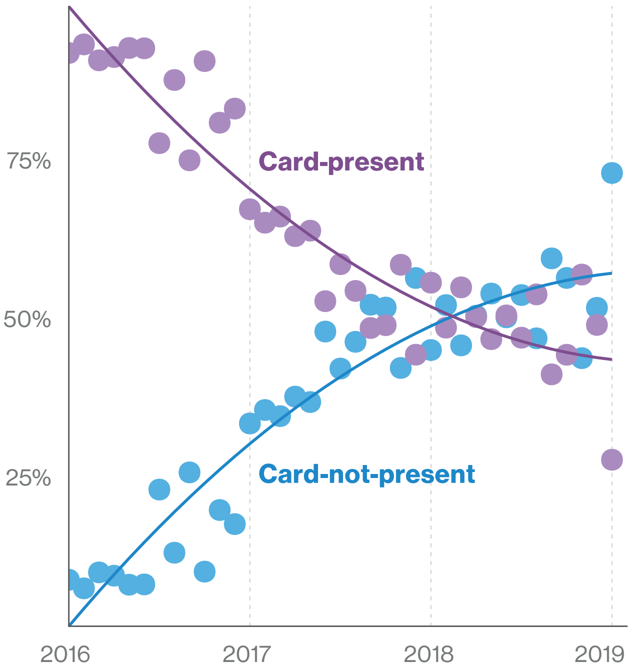


Figure 64. Comparison of card-present vs. card-not-present fraud

The above shift certainly supports the reduction in POS breaches, and to a lesser extent, Payment Card Skimming. Pay at the pump terminals at gas stations would fall into the retail industry as well. We are cautiously optimistic that EMV has diminished the value proposition of card-present fraud for the cyber-criminals in our midst. Alas, it will still not make criminal elements eschew money and move to self-sustaining communes to lead simpler lives.

One door closes, kick in another one

Attacks against e-commerce web applications continue their renaissance. This is shown in Figure 64 on the left as well as Figure 26 back in the Results and Analysis section. To find out more about what tactics are used in attacks against payment applications we will go back to pairings of threat actions and affected assets.

The general modus operandi can be gleaned from Table 8 below. Attacker compromises a web application and installs code into the payment application that will capture customer payment card details as they complete their purchases. Some breaches had details that specified a form-grabber which would be categorized under Spyware/Keylogger as it is another method of user input capture. Other

Action	Asset	Count
Malware - Capture app data	Server - Web application	49
Malware - Spyware/Keylogger	Server - Web application	39
Hacking - Exploit vuln	Server - Web application	15
Hacking - RFI	Server - Web application	11
Malware - RAM scraper	Server - POS controller	8
Malware - RAM scraper	User Dev - POS terminal	7
Hacking - Use of stolen creds	Server - Database	6
Hacking - Use of stolen creds	Server - Mail	6
Hacking - Use of stolen creds	Server - Web application	6
Misuse - Privilege abuse	Server - Database	5

Table 8
Top action and asset variety combinations within Retail breaches, (n=139)

times limited information was provided other than a statement similar to “malicious code that harvested payment card data.” The more general functionality of capture app data was used in those instances. In reality there is likely little to no difference between the two pairings. We are also a little short on information on how the web application was compromised. If a specific method like RFI is noted, we collect it. Often it may be a general notation that a web vuln was exploited, hence the Exploit Vuln variety (new to the latest version of VERIS!). Looking at what we do know and channeling our inner William of Ockham, this general chain of events is likely: scan for specific web application vulnerabilities > exploit and gain access > drop malware > harvest payment card data > profit. We have seen webshell backdoors involved in between the initial hack and introduction of malware in prior breaches. While that action was not recorded in significant numbers in this data set, it is an additional breadcrumb to look for in detection efforts. In brief, vulnerable internet-facing e-commerce applications provide an avenue for efficient, automated, and scalable attacks. And there are criminal groups that specialize in these types of attacks that feast on low-hanging fruit.

Things to consider:

Integrity is integral
The web application compromises are no longer attacks against data at rest. Code is being injected to capture customer data as they enter it into web forms. Widespread implementation of file integrity software may not be a feasible undertaking. Adding this to your malware defenses on payment sites should be considered. This is, of course, in addition to patching OS, and payment application code.

Brick and Mort(ar)y
Continue to embrace technologies that make it harder for criminals to turn your POS terminals into machines of unspeakable doom. EMV, mobile wallets – any method that utilizes a one-time transaction code as opposed to PAN is a good thing.

Not just PCI
Payment cards are not the only data variety that would be useful to the criminally-minded community. Rewards programs that can be leveraged for the “points” or for the personal information of your customer base are also potential targets.

Wrap up

So, this concludes our 12th installment of this annual report. If the DBIR were a bottle of decent Scotch whiskey it would cost you around 100 bucks, instead of being free like this document. Likewise, the decisions you might make after finishing them would probably differ wildly as well[17]. Nevertheless, we hope you gain a certain degree of enjoyment and enlightenment from both.

On behalf of the team that labored to produce this document, we sincerely thank you, our readers, for your continued support and encouragement of this effort. We believe it to be of value to Information Security professionals and to industry at large, and we are grateful for the opportunity to bring it before you once again. As always, a tremendous thank you to our contributors who give of their time, effort, insight, and most importantly, their data. The task of creating this document is in no way trivial and we simply could not do it without their generosity of resources. We look forward to bringing you our 14th report (we are taking the high-rise hotel concept of enumeration here) next year, and in the meantime, may your security budgets be large and your attack surface small. Until then, feel free to reflect on the more noteworthy publicly disclosed security events in 2018 from the VTRAC before jumping into the Appendices.

Year in review

January

On the second day of the year, the Verizon Threat Research Advisory Center (VTRAC) began to learn that researchers had discovered “Meltdown” and “Spectre,” new information disclosure vulnerabilities in most modern microprocessors. The vulnerabilities lie in foundational CPU architectures. Patching continued through 2018. We collected no reports of successful Meltdown or Spectre attacks in 2018. The first week of the month included the first report of malware attacks targeting the 2018 Winter Olympics in Pyeongchang, Republic of Korea. Investigative journalists reported India’s national ID database, “Aadhaar,” suffered a data breach affecting more than 1.2 billion Indian citizens. We began collecting reports of targeted attacks on Latin American banks. Attackers used disk wiping malware, probably to eliminate evidence of their actions and minimize the scale of the banks’ losses. On January 26th, we collected the first report of GandCrab ransomware.

February

The first “zero-day” in Adobe Flash kicked off February after APT37 embedded an exploit in Excel spreadsheets. The Punjab National Bank reported fraudulent transfers of ₹11,600 crore (USD 1.77 billion dollars). The Russian Central Bank reported “unsanctioned operations” caused the loss of ₽339 million (€4.8 million). “Olympic Destroyer” malware disrupted the opening ceremony of the Pyeongchang Olympics but did not result in their cancellation. GitHub was hit with a new type of reflection denial of service attack leveraging misconfigured memcached servers. GitHub and other organizations endured 1.35-terabit-per-second junk traffic storms.

March

Intelligence for attacks on the Pyeongchang Olympics continued after the February 25th closing ceremonies. Operations Gold Dragon, HaoBao and Honeybee began as early as July 2017. In March, we collected intelligence on a full spectrum of APT-grade threat actors including APT28, menuPass (APT10), Patchwork, MuddyWater, OilRig, Lazarus and Cobalt. US-CERT published 15 files with intelligence on Russian actors attacking critical infrastructure in the USA. Malaysia’s Central Bank foiled an attack that involved falsified SWIFT wire-transfer requests. The Drupal project patched a remote code execution vulnerability reminiscent of the 2014 vulnerability that led to “Drupalgeddon.”

April

Attacks on “smart install” software in Cisco IOS switches by Russian threat actors were probably the most noteworthy InfoSec risk development in April. The VTRAC collected updated intelligence on the “Energetic Bear” Russian actor. A supply-chain attack on Latitude Technologies forced four natural-gas pipeline operators to temporarily shut down computer communications with their customers. Latitude supplies Electronic Data Interchange (EDI) services to the Energy and Oil verticals. March’s Drupal vulnerability did indeed attract cybercriminals. A variant of the Mirai IoT botnet began scanning for vulnerable Drupal servers and the subsequent compromises to install cryptomining software became known as Drupalgeddon2. The cyber-heist of US$150,000 in Ethereum from MyEtherWallet paled in significance to the BGP hijacking of the Internet’s infrastructure to do it.

May

Intelligence about the “Double Kill” zero-day vulnerability in Internet Explorer was collected at the end of April. In May the VTRAC collected intelligence of a malicious PDF document with two more zero-day vulnerabilities, one each in Adobe PDF Reader and in Windows. Microsoft and Adobe patched all three on May’s Patch Tuesday. A surge in GandCrab ransomware infections were the focus of several of the best intelligence collections in May. New intelligence collections documented the Cobalt threat actor’s phishing campaign was targeting the financial sector. Multiple sources reported VPNFilter malware had infected routers and network-attached storage (NAS) appliances. Control the router – control the traffic passing through it.

June

Multiple sources released updated intelligence on North Korean threat actors engaged in cyber-conflict and cybercrime operations. Adobe patched a new zero-day vulnerability in Flash. Like February’s, Flash zero-day, it was being used in malicious Excel files but the targets were in the Middle East. Two Canadian Imperial Bank of Commerce subsidiaries – BMO (Bank of Montreal) and Simplii Financial suffered a leak of about 90,000 customer records. They learned of the breach when threat actors demanded US$750,000 for the return of the records. The Lazarus threat actor stole roughly KR ₩35 billion (around $31 million) in cryptocurrency from the South Korea-based exchange Bithumb. DanaBot, a new banking Trojan was discovered targeting Commonwealth Bank in Australia.

July

The first major Magecart attack in 2018 was Ticketmaster’s UK branch. Hackers compromised Inbenta, a third-party functionality supplier. From Inbenta they placed digital skimmers on several Ticketmaster websites. The Ticketmaster attack was part of a campaign targeting third-party providers to perform widespread compromises of card data. July’s Magecart collections included indicators of compromise of over 800 victim websites. A malicious Mobile Device Management platform was used in highly targeted attacks on 13 iPhones and some Android and Windows platforms. Russia’s PIR Bank lost ₽58 million ($920,000) after the MoneyTaker actor compromised an outdated, unsupported Cisco router at a branch office and used it to pivot into the bank’s network.

August

The second Boundary Gateway Protocol (BGP) hijacking to steal cryptocurrency in 2018 redirected legitimate traffic from an Amazon DNS server. The malicious DNS server redirected users of MyEtherWallet to a spoofed site that harvested their credentials. Users of the service lost Ethereum worth about $152,000. Cosmos Bank in Pune, India, was the victim of US$13.4 million of fraudulent SWIFT and ATM transfers. The US Dept. of Justice announced the arrests of three managers from the FIN7 (Anunak, Carbanak, Carbon Spider) threat actor. Intelligence indicated a new vulnerability in Apache Struts, CVE-2018-11776, was following the course set by March 2017’s CVE-2017-9805, the Jakarta multi-parser Struts vulnerability. The 2017 vulnerability led to the Equifax data breach. A detailed code reuse examination of malware linked to North Korea linked most malware attacks to the Lazarus Group. APT37 was linked to a small portion but was assessed to be more skilled and reserved for attacks with national strategic objectives.

September

New intelligence revealed Japanese corporations were being targeted by the menuPass (APT10) threat actor. On September 6th, British Airways announced it had suffered a breach resulting in the theft of customer data. Within a week, we collected intelligence British Airways had become another victim of a Magecart attack. Intelligence indicated in the preceding 6 months, 7,339 E-commerce sites had hosted Magecart payment card skimming scripts including online retailer Newegg. Weaponized IQY (Excel Web Query) attachments were discovered attempting to evade detection to deliver payloads of FlawedAmmyy remote access Trojan (RAT). The FBI and DHS issued an alert about the Remote Desktop Protocol (RDP). The alert listed several threats that exploit RDP connections: Crysis (Dharma), Crypton and SamSam ransomware families. DanaBot expanded its target set to Italy, Germany and Austria.

October

The VTRAC assessed claims that Chinese actors had compromised the technology supply chain did not constitute intelligence. The related report lacked technical details or corroboration and was based on unqualified, unidentified sources. US-CERT issued an updated alert on attacks on MSS providers by the menuPass (APT10) threat actor. Multiple sources reported North Korean actors engaged cyber-crime attacks intended to provide revenue to the sanction-constrained regime. GreyEnergy is the latest successor to the Sandworm/BlackEnergy/Quedagh/Telebots threat actor. GreyEnergy was linked to attacks on the energy sector and other strategic targets in Ukraine and Poland for the past three years. DanaBot began targeting financial services establishments in the USA. The Magecart threat actors executed a scaled supply chain attack on Shopper Approved, a customer scoring plugin used by 7000+ e-commerce sites. Detailed reports in August and October indicated the Cobalt threat actor had re-organized into a group with journeymen and apprentice members and a second group of masters reserved for more sophisticated campaigns.

November

Intelligence based on examination of Magecart malware indicated there are at least six independent threat actors conducting Magecart attacks. The initial Magecart successes in late 2016 and high-profile attacks beginning with Ticketmaster UK/Inbenta in June led to a bandwagon effect. Other threat actors copied and improved upon the TTP of early Magecart threat actor(s). The SamSam ransomware attack came to a standstill after two Iranian hackers were indicted for US$6 million extortion. Cisco released an advisory due to “active exploitation” of a vulnerability in Cisco Adaptive Security Appliance Software (ASA) and Cisco Firepower Threat Defense Software that could allow an unauthenticated, remote attacker to cause a denial of service. US-CERT released Activity Alert AA18-284A, “Publicly Available Tools Seen in Cyber Incidents Worldwide,” on five tools threat actors had been using for their “Living off the Land” tactics. Marriott announced a 2014-18 breach had exposed the records of up to 500 million customers in its Starwood hotels reservation system.

December

VTRAC collections in December began with “Operation Poison Needles.” An unidentified actor exploited the third Adobe Flash zero-day vulnerability to attack Polyclinic of the Presidential Administration of Russia. “Operation Sharpshooter” was a global campaign targeting nuclear, defense, energy and financial companies. Oil and gas services contractor Saipem suffered an attack that employed a new variant of Shamoon disk-wiping malware. December’s Patch Tuesday fixed CVE-2018-8611, the latest Windows zero-day being exploited by the FruityArmor APT threat actor. Partly in reaction to the 77 percent plunge in Bitcoin, cyber-criminals did not abandon cryptomining altogether, instead, SamSam and GandCrab ransomware were being used to attack corporations, government agencies, universities and other large organizations. Criminals targeted larger purses: organizations likely to pay ransom in lieu of days of lost business and productivity recovering from backups, re-imaging or other BCP/DR measures. At the end of 2018 the VTRAC was running like a Formula 1 car finishing a mid-race lap: at full speed, staying ahead of some, striving to catch others and constantly improving our engineering.

Appendix A: Transnational hacker debriefs

Insights into their target selection and tactics, techniques and procedures

– Michael D’Ambrosio, Deputy Assistant Director, United States Secret Service

Over the past fifteen years, the United States Secret Service has successfully identified, located, and arrested numerous high-value cybercriminals. These individuals were responsible for some of the most significant and widely publicized data breaches of public and private industry networks. Over this period, the Secret Service’s Cyber Division has cultivated mutually beneficial partnerships with law enforcement agencies around the globe, which has extended the reach of the Secret Service’s investigative efforts far beyond its traditional limits. This network of collaborative partners has enabled the Secret Service to successfully extradite criminal suspects located overseas and have them face prosecution in the United States. The Secret Service continues to forge new international partnerships in furtherance of its mission to pursue and apprehend cybercriminals regardless of their geography.

As part of its mandate to combat financially motivated cybercrime, the Secret Service combines its investigative efforts with educational outreach programs. These are aimed at strengthening the ability of private and public sector entities to protect themselves against a range of cybercrimes. The Secret Service conducts in-depth analyses of the activities, tools, and methodologies used by the cybercriminals during the commission of their crimes to better assess the evolving threats that cybercriminals pose to financial institutions and other potential targets. The Secret Service then shares the results of these reviews with its network of public and private partners through its outreach programs.

The Secret Service’s Cyber Division has learned that the most prescient information about cybercrime trends often comes from the cybercriminals themselves. The Secret Service conducts extensive debriefings of arrested cybercriminals and uses their first-hand knowledge to understand more fully the spectrum of variables they used to identify and select a particular target for intrusion and exploitation. The Secret Service has recently completed such debriefings with a handful of highly skilled cybercriminals who were responsible for some of the most significant network intrusions in history, and has found that the ways in which these individuals select their targets and perpetrate their crimes share certain common features.

Cybercriminals prey upon human error, IT security complacency, and technical deficiencies present in computer networks all over the world. Individually, each of these tactics, techniques and procedures (TTPs) discussed below are not always initially successful and may seem easily mitigated; it is when multiple TTPs are utilized in concert that cybercriminals are able to gain and maintain access to a computer network, no matter their motives. Once they are inside a network their process is almost always the same: establish continued access, escalate or obtain administrator privileges, move slowly and quietly to map the entire network, look for open ports, locate the "crown jewels," and exfiltrate the data undetected for as long as possible.

The selection of a target is a continual process. Cybercriminals do their research. Almost always during these interviews, the hackers referred to gathering valuable intelligence from the same cybersecurity blogs, online IT security publications, and vulnerability reports that network administrators should be monitoring. They know that once a vulnerability is revealed, they still have a limited amount of time to try to exploit that vulnerability at a potential victim organization. Every time a vulnerability is disclosed or a system update or patch is released, a hacker sees an opportunity. They research the disclosure or update notes to learn if they can exploit the vulnerability and where, searching for their best opportunity to monetize the vulnerability. Hackers also communicate vulnerability information and exploit techniques on hacking forums. Once a target is selected, the hacker conducts thorough research into the victim organization and their network(s), often using free and commercially available Internet scanning tools that reveal extremely useful information about the victim company's network.

Webserver and/or webpage hacking has been a highly successful primary attack vector, as there are various potential avenues for exploitation. These include the main website of an institution or a less protected linked website, which in turn can provide access to the main network. The added use of Structured Query Language (SQL) database injections of malicious code has been a very effective attack vector because these types of intrusion techniques can be deployed at any access point of a website. There are additional webserver attack vectors such as overlooked or forgotten IP addresses, possibly from development or beta-testing and external webservers or data servers that share the same or common domain. Unmanaged servers that still utilize Unicode can be exploited via encoding the URL with certain characters to bypass application filters.

Other traditional and effective attack vectors should not be overlooked. These include spear phishing for login credentials or malware delivery and "Man in the Middle" attacks through poorly secured routers or web gateways. Botnets are a relatively inexpensive tool that have been used to degrade or brute force attack networks in connection with parallel tactics. A very skilled hacker admitted to the Secret Service that he ended up paying a collusive employee (insider threat) when all of his other hacking attempts to access a foreign bank's network were unsuccessful.

Once inside a network, cybercriminals continue to do their research and reconnaissance. Hackers often examine a webserver's default error pages because those pages expose a lot of the target network's system information. Cybercriminals take all of network information they can collect and utilize virtual machines (VMs) to build a mock system to emulate the network of the victim company. This is done both for testing their methods of exploitation and for better understanding the types of network defenses present within the system.

The exploits used by cybercriminals inside a target network depend on the installed network defenses. Undoubtedly, the hacker will try to install a web shell to ensure access into the system. Another sustainment method is the use of cross-site scripting (XSS) for session hijacking (cookie stealing) of a valid user through malicious code injections into a user's JavaScript, ActiveX, Flash, or other code bank. The use of malware delivered to the valid user via spear phishing is a key component of this process.

In addition, hackers utilize directory transversal attacks (directory climbing, backtracking, etc.) on web servers to attempt to reach otherwise restricted directories, such as Secure Socket Layer (SSL) private keys and password files. Hackers can even execute commands on the server by accessing such directories. After administrator privileges are obtained, it is common for the prized data to be exfiltrated by tunneling via a remote access protocol. Cybercriminals will also scan for open ports and attempt to install software of their choosing on non-standard ports for a variety of malicious uses. If the targeted network has the potential to provide valuable data continuously, diligent hackers will continuously clean up their "tracks" within the exploited network to obfuscate their presence indefinitely. Another prominent hacker described having persistent access into a company's networks for 10 years using multiple "backdoors" (web shells) and continually cleaning up his "work" to go undetected. In reality, many of the hackers we debriefed often stated that they could see traces of other hackers in the targeted network which sometimes made it harder to hide their hacking exploits.

These are just some of the tactics, techniques and procedures the Secret Service has observed used by criminal groups to exploit victim networks. The threat is real and the adversary is constantly evolving, driven by diverse and varying motivations. Their success is more often dependent on how well network administrators can adapt their defenses to potential vulnerabilities as they are revealed.

The Secret Service will continue to pursue, arrest, and prosecute cybercriminals no matter where they are and we will continue to provide valuable attack methodology analysis from our investigations to better improve the cybersecurity efforts of our partners in law enforcement, academia, and the public and private sectors alike.

Appendix B: Methodology

One of the things readers value most about this report is the level of rigor and integrity we employ when collecting, analyzing, and presenting data. Knowing our readership cares about such things and consumes this information with a keen eye helps keep us honest. Detailing our methods is an important part of that honesty.

Our overall methodology remains intact and largely unchanged from previous years. All incidents included in this report were individually reviewed and converted (if necessary) into the VERIS framework to create a common, anonymous aggregate data set. If you are unfamiliar with the VERIS framework, it is short for Vocabulary for Event Recording and Incident Sharing, it is free to use, and links to VERIS resources are at the beginning of this report.

The collection method and conversion techniques differed between contributors. In general, three basic methods (expounded below) were used to accomplish this:

1. Direct recording of paid external forensic investigations and related intelligence operations conducted by Verizon using the VERIS Webapp.

2. Direct recording by partners using VERIS.

3. Converting partners existing schema into VERIS.

All contributors received instruction to omit any information that might identify organizations or individuals involved.

Reviewed spreadsheets and VERIS Webapp JavaScript Object Notation (JSON) are ingested by an automated workflow that converts the incidents and breaches within into the VERIS JSON format as necessary, adds missing enumerations, and then validates the record against business logic and the VERIS schema. The automated workflow subsets the data and analyzes the results. Based on the results of this exploratory analysis, the validation logs from the workflow, and discussions with the partners providing the data, the data is cleaned and re-analyzed. This process runs nightly for roughly three months as data is collected and analyzed.

Incident eligibility

For a potential entry to be eligible for the incident/breach corpus, a couple of requirements must be met. The entry must be a confirmed security incident, defined as a loss of confidentiality, integrity, or availability. In addition to meeting the baseline definition of “security incident,” the entry is assessed for quality. We create a subset of incidents (more on subsets later) that pass our quality filter. The details of what is a “quality” incident are:

- The incident must have at least seven enumerations (e.g., threat actor variety, threat action category, variety of integrity loss, et al.) across 34 fields OR be a DDoS attack. Exceptions are given to confirmed data breaches with less than seven enumerations.

- The incident must have at least one known VERIS threat action category (hacking, malware, etc.)

In addition to having the level of detail necessary to pass the quality filter, the incident must be within the timeframe of analysis, (November 1, 2017 to October 31, 2018 for this report). The 2018 caseload is the primary analytical focus of the report, but the entire range of data is referenced throughout, notably in trending graphs. We also exclude incidents and breaches affecting individuals that cannot be tied to an organizational attribute loss. If your friend's personal laptop was hit with CryptoLocker it would not be included in this report.

Lastly, for something to be eligible for inclusion into the DBIR, we have to know about it, which brings us to sample bias.

Acknowledgement of sample bias

We would like to reiterate that we make no claim that the findings of this report are representative of all data breaches in all organizations at all times. Even though the combined records from all our contributors more closely reflect reality than any of them in isolation, it is still a sample. And although we believe many of the findings presented in this report to be appropriate for generalization (and our confidence in this grows as we gather more data and compare it to that of others), bias undoubtedly exists. Unfortunately, we cannot measure exactly how much bias exists (i.e., in order to give a precise margin of error). We have no way of knowing what proportion of all data breaches are represented because we have no way of knowing the total number of data breaches across all organizations in 2018. Many breaches go unreported (though our sample does contain many of those). Many more are as yet unknown by the victim (and thereby unknown to us).

While we believe many of the findings presented in this report to be appropriate, generalization, bias, and methodological flaws undoubtedly exist. However, with 73 contributing organizations this year, we're aggregating across the different collection methods, priorities, and goals of our partners. We hope this aggregation will help minimize the influence of any individual shortcomings in each of the samples, and the whole of this research will be greater than the sum of its parts.

Statistical analysis

We strive for statistical correctness in the DBIR. In this year's data sample, the confidence interval is at least +/- 2% for breaches and +/- 0.5%[18] for incidents. Smaller samples of the data (such as breaches within the Espionage pattern) will be even wider as the size is smaller. We have tried to treat every statement within the DBIR as a hypothesis[19] based on exploratory analysis and ensure that each statement is accurate at a given confidence level (normally 95%). We've tried to express this confidence in the conditional probability bar charts explained in the "tidbits" that precede the Table of Contents.

[18] Bayes method, 95% confidence level.

[19] If you wonder why we treat them as hypotheses rather than findings, to confirm or deny our hypothesis would requires a second, unique data set we had not inspected ahead of time.

Our data is non-exclusively multinomial, meaning a single feature, such as “Action,” can have multiple values (i.e., “social,” “malware,” and “hacking”). This means that percentages do not necessarily add up to 100 percent. For example, if there are 5 botnet breaches, the sample size is 5. However, since each botnet used phishing, installed keyloggers, and used stolen credentials, there would be 5 social actions, 5 hacking actions, and 5 malware actions, adding up to 300 percent. This is normal, expected, and handled correctly in our analysis and tooling.

Another important point is that, when looking at the findings, “unknown” is equivalent to “unmeasured.” Which is to say that if a record (or collection of records) contain elements that have been marked as “unknown” (whether it is something as basic as the number of records involved in the incident, or as complex as what specific capabilities a piece of malware contained) it means that we cannot make statements about that particular element as it stands in the record—we cannot measure where we have too little information. Because they are “unmeasured,” they are not counted in sample sizes. The enumeration “Other” is, however, counted as it means the value was known but not part of VERIS. Finally, “Not Applicable” (normally “NA”) may be counted or not counted depending on the hypothesis.

Data Subsets

We already mentioned the subset of incidents that passed our quality requirements, but as part of our analysis there are other instances where we define subsets of data. These subsets consist of legitimate incidents that would eclipse smaller trends if left in. These are removed and analyzed separately (as called out in the relevant sections). This year we have two subsets of legitimate incidents that are not analyzed as part of the overall corpus:

1. We separately analyzed a subset of web servers that were identified as secondary targets (such as taking over a website to spread malware).

2. We separately analyze botnet-related incidents.

Both subsets were separately analyzed last year as well.

Finally, we create some subsets to help further our analysis. In particular, a single subset is used for all analysis within the DBIR unless otherwise stated. It includes only quality incidents as described above and the aforementioned two subsets.

Non-incident data

Since 2015, the DBIR includes data that requires the analysis that did not fit into our usual categories of “incident” or “breach.” Examples of non-incident data include malware, patching, phishing, DDoS, and other types of data. The sample sizes for non-incident data tend to be much larger than the incident data, but from fewer sources. We make every effort to normalize the data, (for example reporting on the median organization rather than the average of all data). We also attempt to combine multiple contributors with similar data to conduct the analysis wherever possible. Once analysis is complete, we try to discuss our findings with the relevant contributor or contributors so as to validate it against their knowledge of the data.

Appendix C: Watching the watchers

Last year in the “Feeling vulnerable?” appendix, we discussed the services or weaknesses attackers look for in spray and pray internet scans, and how those aren’t necessarily the same things they look for in targeted attacks. In this section, we again examine what services are open to the internet and the adversary activity against them. At the risk of stating the obvious, what the attacker looks for tells you a great deal about what is of value to them.

Any port in a storm

Ports that offer at least some value to, and at the same time require the least amount of investment from the attacker garner a lot of attention. An economist might call the amount invested by the actor per attack the marginal cost. The very best attacks from the criminal’s point of view would cost almost nothing per target. We will refer to these as zero-marginal-cost attacks.

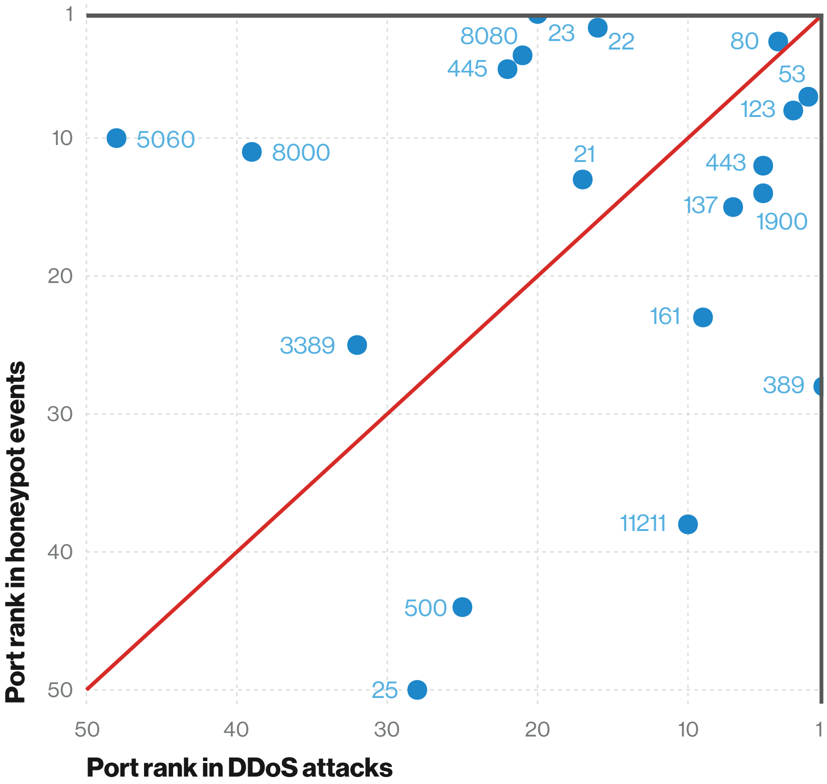


Figure 65. Comparison of ports in DDoS and honeypot attacks

Figure 65 illustrates the ports that are in the top 50 for both honeypot activity and DDoS attacks (with “1” in the upper right being the most common and the rest decreasing from that point). We can consider how often attackers look for a given port as an indicator for how valuable they are to the attacker. Ports below the red line, such as cLDAP (389), DNS (53), and NTP (123) are more valuable due to their DDoS amplification potential. The ports above the red line are more valuable for their non-DDoS malevolence including SSH (22), telnet (23), HTTP (8080), NetBIOS (445), and others.

Portémon Go

Probably the most effective way to judge perceived value for the attacker for a given port in zero-marginal-cost attacks is to examine their ranking in honeypot scans vs their general population ranking on the internet. There are a myriad of organizations that scan the internet regularly, and there are a few of those who are gracious enough to contribute to the DBIR. As a result, we can share this data in Figure 66.

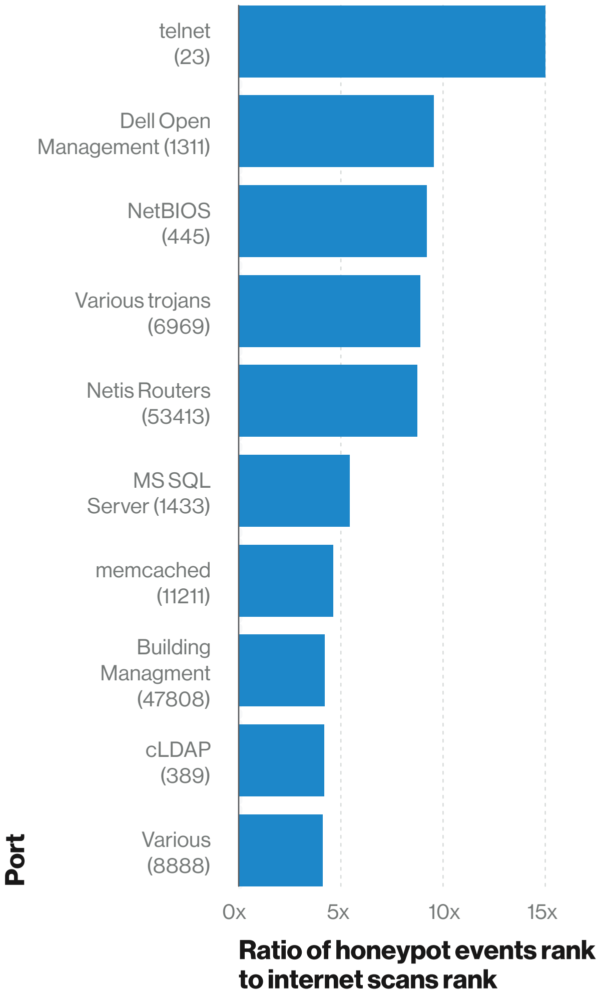


Figure 66. Ports scanned for more often than they exist

Figure 66 lists the top 10 ports by ratio of honeypot activity to internet prevelance.[20] Some of these, for example, Telnet, NetBIOS, and SQL Server – legacy services with known weaknesses that are old enough to vote – may not be as common as dirt, but they still exist and when an attacker finds them you can almost hear the intro to Pink Floyd's "Money" floating in the ether. If your organization has any of these services exposed to the internet, it's probably a good idea to go and take care of that now. We'll wait here. Take your time. This report changes once a year, but those ports are being hammered daily.

Dime a dozen

The above section begs the question, "If those ports are what attackers frequently search for but rarely find, which open ports are plentiful but rarely sought?"
We are glad you asked. For the most part they are unassigned or ephemeral ports. Of more interest are the ports that appear in vulnerability scans, but do not show up in honeypots. Figure 67 gives us some insight into that area. The main takeaway is that there are a lot of ports far down on the list from a honeypot perspective (the big cluster in the lower left of the figure) that get reported often in vulnerability scans. Those are the vulnerabilities that may be useful for attackers but either only for niche attacks or internal pivoting, or are of absolutely no interest whatsoever to the attacker.

[20] For example, if a port was the top ranked port in honeypot scans and the 15th most common on the internet, its ratio would be 15x.

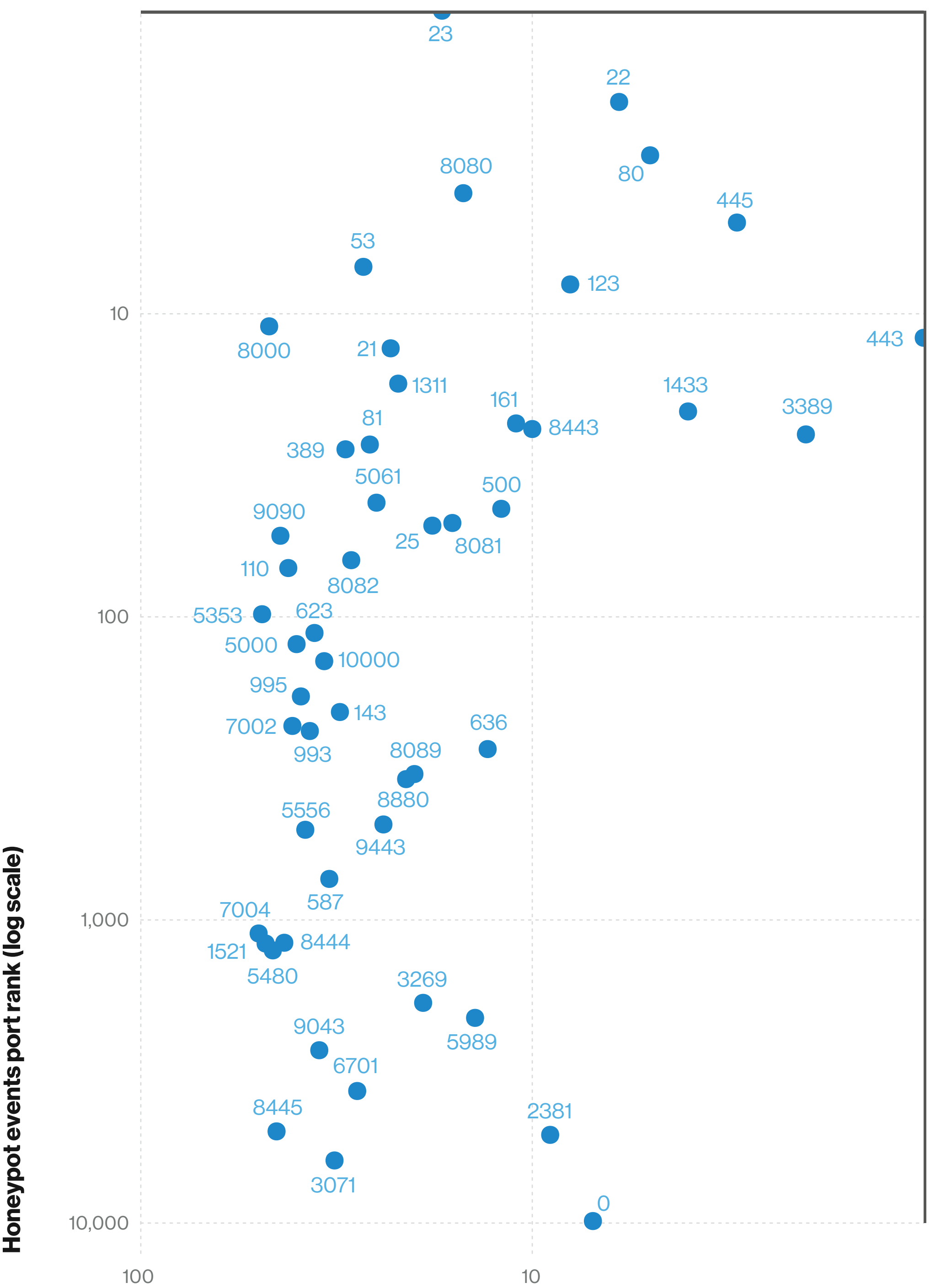


Figure 67. Comparison of ports in vulnerability scans and honeypot events

Take action

There may only be seven seas, but there are 65,535 ports. While not all are found in the figures above, a great many are. So now what? We suggest you take a look to ascertain if you are vulnerable to any zero-marginal-cost attacks (easily identified by their honeypot to internet scan ratio). If so, you are operating below a critical security threshold and you need to take action to get above it. Are you running a honeypot yourself? If not, why is that port open? Finally, take a cue from the Unbroken Chains section and be smart about what else you mitigate. Understand the paths attackers are most likely to take in order to exploit those services.

Appendix D: Contributing organizations

SOCIAL-ENGINEER

UNITED STATES SECRET SERVICE

edgescan™

FEDERAL BUREAU OF INVESTIGATION INTERNET CRIME COMPLAINT CENTER IC3

bit-x-bit SM

Gillware™

U.S. DEPARTMENT OF HOMELAND SECURITY CISA CYBER+INFRASTRUCTURE

Qualys. Continuous Security

RAPID7

BeyondTrust

Center for Internet Security®

Carnegie Mellon University Software Engineering Institute

MOSSADAMS

LARES

DELL

BE

NetDiligence®

CISCO™

swisscom

CROWDSTRIKE

Akamai

CYLANCE®

CIRCL Computer Incident Response Center Luxembourg

zscaler™

digital shadows_

Check Point SOFTWARE TECHNOLOGIES LTD

EMERGENCE

apura

ATTACKIQ

VCDB

SHODAN

GRA QUANTUM

FORTINET

KASPERSKY lab

GRUPO DE DELITOS TELEMATICOS

MALICIOUS STREAMS

DRAGOS

NCFTA

wandera

PALADION
HIGH SPEED CYBER DEFENSE

KnowBe4
Human error. Conquered.

CyberSecurity
MALAYSIA
An agency under MOSTI

BITSIGHT
The Standard in SECURITY RATINGS

Digital Edge
STABILITY ▮ SECURITY ▮ EFFICIENCY ▮ COMPLIANCE

WINSTON & STRAWN
LLP

LIFARS
your digital world, secured

MWR
an F-Secure company

AVANT
RESEARCH GROUP

IRISS
Irish Reporting and
Information Security Service

NETSCOUT

Recorded
Future

VESTIGE
Digital Investigations

INTERSET

DFDR
CONSULTING

McAfee™

CERT-EU
FOR THE EU INSTITUTIONS, BODIES AND AGENCIES

paloalto
NETWORKS®

Mishcon de Reya

tripwire®

proofpoint.
Security Awareness Training

JPCERT CC®

GOVERNMENT OF TELANGANA

CHUBB®

HSC
HYDERABAD SECURITY CLUSTER

S21 SEC

A

Akamai Technologies
Apura Cyber Intelligence
AttackIQ
Avant Research Group, LLC

B

BeyondTrust
BinaryEdge
BitSight
Bit-x-bit

C

Center for Internet Security
CERT Insider Threat Center
CERT European Union
Checkpoint Software Technologies Ltd
Chubb
Cisco Security Services
Computer Incident Response Center Luxembourg (CIRCL)
CrowdStrike
Cybercrime Central Unit of the Guardia Civil (Spain)
CyberSecurity Malaysia, an agency under the Ministry of Science, Technology and Innovation (MOSTI)
Cylance

D

Dell
DFDR Forensics
Digital Edge
Digital Shadows
Dragos, Inc

E

Edgescan
Emergence Insurance

F

Federal Bureau of Investigations Internet Crime Complaint Center (FBI IC3)
Fortinet

G

Gillware Digital Forensics
Government of Telangana, ITE&C Dept., Secretariat
GRA Quantum
GreyNoise Intelligence

I

Interset
Irish Reporting and Information Security Services (IRISS-CERT)

J

JPCERT/CC

K

Kaspersky Lab
KnowBe4

L

Lares Consulting
LIFARS

M

Malicious Streams
McAfee
Mishcon de Reya
Moss Adams (formerly ASTECH consulting)
MWR InfoSecurity

N

National Cyber-Forensics and Training Alliance (NCFTA)
NetDiligence
NETSCOUT

P

Paladion
Palo Alto Networks
Proofpoint

Q

Qualys

R

Rapid7
Recorded Future

S

S21sec
Shodan
Social-Engineer, Inc.
SwissCom

T

Tripwire

U

US Secret Service
US Computer Emergency Readiness Team (US-CERT)

V

VERIS Community Database
Verizon Cyber Risk Programs
Verizon Digital Media Services
Verizon DOS Defense
Verizon Managed Security Services
Verizon Network Operations and Engineering
Verizon Professional Services
Verizon Threat Research Advisory Center
Vestige Ltd

W

Wandera
West Monroe Partners
Winston & Strawn LLP

Z

Zscaler

2019 Data Breach
Investigations Report