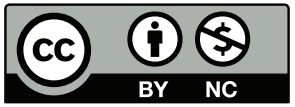
Risks of Computers: Security



Security Risks

- Computerized systems are often susceptible to more security risks than non-computerized alternatives
- On the other hand, there are things computers can do that are infeasible or uneconomical by hand
- Both alternatives are subject to false positives and false negatives
- But—remember that people tend to trust what a computer says

Theft by Computer

- Scale
- Repetition
- Frequently, more access

Scale

- Computers can store *lots* of data
- High-capacity storage media are very small and very cheap
- High-bandwidth connectivity is very common
- Both insiders and outsiders can steal much more data by computer than manually

Large-Scale Manual Thefts

- Of course, large-scale manual thefts have taken place
- In the late 1960s, Israel stole the complete plans for the French Mirage 5 fighter: 250,000 documents, weighing over 3 tons. . .
- Daniel Ellsberg gave the "Pentagon Papers"—47 volumes, 7,000 pages—to the NY Times and other newspapers (1971)
- The "Media 9" broke into an FBI field office, stole all of the files, and sent copies to reporters (1971)
- But it's easier by computer—think Edward Snowden

Repetition

- You can steal a lot of money at once, or you can steal a little bit, repeatedly
- “Bite fraud” versus “nibble fraud”
- Purported nibble fraud: when calculating interest payments, always round down to the lower cent; add the fractions of a cent—from many accounts—to the fraudster’s account

Access

- Locking down things too finely is difficult—users don't understand how to do it
- The operating systems and networks may not permit the kind of controls you want
- It's very easy to forget to revoke permissions when people leave the company or switch job roles
- Attacks

Attacks

- Many kinds!
- Technical attacks
  - Network protocol or system design
  - Cryptographic (rare)
  - Bugs
- Social attacks (phishing, spear-phishing, etc.)
- Combination attacks

Three Crucial Questions

- What are you trying to protect?
- Who is your enemy?
- What are your enemy's powers?

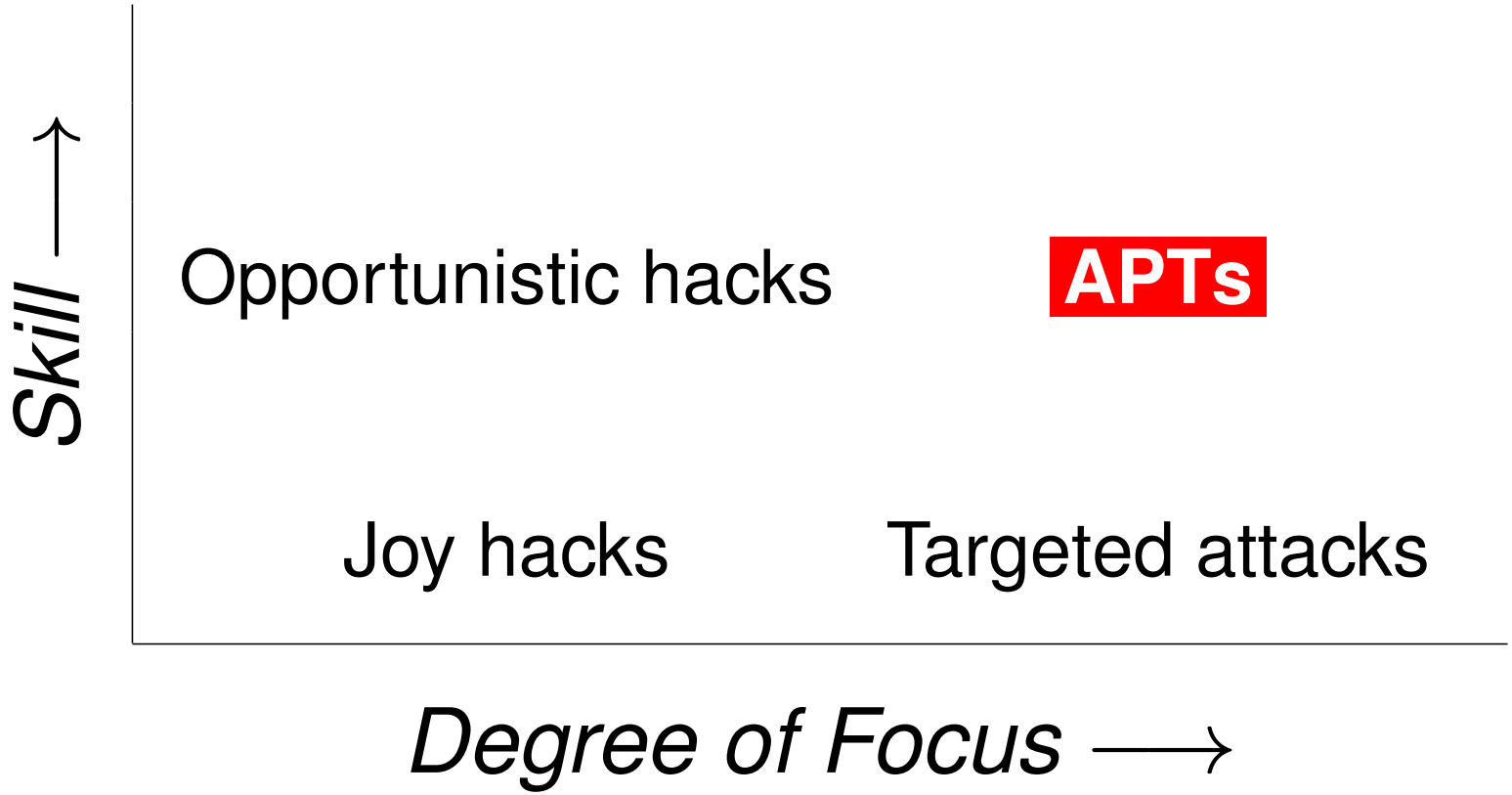
Enemy Goals

- Theft of information
- Damage
- Extortion
- Ransom (via encrypted files)
- Vandalism
- Bragging
- Access to your resources
- Voyeurism
- More? Probably...

Enemies

- (Teenage?) joy hackers
- Low-level criminals (phishers, spammers, etc.)
- Organized crime
- Insiders
- Industrial spies
- Foreign governments
- Or, of course, combinations

The Threat Matrix



Joy Hackers

- Many are “script kiddies”; some are very competent.
- ☞ The scripts are very sophisticated.
- The hackers share tools more than the good guys do.

Are Joy Hackers a Problem?

- What would it cost you to rebuild a machine?
- What would your CEO say if you ended up on the front page of the NY Times?
- What if they're working for someone else?
- N.B. Their target selection has improved.

Opportunistic Attacks

- They're good, often very good—but they don't care whom they get
- Most viruses, spam emails, phishing emails, etc., fall into this category
- First you shoot the arrows, then you paint your target. . .

Hacking for Profit

- The hackers have allied themselves with the spammers and the phishers
- The primary motivation for most current attacks is *money*
- The market has worked—the existence of a profit motive has drawn new talent into the field
- We are seeing, in the wild, sophisticated attacks
- We're seeing less pure vandalism
- Most of today's worms and viruses are designed to turn victim computers into "bots"
- Turning off the Internet isn't profitable. . .

Organized and Disorganized Crime

- In many cases, hacking is just another venue for ordinary criminal activity
- The same people who hack steal also credit card numbers, launder money, etc.
- Some are even former drug dealers

Targeted Attacks

- Often an insider
- They'll do lots of research on *you*
- May send "spear-phishing" emails

Inside Jobs

- Insiders know what you have.
- Insiders often know the weak points.
- Insiders are on the inside of your firewall.
- Etc., etc., etc.

☞ What if your system administrator turns to the Dark Side?

Industrial Espionage

- Less than 5% of attacks are detected. Professionals who are after you won't use your machine to attack other companies, and that's how successful penetrations are usually found.
- Professionals are more likely to use non-technical means, too: social engineering, bribery, wiretaps, etc.
- Professionals tend to know what they want.

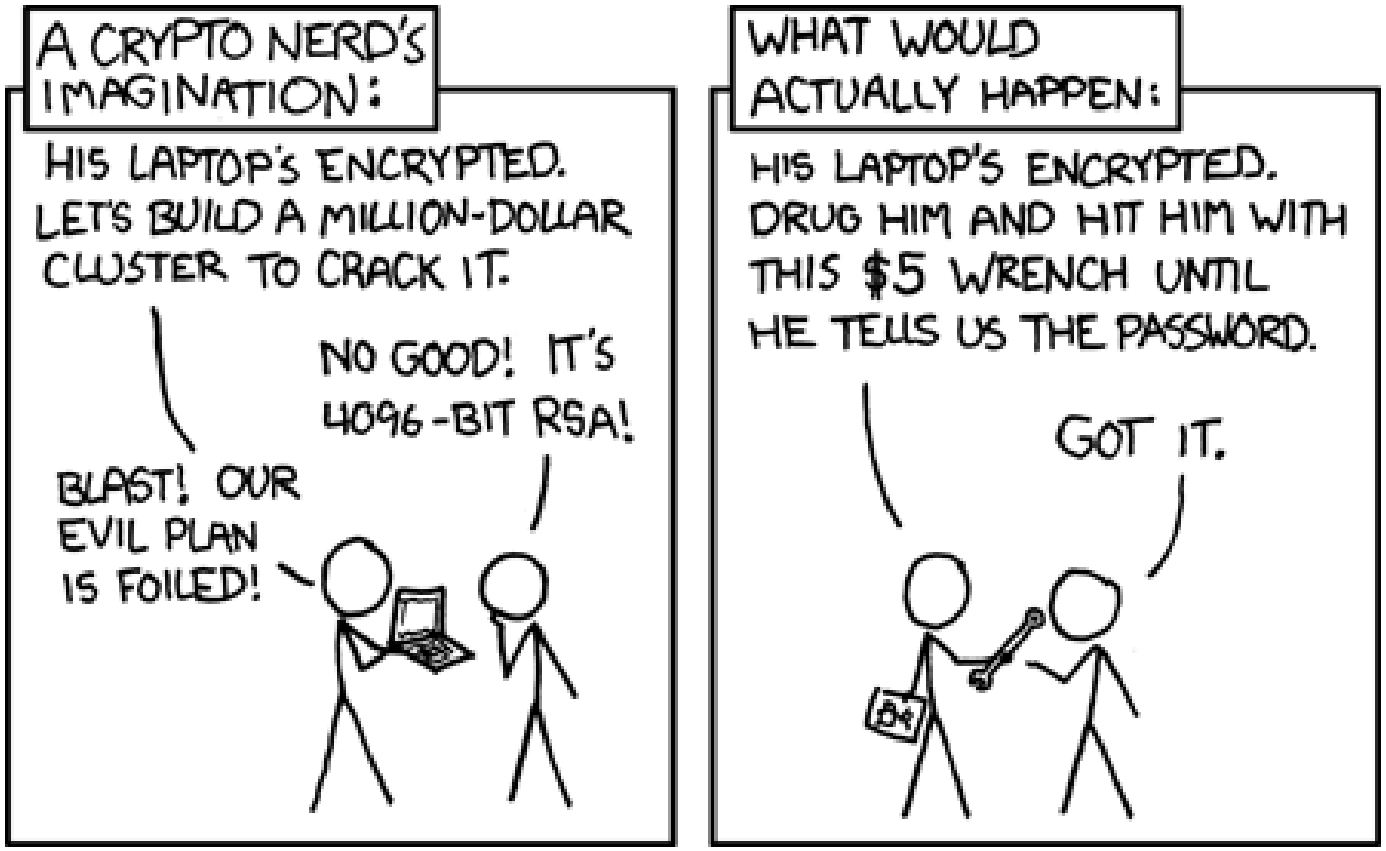
Advanced Persistent Threats

- Generally a codename for governments
- ☞ In the US, it usually means China or Russia
- Get in, often by clever means
- Do what's necessary
- *Stay hidden*!

Spies

- Governments may want your technology.
- Some governments lend tangible support to companies in their own countries.
- Spies tend to be sophisticated, well-funded, etc.
- Governments can attack cryptosystems
- Is cyberwarfare a threat?

Why the Attacker Matters



(http://www.xkcd.com/538/)

The Threat Level

- What sorts of activities are taking place?
- What could happen?
- Is it real or is it hype?

Types of Activity

Cyberespionage Spying, but by computer

Cyberattack Offensive attack; may or may not be an act of war

Preparing the Battlefield Penetrate a crucial system and stay there, against possible future need

The NSA

- According to the Snowden revelations, the NSA has engaged in large-scale, sophisticated system and network penetrations
- Massive spying on Internet backbone links
- Highly targeted attacks against specific countries and individuals–even tampering with computers during shipment
- Supposedly worked with Israel to develop Stuxnet, attack software that damaged Iran's uranium enrichment centrifuges
- Who's better, the NSA or the Russians?

Stuxnet

- Extremely sophisticated malware—jumped airgaps to attack
- Highly targeted—would attack *only* the centrifuge plant
- (Would spread elsewhere, but not cause damage)
- Attacked Programmable Logic Controllers (PLCs), specialized interfaces to industrial equipment
- Attackers had detailed knowledge of the plant—how?
- Used five “zero-days”—holes for which there was no known defense
- Persisted for years; related to other malware found in the wild

What's a Cyberwar?

- No one knows—we've never had one
- Some experts doubt there could be a strategic-grade cyber attack—the effects are too upredictable
- There don't seem to be any feasible defenses
- Could deterrence work? It's hard—all too often, we don't know who the attacker is
- "I have seen too many situations where government officials claimed a high degree of confidence as to the source, intent, and scope of a [cyber]attack, and it turned out they were wrong on every aspect of it. That is, they were often wrong, but never in doubt." (DoJ official)

What Might One Be Like?

- Disrupt the power grid (the CIA claims that extortionists have done this abroad)
- Scramble financial records
- Interfere with transportation
- Blow up pipelines (the report of the CIA doing that to the Soviets in 1982 does not appear to be true)

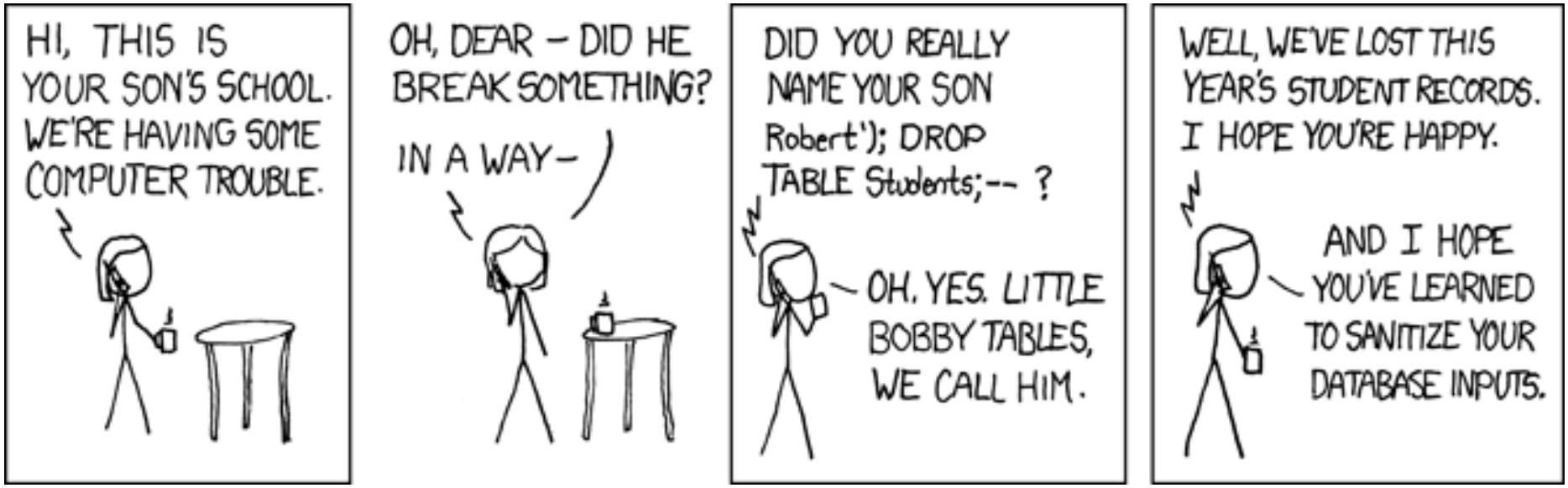
Is this Plausible?

- Some experts doubt all this
- There's no profit in cyberwar—and it may be more valuable to spy on your enemies than to destroy their communications networks
- Besides, recovery is often not that difficult, and defenders will be busy, too

Back to Bugs. . .

- The most common way to penetrate a system
- As we've discussed, eliminating all bugs is very hard
- Defending against attackers exploiting such bugs is even harder
- Einstein said "Nature is subtle but not malicious". Attackers are subtle *and* malicious

Subtle Bugs



(http://xkcd.com/327/)

So What's the Problem?

- We've created a very fragile world
- The investment necessary to acquire significant attack abilities is relatively low
- "If builders built buildings the way programmers build programs, then the first woodpecker that came along would destroy civilization" (Gerald Weinberg)

What Do We Do?

- Work on program correctness (but we're not going to succeed any time soon)
- Work on usability—too often, it's been ignored
- Look for another path to safety, such as "resilient systems"