

# Android Security & Privacy 2018 Year In Review

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March 2019

Celebrating 10 years of Android

**android**



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# Overview

This being our fifth Year in Review it is very special in that it coincides with the tenth anniversary of Android. Dianne Hackborn said it best in her blog post [Celebrating a Sweet Decade of Android](#):

“

Ten years ago, we introduced the first version of the Android operating system with the T-Mobile G1, and launched Android Market (now Google Play) the very same day. Android has grown up a lot since then—there are now more than 2 billion active Android devices around the world.

The operating system itself has gone through some major transformations, too. The G1 ran on Android 1.0—a version so early, we didn't even name it after a dessert. The debut included features that you know and love today like pull-down notifications, sharing content across apps and multitasking between apps. But it didn't have more advanced features like voice search, turn-by-turn navigation or NFC. 10 years later, we've come a long way! Our latest release of the operating system, Android 9 Pie, has all of those features and harnesses the power of artificial intelligence to make your phone smarter, simpler and more adaptive. ”

Every new Android version released comes with new features, improvements, and security enhancements. The data discussed in this report shows that Android becomes more secure with every major version. The major security enhancements are documented on [source.android.com](https://source.android.com) in the [Enhancements](#) section.

## Our Strategy

The Android security team's mission is to protect every one of the more than two billion Android users. We do this through massive investment and continuous improvement in our security and privacy technology and operations.

Our strategy can be broken down into the following three pillars:



### Layered Security

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We apply a layered approach to protection. Each layer in the Android security model works together to build a strong defense that runs smoothly and effectively. The main layers of Android security include:

- Operating system defense
- App safety defense
- Human research and analysis
- Security development lifecycle



### Transparency

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Transparency and openness are the foundation of Android. We firmly believe that transparency creates trust, while closed platforms lead to distrust and a dangerous false sense of security through obscurity. Android transparency goes well beyond the open source nature of the operating system itself. Our team regularly publishes threat research, blogs about new features, and distributes comprehensive monthly bulletins of security fixes. We also recently launched our [Android ecosystem transparency report](#), which is refreshed quarterly, and we publish a myriad of information on our recently updated [Android Security Center](#) website, which provides easier access to our blogs, videos, and reports.



### Backed by Google

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Android is backed by Google which means that our security team collaborates with some of the best security and computer science professionals in the industry, with world class expertise in identity management, artificial intelligence, privacy research, and cloud security.

## The best of Android Security & Privacy in 2018

The broadest statistic for measuring device hygiene is how frequently a full-device scan detects Potentially Harmful Applications (PHAs). Google Play Protect, Android's built-in defense mechanism, is incredibly effective at keeping PHAs out of Google Play, but malicious apps can still be downloaded from other sources. These apps endanger not only the device but also threaten the sanctity of the Android environment. This is why Google Play Protect scans all apps installed on a device regardless of the source.

In 2018 only 0.08% of devices that used Google Play exclusively for app downloads were affected by PHAs. In contrast, devices that installed apps from outside of Google Play were affected by PHAs eight times more often. Compared to the previous year, even those devices saw a 15% reduction in malware due to the vigilance of Google Play Protect.

Android's security saw a strengthened application sandbox in 2018 along with hardened developer APIs with features like BiometricPrompt and an updated target API level for apps. The Android Security team continued their investment in hardware backed security through discrete tamper-resistant secure elements that enable the use of industry-first security APIs, such as [Protected Confirmation](#) and [Strongbox](#).

In 2018 we surpassed \$3 million in total reward program payouts.

Our Android security rewards programs allow us to work with top researchers from around the world to improve the security of the Android ecosystem. These programs offer some of the highest priced rewards in the industry.

Through a combination of platform improvements like [Treble](#), new original equipment manufacturer (OEM) agreements, and partner programs such as [Android Enterprise Recommended](#), the Android ecosystem has made significant progress in releasing security updates.

In the 4th quarter of 2018 we had 84% more devices receiving a security update than in the same quarter the prior year.

# Android platform security and privacy

Improving Android's security with every major [Android release](#) and [monthly security updates](#) is critical. However, in order to be even more effective, we must work to continuously increase security without putting a burden on our end users. A layered security model is part of our fundamental design principle and is a foundation of Android's architecture. The Android platform controls how the operating system works and how apps interact with other apps, device hardware, and other services. Supported by Google Play Protect, Android is protected around the clock. The following table lists some of these protections that are designed to provide better platform-level security.

Platform security feature	Protection
Encryption	Protects data from unauthorized access.
Hardware-backed security	Strengthens key storage and cryptographic services and enables strong remote authentication.
Kernel self-protections	Protects the kernel against memory corruption vulnerabilities and other security flaws in kernel components and drivers.
Sandboxing	Keeps each app in a separate space, protecting its data and processing from other apps.
SELinux	Provides an auditable definition of—and enforcement of—security boundaries on all operating system and app components above the kernel.
Userspace hardening	Protects the operating system and apps against memory corruption vulnerabilities and other security flaws; includes address space layout randomization (ASLR), data execution prevention (DEP), and Control Flow Integrity (CFI).
Verified boot	Cryptographically verifies that the operating system starts in a known good state.

## Updates and features

With Android 9, we added a myriad of great security features. We strengthened the application sandbox and hardened the developer APIs. We continued to invest in hardware-backed security via the [trusted execution environment \(TEE\)](#) and on select devices through discrete tamper-resistant hardware. We also layered a set of privacy preserving enhancements and adopted more anti-exploitation techniques so that bugs don't turn into exploitable vulnerabilities.

Learn more about all of the Android 9 security and privacy features at [Android Pie à la mode: Security & Privacy](#).

## Vulnerability rewards and updates

The Android Security & Privacy team oversees many programs to provide more frequent security updates to Android devices. In 2018, we have continued our close collaboration with Android partners to keep devices secure.

### Android security rewards programs

Our [Android](#) and [Play Security Rewards](#) programs help us work with top researchers from around the world to improve Android ecosystem security every day.

Learn more about the rewards program at [Android and Google Play Security Rewards Programs surpass \\$3M in payouts](#).

### Security research competitions and zero day vulnerabilities

The Android Security & Privacy team participated in a number of external vulnerability discovery and disclosure competitions, including [Mobile Pwn2Own](#), which took place at the PacSec conference in Tokyo, Japan. At this event, researchers were rewarded for demonstrating working exploits against major mobile operating systems. Exploits against Google Pixel devices were categorized in the top reward category along with other devices such as the iPhone. No exploits successfully compromised Google Pixel devices and none of the exploits demonstrated against devices running Android utilized a security vulnerability in the Android operating system. Further, in 2018, no critical security vulnerabilities affecting the Android platform were publicly disclosed without a security update or mitigation available for Android devices.

### Researcher partnerships

The Android security team worked closely with leading security researchers to identify and integrate unique technology into the Android ecosystem to help increase the security of devices. One example of this was SnoopSnitch, an independently developed technology by [Security Research Labs \(SRLabs\)](#) that has the ability to detect if an Android device is protected against all of the security vulnerabilities covered in the security patch level (SPL). We worked closely with SRLabs to evaluate, improve, and integrate elements of this technology into the development workflows used by all Android device manufacturers.

### Android security updates program

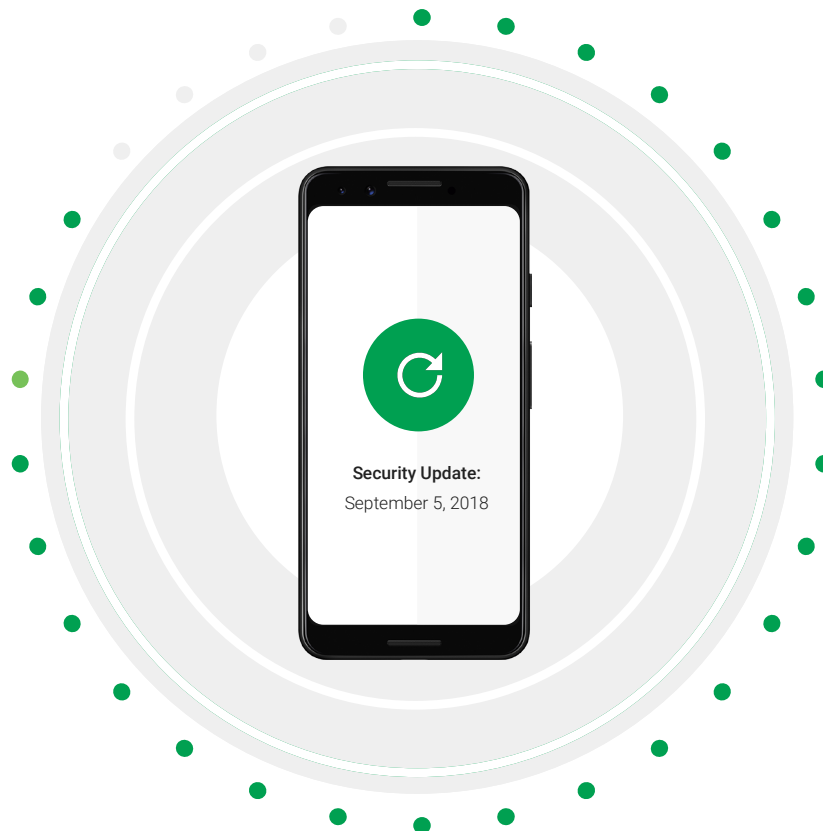
Google mitigates security vulnerabilities discovered through the [Android Security Rewards program](#) and additional engagements through regular Android security updates. In 2018, we continued to work with Android device manufacturers, mobile network operators, and system-on-chip (SOC) vendors to increase the number of devices receiving regular security updates. Through our combined efforts, which include platform improvements, new OEM agreements, and partner programs such as [Android One](#) and [Android Enterprise Recommended](#), we've made significant progress in releasing the latest Android security updates. In fact, in the 4th quarter of 2018 we had 84% more devices receiving a security update than in the same quarter the prior year.

As of December 2018, over 95% of deployed Google Pixel 3 and Pixel 3 XL devices were running a security update from the last 90 days.

### App security improvements program

The [App Security Improvement program](#) helps identify potential security issues. Before any app is accepted into Google Play, it's scanned for safety and security issues. To date the program has helped over 300,000 developers remediate over 1,000,000 Play applications.

Learn more about this program and all of it's updates at [Helping developers harden their apps, one thwarted vulnerability at a time.](#)



<https://t.me/learningnets>

# Google Play Protect

**The most widely deployed mobile threat protection service in the world**

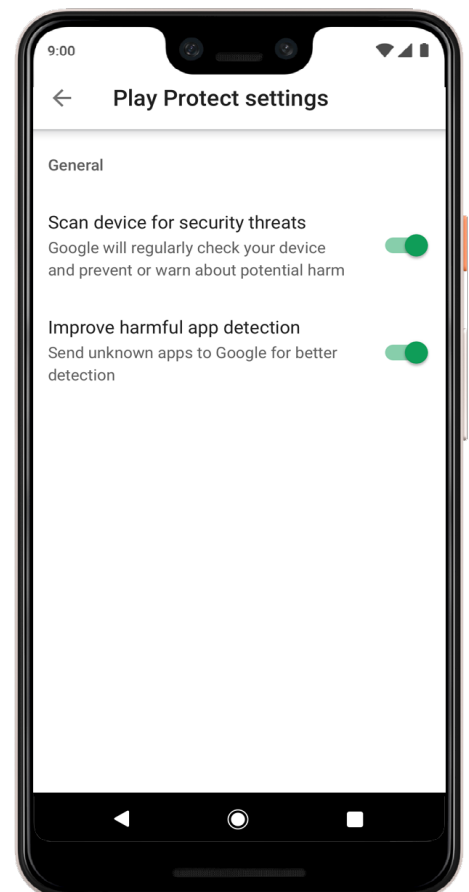
Google Play Protect debuted in 2017, combining new and existing Android security features, and quickly became the most widely deployed mobile threat protection service in the world. Every device with Google Play Protect has on-device protections that also leverages a cloud-based infrastructure that keep the device secure and its data private.

Google Play Protect scans over 50 billion apps every day across more than two billion devices.

Google Play Protect works hard to keep harmful apps out of Google Play and off of user's devices. By analyzing and reviewing upwards of 500,000 apps daily in its cloud-based vetting process, Google Play Protect helps keep harmful apps from ever reaching Google Play.

You can learn all about Google Play Protect's existing client-side and backend features as well as details about every Potentially Harmful Application (PHA) category on the newly launched [Google Play Protect developer site](#).

## Google Play Protect Settings



## New features and improvements in Google Play Protect and Find My Device

In 2018, Google Play Protect made Android devices running Google Play some of the most secure smartphones available, with a series of new updates that give our users even greater protection:

- Google Play Protect is now enabled by default to secure all new devices, right out of the box.
- We launched a new feature that notifies users when they are installing apps outside of the Google Play Store that are new or rarely installed in the ecosystem.
- We created a new, contextual warning dialog in Google Play Protect that warns users when they are about to launch a potentially harmful app on their device.
- We extended our coverage of automatically disabled apps to include those that violate Google Play policies, such as privacy issues and deceptive behavior or content.

To learn more about these changes, read our write-up: [Google Play Protect in 2018: New updates to keep Android users secure.](#)

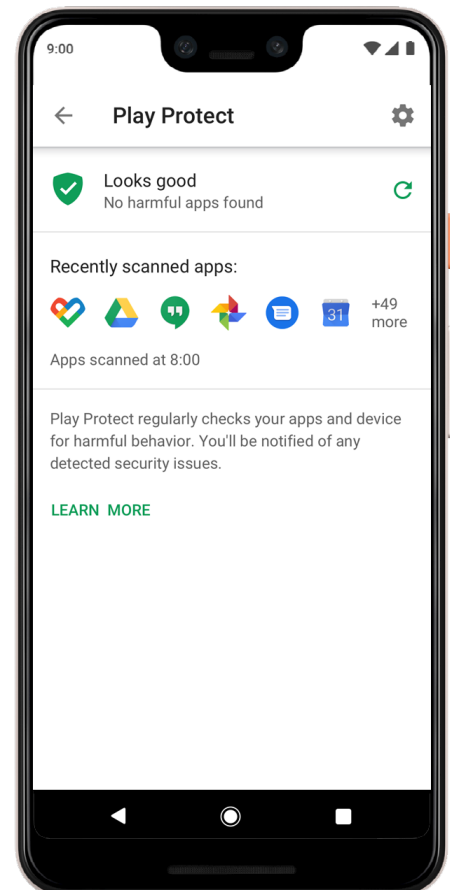
Find My Device also benefited from a few new changes as well, including:

- We added support for indoor maps so individuals can more easily locate lost devices in large buildings, such as airports.
- We allow users to register the devices in Find My Device using a work profile.
- We prompt the user to perform a [Security Checkup](#) if they remotely lock a device.
- We display device-specific information, such as IMEI and device registration date, right in the app.

## Improvements in cloud-based security analysis

In 2018, we continued to expand Google Play Protect's machine-learning capabilities by exploring different techniques and leveraging knowledge from all across Google. To learn more, read our blog post: [Keeping 2 billion Android devices safe with machine learning.](#)

### Google Play Protect status screen



The Android Security and Privacy team also uses machine learning to dramatically increase our ability to detect and classify PHAs. Learn more about some of the datasets that make the training and implementation of machine learning models possible by reading our write-up: [Combating Potentially Harmful Applications with Machine Learning at Google: Datasets and Models](#).

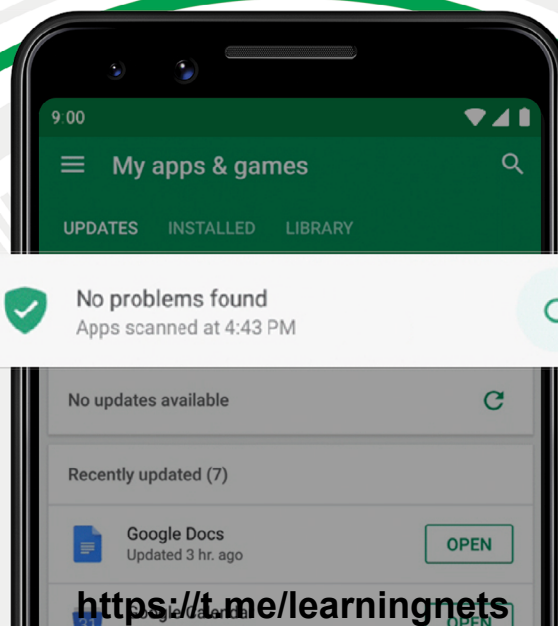
## System image scanning

In the [Android Security 2017 Year in Review](#) report, we announced that we had begun scanning for pre-installed PHAs across many software builds for devices with Google services. In 2018, we expanded this program and launched it as Build Test Suite (BTS) for partner OEMs.

BTS is similar to the [Compatibility Test Suite \(CTS\)](#). OEMs submit their new or updated build images to BTS. BTS then runs a series of tests that look for security issues on the system image. One of these security tests scans for pre-installed PHAs included in the system image. If we find a PHA on the build, we work with the OEM partner to remediate and remove the PHA from the build before it can be offered to users.

During its first calendar year, BTS prevented 242 builds with PHAs from entering the ecosystem.

Anytime BTS detects an issue we work with our OEM partners to remediate and understand how the application was included in the build. This teamwork has allowed us to identify and mitigate systemic threats to the ecosystem. Through the BTS program, we discovered, analyzed, and remediated PHA families such as Chamois and EagerFonts, which are described in detail in the [PHA Families](#) section. In 2019, we're continuing our commitment to vetting approved Android devices for security issues.



# Ecosystem data

A variety of systems work together to gather information about Potentially Harmful Application (PHA) categories in the Android ecosystem, both inside and outside of Google Play. For example, SafetyNet gathers information on the big picture over time using anonymized device telemetry to track PHAs, which provides insights on security-related services use. In contrast, Verify Apps focuses on details by scanning apps for PHAs before users install them.

## Potentially Harmful Applications (PHAs)

Potentially Harmful Applications (PHAs) are apps that could put users, user data, or devices at risk. Common PHA categories include trojans, spyware, and phishing apps. In 2018, we started tracking click fraud as a PHA category. Click fraud apps simulate clicks on advertisements without user consent.

### User-wanted PHAs

Some apps with attractive features also weaken Android's built-in security. When users try to install these apps, Google Play Protect warns users about potential hazards so that they can make informed decisions. Our statistics separate these from classic "malware" PHAs. For example, Google Play Protect warns users about apps that disable Android security features, such as SELinux, or root the device with disclosure and user consent. Google Play Protect discourages changes that lower Android's built-in security protections, but allows individuals to choose the risks that they are willing to take with their devices.

A warning message is displayed to the user anytime a PHA installation is detected. If they decide to ignore this warning and proceed with the installation, they will not receive further security warnings about that app. Interrupting the Android user experience with constant warnings would make Google Play Protect more annoying than useful.

In 2018, user-wanted PHAs comprised 0.11% of app installations downloaded outside of Google Play (Google Play doesn't allow any security-breaking apps even if they are user-wanted).

### Mobile unwanted software (MUwS)

Google defines unwanted software (UwS) as apps that aren't strictly malware, but are harmful to the software ecosystem. Mobile unwanted software (MUwS) impersonates other apps or collects at least one of the following without user consent:

- Device phone number
- Primary email address
- Information about installed apps
- Information about third-party accounts

Google Play policies prohibit MUwS, but users who decide to install software from outside of Google Play can still be affected by MUwS. To combat this issue, in 2018 Google Play began warning users about MUwS if they initiate a download from outside of Google Play. With this change, the total number of install attempts coming from MUwS apps declined from 2.09% in 2017 to 0.75% in 2018.

### Changes in methodology

In 2018, we changed some of our methodology, which led to some variances in numbers in this report compared to last year. These changes include:

- Added click fraud to our PHAs definitions
- Introduced the concept of **user-wanted PHAs**. These apps are classified as PHAs, but are intentionally installed by users who want them for their unique system capabilities. For example, power users install apps to root their device or disable security settings, such as SELinux
- Introduced the **don't-warn-again** concept. If Google Play Protect flags apps as PHAs, users receive a warning at the time of install, allowing them to make an informed decision to continue or cancel the installation. If they proceed, this specific installation is removed from the metrics for PHAs used for calculating device hygiene

### Threat landscape changes

In 2018, there were two notable changes to the Android threat landscape: an increase in pre-installed PHAs and backdoored SDKs (software development kits).

#### *Pre-installed PHAs*

Malicious actors increased their efforts to embed PHAs into the supply chain using two main entry points: new devices sold with pre-installed PHAs and over the air (OTA) updates that bundle legitimate system updates with PHAs. Neither entry point requires action from users, making them difficult to defend against.

There are three possible reasons for an increase in the number of pre-installed PHAs.

First, the developers of pre-installed PHAs only need to deceive the device manufacturer or another company in the supply chain instead of large numbers of users, so it's easier to achieve large-scale distribution. Even a less popular device model can compromise hundreds of thousands of users through one pre-installed harmful application.

Second, pre-installed PHAs can gain more privileged access to the device, so it's easier to execute malicious behavior that would usually be blocked by Android's security model. At the same time, these additional privileges allow PHAs to defend against security tools or removal attempts by users.

Third, large families of PHAs used exploits to root devices, but this is increasingly more difficult due to Android's constantly improving security model which blocks privilege escalation exploits to achieve similar privileges and defense levels for regular apps. Developers of these apps know that it is easier to compromise the supply chain of device manufacturers than to attack the Android platform security model.

To combat the problem of pre-installed PHAs, the Android Security team launched a security program in 2017 as part of the Android device certification process. We expanded the program in 2018 and now every new Android-certified device goes through the same app scanning process as apps on Google Play. Additionally, our security scanner looks for other common security and privacy issues and denies device certification until device manufacturers fix these problems.

### *Backdoored SDKs, apps, and other code*

Some SDKs appear legitimate, but include behaviors and functionality that the app developer may not have known about when they included the SDK. This functionality may compromise user data, device integrity, or experience. It may also be used as a part of a larger initiative, such as committing click fraud, mining cryptocurrency, or app install attribution fraud.

Here are some approaches developers use to include malicious code in legitimate SDKs:

- Backdoored SDKs with legitimate functionality
- Backdoored Android system code that injects the malicious code into every app on the device
- Modified Google apps with backdoor code injected
- Modified SDKs rehosted with similar names to confuse legitimate developers into accidentally downloading them

Hundreds of apps have been affected by backdoored code. We have been working with impacted developers to educate them about this new threat and to publish updated versions of their apps without the backdoor code.

## Device and ecosystem hygiene

The broadest statistic for measuring device hygiene is how frequently a routine full-device scan detects PHAs. Since we began to measure device hygiene in late 2014, an average of less than 1% of devices have PHAs installed at any point. This trend remained steady in 2018.

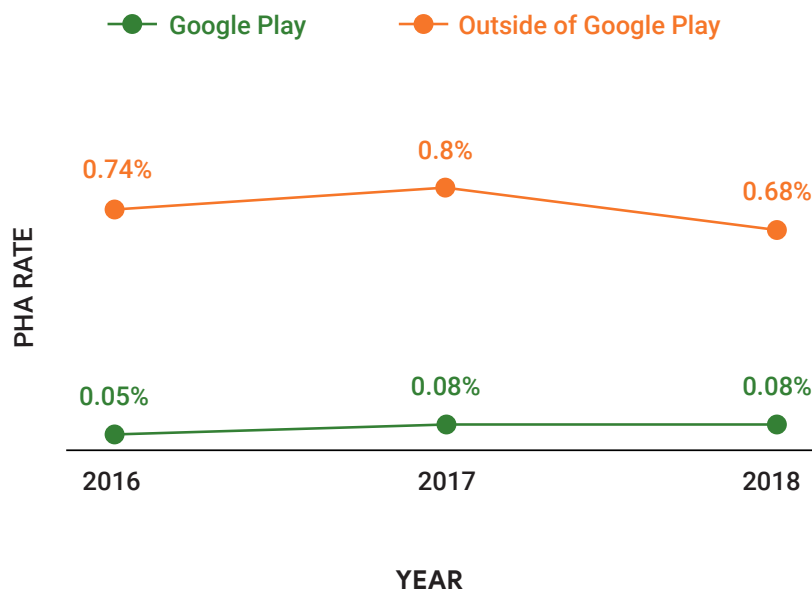
In 2018, 0.45% of all Android devices running Google Play Protect had installed PHAs, compared to 0.56% of PHA-affected devices in 2017. This equates to a 20% year-over-year improvement to the health of the Android ecosystem.

Apps available on Google Play must adhere to published policies and are reviewed to verify their compliance. Of the millions of apps published on Google Play, only 0.08% of devices that exclusively used Google Play had one or more PHAs installed (unchanged from last year).

In contrast, 0.68% of devices that installed apps from outside of Google Play were affected by one or more PHAs in 2018. While this number is 8 times higher than devices that exclusively used Google Play, it's a noticeable improvement from 0.80% in 2017.

Devices that installed apps only from Google Play were 8 times less likely to be affected by PHAs.

Percentage of devices with PHAs installed, 2016-2018

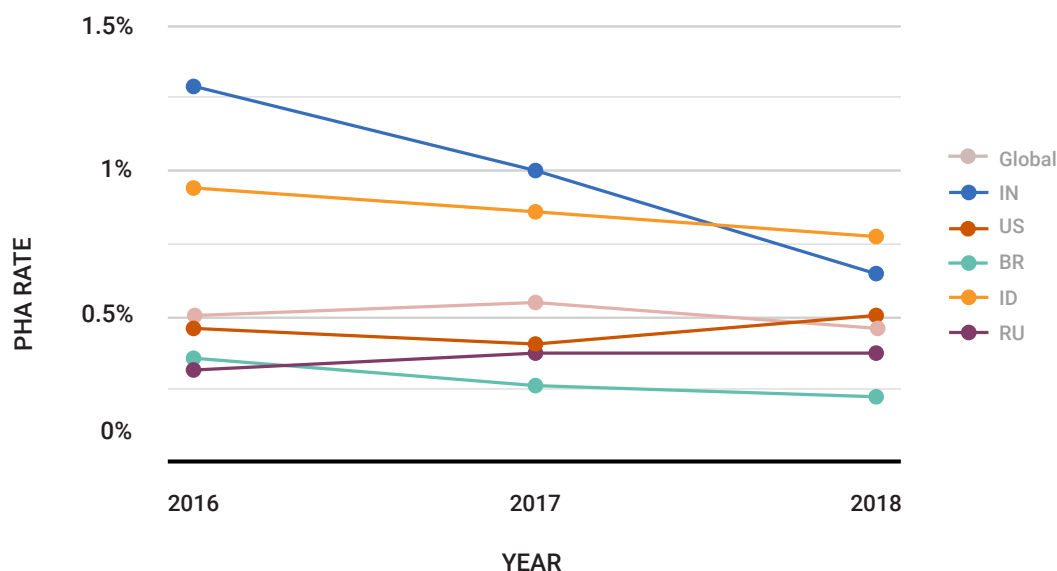


This graph shows the percentage of devices that were affected by PHAs over the past three years. The green line represents devices that only downloaded apps from Google Play while the orange line represents devices that also installed apps from outside of Google Play.

### Device hygiene in the largest Android markets

While Google Play and the overall Android ecosystem became safer in 2018, there is some variance based on the country of the device. Of the five largest Android markets, three (India, Indonesia, Brazil) became cleaner year-over-year, one (Russia) stayed at the same level, and for one the numbers went up (USA). These markets have unique challenges for threat severity and distribution of PHAs, so each is discussed in more detail in this section.

#### Device hygiene of the largest Android markets, 2018



In India, which is by far the biggest Android market, the number of devices affected by PHAs has decreased each year. In 2018, 0.65% of all Indian devices were affected by PHAs at any time, a 35% drop from the previous year. For the first time, India didn't have the highest device rate of PHAs among the top Android markets. In India, most PHAs were Trojans, backdoors, or hostile downloaders that downloaded more PHAs onto devices. These apps were introduced to users through supply chain attacks either in the form of pre-installed apps on new devices or OTA updates handled by untrustworthy OTA companies. Pre-installed apps from the EagerFonts, Snowfox, and Chamois families were the most common. For more details on these families, see PHA Families. Two apps outside of this category are versions of a popular video player that mines cryptocurrency in the background without user consent. Mobile devices have been damaged by cryptocurrency mining in the past, so we flag apps with this behavior as PHAs.

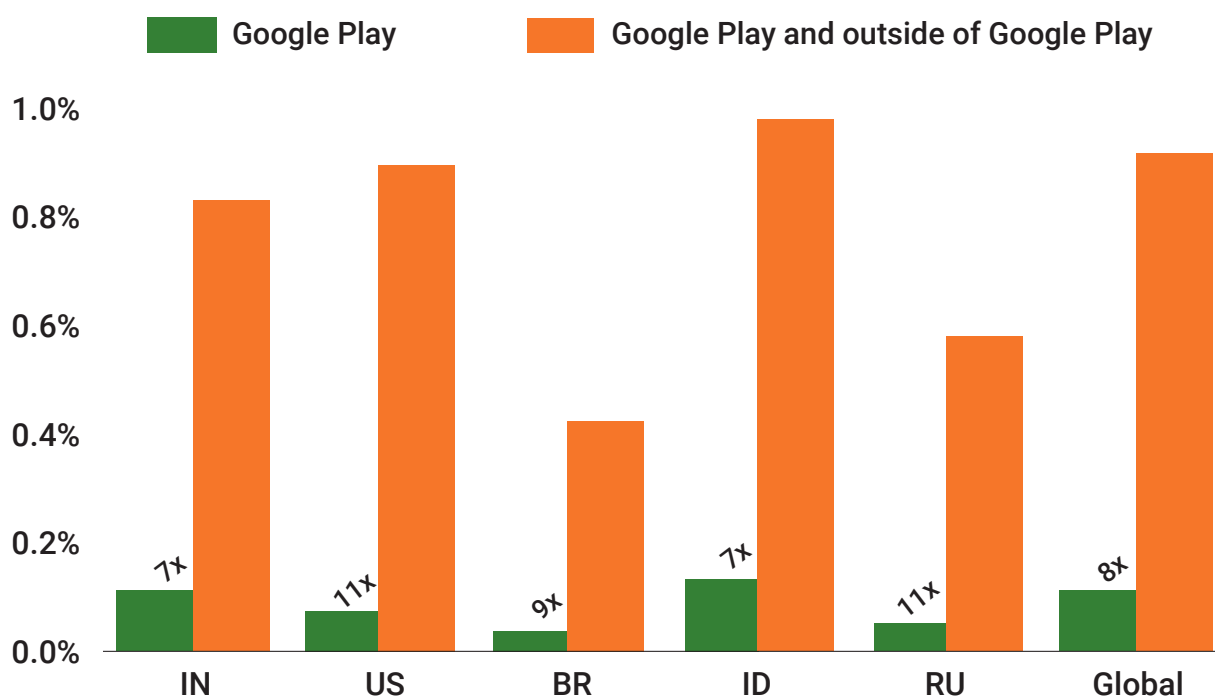
As in previous years, the USA is the second biggest Android market. In 2018, the number of impacted devices rose from 0.4% to 0.5% due to the introduction of click fraud as a PHA category. However, compared to India, the USA's context for PHAs is different and less severe. Eight of the top ten PHAs in the USA are wanted by users or don't significantly impact them directly. Of these eight, four are power-user tools for rooting devices or for circumventing other security settings and four are click fraud apps (of the CardinalFall and Snowfox families) that may harm advertising networks but not users. As a reminder, click fraud wasn't considered a PHA before 2018 and was treated only as a Google Play policy violation. Thus, the increase is significantly impacted by the inclusion of click fraud as a PHA category. Only two of the top ten are hostile downloaders or Trojans. In the USA, Of the top ten PHAs, only one was distributed pre-installed on the device, and that was limited to a single device type from one carrier.

Brazil continued to be the third-largest Android market in 2018. In 2017, and again in 2018, Brazilian Android devices were the cleanest among major markets with a 0.23% PHAs device rate (about half the global average). While the number of affected devices was lower than in other markets, the data suggests that Brazil, like India, still faces challenges in ensuring device integrity through the supply chain process. Four of the top ten PHAs in Brazil were pre-installed PHAs that were shipped on devices of a single Brazilian original equipment manufacturer (OEM). Two others were OEM-specific third-party stores from a different OEM that offered high numbers of PHAs to users for download. The remaining four PHAs on the top ten list were power user tools that disabled security settings to enable app piracy.

Indonesia is the fourth-largest Android market and the major market most affected by PHAs. Its overall landscape of PHAs looks similar to India's, likely because the Android OEMs and distributors targeting these countries are similar. That means Indonesia's Android PHAs are hostile and dangerous to users, and many PHAs come pre-installed on devices sold and used in Indonesia without end users' knowledge. Of the top ten PHAs in Indonesia in 2018, four were pre-installed Trojans posing as system settings apps, font manager apps, or quick search apps. Two others were Trojanized utility apps (a flashlight app and a camera app) for which the distribution vectors are unknown.

The last of the five largest Android markets is Russia. While below the world-wide average for PHA infections, Russia's infections are user-hostile and often pre-installed on devices. Seven of the top ten PHAs in Russia in 2018 were pre-installed Trojans. Several of those have been known to us since 2016 (Chamois family), which hints at a greater device longevity in Russia compared to the other surveyed countries. Two more of the top ten apps were problematic third-party app stores that either offer many PHAs for download or tamper with device security settings without user consent.

Percentage of devices with PHAs installed in 2018, by top countries



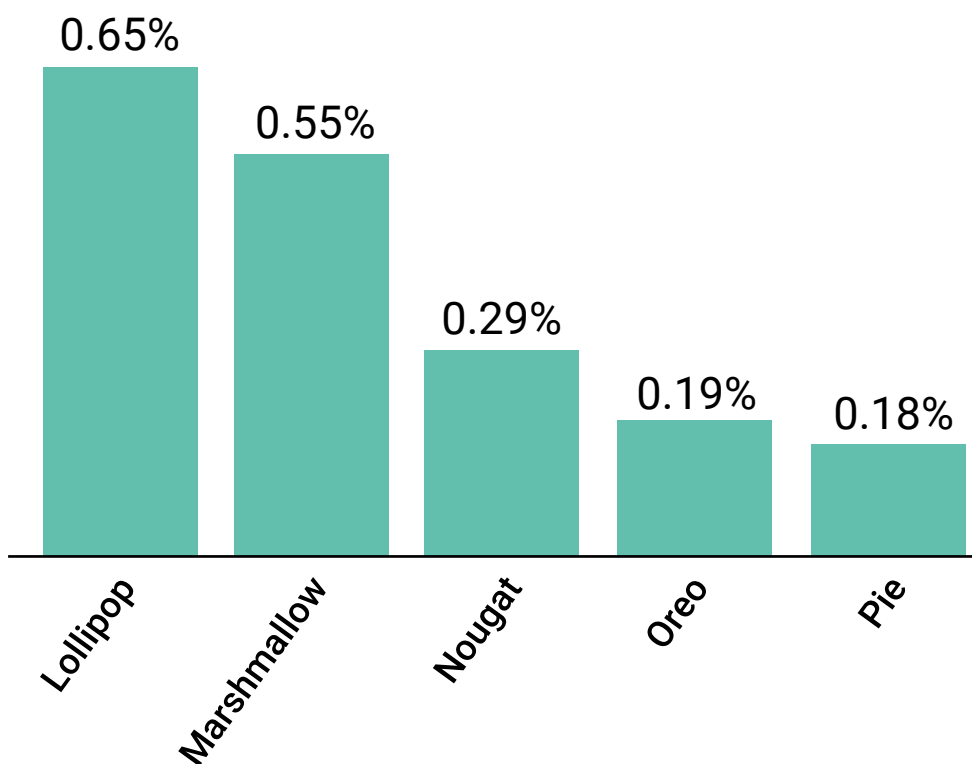
### Device hygiene by Android version

Newer versions of Android are less affected by PHAs.

Android 8 and Android 9 have PHA rates that are at 0.19% and 0.18% respectively.

We attribute this trend to advancements in platform security. In particular, newer Android versions are more resilient to privilege escalation attacks that previously allowed PHAs to gain persistence on devices and protect themselves against removal attempts. On newer versions, GPP is effectively cleaning PHAs. In conjunction with platform changes, GPP is preventing PHAs from protecting themselves from removal or disabling.

#### Percentage of devices with PHAs installed in 2018, by Android version

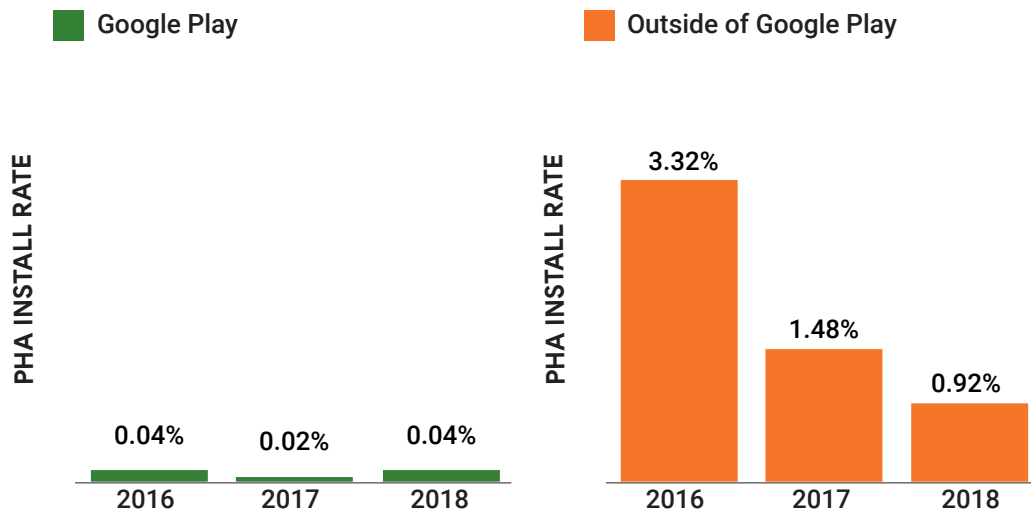


### PHA distribution analysis

The device hygiene metric discussed in the previous section provides a way to track how many devices have installed one or more PHAs. This section focuses on how those PHAs are distributed inside and outside of Google Play.

Many devices install from both inside and outside of Google Play, so device hygiene is a blended average of all distribution paths. Device hygiene varies across the ecosystem based on the number of apps users install, which ranges from zero to several hundred apps per device. To provide more insight into the root cause of changes in device hygiene, we also analyze the individual install events and distribution paths.

## Percentage of PHA installs by market segment, 2016-2018



PHA install rates from Google Play increased from 0.02% in 2017 to 0.04% in 2018 (+100% YoY). This increase is due to the inclusion of click fraud as a PHA category. As mentioned earlier, before 2018 click fraud wasn't considered a PHA and was treated only as a Google Play policy violation. If we remove the numbers for click fraud from these stats, the data shows that PHAs on Google Play declined by 31% year-over-year.

In Google Play, we can remove any app that shows PHA behavior. For apps outside of Google Play, this isn't the case. Because of this difference, in addition to actual installs, we also track installation attempts for apps installed from outside of Google Play. Not all installation attempts result in actual installs: if users heed the warning that an app is a type of PHA, they won't install the app. In particularly harmful cases, such as ransomware or banking phishing apps, Google Play Protect blocks the installation in addition to warning users.

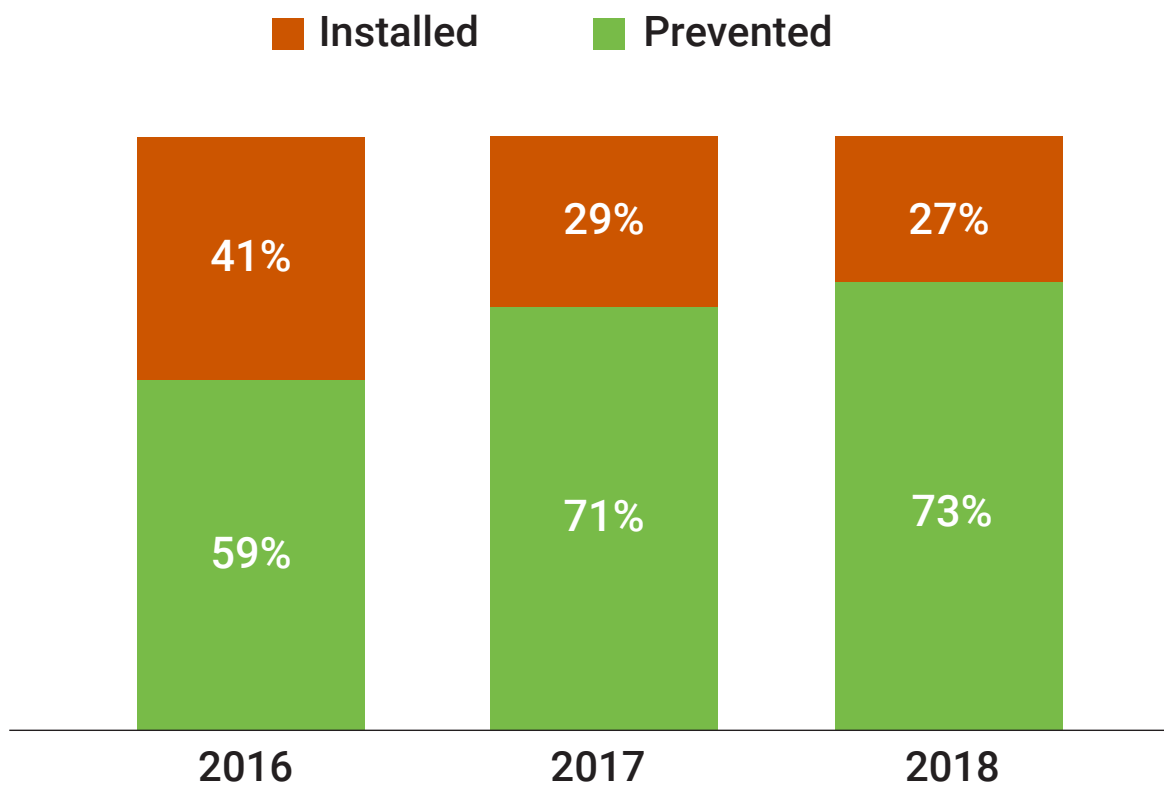
In 2018 the total number of app installations in Google Play grew 16% compared to 2017.

The sideloaded PHA install rate also showed a drastic reduction from 1.48% in 2017 to 0.92% in 2018 (-38% YoY).

Outside of Google Play, PHA installation attempts in 2018 fell by 20% from the previous year. Google Play Protect stopped 73% of PHA installations from outside of Google Play in 2018 compared to 71% in 2017 and 59% in 2016. The other 27% were a combination of apps that were installed before we identified them as PHAs and users who ignored Google Play Protect's warnings.

Google Play Protect prevented 1.6 billion PHA installation attempts from outside of Google Play in 2018.

PHA install attempts outside of Google Play, 2016-2018



**Google Play: PHA Trends**

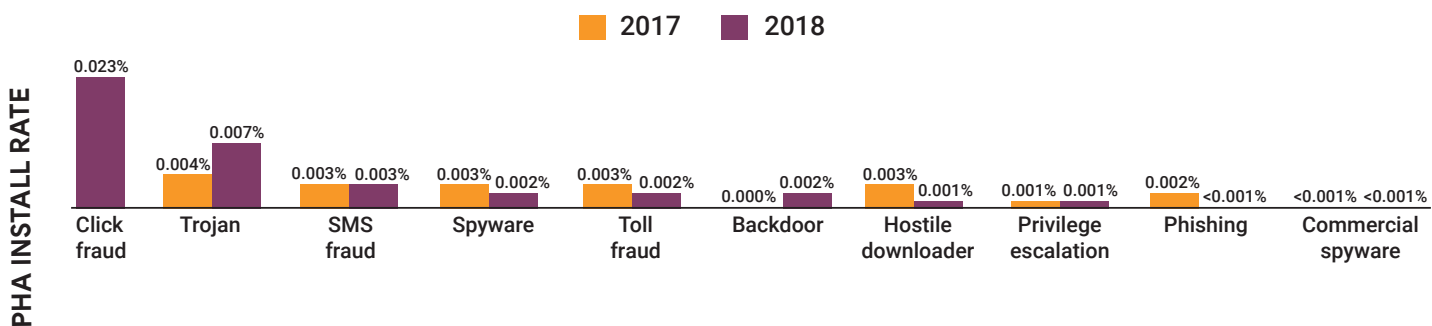
In 2018, 0.04% of all downloads from Google Play were PHAs. In 2017, the number was 0.02%. This increase is due to the change in methodology of upgrading the severity level of click fraud applications from policy violations to PHAs. If we omit the addition of click fraud for a comparison, 2018 is at 0.017% which is still a reduction from 2017. Now we look for click fraud inside and outside of Google Play and warn users about these apps. All other PHA categories have declined each year or increased at low levels.

The following sections highlight trends in the most important PHA categories on Google Play.

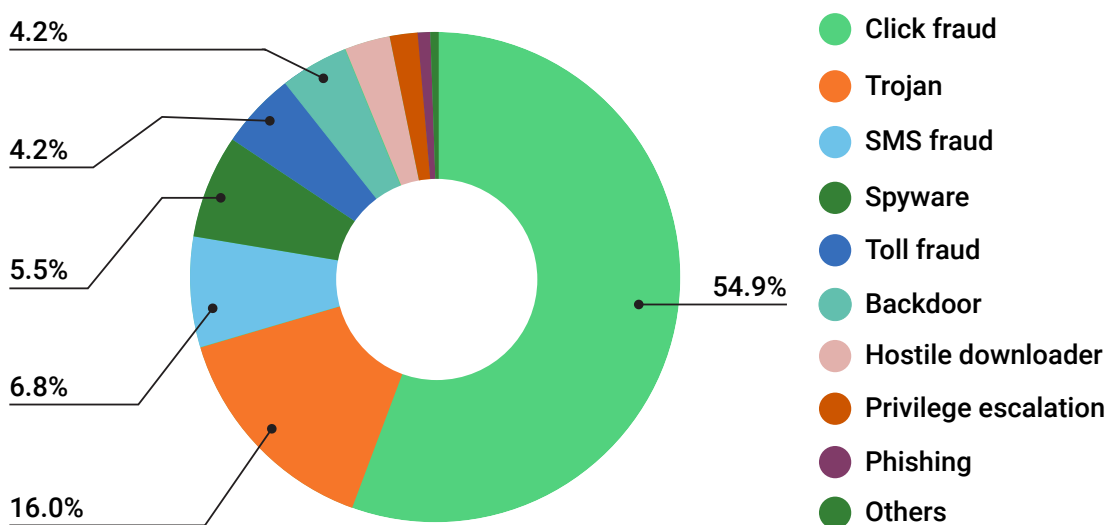
*Top PHA categories*

These charts compare all PHA categories by percentage. For example, click fraud installs accounted for 0.023% of all installs in Google Play during 2018.

Percentage of PHA installs by category in Google Play, 2017 vs. 2018



Distribution of PHA categories in Google Play, 2018



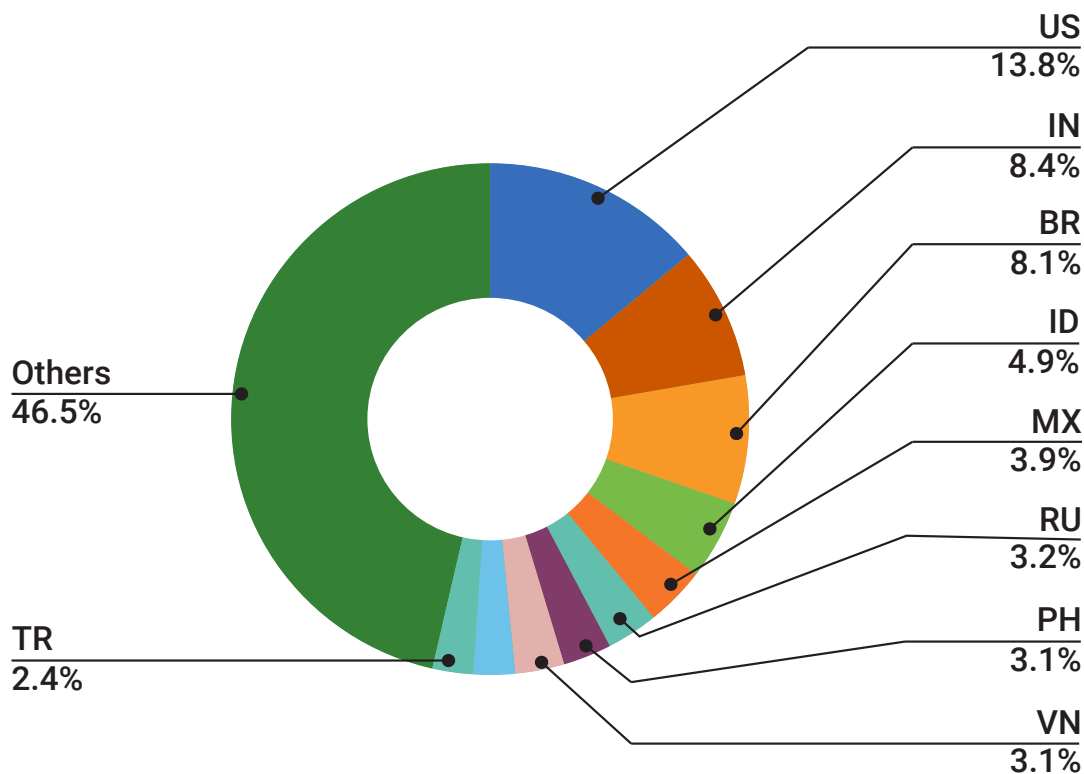
**Google Play: Click fraud**

In 2018, click fraud apps accounted for 54.9% of the total installation rate of PHAs (or 0.023% of all app installs). We recategorized click fraud apps from policy violations to PHAs, which increased Google Play Protect’s detection and removal of these apps. We expect click fraud to remain a profitable fraud vector, but at a lower scale than in 2018.

Last year, click fraud apps were mainly targeting the USA, Brazil, and Mexico.

While such apps do exist, it is hard to scale up and make money that way. Instead, these apps appear to have desirable features such as music or gaming, but an embedded SDK is executing click fraud in the background, often without the knowledge of the app developers themselves. Distributing click fraud code in this way is easily scalable and makes it easy for click fraud SDK developers to be present in the apps of hundreds or even thousands of developers.

Many of the major apps that we removed from Google Play in 2018 because of embedded click fraud code were flashlight, music player, or game apps. Click fraud developers build their code into apps that users tend to use daily and keep installed on their devices.

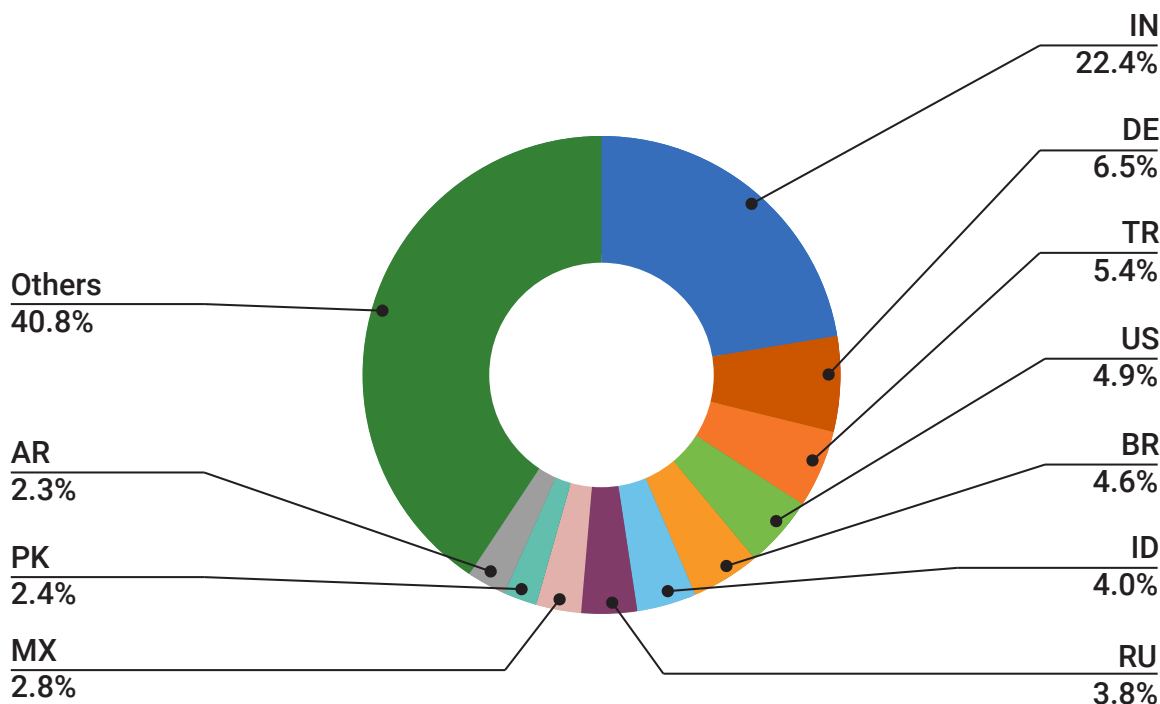


For details on two of the biggest click fraud families on Google Play, see [FlashingPuma](#) and [CardinalFall](#).

### Google Play: Trojan

In 2018, about 0.007% of all app installs on Google Play were Trojan applications, an increase of 0.004% compared to 2017. That's equivalent to about 16.0% of all PHA apps downloaded from Google Play last year. In 2018, Trojan apps were mainly targeting India, Germany, and Turkey.

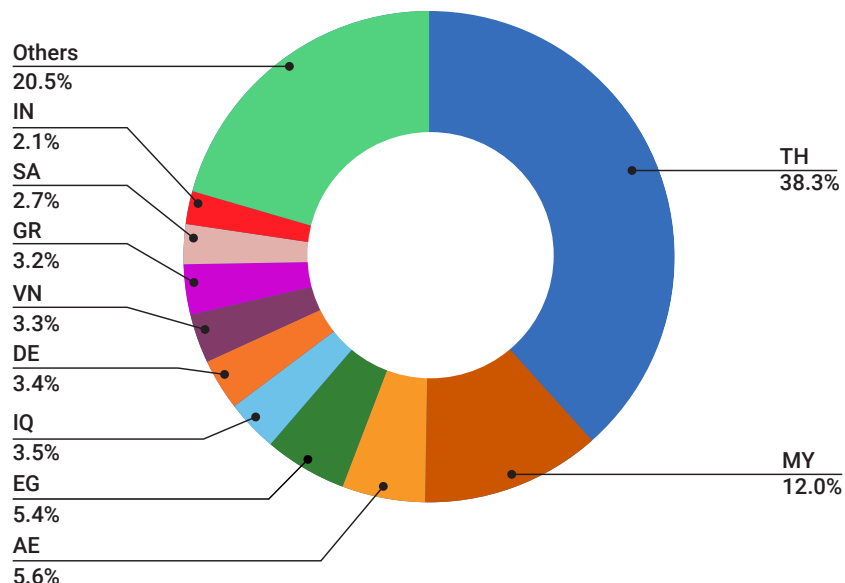
The vast majority of Trojan applications downloaded from Google Play fall into a single family called Idle Coconut which is distributed as an SDK to legitimate developers. When these developers include the Idle Coconut SDK in their apps, the apps double as end points of a certain commercial VPN that routes traffic through affected Android devices. This behavior is not disclosed to users who may notice unusual network traffic coming from some apps. For a more detailed description, please see the section about Idle Coconut further down in this report.



**Google Play: SMS fraud**

In 2018, about 0.003% of all app installs from Google Play were SMS fraud, the same level as in 2017. With click fraud recategorized as a PHA, SMS fraud among all PHAs dropped to 6.8%. Last year, SMS fraud apps were mainly targeting devices in Thailand, Malaysia, UAE, Egypt, and Iraq. In October we announced a Google Play policy change limiting which apps are allowed to ask for SMS permissions. This means only an app that has been selected as a user's default app for sending text messages will be able to access SMS.

BreadSMS remains the largest SMS fraud family on Google Play. This family targets users in Thailand almost exclusively. When users run a BreadSMS app, the app subscribes the device to premium SMS content without user consent. For a more detailed description of BreadSMS, see our 2017 Year in Review.



### Outside of Google Play: PHA Trends

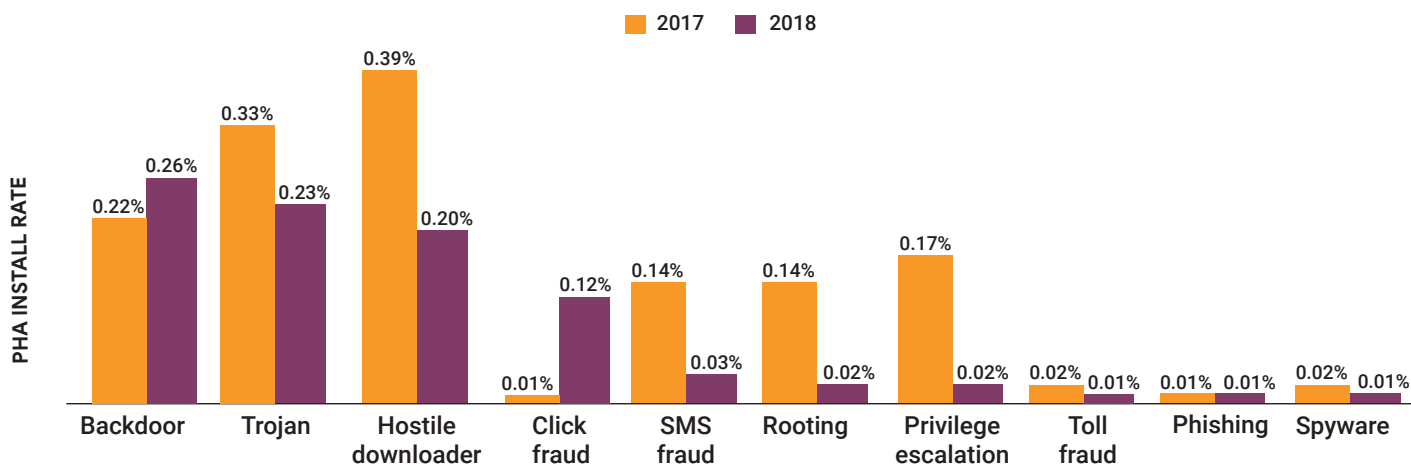
In 2018, the ratio of PHA installs to total installs decreased by roughly 38% from the previous year, so the overall health of the Android ecosystem improved.

In 2018, 0.92% of sideloaded apps were PHAs, compared to 1.48% in 2017. In context, this positive downward trend doesn't include pre-installed apps. Nevertheless, with the exception of the top PHA category (backdoors) and the new category (click fraud), all PHA categories saw strong declines outside Google Play.

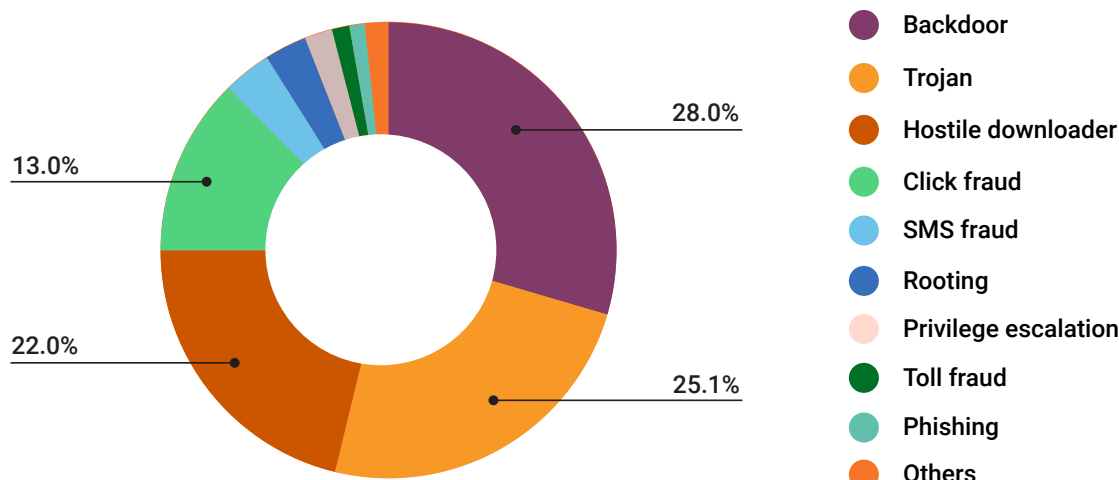
### Top PHA categories

These charts show all PHA categories broken down by percentage against other PHAs in 2017 and 2018. For example, in 2017 backdoor installs accounted for 0.22% of all installs outside of Google Play and in 2018 they represented 0.26%.

Percentage of PHA installs by category outside of Google Play, 2017 vs. 2018



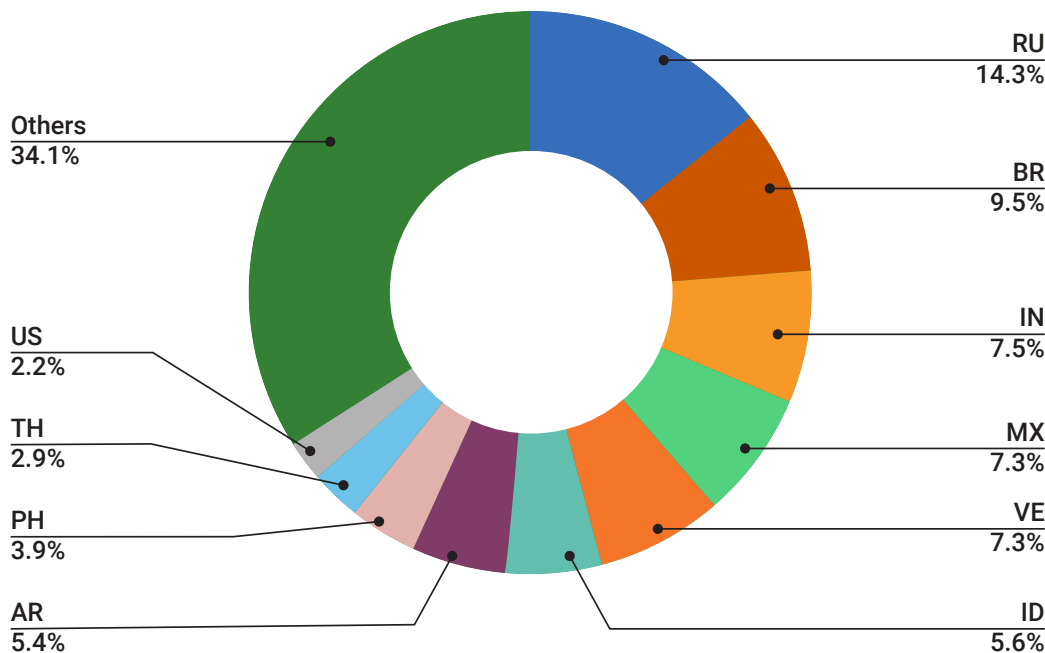
Distribution of PHA categories outside of Google Play, 2018



*Outside of Google Play: Backdoors*

In 2018, backdoors were the most prevalent PHA category outside of Google Play where they make up 28.0% of all PHA installs and 0.26% of all app installs (up from 0.22% in 2017). Last year, backdoor apps were mainly targeting devices in Russia, Brazil, Mexico, and Vietnam.

As the prevalence of Trojans and hostile downloaders decreased in 2018, backdoors took the top spot. However, the spread of backdoor PHAs is attributed to a specific PHA family—Chamois—that we previously discussed publicly. Chamois apps are pre-installed on popular devices from different OEMs that didn’t carefully scan for malware. As a consequence, users are buying compromised systems. When users start up their new devices, the pre-installed Chamois apps (usually disguised as system apps) download and install PHAs and other apps in the background.

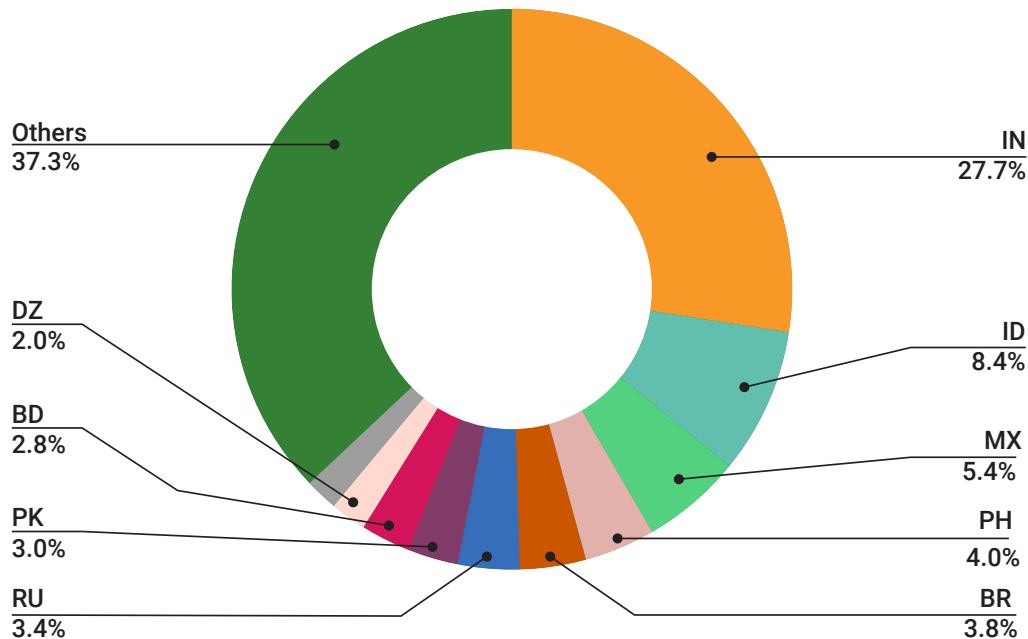


For more information on the Chamois family, see [Chamois](#).

*Outside of Google Play: Trojans*

The prevalence of Trojans among all installed apps fell from 0.33% in 2017 to 0.23% in 2018, decreasing their rank to second. Trojans now only account for 25.1% of all sideloaded PHAs. Last year, Trojans were particularly targeting devices in India, Indonesia, Mexico, and the Philippines.

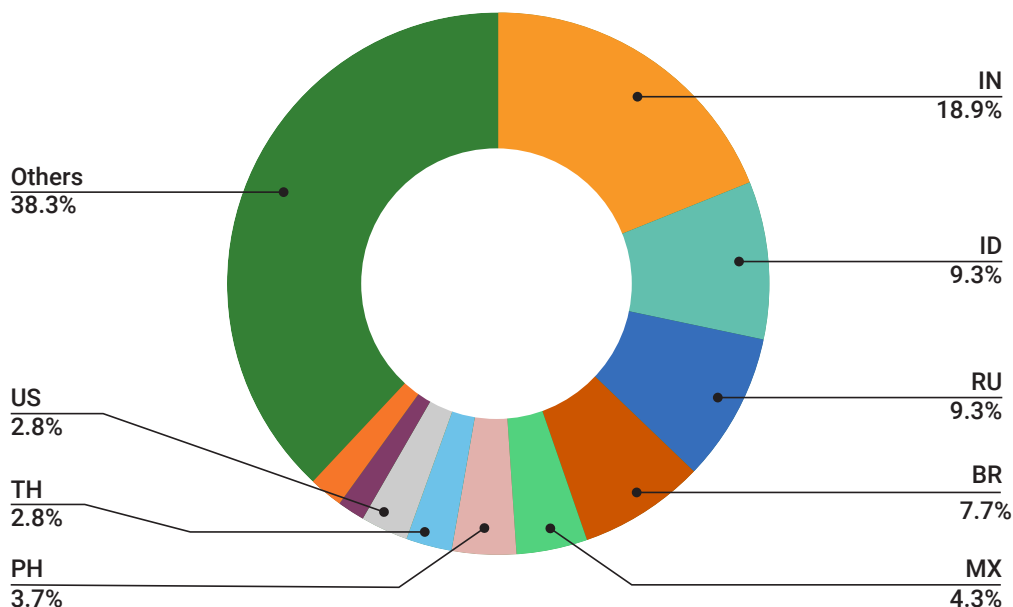
Like hostile downloaders, Trojans have many variations and aren’t from a particular PHA family. The only noteworthy Trojans are those that mine cryptocurrency without user consent. As cryptocurrency prices rose dramatically at the end of 2017 and early 2018, the number of malicious actors also rose. Google Play Protect started warning users about the potential problems of cryptocurrency mining on their devices. In 2018, 4 of the top 11 Trojans were cryptocurrency miners, all embedded in a popular video player app (previously mentioned as the most prevalent PHA in India).



**Outside of Google Play: Hostile downloaders**

In 2018, hostile downloaders made up 22.0% of all sideloaded PHAs, making this the third most prevalent category, as in 2017. While this category accounted for 0.39% of all sideloaded apps in 2017, it is down to 0.20% in 2018, a sharp decline. Last year, Trojans were particularly targeting devices in India, Indonesia, Russia, Brazil, and Mexico.

The prevalence of hostile downloaders is due to a combination of legitimate third-party stores with poor security setups that distribute PHAs, fake stores that are built specifically for spreading PHAs, pre-installed apps that slipped through the security scans of OEMs, and plain apps that pretend to (or actually do) offer user-wanted features while downloading PHAs in the background.



## PHA Families

Google Play Protect removes all apps it detects from Google Play that are part of any of the PHA families listed below.

### Chamois

Chamois was one of the most impactful PHA families in Android in 2018 with more than 199 million installs. It originally emerged in late 2016 and again in early 2017; Google detected and disrupted the first two variants. After an eight month hiatus, Chamois re-emerged in November 2017 outside of Google Play. Chamois uses a variety of distribution mechanisms including being pre-installed, added as an advertising SDK, and injected into popular sideloaded applications. The Android security team implemented detection and remediation techniques across these channels, leading to a sharp decline in installs in 2018.

Chamois is a well-engineered, sophisticated piece of malware. As of November 2018, there were five known variants of the Chamois botnet family, three of which emerged after November 2017. These variants are comprised of four or five stages with anti-analysis features and a command-and-control infrastructure for deploying their payload. Google Play Protect classifies Chamois as a backdoor due to the remote command-and-control capabilities it has. The payloads for Chamois range from a variety of ad fraud payloads to SMS fraud to dynamic code loading.

### Snowfox

Snowfox is an advertising SDK with two variants; one variant steals OAuth tokens from a device and the other injects JavaScript for click fraud into WebViews with loaded ads. The Snowfox campaign began in late 2017 and peaked in March 2018. Over the course of 2018, apps with the malicious Snowfox SDK were installed more than 16 million times.

Snowfox is predominantly distributed outside of Google Play by apps including the SDK. However there are some distribution mechanisms where an application dynamically downloads the Snowfox SDK as a plugin, probably to bypass static analysis.

### Cosiloon

Cosiloon is a family of hostile downloader PHAs that was pre-installed on uncertified Android devices. Cosiloon apps are two-stage PHAs with the first stage pre-installed on the device. There are two variants of the first stage: a standalone, pre-installed application and a backdoored System UI application. The first stage downloads and installs the second stage, which shows ads and installs other PHAs.

Cosiloon was initially detected in November 2017. In early 2018, [Avast](#) and [Google Play Protect](#) collaborated on a threat analysis. Google Play Protect then deployed two remediation solutions to protect users. By March 2018, Cosiloon was largely eradicated from the Android ecosystem. Because it was pre-installed, Cosiloon was exclusively found outside of Google Play.

### BreadSMS

BreadSMS is a large PHA family that Google Play Protect began tracking in the beginning of 2017. BreadSMS evolved rapidly in 2018, accumulating over 11 million installs with approximately 98% of those occurring on Google Play.

In 2018, BreadSMS added cloaking and obfuscation techniques to evade detection. For example, when some BreadSMS apps detect that they are being analyzed, a disclosure and consent dialog opens for premium SMS messages. The dialog doesn't appear when running on users' devices. In 2018, BreadSMS added WAP fraud, subscribing users to services that charge their mobile bills without their knowledge or consent.

In 2018, 52.6% of BreadSMS installs occurred in Thailand and 19.1% occurred in Malaysia.

### View SDK

View SDK is a monetization SDK that uses JavaScript to perform ad click fraud. View SDK was originally discovered by Google Play Protect in December 2017. However, Google Play Protect didn't begin treating click fraud as a PHA category until March 2018. During 2018, there were approximately 5.2 million app installs containing View SDK. All of these installs were sideloaded; none occurred from Google Play.

Affected apps drop a JAR file containing View SDK during execution. View SDK then downloads JavaScript from a remote server and injects it into a WebView showing ads and triggering fake ad clicks without user intervention.

### Triada

Triada software was first documented by Kaspersky in 2016 as a rooting Trojan. In mid-2017, Dr. Web documented a pre-installed backdoor variant where the log function in the Android framework of the device's firmware had been backdoored. Any application related to Triada can then communicate and perform commands using the backdoored log method. This variant also injects code into other processes, such as browsers or Google Play. The purpose of this backdoor was to show ads and install other applications.

During 2018, Google identified all Triada variants, including new ones, and all devices infected with Triada. Based on this information Google reached out to OEMs to remediate. OEMs provided users with system updates that removed the Triada backdoor.

### CardinalFall

CardinalFall is a large PHA family with an SDK that implements click fraud and, in some cases, dynamic code loading. The CardinalFall SDK uses encrypted communication with a number of command-and-control servers to evade detection. The servers provide CardinalFall apps with specific ad IDs (including AdMob and Facebook ad IDs) that are used to serve ads to the affected devices. When an ad is fetched, the CardinalFall app uses the click API on a WebView to automatically trigger fake clicks on the loaded ad without user intervention.

More than 90% of all CardinalFall apps have been found on Google Play. The countries most significantly affected by this PHA family in 2018 were India, the US, and Pakistan; although users in more than 10 other countries were also impacted.

### FlashingPuma

FlashingPuma is a large click fraud family discovered in 2018. More than 75% of these apps are from outside of Google Play. The FlashingPuma SDK fetches ads and generates fake clicks without user intervention, crediting the fraudsters.

FlashingPuma apps were propagated worldwide, but India was the most affected country with 30% of all installs. Enforcement fluctuated during 2018, as new variants were being produced and identified. Now Google Play Protect is detecting all apps that belong to this family, whose footprint is significantly reduced.

### EagerFonts

EagerFonts is an SDK embedded in the Fonts apps that come pre-installed on some Android devices. The EagerFonts PHA family was discovered by Google in mid-2018 and at its peak was present in approximately 12 million devices globally across hundreds of OEMs. Google Play Protect treats EagerFonts as a backdoor because it uses a remote server to dynamically download and run fake plugins; these are known PHAs, including Chamois and Snowfox. Unlike other hostile downloaders, EagerFonts didn't install an app, but loaded and ran the fake plugins dynamically in the original app's process.

Google has worked with the affected OEMs to remediate the EagerFonts infections. Upon discovering this family, Google immediately stemmed the infection by halting the shipment of new builds containing the PHAs.

### Idle Coconut

Idle Coconut is an SDK that developers include in their apps for monetization. The apps double as end points of a certain commercial VPN that routes traffic through affected Android devices. The SDKs use a websocket for communications with a command-and-control (CnC) server and then connect to hosts that the CnC commanded over "normal" sockets. None of this behavior is disclosed and the user's device unknowingly becomes used in a proxy network. Thus, Google flags these apps as Trojans.

About 60% of the installs of Idle Coconut in 2018 came from Google Play and approximately 40% were from sideloaded applications. India had the highest rate of installs (approximately 25%) during 2018.



# Acknowledgments

This report—and all of the hard work that it represents—isn't the product of a single team or company.

Thank you to the Google teams, our Android partners, and the external researchers who contribute to the security of Android throughout the year. Your hard work, effort, and commitment to security makes the entire Android ecosystem safer and protects Android users across the world.



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