Chamois

Android’s most impactful Botnet of 2018

Based on Maddie Stone, KasperskySAS2019.Chamois

What it does?

Chamois is a:

- sophisticated botnet
- that backdoors applications
- to do:
  - Ad fraud
  - SMS fraud
  - Install fraud

Basic terms & Android Application Ecosystem

Botnet: What?

Backdoor

PHA:

- Potentially Harmful Applications
- PHA status

Google Play Protect:

- Google Play Protect
- Play Protect

APK - Android Package

Application distribution:

- Google Play
- Sideloaded
- Third Party stores
- Pre-Installed, by OEM

Summary

- PHA category: Backdoor
- Initially detected in Mid-2016
- As SDK for 3rd party
- 4 distinct variants
- 4-6 stages in each variant

Payloads:

- Premium SMS fraud
- App install fraud
- Ad fraud
- Arbitrary module loading

Timeline

- August 2016 - version 1 detected on Google Play
- November 2016 - version 2 with SMS fraud on Google Play
- March 2017 - eliminated from Google play - Google Blog post Detecting and eliminating Chamois, a fraud botnet on Android
- January 2018 - version 3 detected - 2 independent teams
- Summer 2018 - version 4 detected - multi-team investigation
- December 2018 - Monitoring & Maintenance

Why “Most impactful”?

- **Technical complexity**
- **Multiple distribution channels**
- Rapid and mature **release process**
- Actor has resources: **technical expertise, funding, infrastructure**, etc.
- Advanced ad fraud techniques

Technical details

Variants Overview

V1: Aug 2016 - Mar 2017

- Ad fraud
- Google Play fraud

V2: NOv 2016 - Mar 2017

- New premium SMS fraud payload
- Google Play fraud

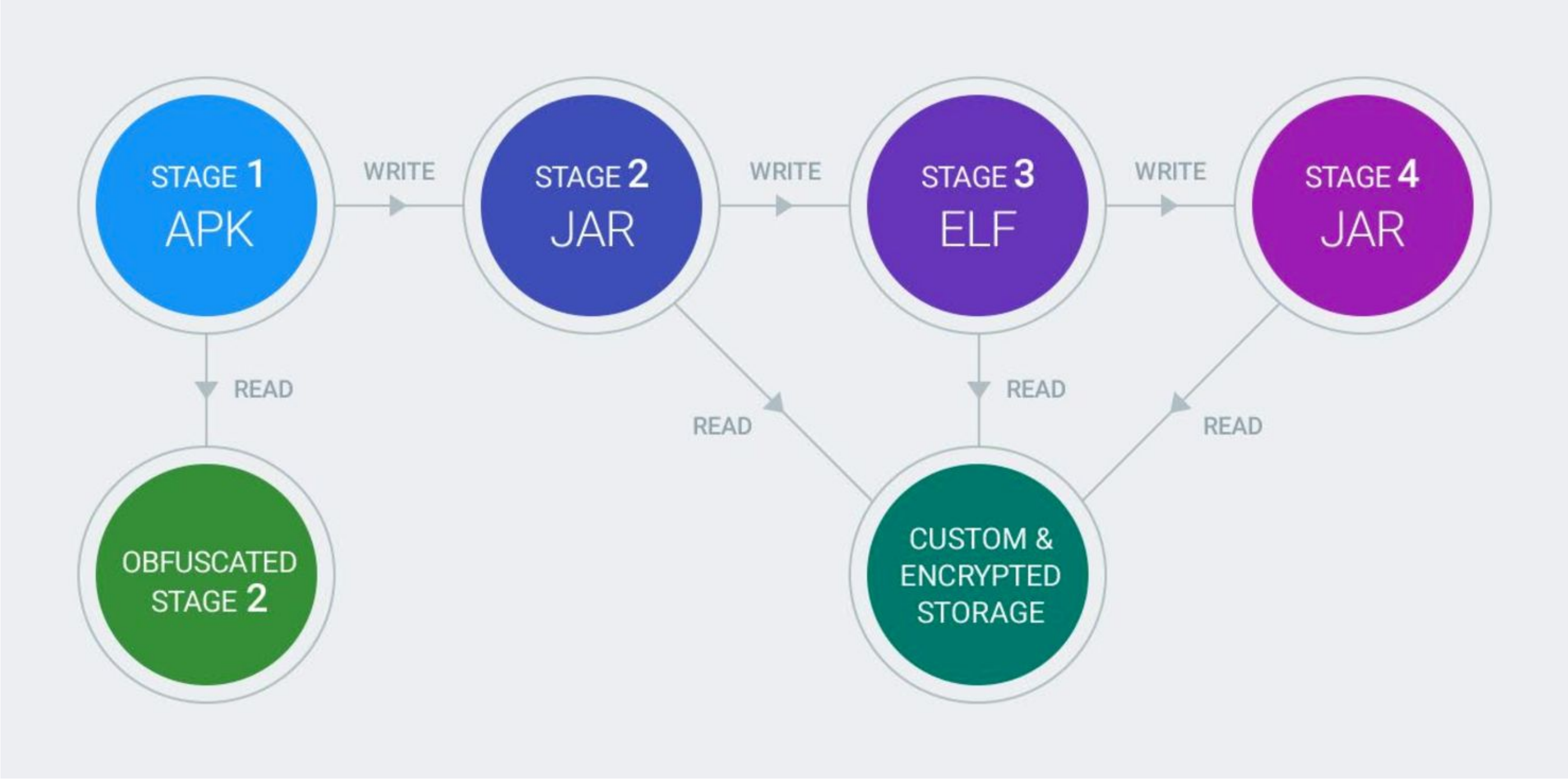
V3: Nov 2017 - Aug 2018

- Additional stages
- Overall more sophisticated
- Pre-installed & off-Google Play

V4: Aug 2018 - somewhere in 2019

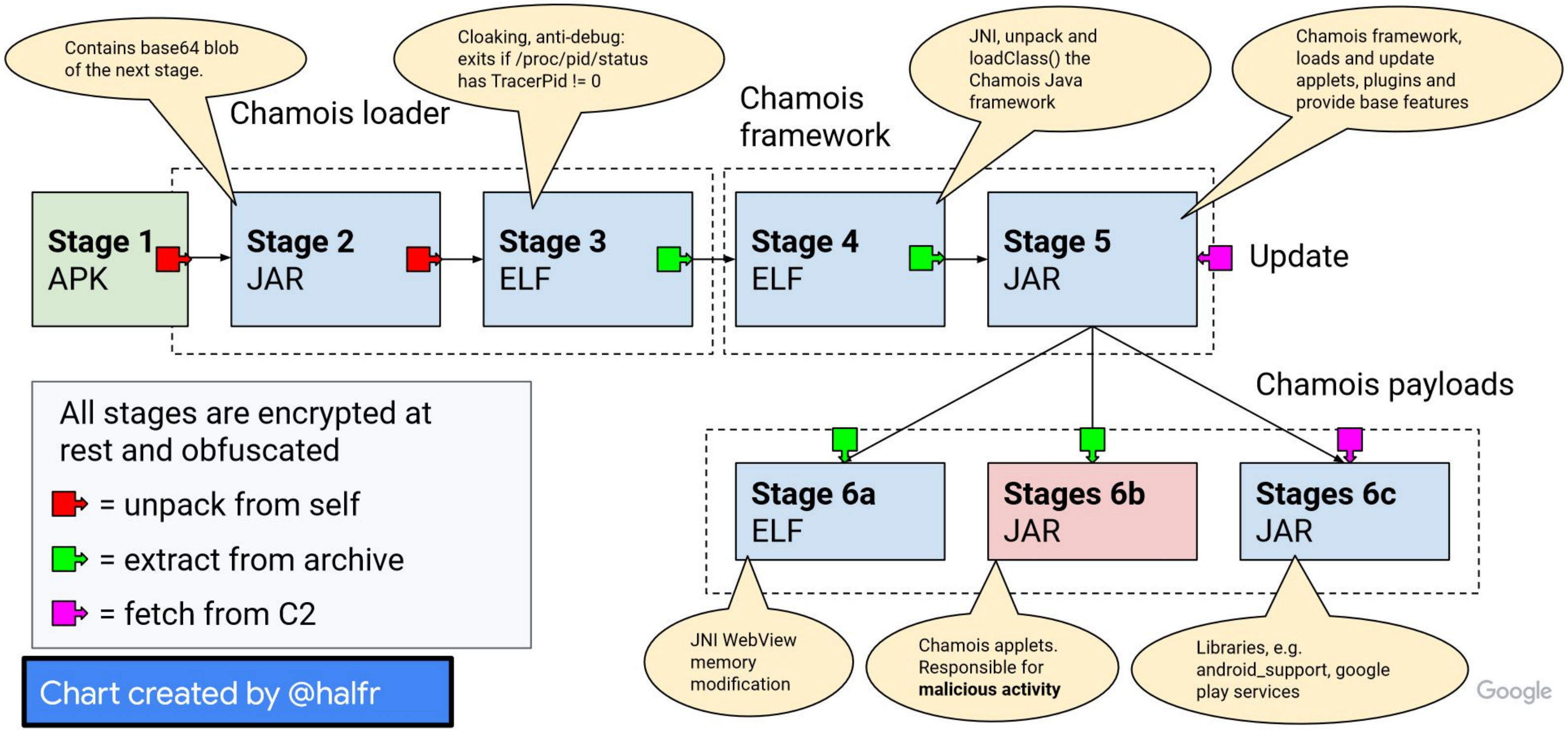
- off-Google Play

Stages - Variants 1 & 2



Stages - Variants 3 & 4

Stages - Variants #3 & #4



Contains base64 blob of the next stage.

Cloaking, anti-debug: exits if /proc/pid/status has TracerPid != 0

JNI, unpack and loadClass() the Chamois Java framework

Chamois framework, loads and update applets, plugins and provide base features

JNI WebView memory modification

Chamois applets. Responsible for **malicious activity**

Libraries, e.g. android_support, google play services

All stages are encrypted at rest and obfuscated

🟥 = unpack from self

🟩 = extract from archive

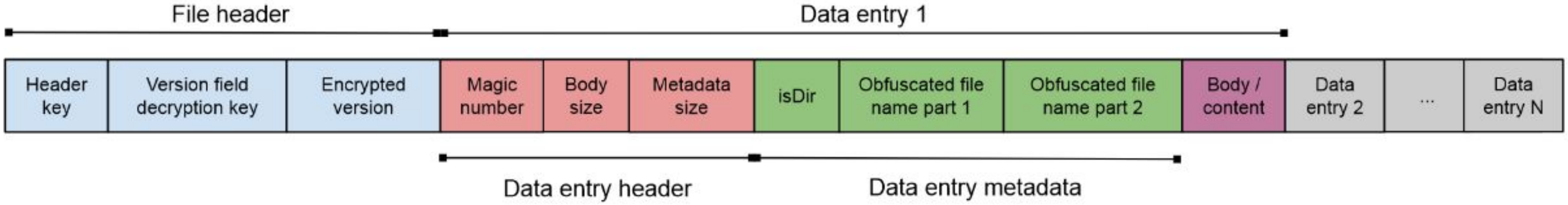
🟪 = fetch from C2

Chart created by @halfr

Google

Custom Archive Format

- Usage: similar to a ZIP containing JARs
- Supports directories & files
- Contains code packages, configuration and other support files
- Encryption: XXTEA, key material in the archive and in the app
- Used by multiple components: main framework and payloads



File header

Data entry 1

Header key

Version field decryption key

Encrypted version

Magic number

Body size

Metadata size

isDir

Obfuscated file name part 1

Obfuscated file name part 2

Body / content

Data entry 2

...

Data entry N

Data entry header

Data entry metadata

Anti-detection techniques

- Stages 1 & 2 - randomized class names & file names for each new class name
- Stage 3 - ELF library containing sophisticated anti-analysis features (WeddingCake)
  - In-place decryption
  - Anti-reverse engineering
  - Anti-emulation
    - 37 system property checks
    - CPU architecture
    - Xposed and Monkey checks
  - Presentations about these:
    - ”Unpacking the Packed Unpacker” video paper

Payloads

Mobile payment solution

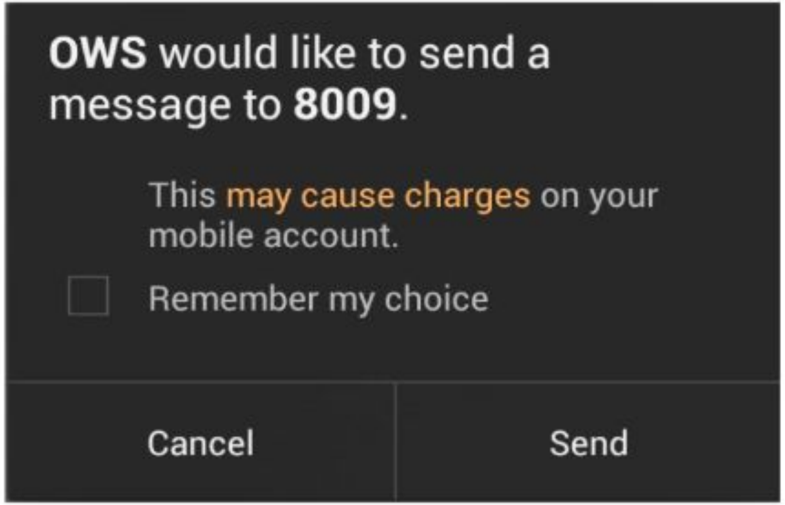
- Card payment
- SMS payment
- Mobile payment
- WAP payment

Malicious

- Ad fraud
  - Automated browsing
  - Click injection
  - Deceptive overlays
- App installs
- Traffic pumping
- Sends premium SMS

Premium SMS payload

- Apps must have the permission to send SMS
  - Chamois apps have it because they are phone-related
- Android platform asks the user to confirm sending a SMS
  - Chamois uses root access to enable internal permission flag and bypass the dialog
- No root, no problem, use accessibility services
  - Use it to automatically tap ”Send”



OWS would like to send a message to **8009**.

This may cause charges on your mobile account.

□ Remember my choice

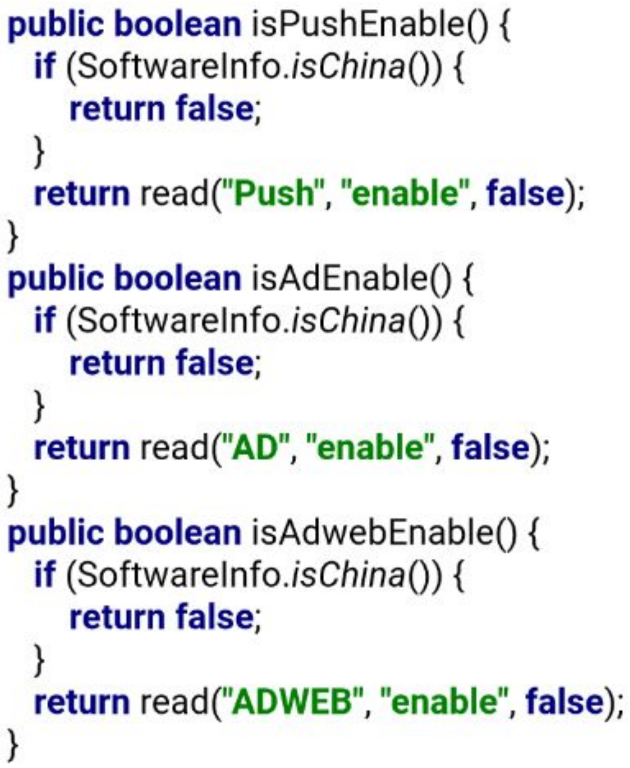
Testing infrastructure

- Iterating on malware loader obfuscation to defeat existing rules
- Staging and production servers
- Multiple feature flags to control infected population behavior
- Progressive rollout of C2 configuration based on querying countries
- Using mobile analytics services and logging

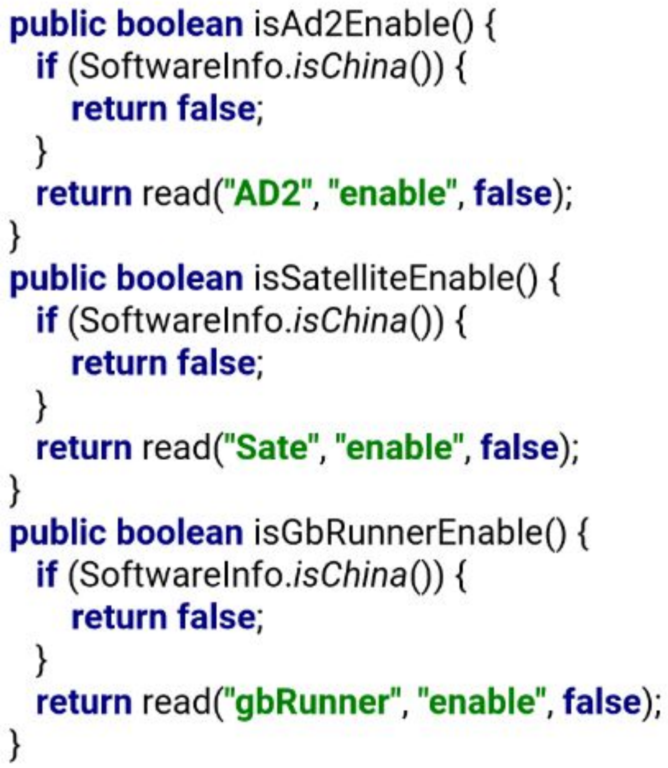
Network infrastructure

- 10+ API C2 domains
- 20+ module-specific C2 domains
- 150+ domains for ad fraud activity
- Deployed on large cloud providers
- Automated cloud deployment
    - HTTPS with Let’s Encrypt

Localization checks



```
public boolean isPushEnable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("Push", "enable", false);
}
public boolean isAdEnable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("AD", "enable", false);
}
public boolean isAdwebEnable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("ADWEB", "enable", false);
}
```



```
public boolean isAd2Enable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("AD2", "enable", false);
}
public boolean isSatelliteEnable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("Sate", "enable", false);
}
public boolean isGbRunnerEnable() {
  if (SoftwareInfo.isChina()) {
     return false;
  }
  return read("gbRunner", "enable", false);
}
```

Distribution

- Pre-installed
  - Convinced ODM and OEMs to include the SDK by advertising as a “mobile payment” solution
- Distributed to developers as a static SDK
- Sideloaded
  - Downloaded by apps as “plugins”
  - Distributed by other harmful downloader families

EagerFonts

- Fonts application included in SOC platform from 3rd party developer
- Included an advertising SDK that used dynamic code loading(DCL) to download from a 3rd party server and run “plugins” in the app context
- Plugins known malicious trojans:
  - Chamois - Backdoor
  - Snowfox - Trojan and Click fraud
  - And others.
- Affected 250+ OEMs across 1000+ different devices

- SOC Platform immediately pulled app, contacted their customers, and created a plan to prevent this issue in the future.

Fighting Chamois

Eradication Efforts

OEM Outreach Stem the supply and distribution

Google Play Protect Protect users and block existing infections.

Ad Fraud Defenses Prevent ability to monetize.

OEM Outreach

- Detected that some devices had Chamois pre-installed
- Initiated OEM Remediation process for devices in wild
  - 1. Alert OEM’s to presence on their devices
  - 2. Require OTAs to remediate
  - 3. OEM’s do post-mortem to determine how issued ended up on device
  - 4. OEM’s create plan for how they will prevent in the future
- Through certification program, test all potential new OEM builds for Chamois prior to approval and launch to users.

Google Play Protect

- Many types of automated detections
  - Signature based
  - Behavioral based
  - Network behaviors
  - Code similarity
  - Machine learning models
- More severe enforcement

Why was it hard?

Sophisticated Actor

- Industry presence/resources
  - Offers “monetization sdk” to OEM’s and ODM’s and references other entities
  - Using large cloud services
- Good engineering and release processes
- Sophisticated technical solutions
- Mature infrastructure

Stealthy

- Anti-analysis in depth:
  - Data encrypted at rest and deleted after load if dropped decrypted
  - Malicious payloads dynamically downloaded
  - Network traffic asymmetrically encrypted
- Anti-debugging in depth:
  - Network certificate pinning
  - Application certificate pinning
  - Anti-debugging at each stage
- Progressive rollout of payloads

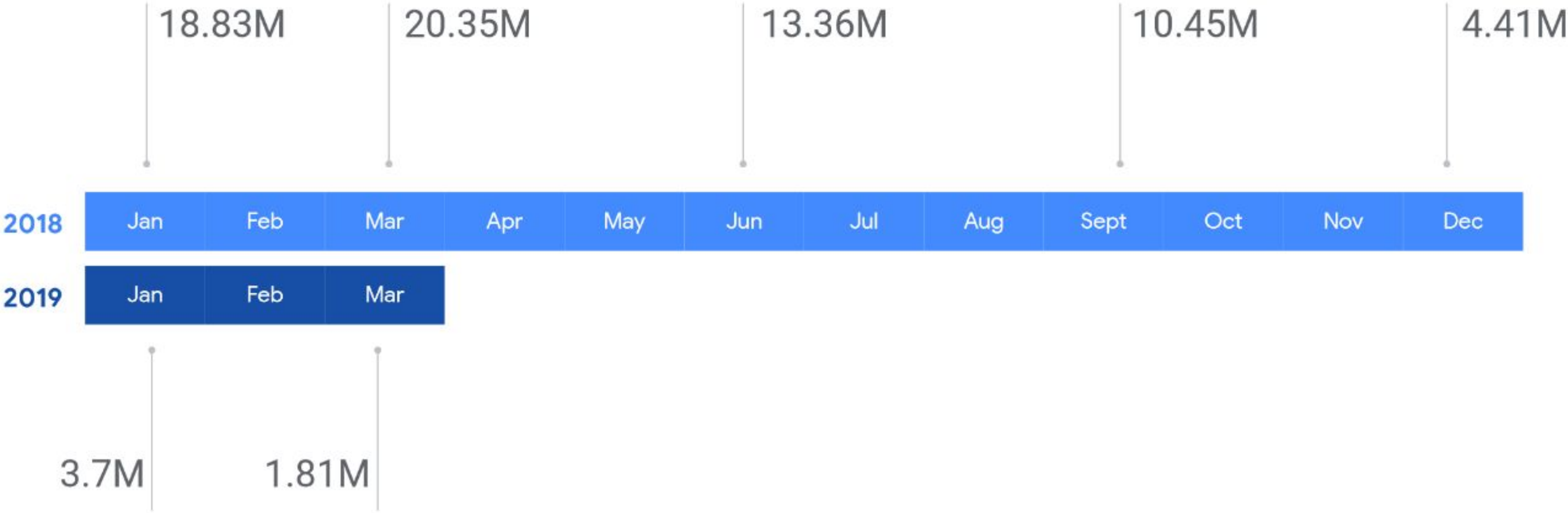
Rapid Response to Google Enforcements

- In response to enabling new detections, we often saw new samples that were trying to test the detections.
  - Moving bytes around, changing file, class, and string naming patterns
  - Removing some stages
  - New domains
- Fingerprinted Google’s automated analysis environment

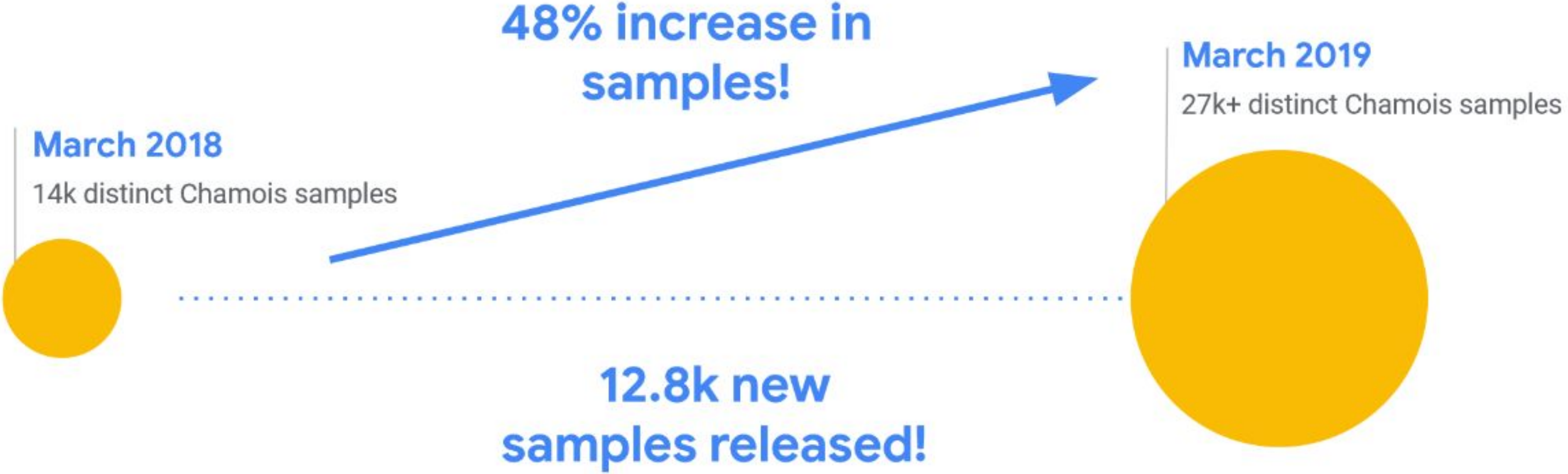
Chamois: Controlled

By the numbers

Number of devices in the previous 28 days that had an active Chamois application



By the numbers: March 2018 until March 2019



48% increase in samples!

March 2018

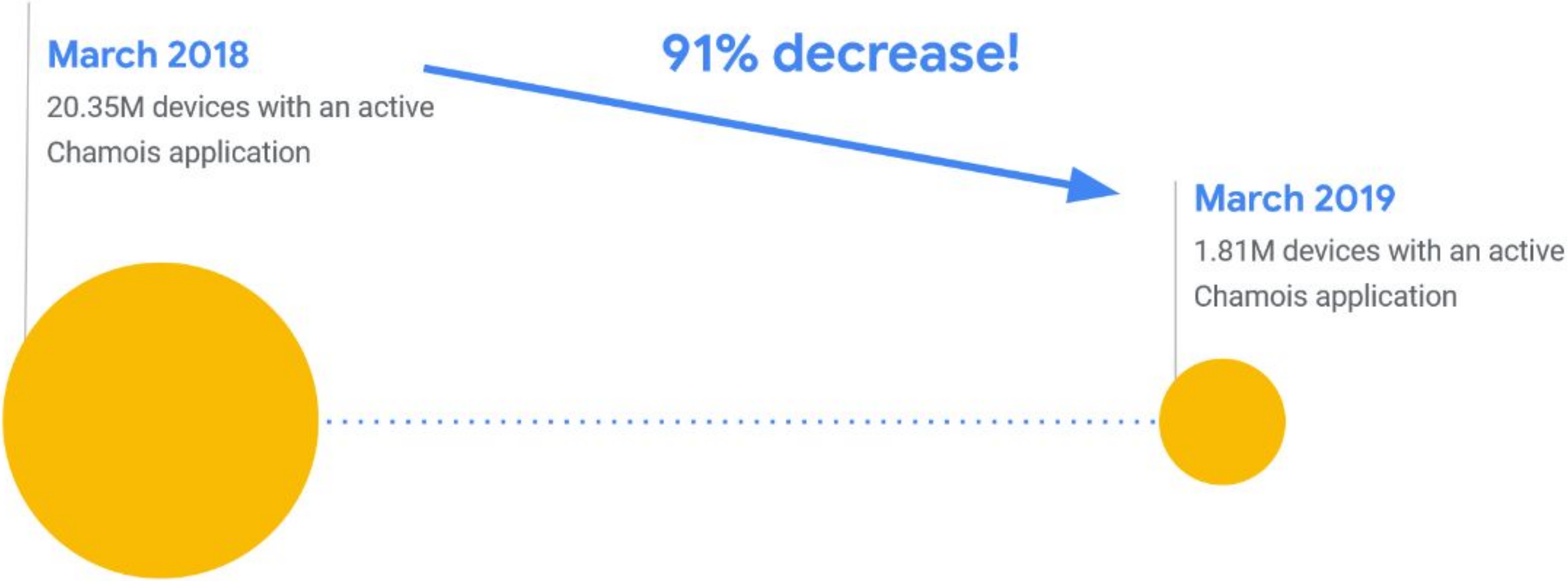
14k distinct Chamois samples

March 2019

27k+ distinct Chamois samples

12.8k new samples released!

By the numbers: March 2018 until March 2019



March 2018

20.35M devices with an active Chamois application

91% decrease!

March 2019

1.81M devices with an active Chamois application

The biggest botnet you never heard about.

What do you need to be successful?

- Time - The main resource
- Experts - Probably lots of them
- Distribution - Whole World Wide infrastructure
- Influence - Convince Developers, OEMs
- Rapid Response - exploit new vulnerabilities, evade checks,
- Bad will - For sure. **Think about if all of these resources would be used for good?**

- Chamois = Capră neagră

- Questions?

Bonus

- Android Reverse Engineering 101
- Tutorial for becoming a Android App Reverse Engineer:
- Android App Reverse Engineering 101 | Learn to reverse engineer Android applications!