Security Engineering

INFR11208 (UG4) // NFR11228 (MSc)

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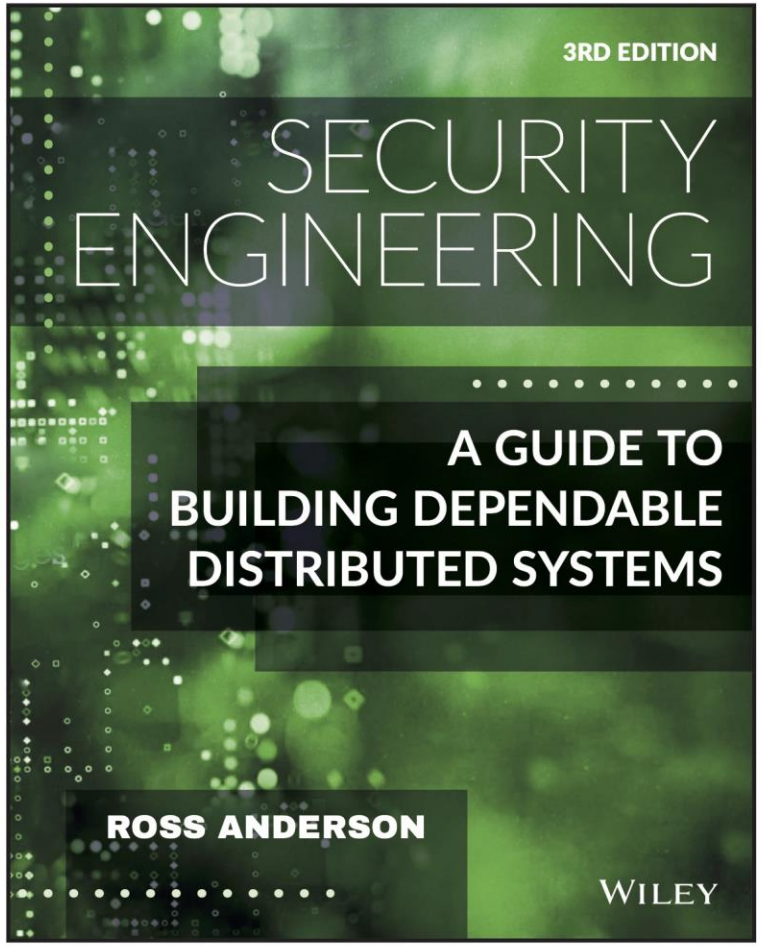
Warning: Politics & Security

- Who is targeted is often political
  - Nation states targeting each other (espionage)
  - Nation states targeting civilians (surveillance)
  - Civilians targeting civilians based on all kinds of politics (activism/extremism)
  - Civilians + NGOs targeting nation states (hacktivism)

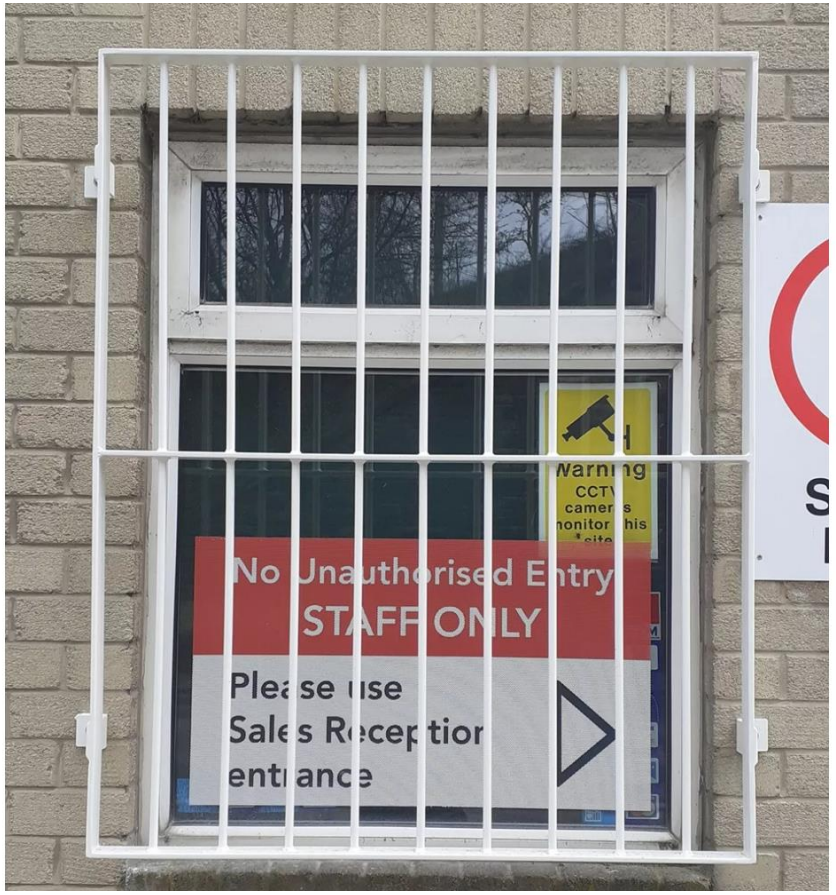
- Good security engineers understand that threat models often include political actors

That said, I will never intentionally ask you to make a political judgement. I will try not to share my own.

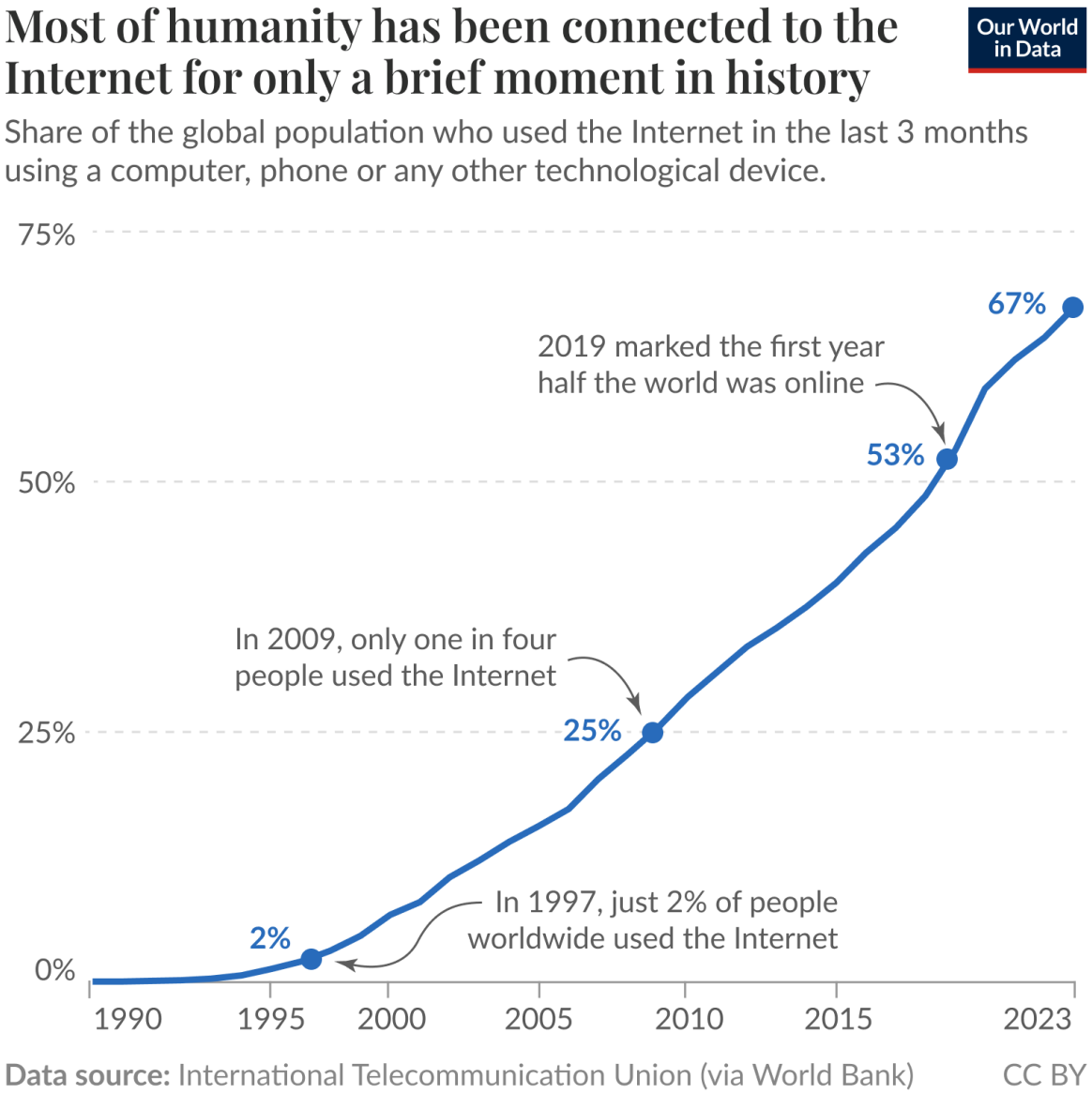
Chapter 2 - Who is the Opponent?



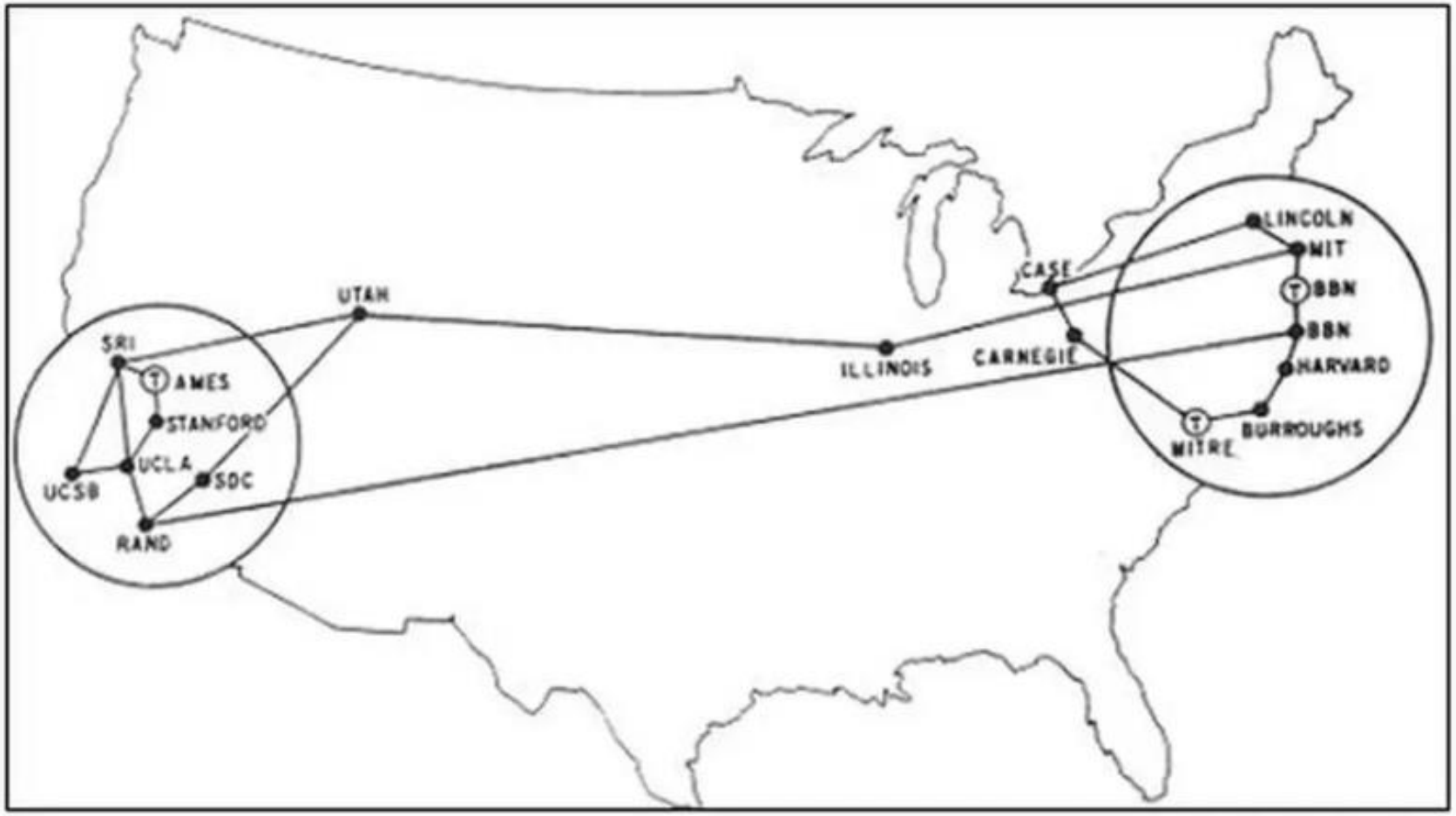
Why threat modelling matters



Why digital threat modelling is hard



Core infra designed for another threat landscape



By 1971, Arpanet connected the east and west coasts of the US, but did not go beyond

https://www.bbc.co.uk/news/technology-35579225

Why pay attention to the opponent?

"Security engineering is about building systems to remain dependable in the face of **malice**, error and mischance."

Defenders face different threat actors, and those threat actors have different capabilities:

- A firewalls don't work against actors with firewall vulnerabilities
- Preventative controls don't work against a malicious insider
- Intimate partners know the answers to password recovery questions
- Not much works against the intelligence community

This lecture

Who are the opponents? What are their tools/capabilities?

1. Criminals (the crooks)
   - Ransomware gangs, botnet operators, fraud gangs, malicious insiders
2. State actors (The spooks)–
   - Five eyes; Russia; China; third-tier
3. Lawful operators (The geeks) –
   - Employees, security researchers, competitors
4. The swamp
   - hate crimes, sex abuse, bullying

Further reading: Security Engineering chapter 2

The crooks

Financially-motivated actors willing to break the law

The boundaries of cyber vs traditional crime

Online highs are old as the net: the first e-commerce was a drugs deal

Mike Power

Ever since the 1970s, drug users have employed chemistry and telecommunications to stay several steps ahead of the law

Through the 70s, 80s and 90s, all manner of drugs – both legal and illegal – were sold online. Photograph: Ted S Warren/AP

Discuss and come up with an example of each

1. Cyber-Dependent Crime

These are "true" cybercrimes that **can only be committed using computers**. The device is both the tool and the target.

2. Cyber-Enabled Crime

These are traditional crimes that are **increased in scale, speed, or reach** by the use of technology.

3. Cyber-Assisted Crime (or Computer-Supported)

Crimes where the computer is **incidental** to the criminal activity.

Cyber dependent crime ✅ vs cyber enabled crime ❌

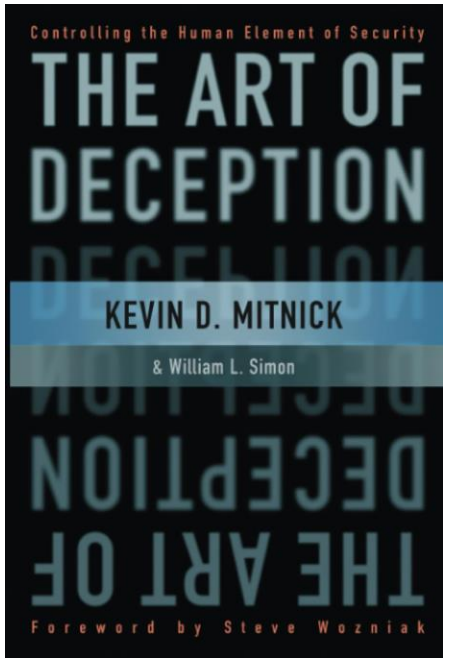
2024 CRIME TYPES *continued*

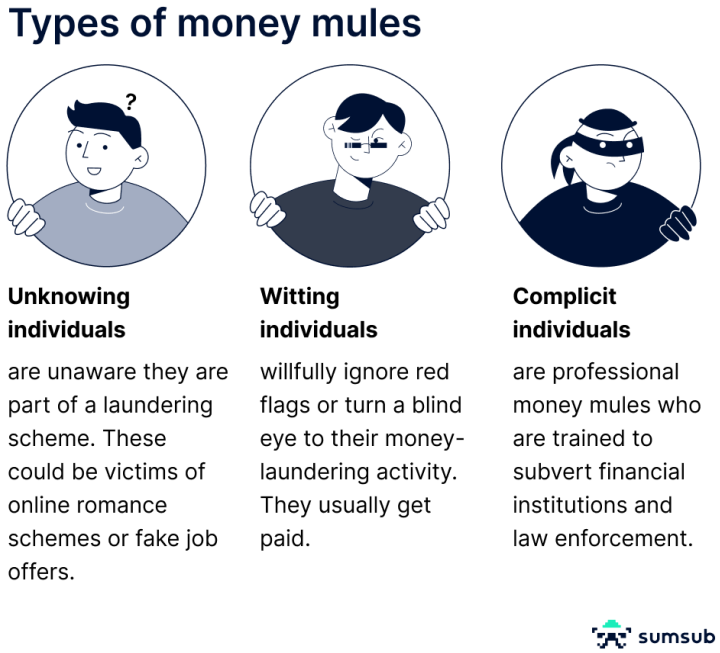
BY COMPLAINT LOSS

Crime Type	Loss	
Investment	$6,570,639,864	→ ❌ Social engineer individuals
Business Email Compromise	$2,770,151,146	→ ❌ Social engineer business, ✅ sometimes via hack
Tech Support	$1,464,755,976	→ ❌ Social engineer individuals
Personal Data Breach	$1,453,296,303	→ ✅ Mostly remote hacking
Non-Payment/Non-Delivery	$785,436,888	→ ❌ Defraud ecommerce buyers (mail order fraud as a comparison)
Confidence/Romance	$672,009,052	❌ Social engineer individuals (digital sweetheart scam)
Government Impersonation	$405,624,084	❌ Social engineer individuals
Data Breach	$364,855,818	→ ✅ Mostly remote hacking
Other	$280,278,325	
Employment	$264,223,271	→ ❌ Weird but not remote hacking
Credit Card/Check Fraud	$199,889,841	→ ❌ Auth failures, but not via remote hacking
Identity Theft	$174,354,745	→ ❌ Auth failures at banks, ✅ using data from hacking
Real Estate	$173,586,820	→ ❌ Social engineer renters/house buyers

Cyber-enabled crime capabilities

Core/necessary capabilities





Other capabilities

- Access to leaked data to establish trust
- Organizational capital, e.g. crime playbooks
- Technical capabilities, e.g. to build/contract fake websites
- People trafficking, e.g. to have real people for romance fraud and/or people to run scams

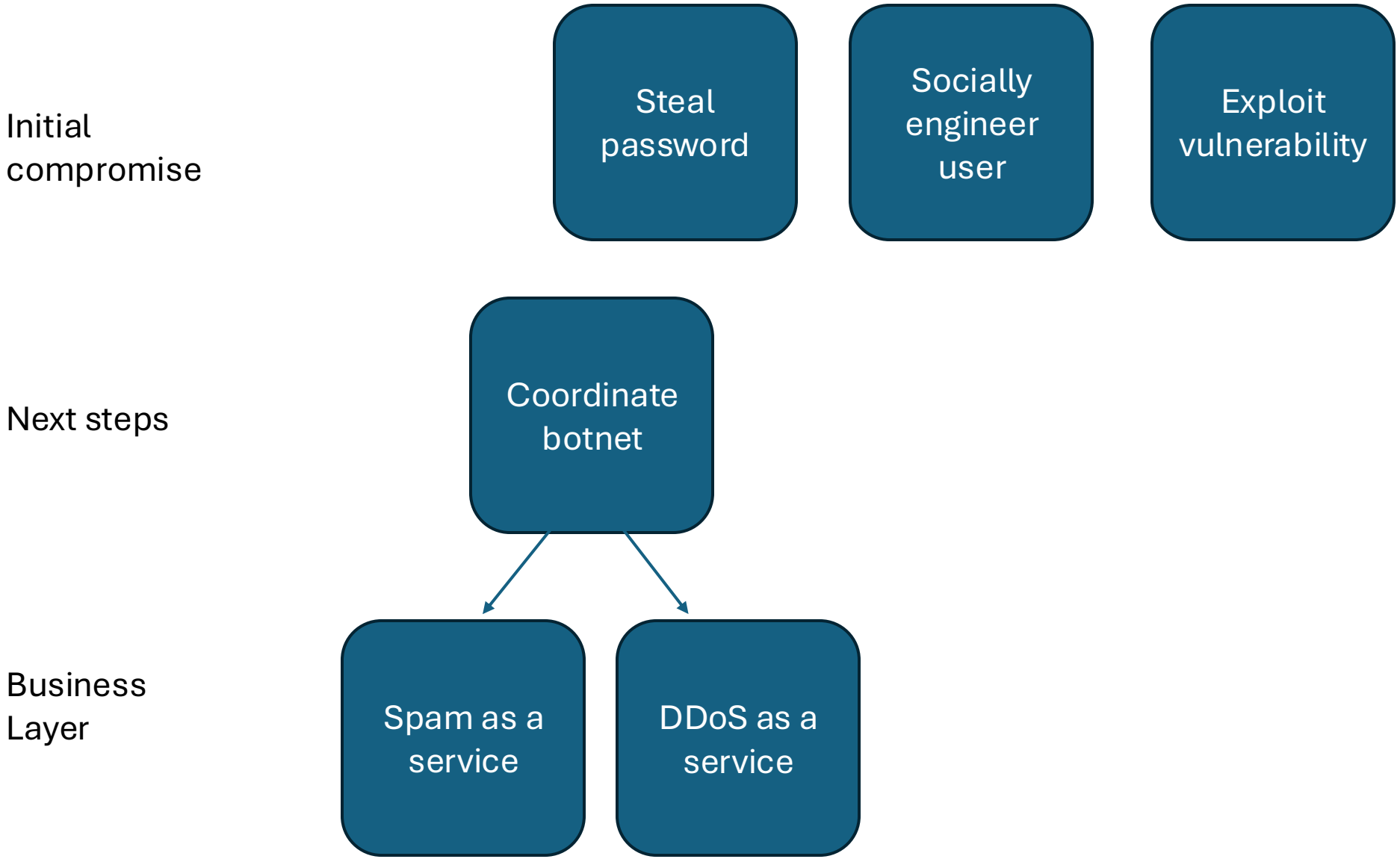
Feds seize $15 billion in crypto from 'pig butchering' scheme involving forced labor camps

OCT 14, 2025

By  Kara Scannell

Don't be fooled. Most cyber frauds are run by serious crime organizations.

Cyber Dependent Crimes before ~2005

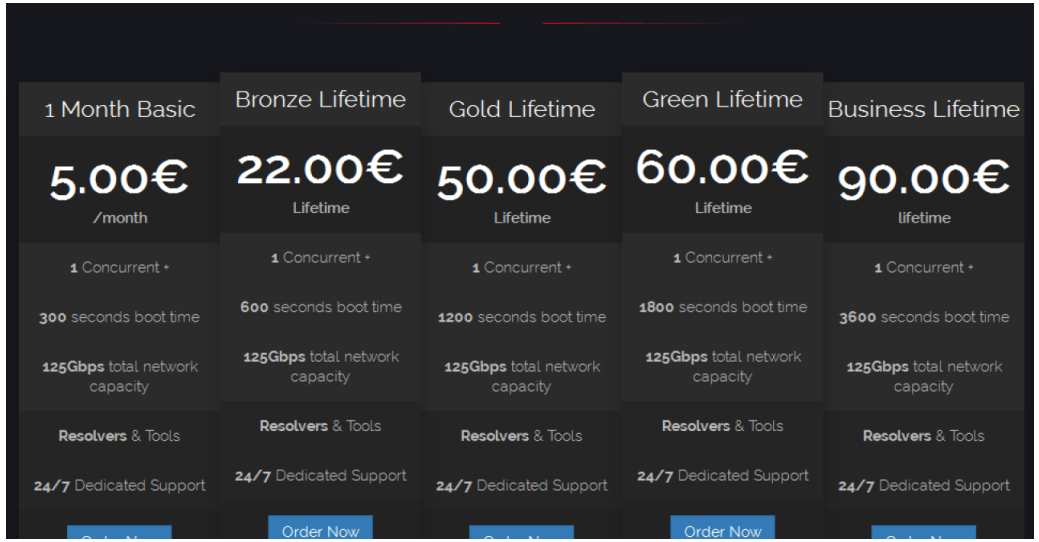


Cyber-dependent crime: DDoS for hire

September 14, 1996

New York's Panix Service Is Crippled by Hacker Attack

By ROBERT E. CALEM



Capabilities

- A network of computers to flood a system with traffic
  - Later DDoS for hire emerged (Booter as a service)
- Some cash out mechanism
  - It's easier to cash out when the adversary pays you than the victim. **Why?**

Who is targeted by DDoS?

- Extortion attempts have largely failed
- Largely a crime of passion linked to "revenge" targeting
  - Cyber crime researchers
  - Countries who "offended" other countries
  - Gamers
- Fascinating quant approach "back scatter analysis"
  - "for direct denial-of-service attacks, programs spoofing their address typically select source addresses at random for each packet sent"
  - "attacks against home machines … constitute relatively large, severe attacks .. One explanation is that minor denial-of-service attacks are being used to settle personal vendettas."

DDoS attack takes down Krebs site

News

Sep 23, 2016 • 4 mins

Attack was so powerful that Akamai threw up its hands

Credit: Thinkstock/Stephen Sauer

World news

This article is more than 18 years old

Russia accused of unleashing cyberwar to disable Estonia

· Parliament, ministries, banks, media targeted
· Nato experts sent in to strengthen defences

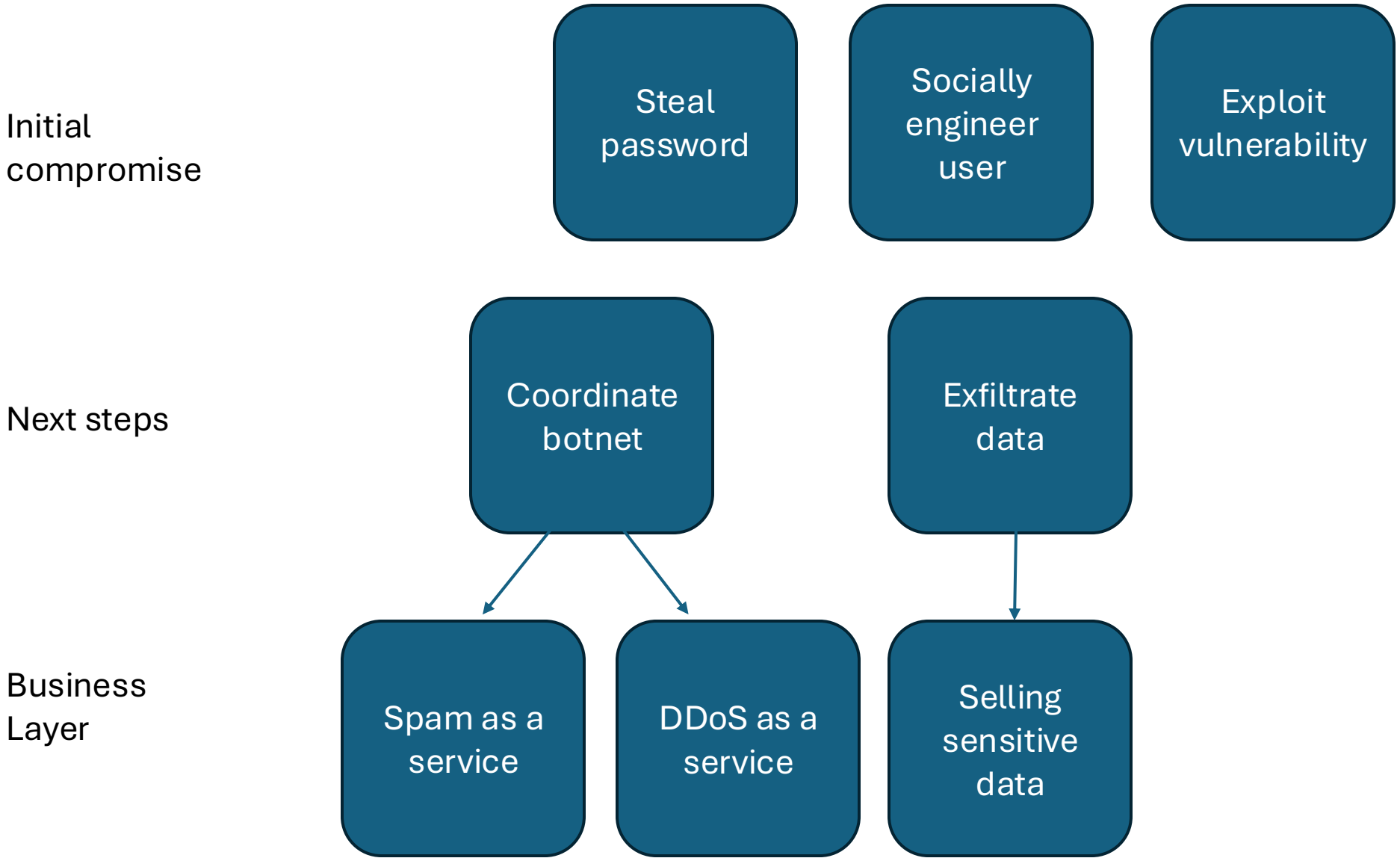
Ian Traynor *in Brussels*

Thu 17 May 2007 02.32 BST

Share

Source: Moore, David, Colleen Shannon, Douglas J. Brown, Geoffrey M. Voelker, and Stefan Savage. "Inferring internet denial-of-service activity." ACM Transactions on Computer Systems (TOCS) 24, no. 2 (2006): 115-139.

Cyber Dependent Crimes in ~2005



Cyber-dependent crime: Info stealing + selling

Capabilities

- Access to a network or machine with sensitive data
  - In the 2005—2015, this meant large retail firms for credit card data
  - Increasingly "info stealer" malware focuses on harvesting credentials
- A market to find a buyer, plus a cashout mechanism

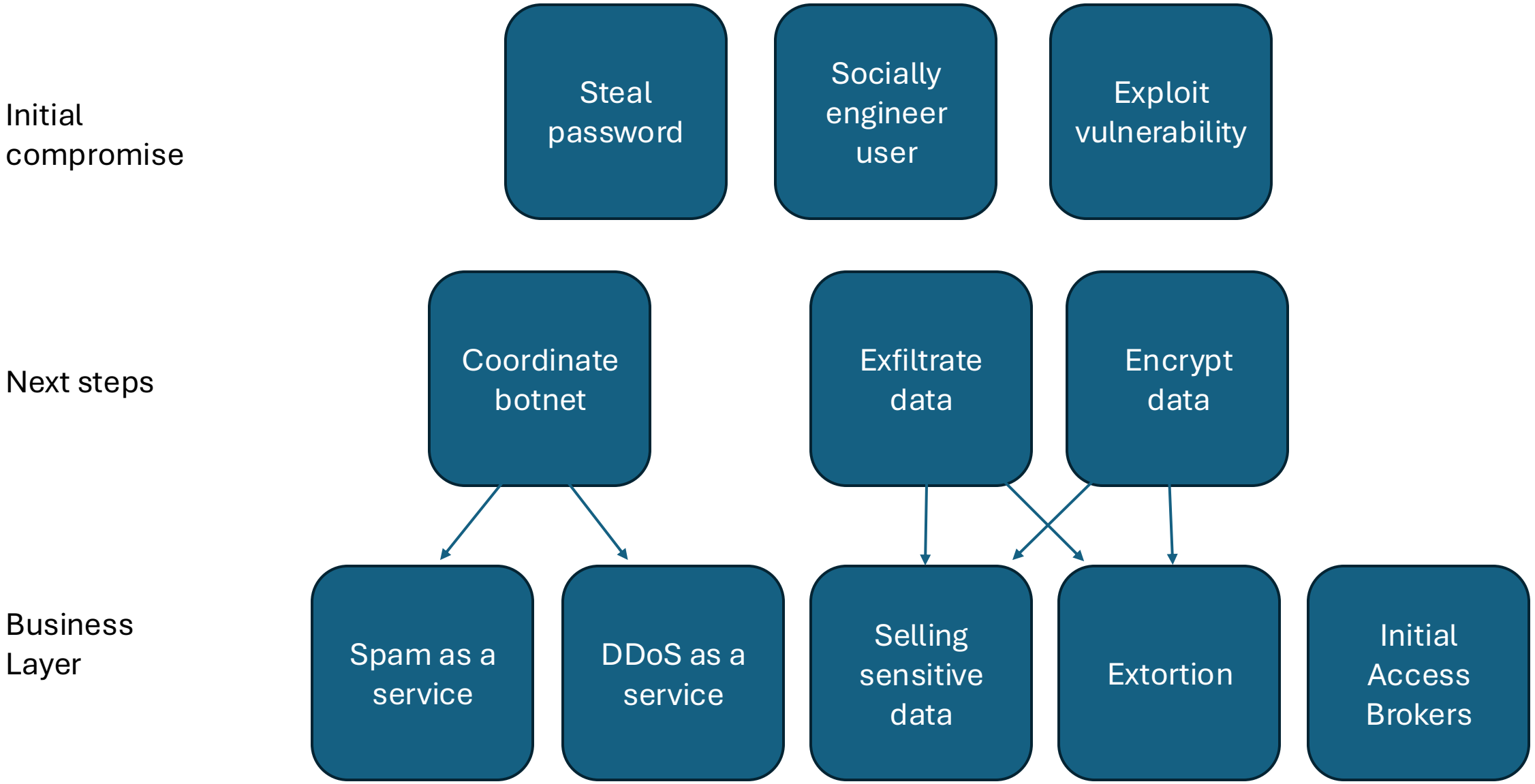
Who is targeted?

More or less everyone!

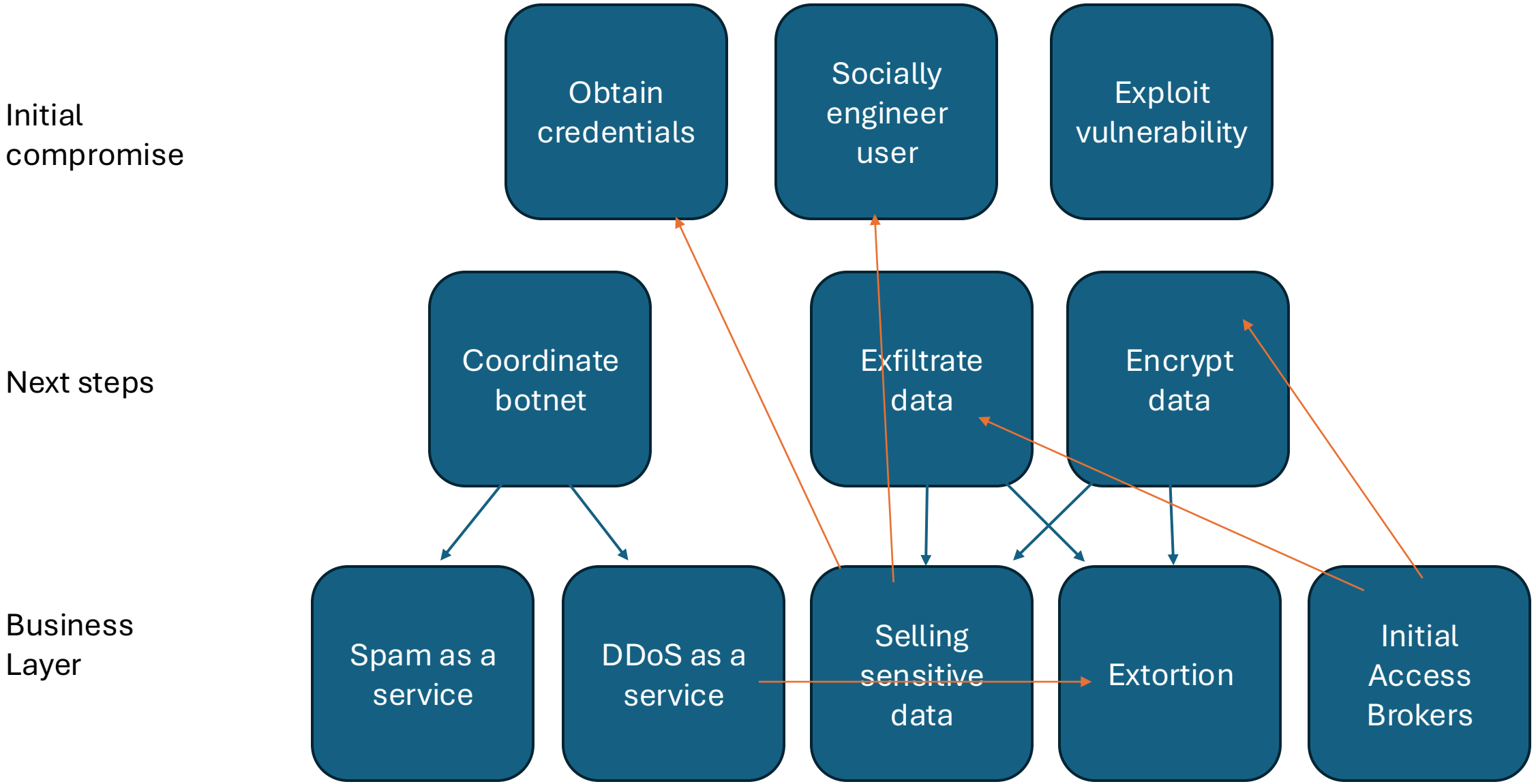
http://deepstrike.io/blog/dark-web-data-pricing-2025

- "Standard U.S. credit card with CVV sells for $10 to $40. A card with a verified high credit limit, such as $5,000, can be priced at $110 to $120"
- "A low balance account might sell for $200 to $500, but credentials for a high balance account can easily command $1,000 or more."

Cyber Dependent Crimes since 2015



Cyber Dependent Crimes



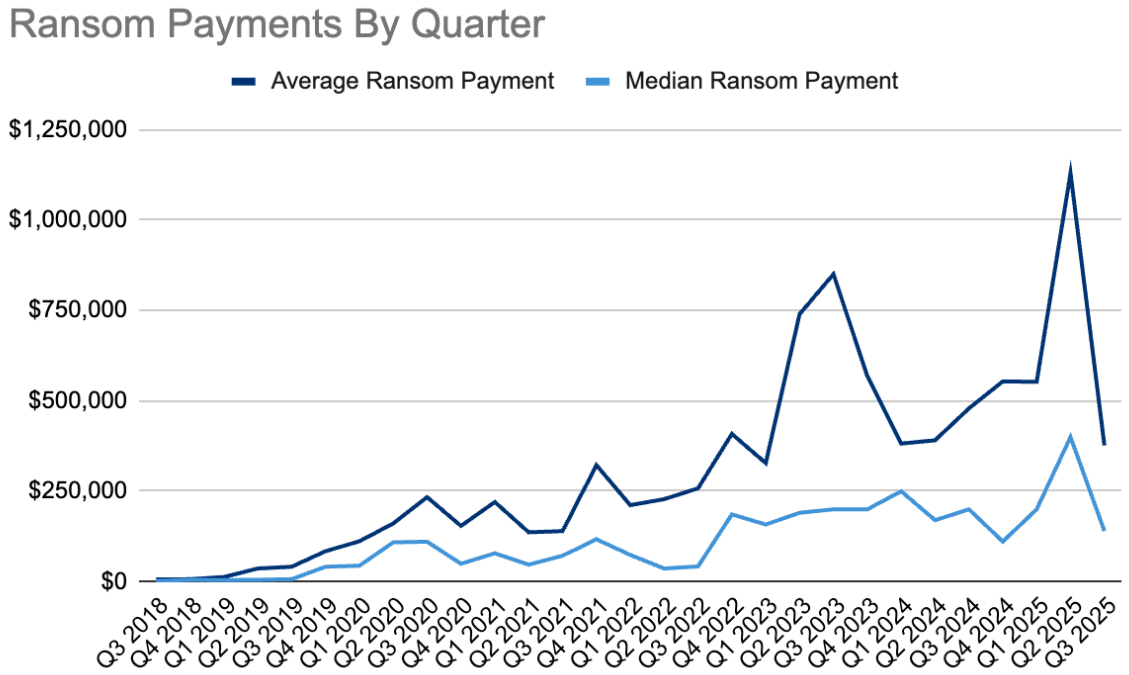
Cyber-dependent crime: Extortion

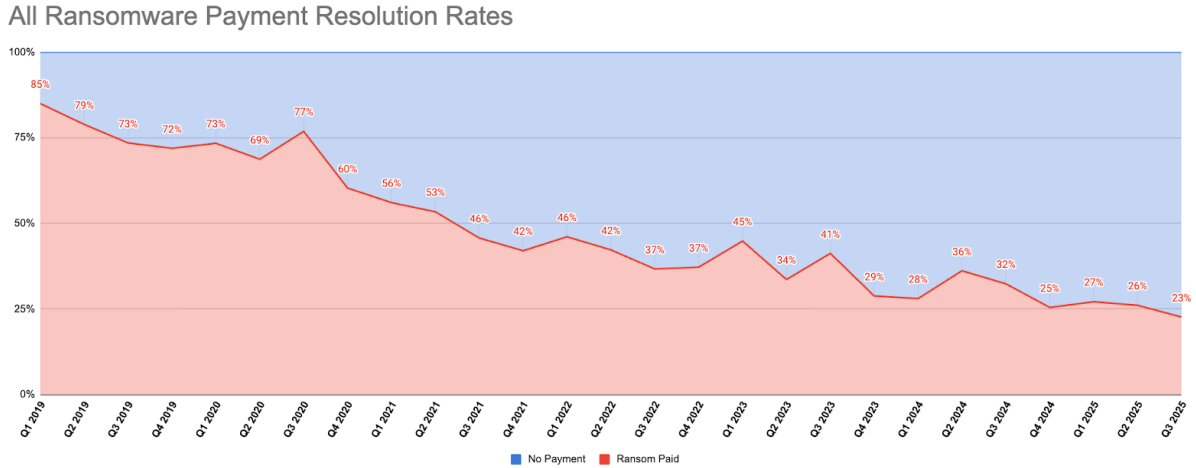
Capabilities

- Access to a network or machine
- Encryption software and/or exfiltration
- Negotiation skills
- Cash out

Who is targeted?

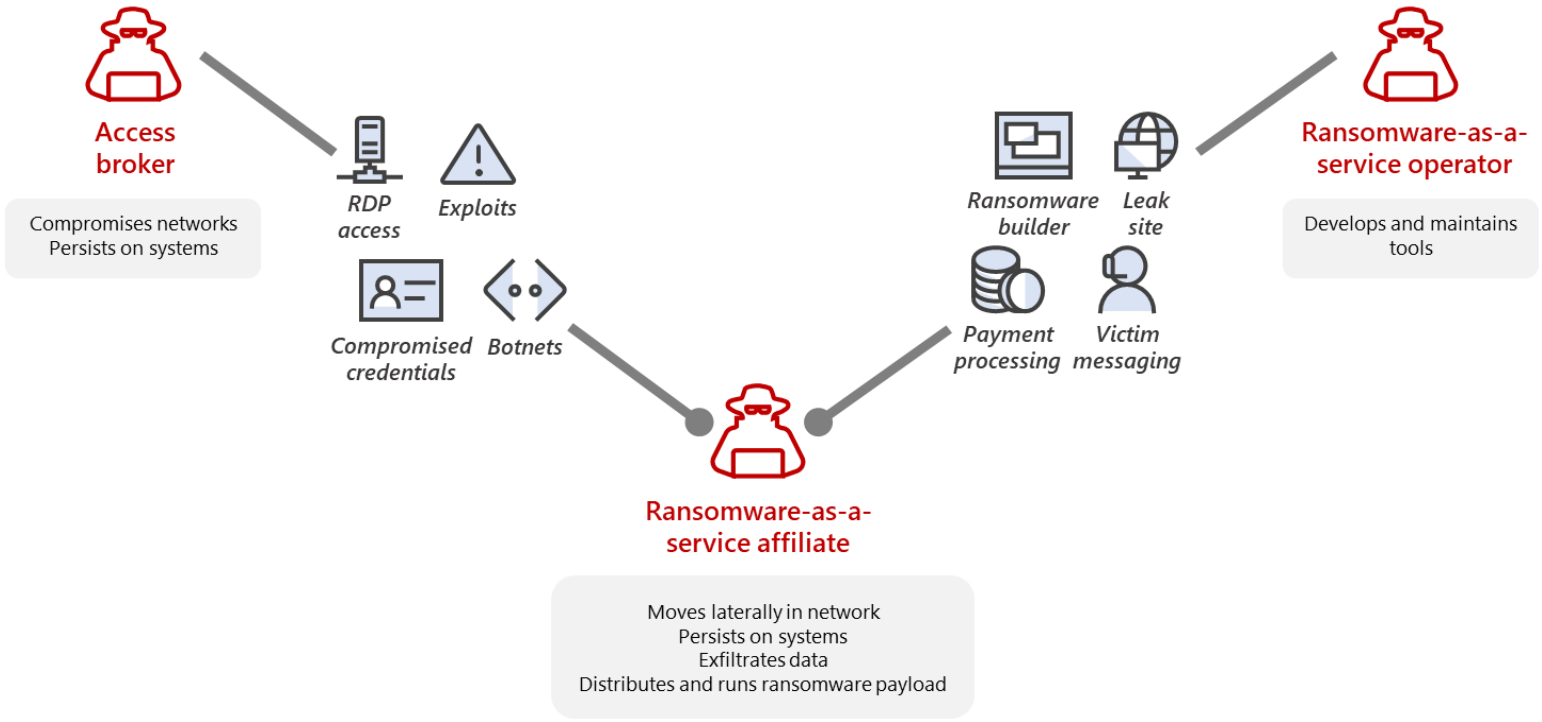
More or less everyone!





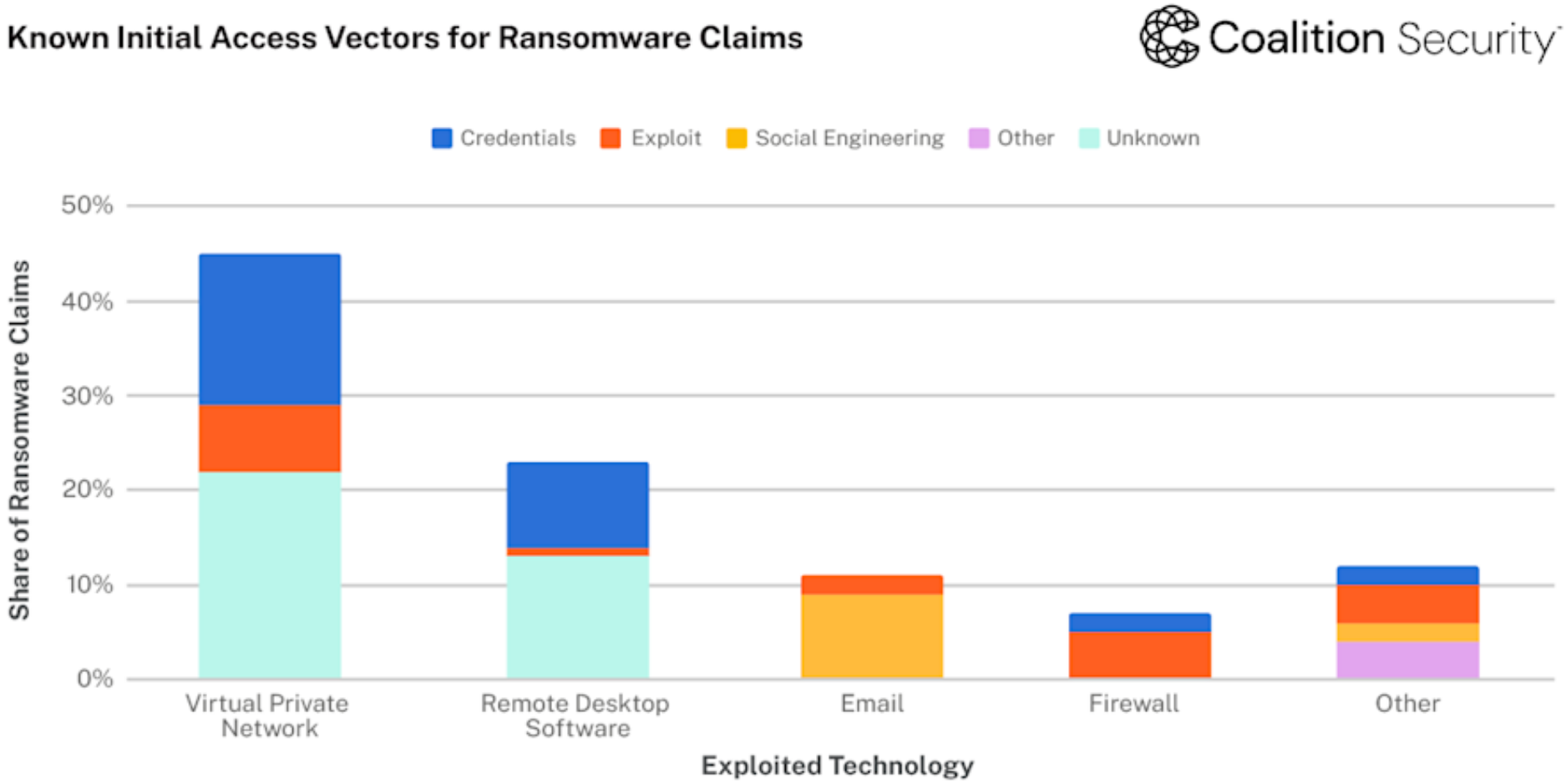
https://www.coveware.com/blog/2025/10/24/insider-threats-loom-while-ransom-payment-rates-plummet

Specialization and cyber crime



https://www.microsoft.com/en-us/security/blog/2022/05/09/ransomware-as-a-service-understanding-the-cybercrime-gig-economy-and-how-to-protect-yourself/

How ransomware gangs get access



https://www.microsoft.com/en-us/security/blog/2022/05/09/ransomware-as-a-service-understanding-the-cybercrime-gig-economy-and-how-to-protect-yourself/

The spooks

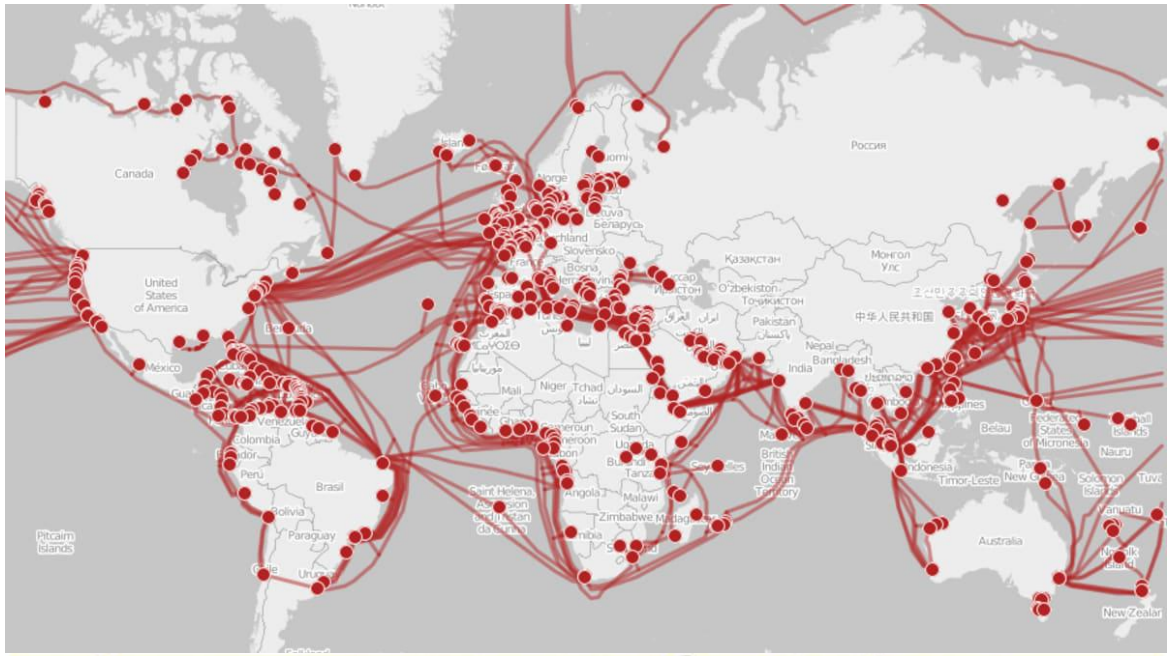
Politically-motivated actors with near endless resources

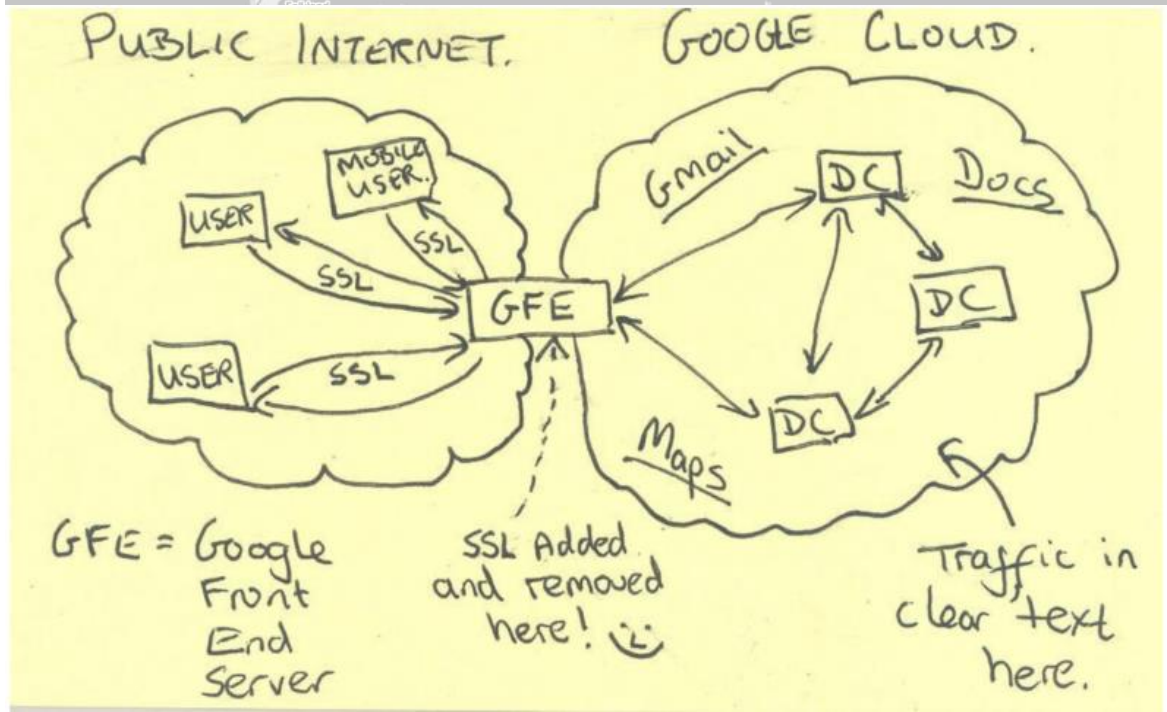
The Five Eyes

- USA, UK, Canada, Australia and New Zealand share intelligence infra

Capabilities

- PRISM "downstream" access to internet company data
- Combined with "upstream access" via satellites and cables (e.g. Cornwall, Gibraltar etc)
- Computer network exploitation (CNE) hacking, both bulk and targeted
  - 0-day vulns (see Shadow Brokers)





The Five Eyes

Who is targeted?

- Hostile states, terror suspects
- Domestic politics
  - Typically focused on "extremists", but who defines that?
- Even allies targeted
- Own citizens, typically required warrant:
  - probable cause for US persons, typically requested by the FBI
- Less oversight for foreign targets
  - Your citizens are foreign to your allies…

Reuters Subscribe

U.S. spied on Merkel and other Europeans through Danish cables - broadcaster DR

By Reuters

May 31, 2021 5:09 PM GMT+1 · Updated May 31, 2021

Germany eavesdropped on some Obama calls from Air Force One, book says

Germany's foreign intelligence agency, the BND, intercepted some unencrypted calls around the same time the U.S. was spying on Chancellor Angela Merkel, a new book reveals.

January 5, 2026

GCHQ's mass data interception violated right to privacy, court rules

Human rights judgment follows legal challenge begun in 2013 after Edward Snowden's whistleblowing revelations

Haroon Siddique

Tue 25 May 2021 15.45 BST

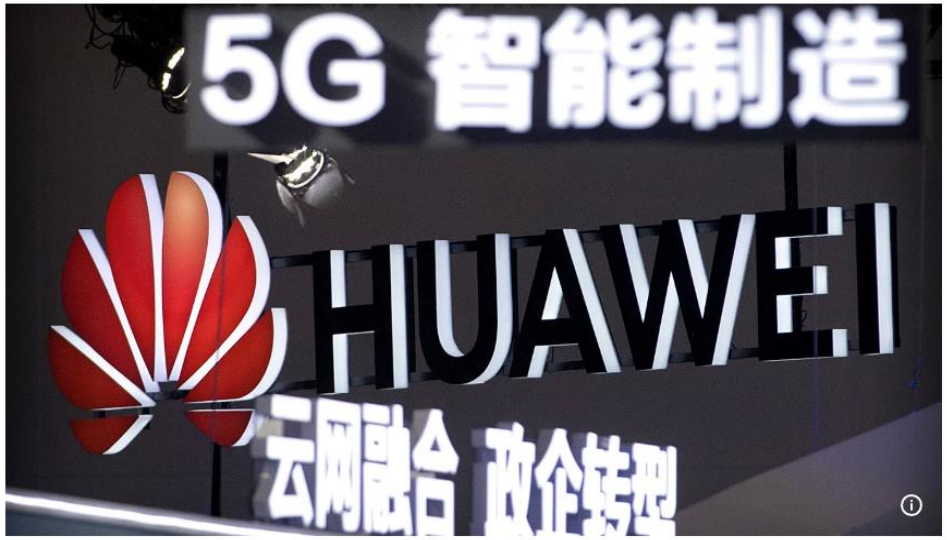
China

America's strategic peer competitor

Capabilities

- Hacking went from smart people + simple tools in 2000s to more systematic operations now
- Building own infrastructure over time access via Belt and Road
  - Huawei, ZTE, etc
  - TikTok
- Full-stack competition:
  - chips; 'offshoring' manufacture for US firms; its own tech majors, …
  - Microsoft uses China-based engineers for U.S. government cloud services

Eleven EU countries took 5G security measures to ban Huawei, ZTE



Explainer: what is Volt Typhoon and why is it the 'defining threat of our generation'?

FBI director has publicly identified the risk posed by a Chinese cyber operation that is believed to have compromised thousands of internet-connected devices

Helen Davidson *and agencies*

China

Who is targeted?

- Foreign states and political figures
- Domestic politics
  - Typically focused on "extremists", but who defines that?
- Own citizens, including those living abroad
- IP rich companies
- …

Dalai Lama's Chinese website hacked and infected

13 August 2013

BRENDAN I. KOERNER SECURITY OCT 23, 2016 5:00 PM

Inside the Cyberattack That Shocked the US Government

On April 15, 2015, a network engineer noticed a strange signal emanating from the US Office of Personnel Management. That was just the tip of the iceberg.

Chinese hackers took trillions in intellectual property from about 30 multinational companies

By Nicole Sganga

May 4, 2022 / 12:01 AM EDT / CBS News

China's Software Stalked Uighurs Earlier and More Widely, Researchers Learn

A new report revealed a broad campaign that targeted Muslims in China and their diaspora in other countries, beginning as early as 2013.

Russia, Iran, North Korea …

- Lacking platform advantage, instead rely on spear-phishing and hacking
- Russia uses cyber weapons in regional conflicts, e.g. Ukraine's grid in 2015
- NotPetya in 2017 estimated to have caused $10bn of damage
- SolarWinds hack against US gov
- Iran hacks Saudi Aramco in response to Stuxnet
- …

North Korean programmer charged in Sony hack, WannaCry attack

Nation Sep 6, 2018 2:16 PM EST

Ukrainian blackout caused by hackers that attacked media company, researchers say

Power company suffered a major attack that led to blackouts across western Ukraine, after an attack on a Ukrainian media company

Alex Hern

Thu 7 Jan 2016 13.20 GMT

ANDY GREENBERG EXCERPT SECURITY AUG 22, 2018 5:00 AM

The Untold Story of NotPetya, the Most Devastating Cyberattack in History

Crippled ports. Paralyzed corporations. Frozen government agencies. How a single piece of code crashed the world.

Advanced Persistent Threat Compromise of Government Agencies, Critical Infrastructure, and Private Sector Organizations

Last Revised: April 15, 2021 **Alert Code:** AA20-352A

Summary

Updated April 15, 2021: The U.S. Government attributes this activity to the Russian Foreign Intelligence Service

Third tier cyber powers

Capabilities

- No strong internal capabilities, instead buy it from contractors
  - Intelligence-as-a-service
  - Famously, 0-click exploits of phones..
- More constrained than others
  - Can't be too noisy or you burn the exploit
  - May face public backlash (see NSO)

Who do they target

- Political figures, dissidents, journalists

Jeff Bezos hack: Amazon boss's phone 'hacked by Saudi crown prince'

Exclusive: investigation suggests Washington Post owner was targeted five months before murder of Jamal Khashoggi

Revealed: the Saudi heir and the alleged plot to undermine Jeff Bezos

Stephanie Kirchgaessner *in Washington*

Wed 22 Jan 2020 09.04 GMT

Paranoia as how to mitigate spooks

The geeks

"Good" actors with technical skills and/or elevated access

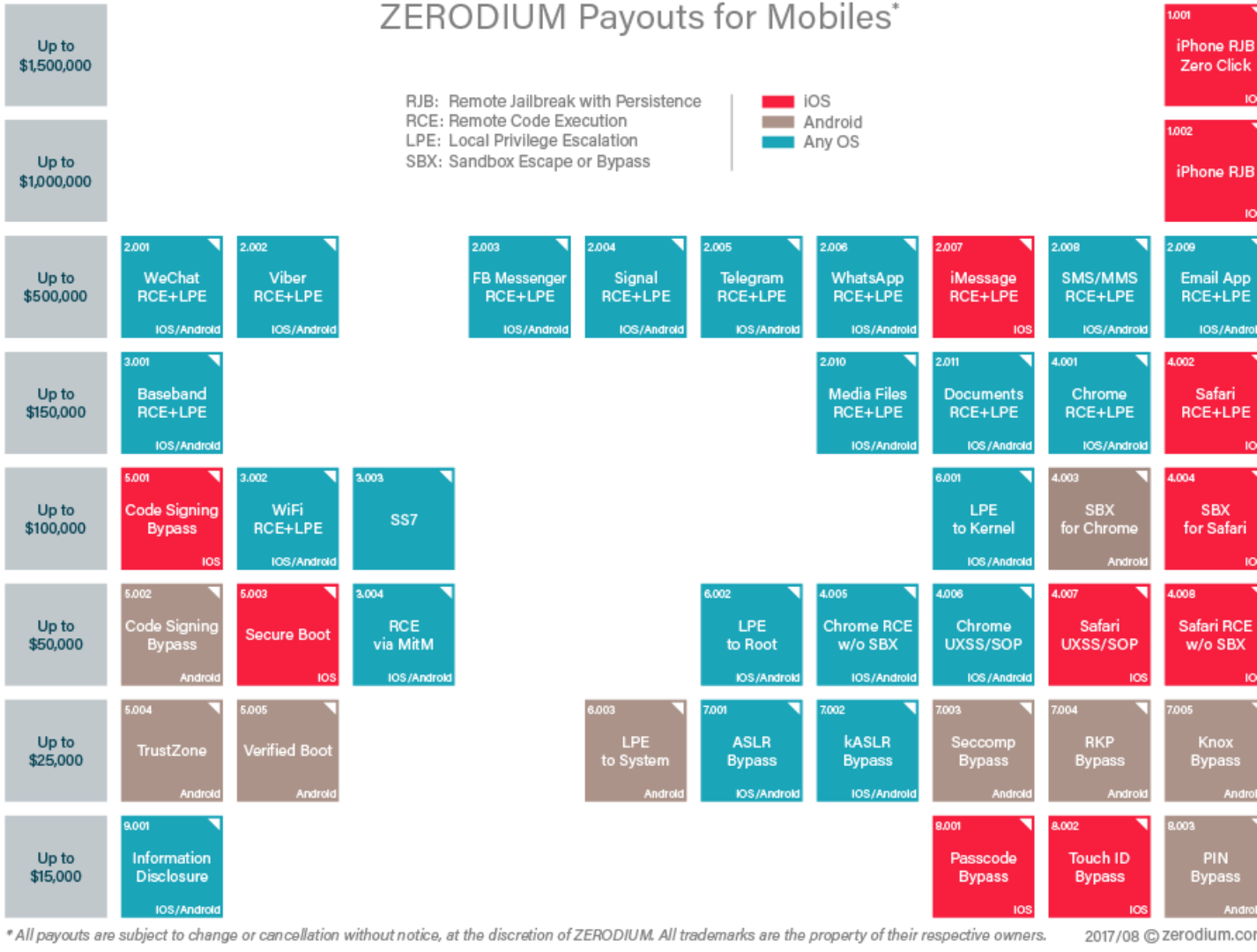
Freelance hackers

Capabilities

- Smart and v talented
  - Some train as spooks, and then get sick of bureaucracy
- Typically specialize in one system

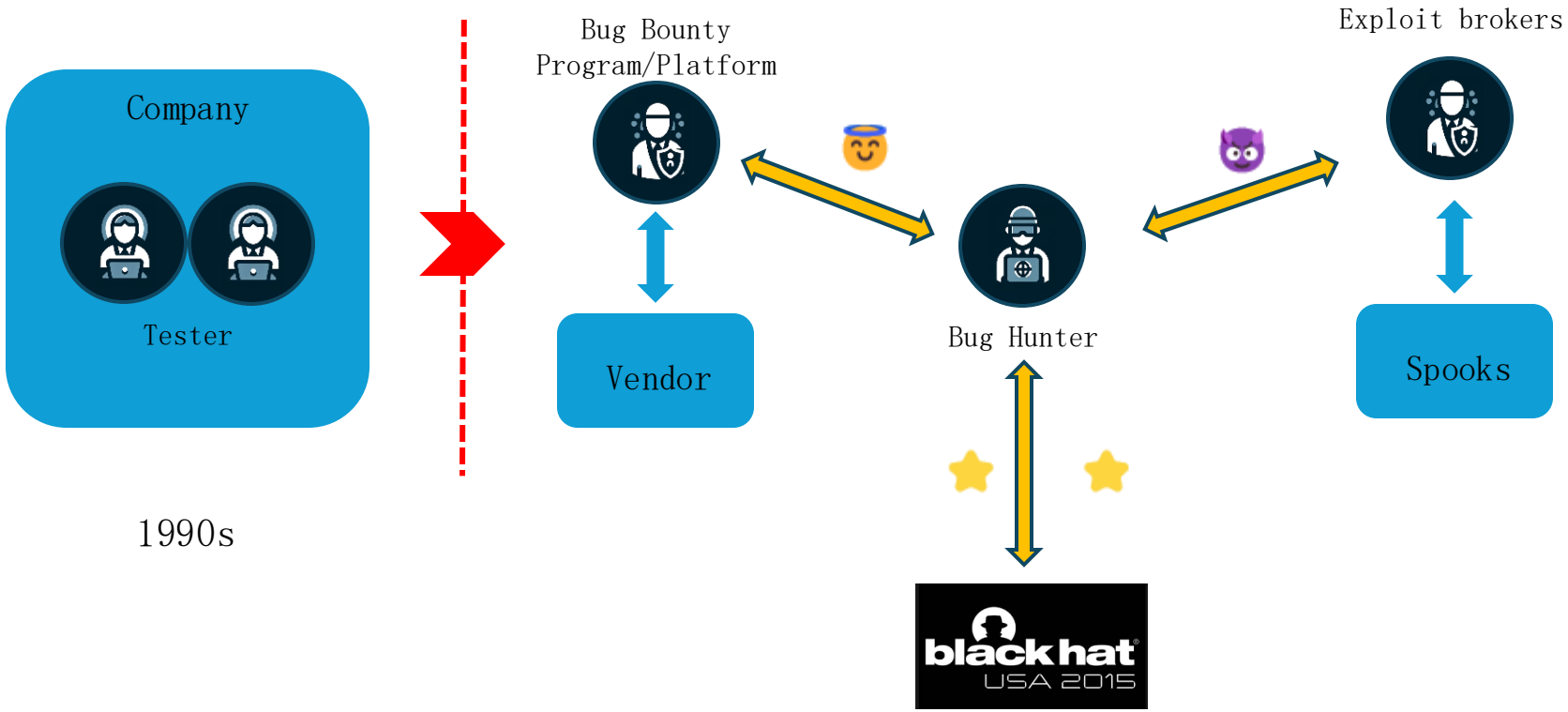
Who do they target

- Depends on disclosure
  - Sell to "responsible" buyers
  - Sell to the vendor
  - Present at conference



Source: Dellago, Matthias, Daniel W. Woods, and Andrew C. Simpson. "Characterising 0-day exploit brokers." In The 21st Workshop on the Economics of Information Security. 2022.

Freelance hackers



1990s

Conference

US charges American mercenary hackers over their work in UAE

Three former US intelligence operatives accused of helping UAE spy on enemies

Reuters

Tue 14 Sep 2021 23.57 BST

More money, more problems

JENNIFER GRANICK SCIENCE AUG 5, 2005 11:00 AM

An Insider's View of 'Ciscogate'

What was it like at the center of the fast-moving legal uproar that pitted a whistle-blowing security researcher against two corporate giants?

At what cost, fame

Source: Dellago, Matthias, Daniel W. Woods, and Andrew C. Simpson. "Characterising 0-day exploit brokers." In The 21st Workshop on the Economics of Information Security. 2022.

Responsible Disclosure

- Google Zero: *“**Disclosure deadline of 90 days**. If an issue remains unpatched after 90 days, technical details are published immediately. If the issue is fixed within 90 days, technical details are published 30 days after the fix.”*

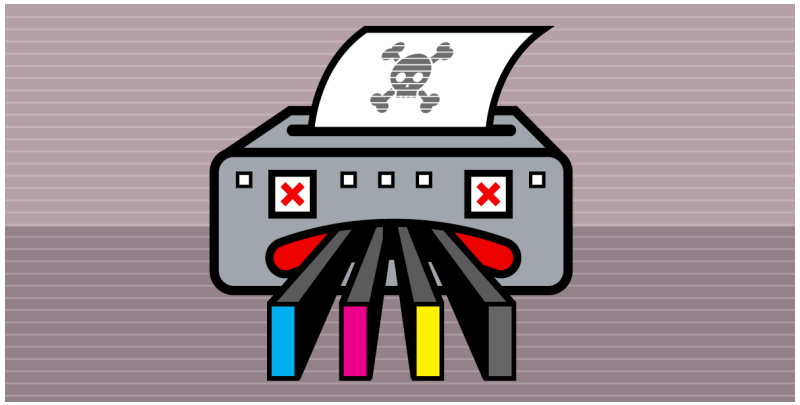
https://googleprojectzero.blogspot.com/p/vulnerability-disclosure-faq.html

Responsible Disclosure: CERT

- CERT vulnerability reporting chain: JANET CSIRT – UK NCSC – Pittsburgh US NSA – Microsoft's Patch Tuesday.
- 45+/90 day window of disclosure.
- Liability shield/credit for the hacker.
- Only good for OS/networks, not finance.

https://www.ncsc.gov.uk/files/NCSC_Vulnerability_Toolkit.pdf
https://vuls.cert.org/confluence/pages/viewpage.action?pageId=4718642
https://hackerone.com/disclosure-assistance

Vendor on vendor violence



- Vendors design printers to refuse 3rd party cartridges
- Competitors break the security to enable their catridgdes
- Lexmark Int'l, Inc. v. Static Control Components, Inc rules vendors cannot sue under DCMA

==> Crypto arms race

Microsoft hits out at Google team over bug report

12 January 2015

- Google Project zero conducts vulnerability research.... into other companies' products
- Other vendors may do the same

==> Conflict of interest?

Uber fires self-driving car engineer amid legal fight with Google

30 May 2017

- Employees may steal IP to found companies/join competitors

==> easier to sue here

Insider threats

Your employees have elevated privileges by design… can you trust them?

56% Of All Cybercrime Prosecutions in the UK Involve Police Officers Misusing Data Access

March 1, 2025 :: 1 min read

And the victims are disproportionately women.

Source: Hutchings, Alice. "Police behaving badly." IEEE Security & Privacy 23, no. 1 (2025): 80-82.

Accountant and two bankers jailed for stealing £390k from customers

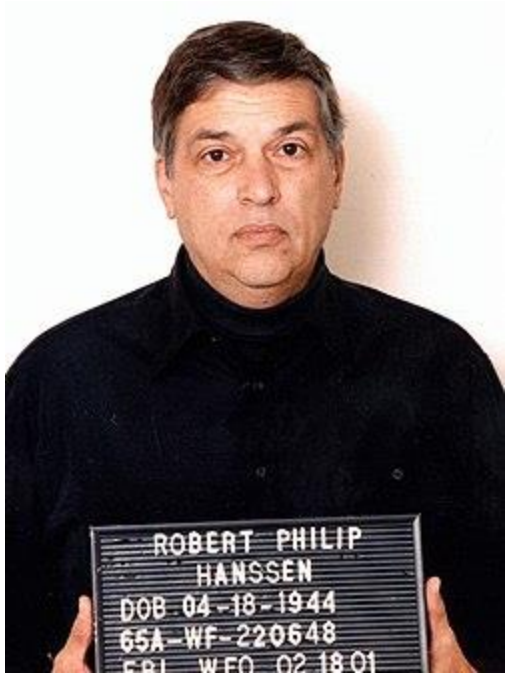
Fraud

Accountant and two bankers jailed for stealing £390k from customers

Three men have been jailed after defrauding elderly bank customers of more than £390,000 and laundering the cash through multiple fake accounts.

Taminder Virdi aged 33, from Ilford in Essex, and Abubakar Salim, aged 36, from Leyton, who both worked at the same TSB branch in Stoke Newington in 2014, transferred funds out of customer accounts into 65 fraudulent beneficiary accounts they had opened.

Source: https://www.nationalcrimeagency.gov.uk/news/accountant-and-two-bankers-jailed-for-stealing-390k-from-customers



FBI agent for 2 decades, sending info to soviets

The swamp

Variously motivated actors with few technical skills

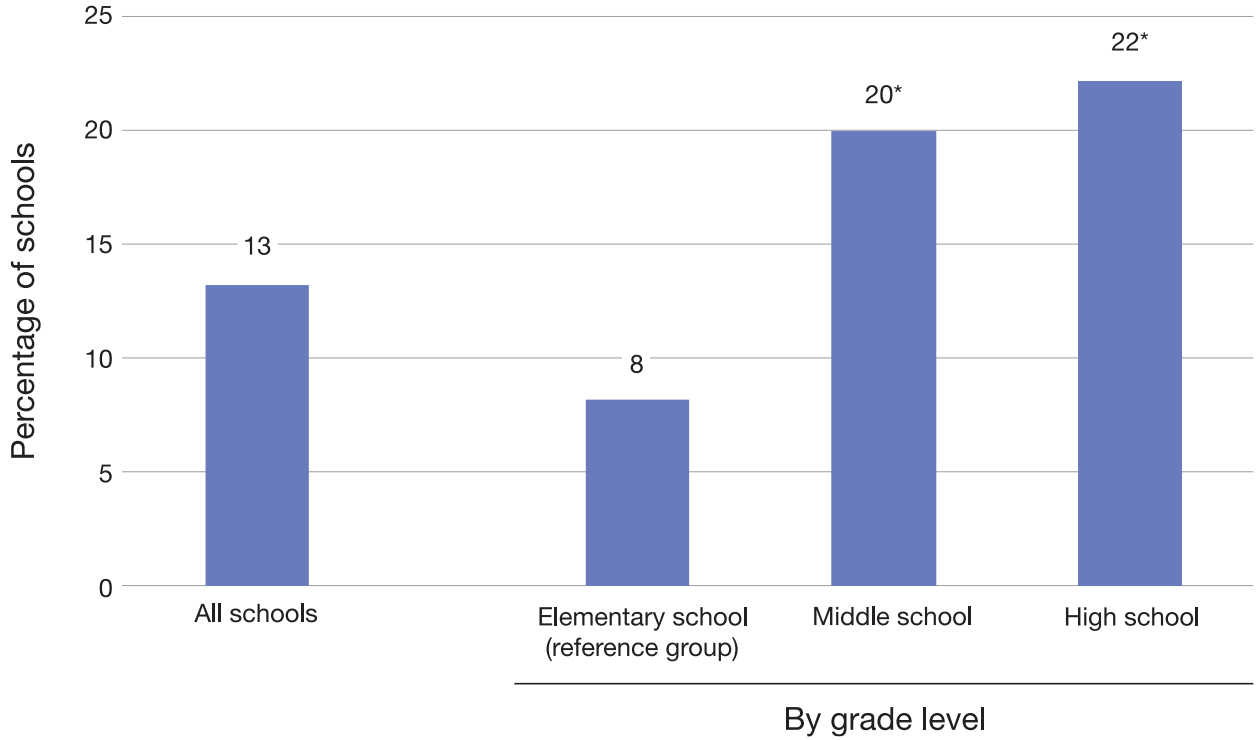
Children

Capabilities

- Access to the victim's social network + personal information
- Increasingly use deepfakes

Who do they target

- Mostly fellow classmates



https://www.rand.org/pubs/research_reports/RRA3930-5.html

Online mobs

Capabilities

- Coordinated groups can manipulate algorithms by mimicking virality
- Weaponizing privacy (doxxing)
- DDoS as a service
- Physical impact too
  - Swatting
  - Mob justice
- Increasingly use deepfakes

Who do they target

- Usually political
  - Broad definition of politics

Feminist Critics of Video Games Facing Threats in 'GamerGate' Campaign

China's internet vigilantes and the 'human flesh search engine'

28 January 2014

Police shoot man dead after alleged Call of Duty 'swatting' hoax

30 December 2017

How WhatsApp helped turn an Indian village into a lynch mob

19 July 2018

Extremists

Capabilities

- Sophisticated media operations with the goal of radicalization
  - High-quality content produced centrally
  - Botnets + decentralized members to amplify
  - "Grooming" targeted at vulnerable groups
- Privacy preserving communications
  - E2E, Tor, bullet proof hosting, "privacy" hardware
- Fund raising/money laundering infrastructure
  - Cryptocurrencies, fake charities

Who do they target

- Typically vulnerable people not integrated in society

Family members

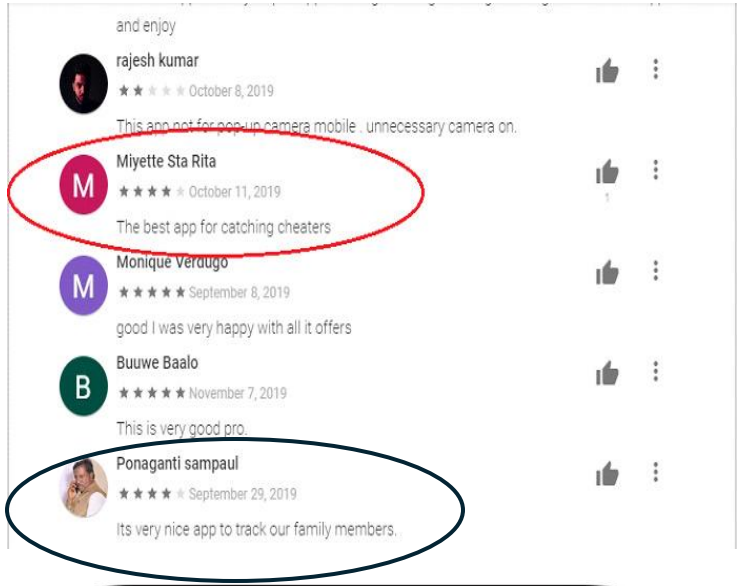
Capabilities

- Complete knowledge about victims
  - Password recovery questions
  - Coerced into sharing PINs + passwords
- Physical access to devices
- Stalkerware is common
  - Hidden once installed on phone and reports back to another device
  - Why do app stores allow it?
    - Parent tracking child is an ambiguous use case

Who do they target

- Partners and family members

😈 ?



😇 ?

Summary

Depending on the task, a security engineer might have to worry about:

1. Criminals (the crooks)
   - Ransomware gangs, botnet operators, fraud gangs, malicious insiders
2. State actors (The spooks)–
   - Five eyes; Russia; China; third-tier
3. Lawful operators (The geeks) –
   - Employees, security researchers, competitors
4. The swamp
   - hate crimes, bullying, family members etc

Further reading: Security Engineering chapter 2