Domain Fronting FTW!

Why you could and should use domain fronting on engagements

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Who Am I?

- Currently:
  - Federal contractor, threat hunting and threat detection analytics
  - Research and emulate threats and techniques for customers
  - Aspiring pen tester
  - SANS 504 Mentor/Advisory Board
  - NoVA Hackers
- Formerly:
  - Satellite terminal operator, firewall tech support, network engineer
  - IT systems engineer/administrator
  - Enterprise security analyst/defender

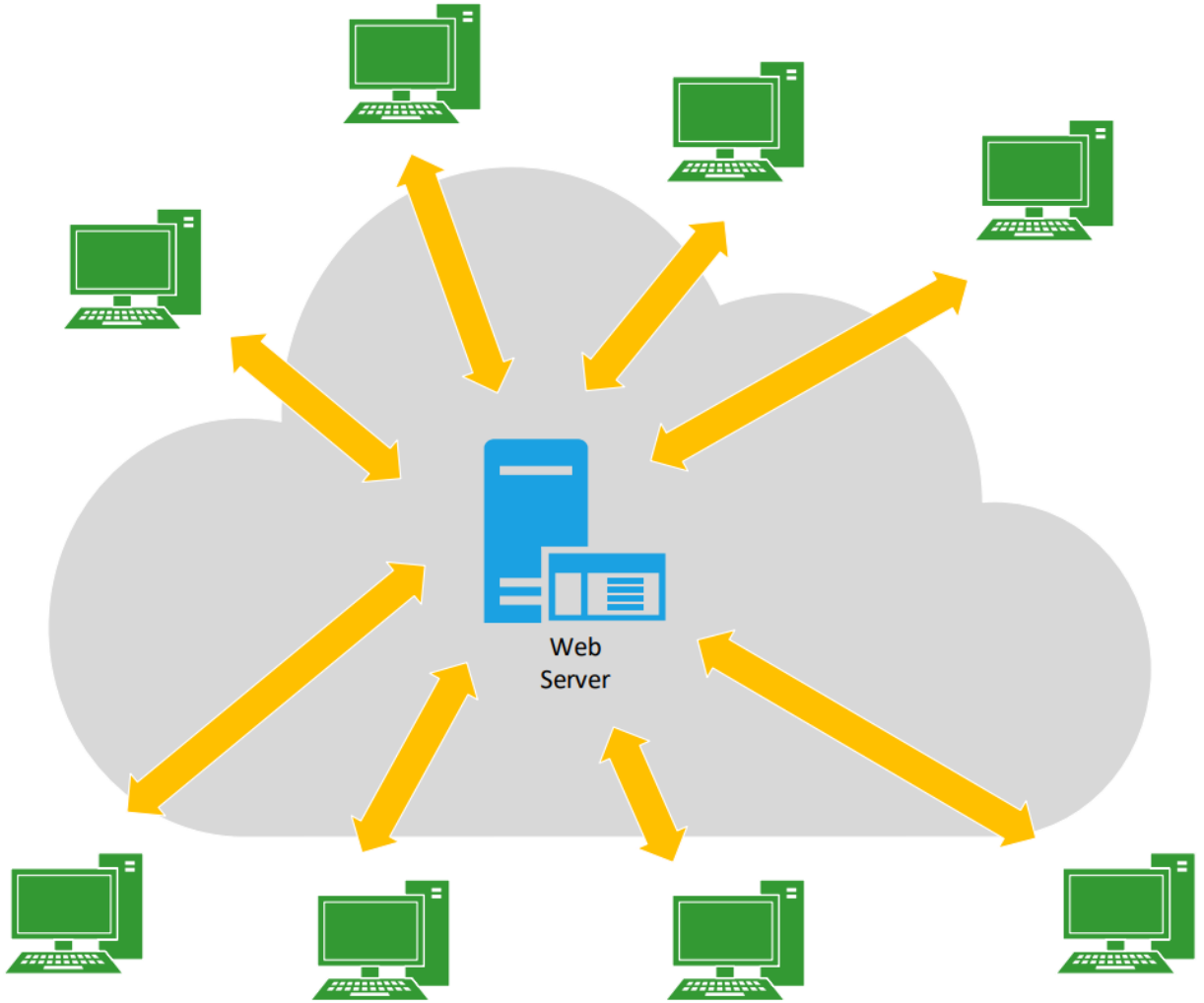
Overview

- Objective: Demystify the technique, discuss issues
- Background
  - CDNs/CSPs
- Domain Fronting
  - Technical details
  - Use cases
  - Identification
  - History
  - In the News
  - Risks
  - How/When to use it
  - Future

Content Delivery Networks

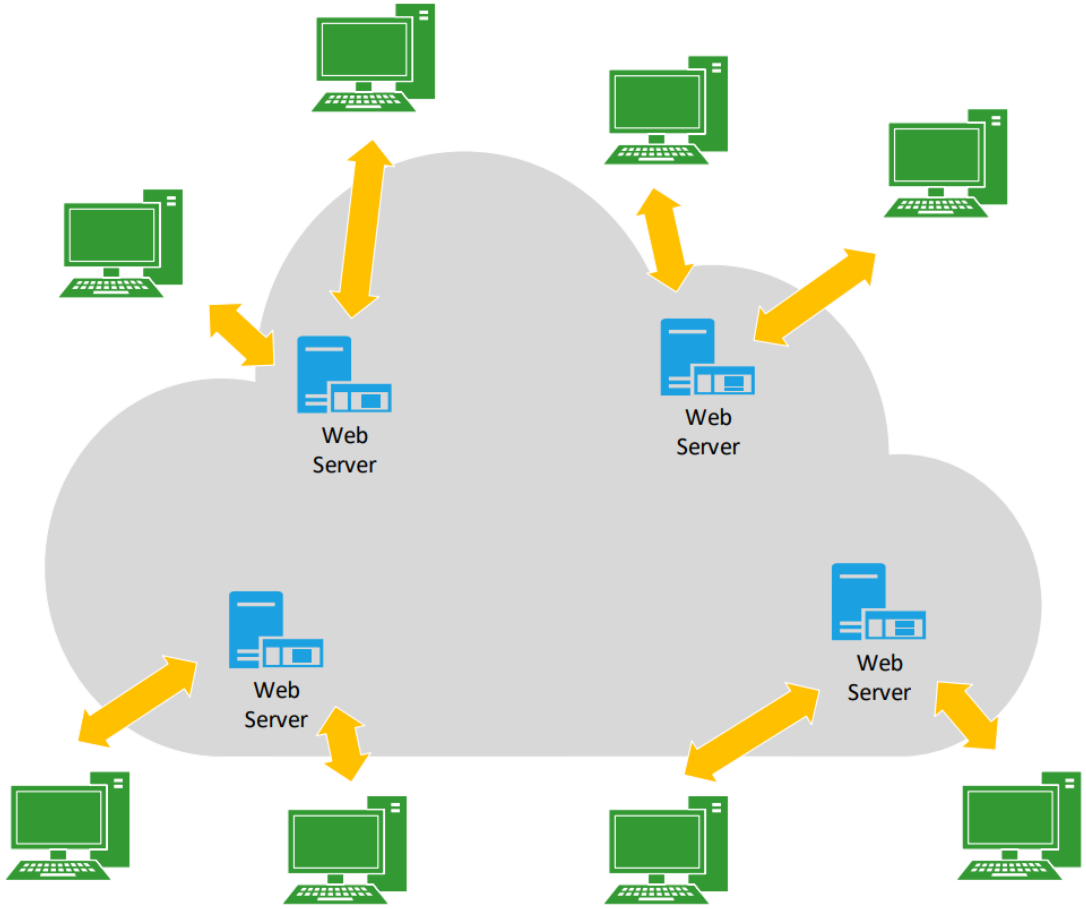
- Level set on CDNs/CSPs
  - Crucial to understanding Domain Fronting
- Meets business needs:
  - Localized delivery of content (decentralized)
  - Scalability
  - Resilience

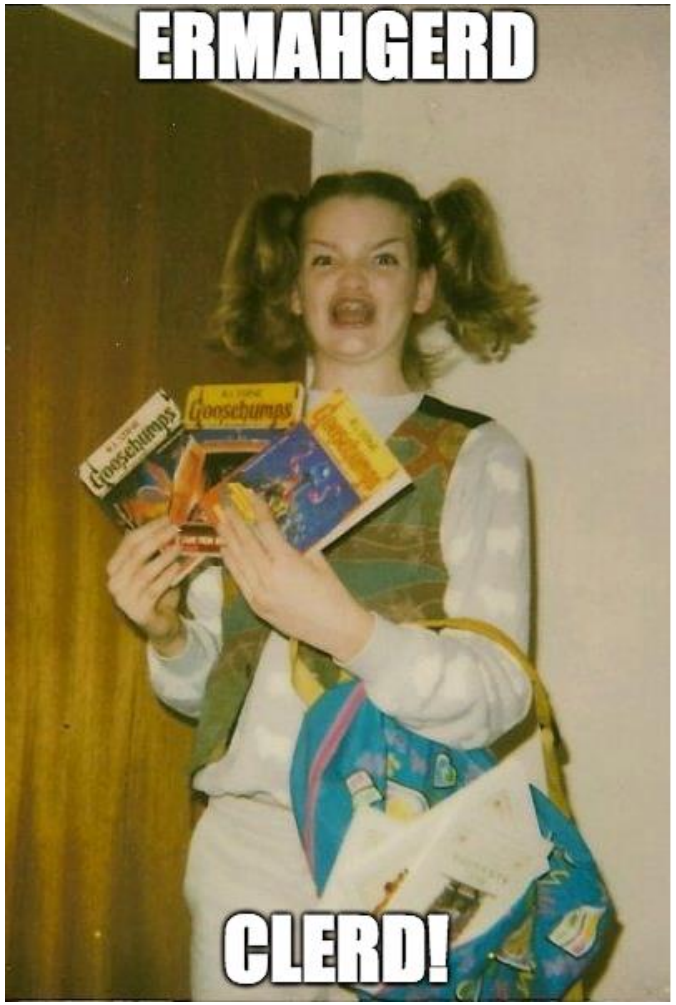
Content Delivery Networks



Content Delivery Networks

- Get MOAR memes/cat pics faster!





Content Delivery Networks

- CDNs:
  - Get content to the user faster and in larger quantities
  - Images, videos, ads, scripts, web elements etc.
  - Coalesces the bits in the browser
- Performance, load balancing, caching
- Manipulates “normal” DNS behavior, pointing clients to provider edge nodes
  - “DNS Gerrymandering”
  - Leads to other issues
- Essentially inserts a Man-in-the-Middle between client and server
  - Introduces risk

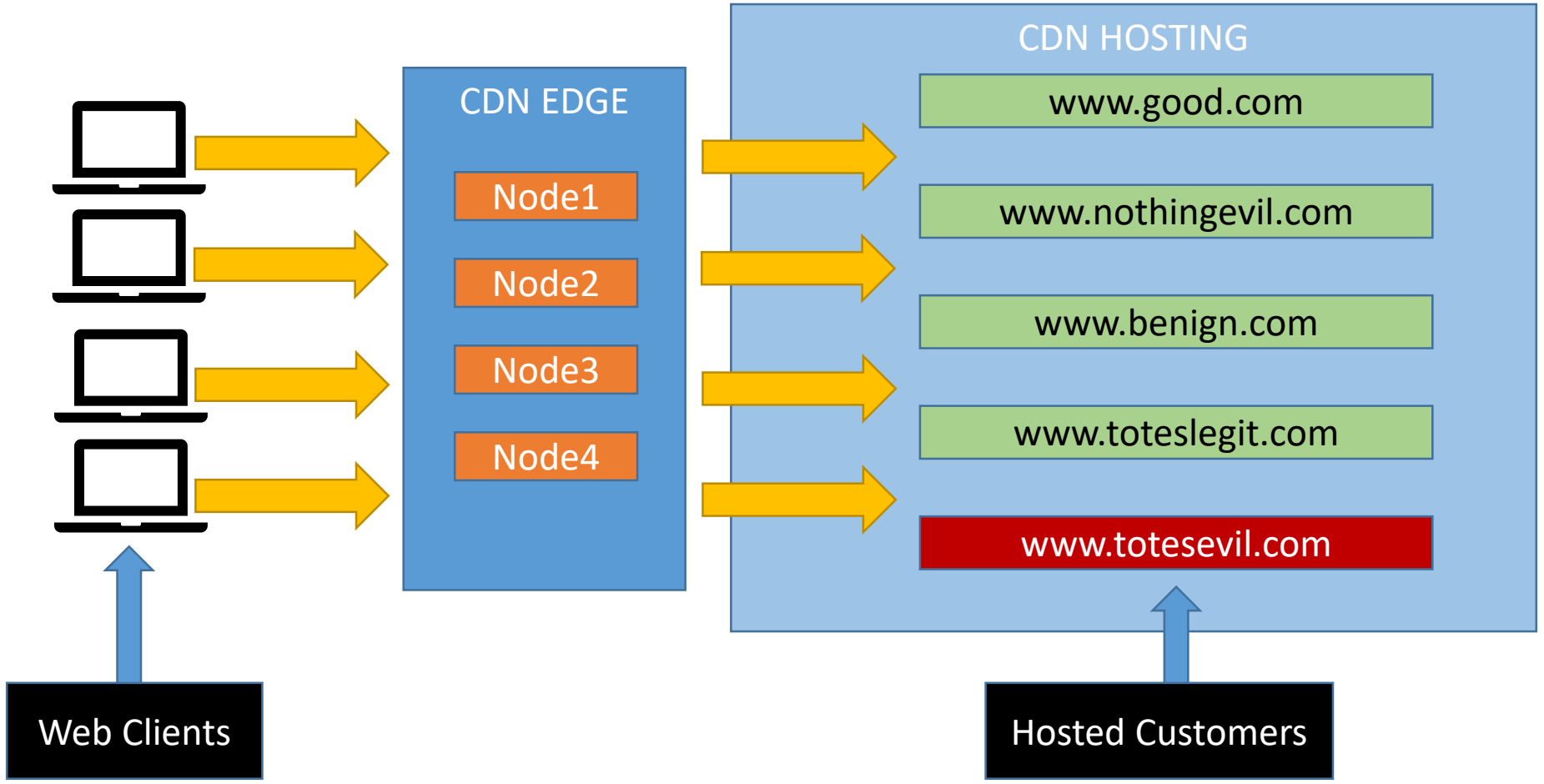
What is Domain Fronting?

- An undocumented feature of Content Delivery Networks and Cloud Service Providers that allows clients to proxy web traffic through them covertly
- Uses different destinations at different layers
- Combined with encryption = dangerous
- Abuses the way CDNs/CSPs redirect traffic
- A topic of much controversy
- Introduces significant risk for organizational networks

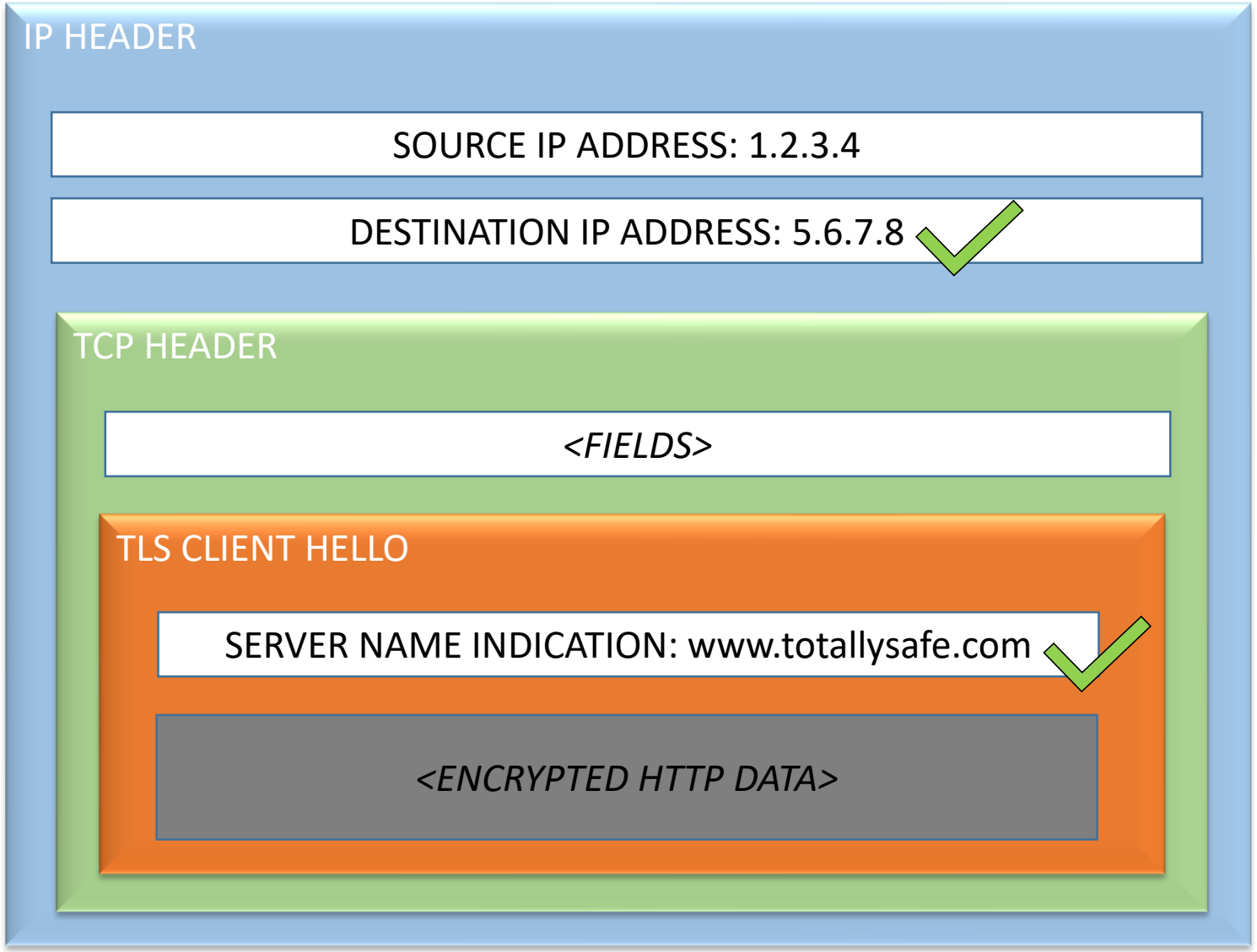
What is Domain Fronting?

- Seminal paper on the topic:
  - Blocking-resistant Communication Through Domain Fronting
- Several good demos/articles (at the end)
- MITRE ATT&CK
- APT 29

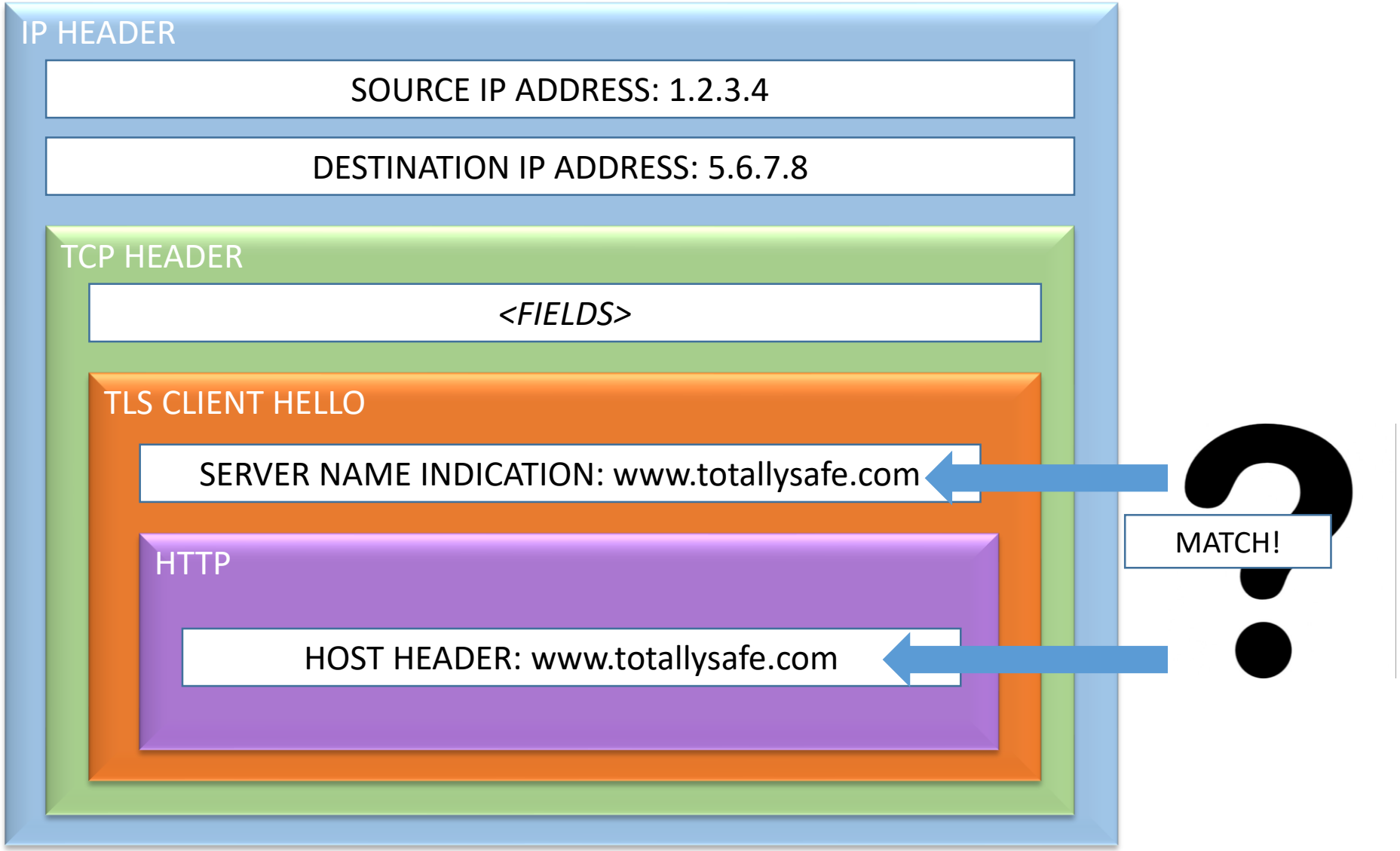
What is Domain Fronting?



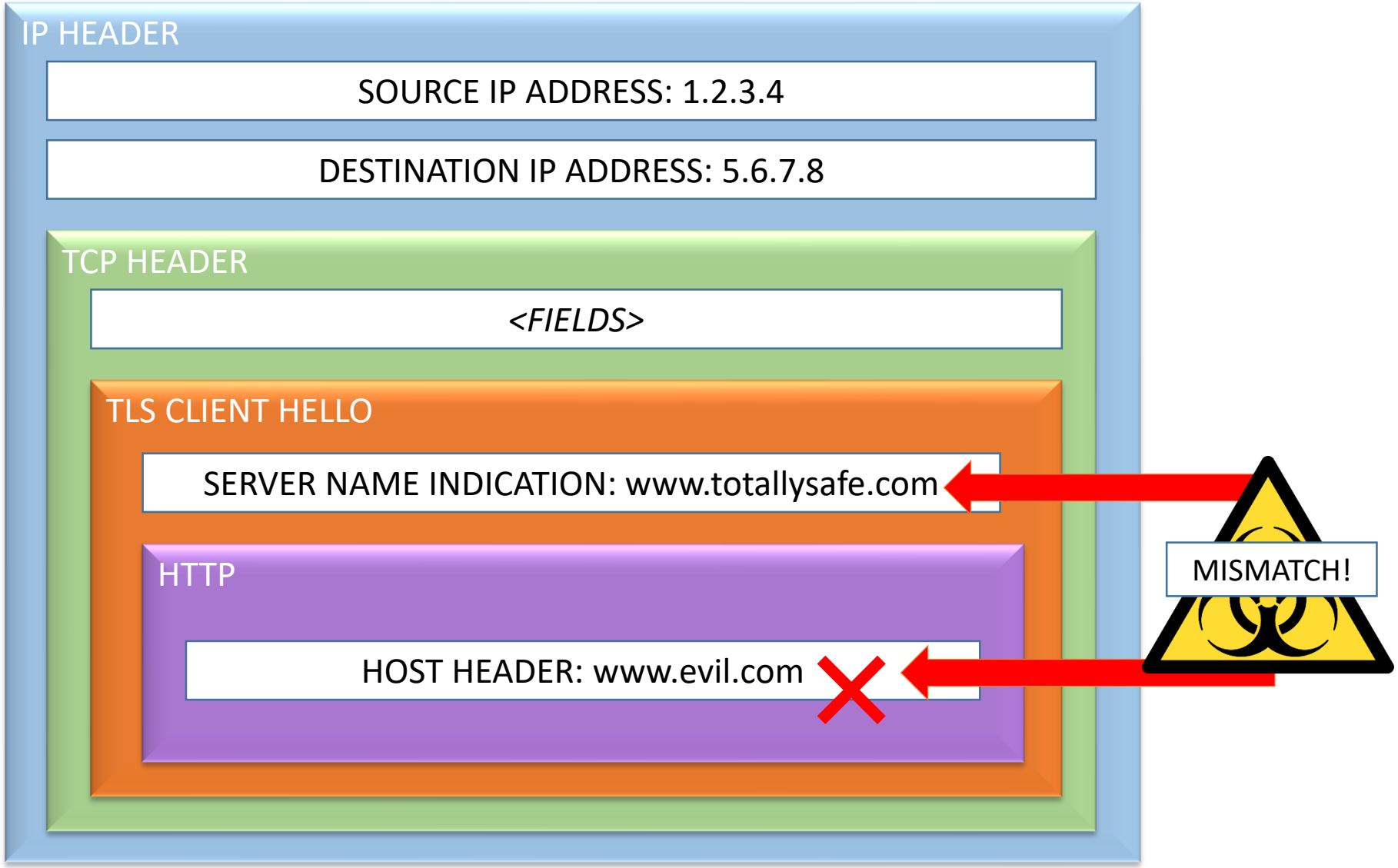
Fun with Headers – What Routers See



Fun with Headers – What Servers & Clients See



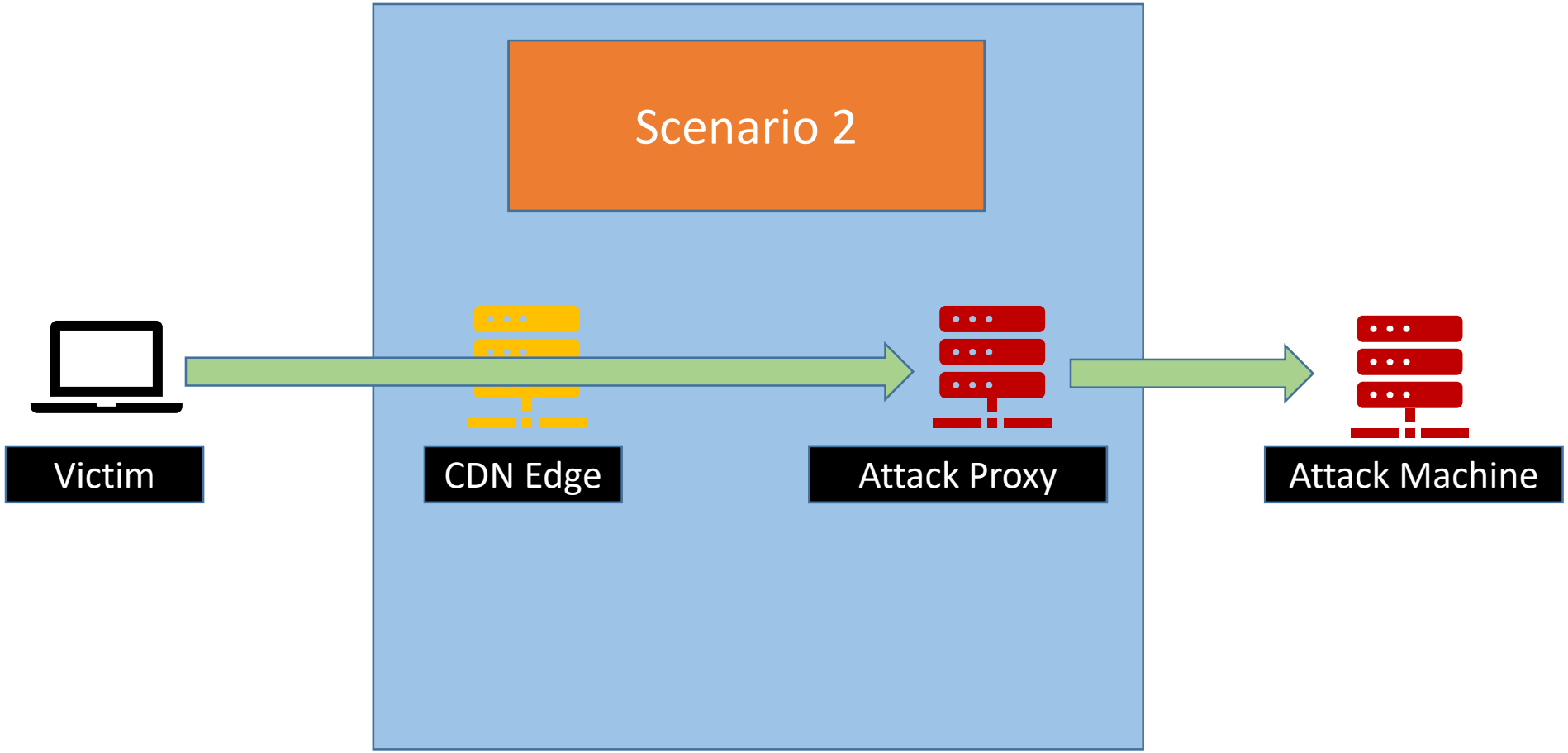
Fun with Headers – What Servers & Clients See



Requirements

- Co-location on service provider's network
  - The "fronted" domain must exist on the provider's network
  - Attack machine with listener
  - Alternatively, a bridge/proxy
- Browser/script/tool that allows for SNI/HTTP Host Header manipulation
- Little to no coding required
  - Cobalt Strike
  - PowerShell Empire
  - Possible:
    - Metasploit
    - Python
    - PowerShell

Infrastructure



Use Cases

- Political dissidents, reporters, etc. in heavily censored nations
  - Circumvention of censorship, anti-privacy/anti-free speech controls
- Messaging:
  - Open Whisper apps (WhatsApp, Signal)
  - Telegram
- Proxy networks:
  - Tor (via Meek), Psiphon, Lantern, etc.
- Bad guys exploit this behavior to bypass controls
  - Command and Control, egress, data exfiltration
  - Web proxies, IDS, reputation and blacklist filtering
  - APT29/Cozy Bear/The Dukes (2015)
- And you!

Identification

- TLS Proxy
  - Almost nobody does it
  - May or may not be feasible
- Standard C2/Exfiltration detections in cloud-based traffic:
  - Block the service provider (Ha!)
  - Internet whitelisting
  - Detect beacons, high producer-to-consumer ratios, long-running, high-volume otherwise “weird” connections
  - Cross-reference, test “frontable” domain lists with web proxy logs/flow data
  - Find other ways to fingerprint services (like TLS cipher list signatures)
- Standard host-based detections/controls
  - Application whitelisting
  - CLI logging, shell history, etc.

Fronting History (1)

- 2012: Bryce Boe blog post proves that SNI and HTTP need not agree
- 2014: Meek plugin for Tor uses “Domain Fronting”
- 2015: Documented in a white paper
- 2015: APT29 used in large scale breach
- 2016: Fireeye/Mandiant @ShmooCon and @DerbyCon 2016 reported on APT 29’s use during a 2015 breach
- 2016: Open Whisper announces fronting support using Google, Amazon CloudFront, S3, Azure, Cloudflare, Fastly and Akamai

Fronting History (2)

- January 2017: Optiv researchers blogged about fronting using Cobalt Strike
- February 2017: Raphael Mudge demos fronting using Cobalt Strike via Malleable C2
- April 2018: Google kills fronting on App Engine
- April 2018: Amazon kills fronting on CloudFront
- May 2018: Privacy advocates petition Google and Amazon to allow Domain Fronting
- May 2018: Amazon informs Open Whisper that they are in violation of AWS Service Terms and threatens to suspend the account

In The News

- "Google kills off domain fronting – and so secure comms just got tougher" – April 2018
- "Amazon blocks domain fronting, threatens to shut down Signal's account" – May 2018
- "Domain fronting has a dwindling future" – July 2018
- "Digital Rights Groups Ask Congress for Help as Russia Ramps up Its War on Telegram" – May 2018
- "Amazon Bends the Knee to Autocrats, Threatens to Cut Off Signal for Using Anti-Censorship Technique" – May 2018
- "Lawmakers call on Amazon and Google to reconsider ban on domain fronting" – July 2018

The Risks

- Clients:
  - It's illegal in some cases
- Defenders:
  - Perimeter network tools have no clue where the traffic is actually going
  - Risk acceptance by trusting the provider
- Service Providers:
  - Complicit in unintentional web proxy-like behavior
  - Liability
- Black hats/penetration testers:
  - Winning!

To Fix or Not to Fix?

- Do nothing:
  - Good for the innocent, bad for the ignorant
- Organizations/enterprises:
  - Poses a real security risk
- Service Providers:
  - The immediate power to change Fronting
  - Disallow SNI/HTTP Host Header mismatches
  - Shut down bridges
- IETF:
  - Update TLS RFC to move the HTTP Host Header outside the encrypted payload
  - Remove the HTTP Host Header (replace with the SNI field value)
  - TLS 1.3 is moving in the opposite direction

When To Use It?

- Use maturity as your guide
- The height of stealth:
  - Use only as required
  - Don’t front unless you need to
- May not be a critical finding
  - Not a lot they can do about it
  - Still raises awareness

Why Use It?

- To accurately model the threats to your clients
- To draw more attention to the issue
- If the issue arises in more places, something will happen (eventually)

The Future of Fronting

- Probably will not last forever
- Eventually all respectable service providers will kill it
- A step towards a 100% attributable Internet
  - Scary!
- People will find other ways around controls
  - Censors will fight those too
- RFCs will continue to favor privacy
  - TLS 1.3 moves everything after the “Hello” messages into the encrypted payload
  - Encrypted SNI coming soon (already implemented in BoringSSL)

Wrap-Up

- Plan of Action:
  - Everyone: Learn it (risks vs. costs)
  - Educate others
- Formulate a strategy and implement
  - Defenders: Detect it
  - Pen Testers: Use it
- Voice your opinion

Sources/Further Reading

- Bryce Boe blog
- Tor Meek documentation
- Vincent Yiu Write-up
- Beau Bullock, Ralph May demo (Tradecraft Security Weekly)
- CyberArk Write-up
- Raphael Mudge/Cobalt Strike Write-up
- Optiv blog post
- Fireeye/Mandiant blog
- Fireeye/Mandiant ShmooCon Talk
- Mitre ATT&CK
- IETF TLS 1.3
- IETF ESNI Draft
- Signal blog post

Thank you!

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