Program Analysis for Cybersecurity

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$ whoami

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- B.S. in Computer Engineering (2005-2010)
  - Internships: Wabtec Railway Electronics, Ames Lab, Rockwell Collins
- B.S. in Computer Science (2010 – 2011)
- M.S. in Computer Engineering and Information Assurance (2010 – 2012)
  - Internships: MITRE
- Iowa State University Research (2012 – 2015)
  - DARPA Automated Program Analysis for Cybersecurity (APAC) Program
- Ph.D. in Computer Engineering (2015-2018)
  - DARPA Space/Time Analysis for Cybersecurity (STAC) Program
- Apogee Research (2019+)

Let’s break the ice…

What’s a Hacker?

wikiHow Google™ Custom Search Search

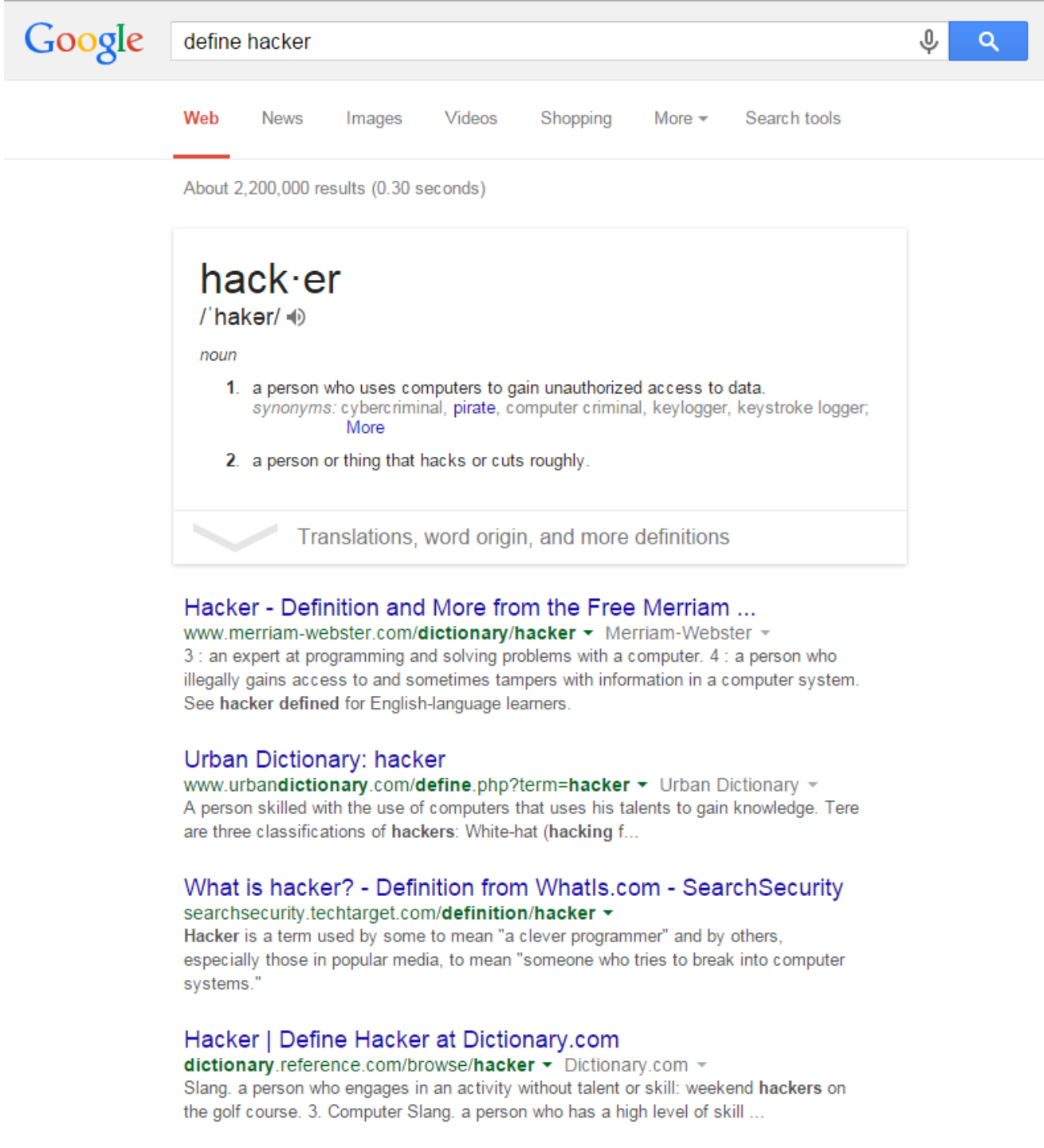
Part 2 of 3: Thinking Like a Hacker

3 **Learn to recognize and fight authority.** The enemy of the hacker is boredom, drudgery, and authoritarian figures who use censorship and secrecy to strangle the freedom of information. Monotonous work keeps the hacker from hacking.

- Embracing hacking as a way of life is to reject so-called "normal" concepts of work and property, choosing instead to fight for equality and common knowledge.

A little melodramatic…
Who draws all these anyway?

Ok the media definition of hacker wins…
Hackers are criminals by popular definition.



Let’s define hacking (in non-media terms)

- Problem solving
- Critical thinking
- Tinkering
- Exploring how things work

Learning Objectives

By the end of this course you should be able to:

- Think like a hacker
- Demonstrate basic bug hunting, exploitation, evasion, and post-exploitation skills
- Describe commonalities between vulnerability analysis and malware detection
- Describe fundamental limits in program analysis
- Challenge conventional viewpoints of security
- Confidently approach large third party software
- Critically evaluate software security products
- Locate additional relevant resources
- ASK “HOW DOES THIS WORK”?
- THINK CRITICALLY!

Digression

- Let’s get our minds thinking like a hacker…
- 3 quick examples

Hacking: Tamper Evident Devices

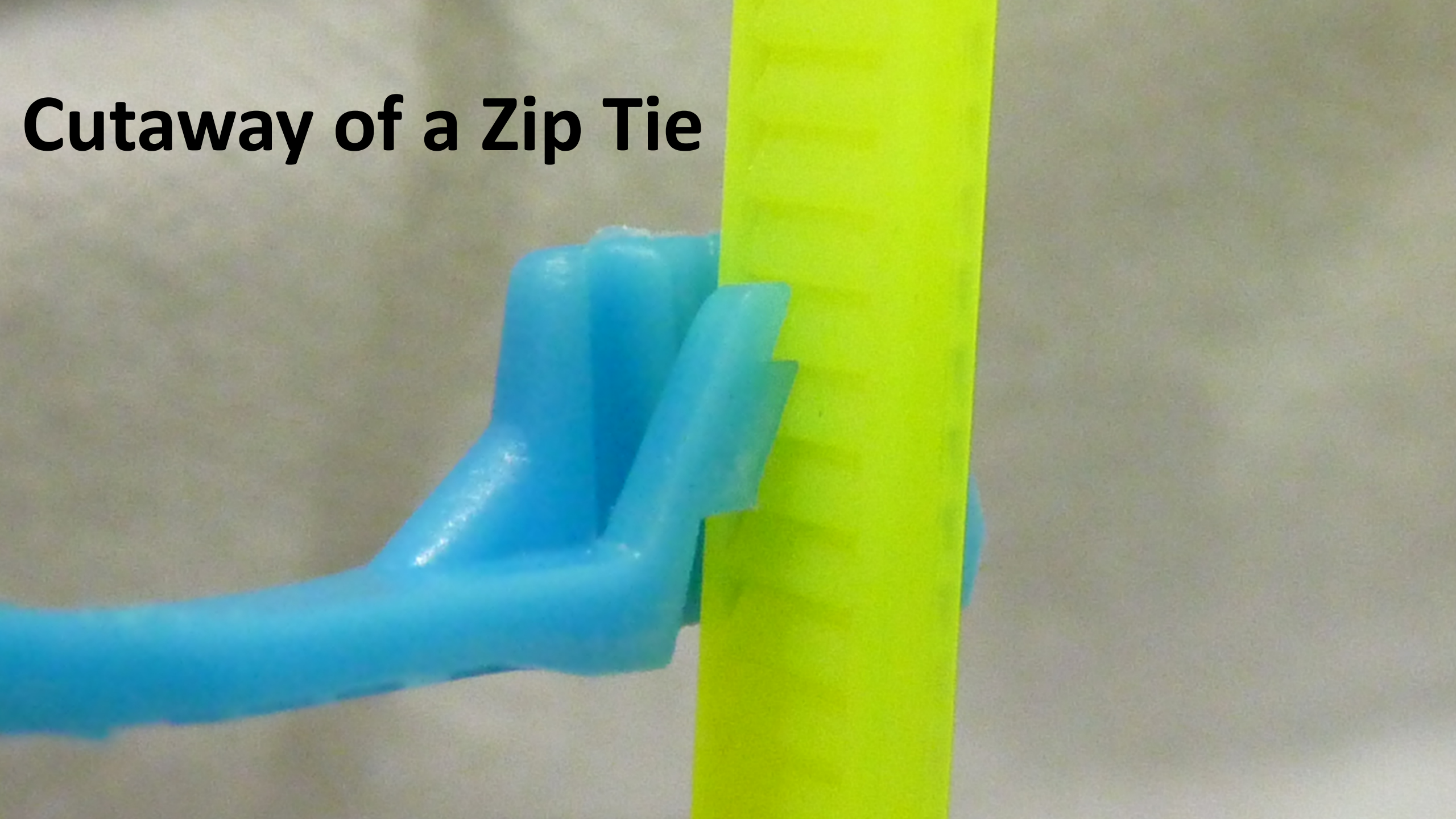
- Detect unauthorized access
- Not a “lock”
- Also known as “seals”
- How is the seal inspected?


SEALED
8744329
SEALED
0023518 1
022850
ONESEAL

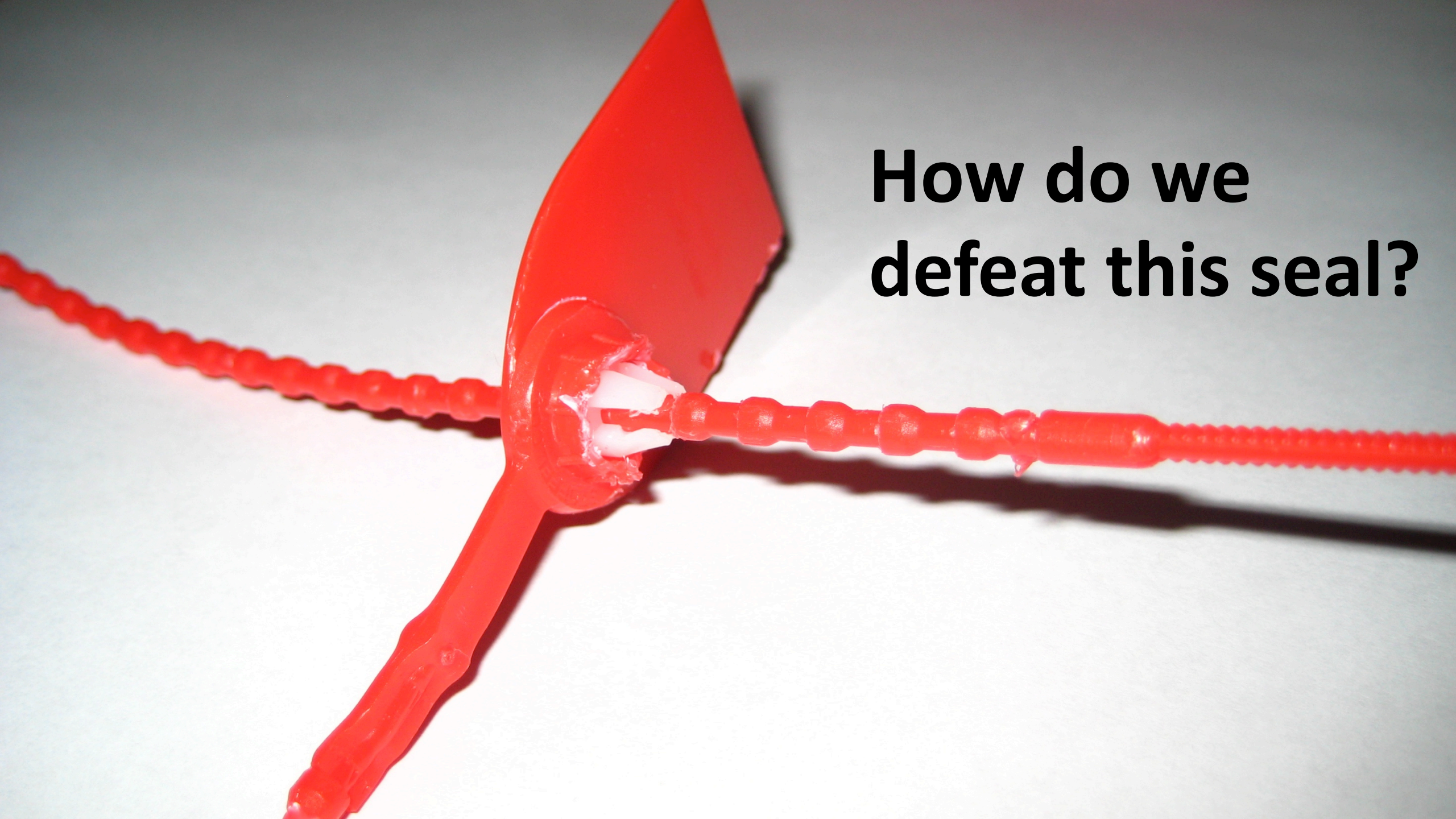
Defeating Tamper Evident Seals

- Important Question: How does it work?
- Works similar to a zip tie

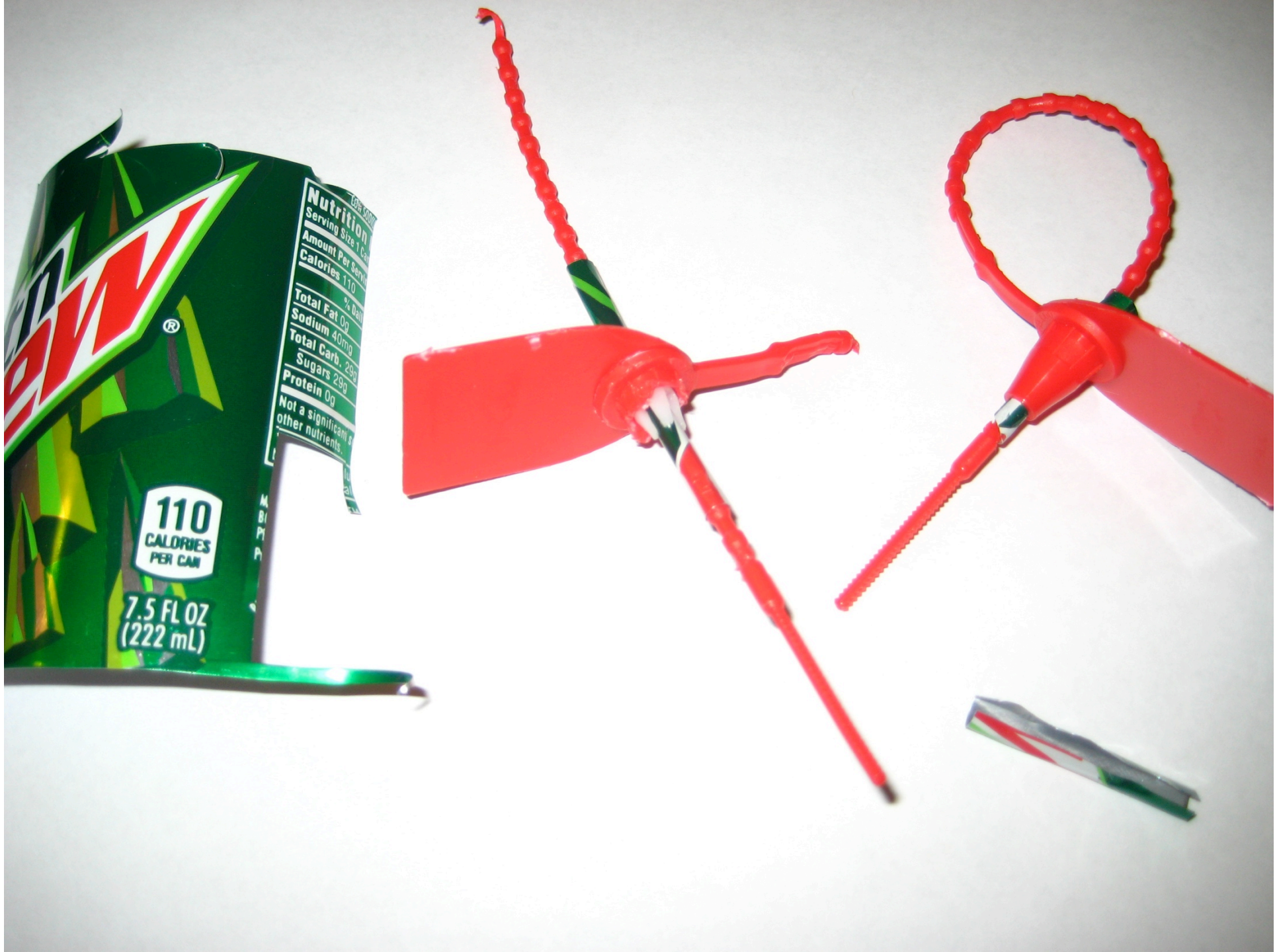
Cutaway of a Zip Tie



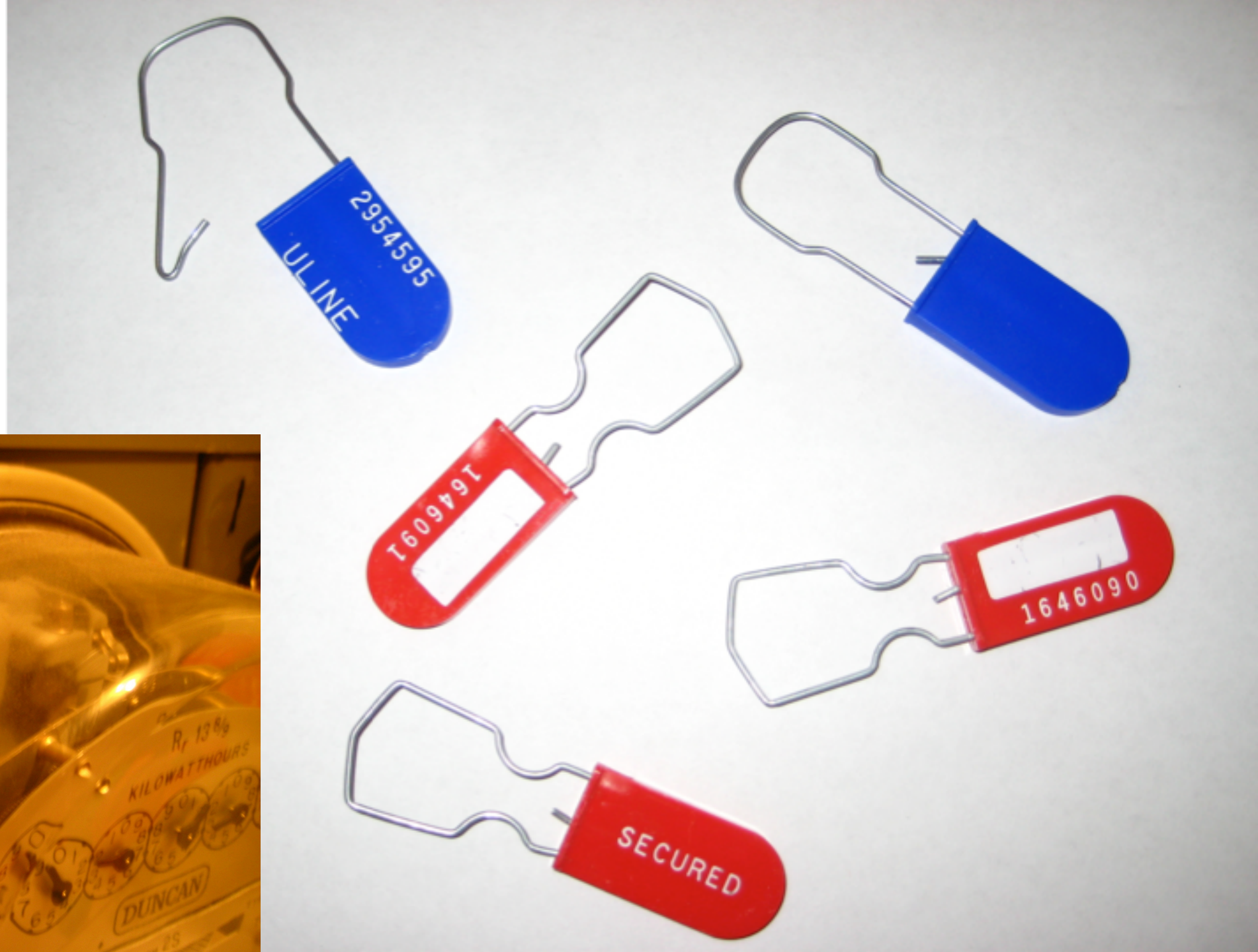

Defeating a Zip Tie


How do we
defeat this seal?


Shimming with
a pop can…

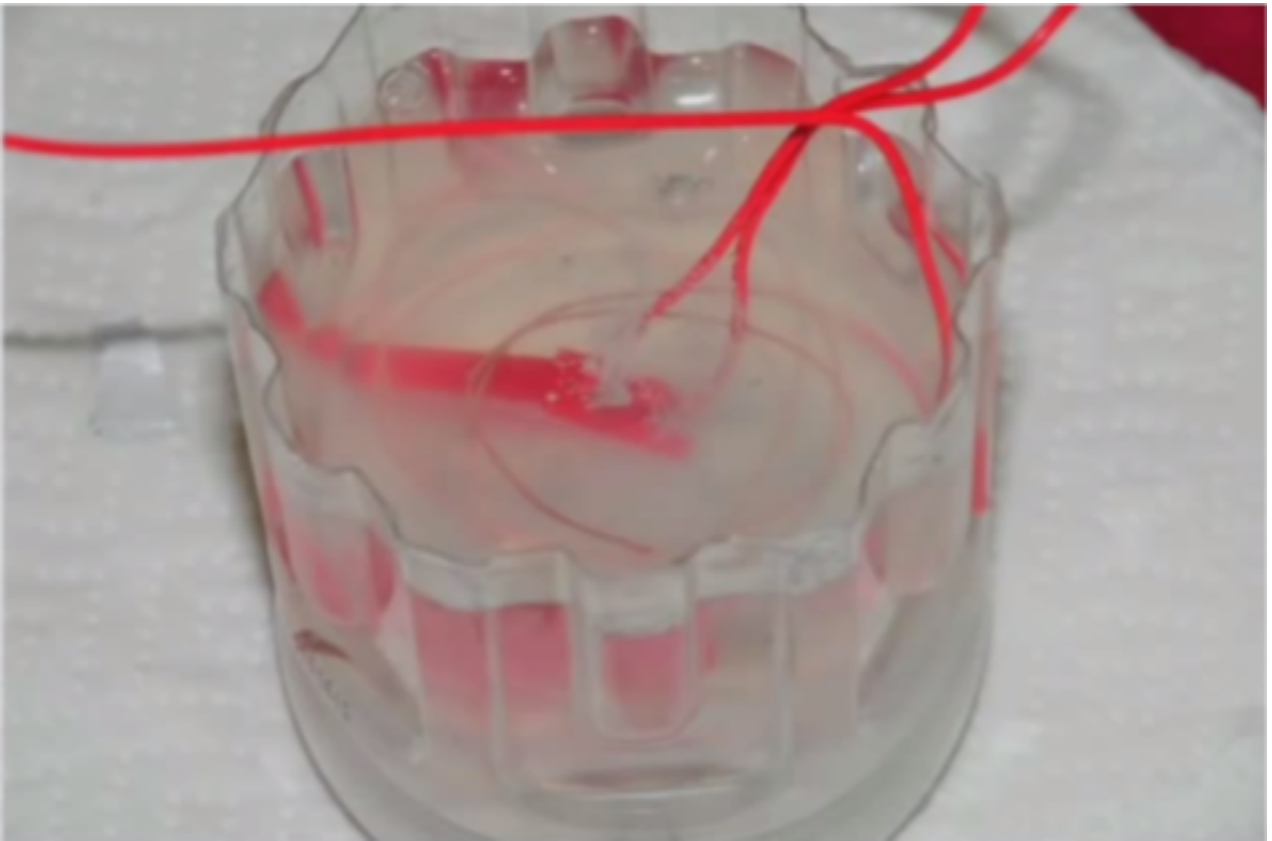

Nutrition
Total Fat 0g
Sodium 40mg
Total Carb. 29g
Sugars 29g
Protein 0g
110
CALORIES
PER CAN
7.5 FL OZ
(222 mL)

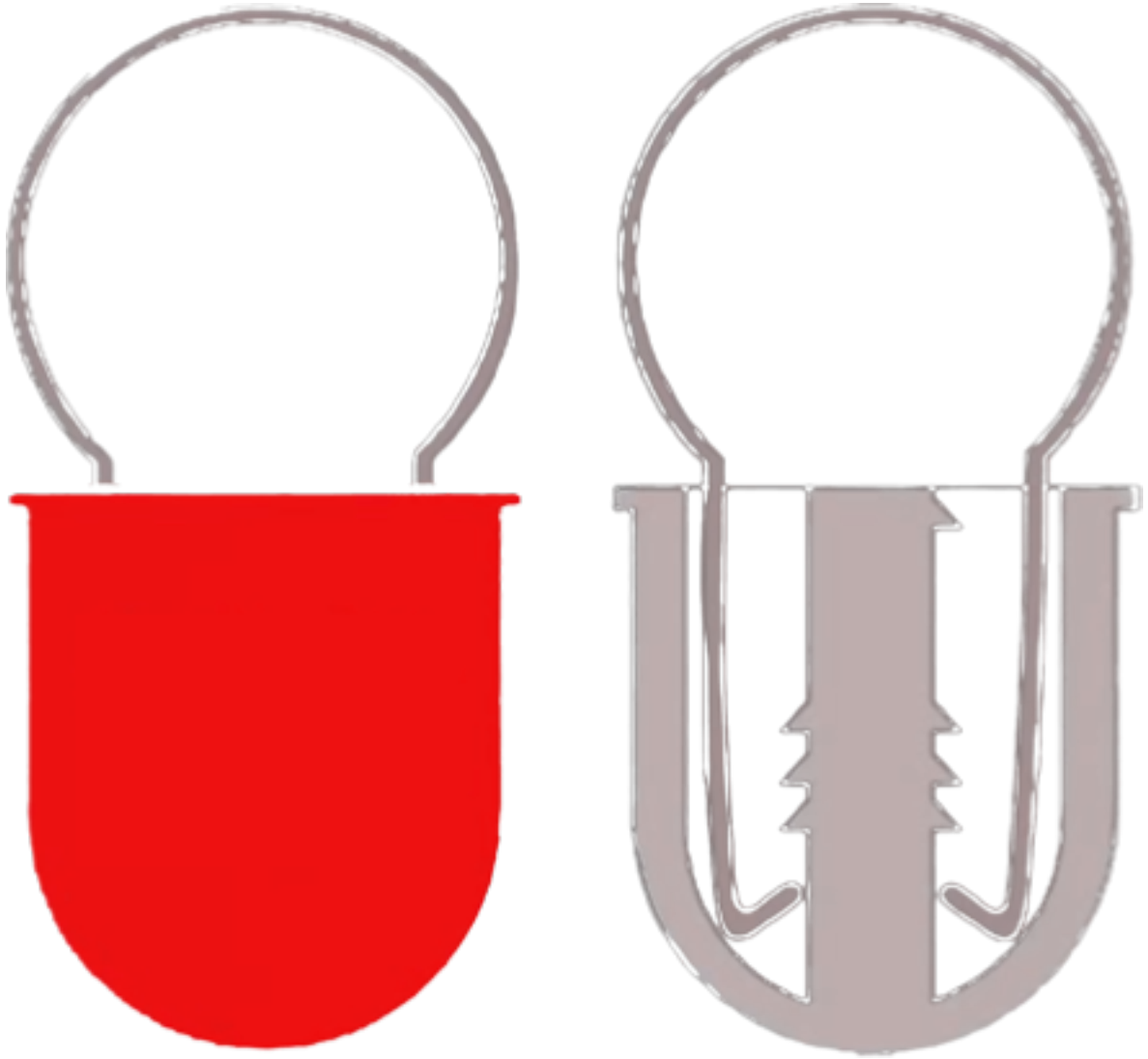
How do we defeat this seal?



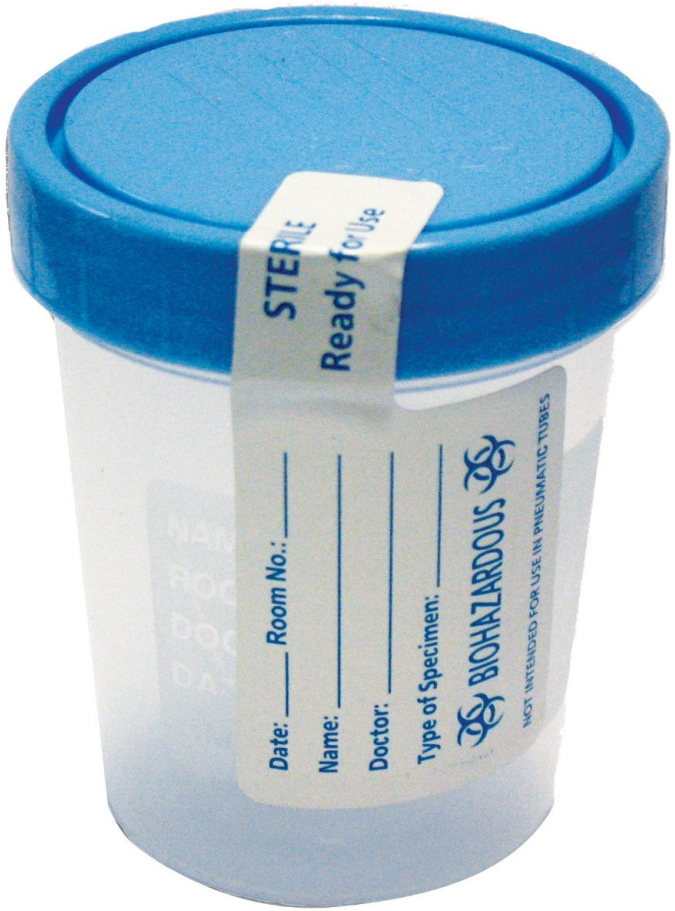
Defeating Tamper Evident Seals

- How does it work?





Tamper Evident Adhesives

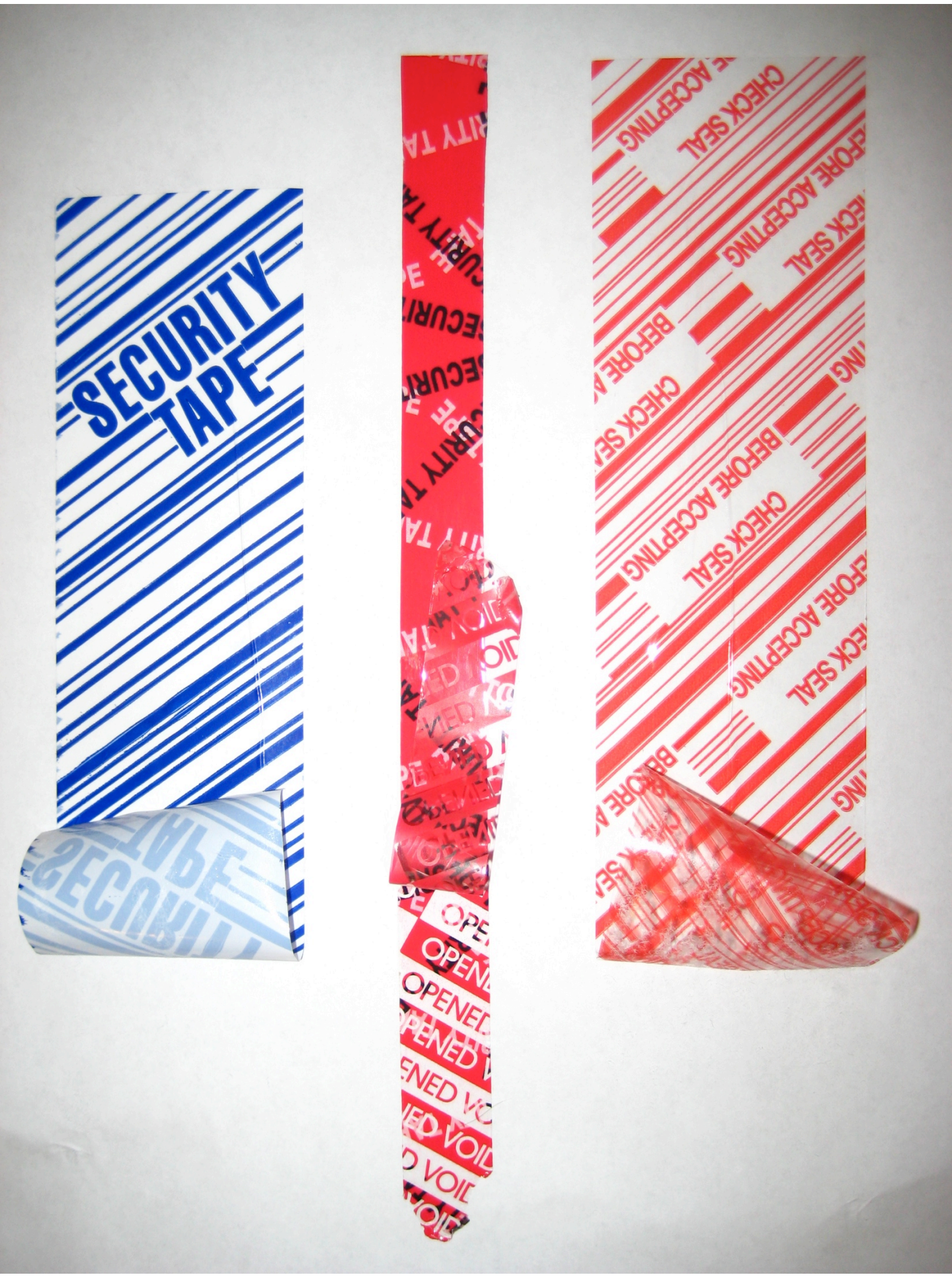


SECURITY TAPE

SECURITY TAPE

SECURITY TAPE

CHECK SEAL BEFORE ACCEPTING


SECURITY
TAPE
CHECK SEAL
BEFORE ACCEPTING
OPENED VOID

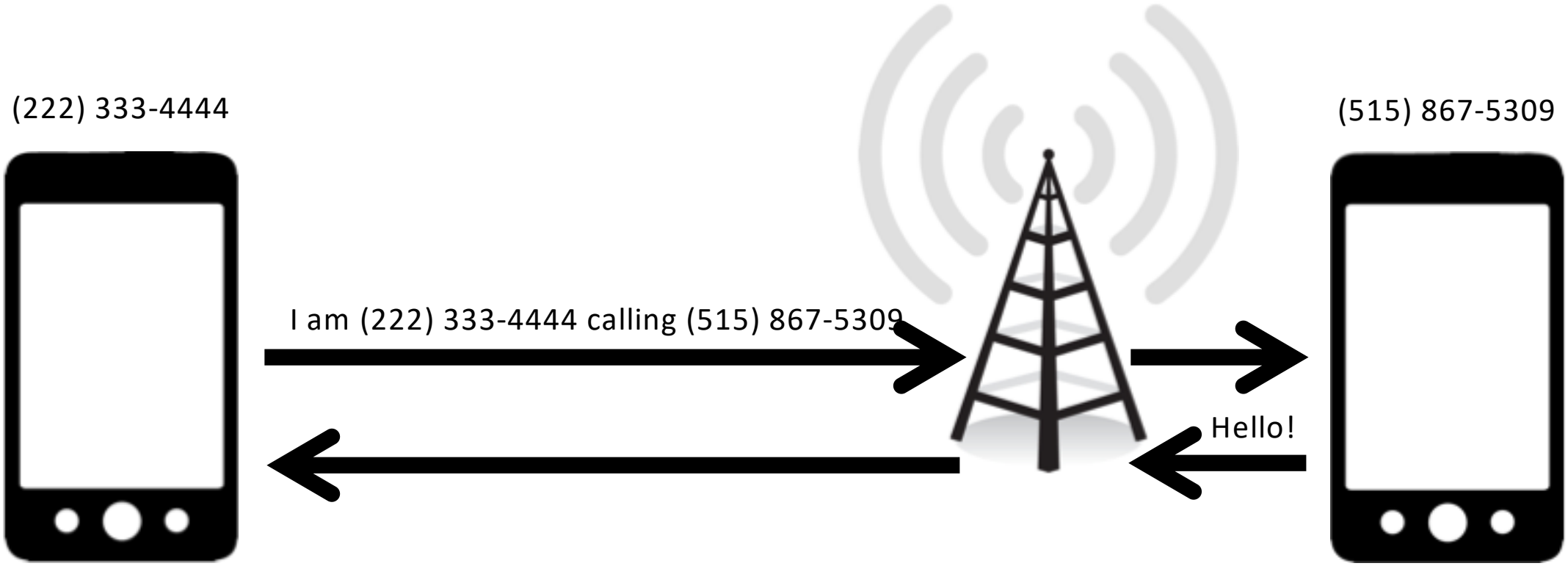
Defeating Adhesive Seals

- Dry Peeling/Breaking/Lifting
- Water/Steaming
- Heating/Cooling
- Counterfeiting (replace)
- Solvents
  - Acetone (nail polish remover)
  - Isopropyl Alcohol
  - Mineral Spirits
  - “Stamp lift” Fluid

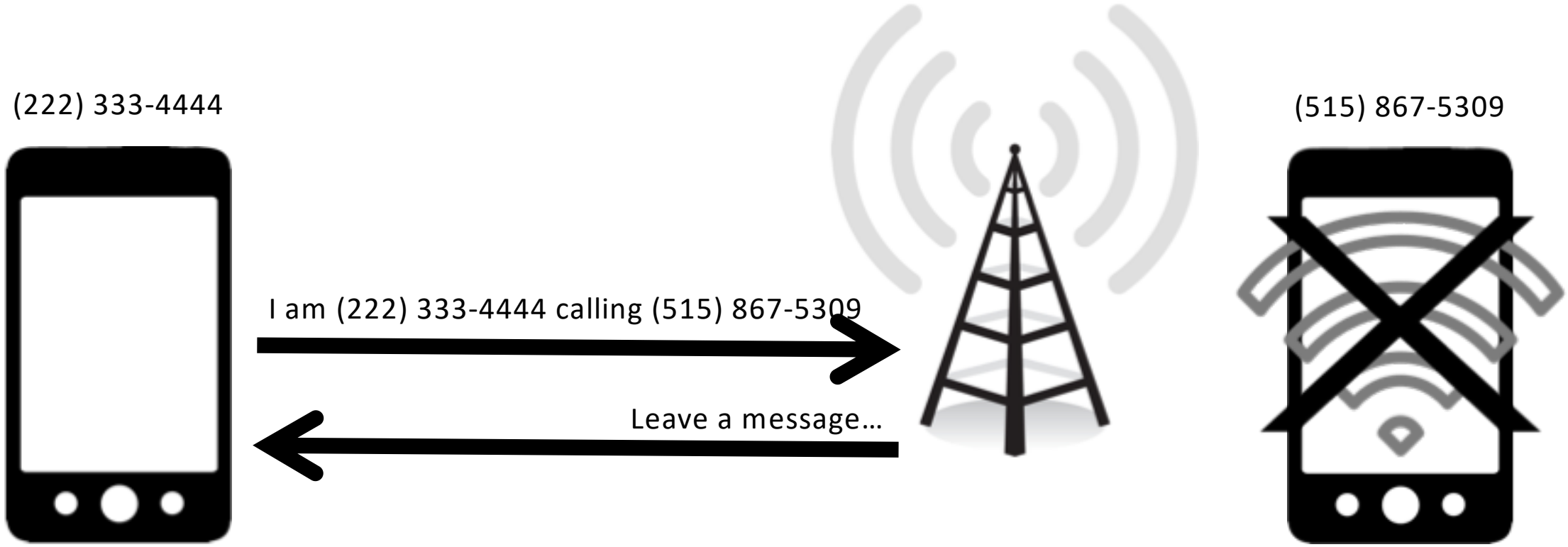
Hacking: Voicemail

- What question(s) should we ask?

How does voicemail work?



How does voicemail work?



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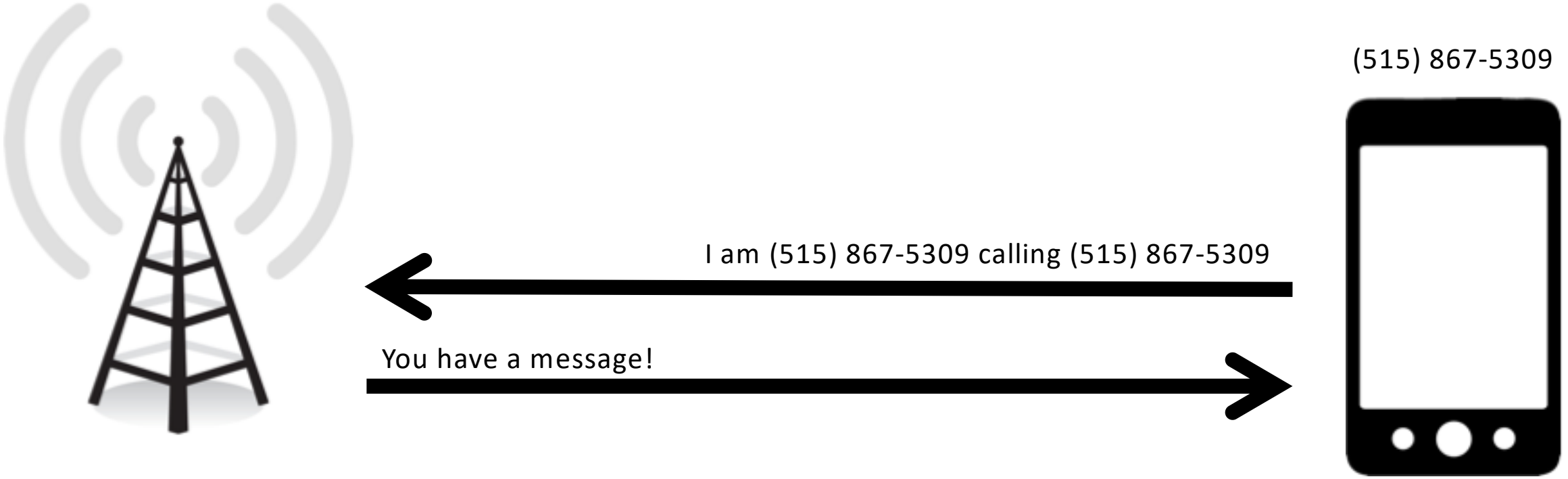
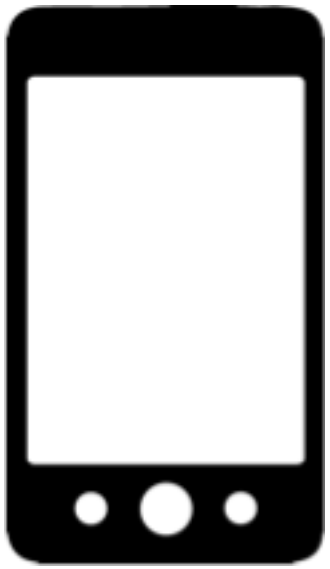


How does voicemail work?

(222) 333-4444



I am (515) 867-5309 calling (515) 867-5309

You have a message!

Voicemail Hacking Demo

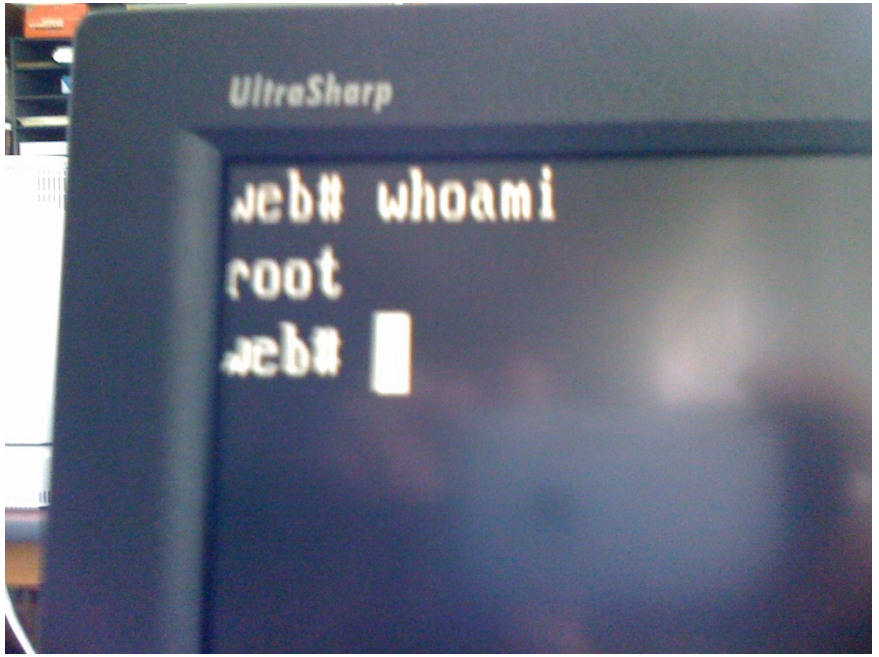
- Fake Victim: (515) 200-1301 (github.com/benjholla/VoicemailVictim)
- SpoofCard Service: (305) 501-2777
  - Press 1 (login with your phone number)
  - SpoofCard User: (319) 435-0116
  - SpoofCard PIN: 1234
  - Press 1 (place a call)
  - Press 1 (use your normal voice)
  - Press 2 (don’t record call)
- Caller ID spoofing is legal in the United States if it is not done with “the intent to defraud, cause harm, or wrongfully obtain anything of value”.

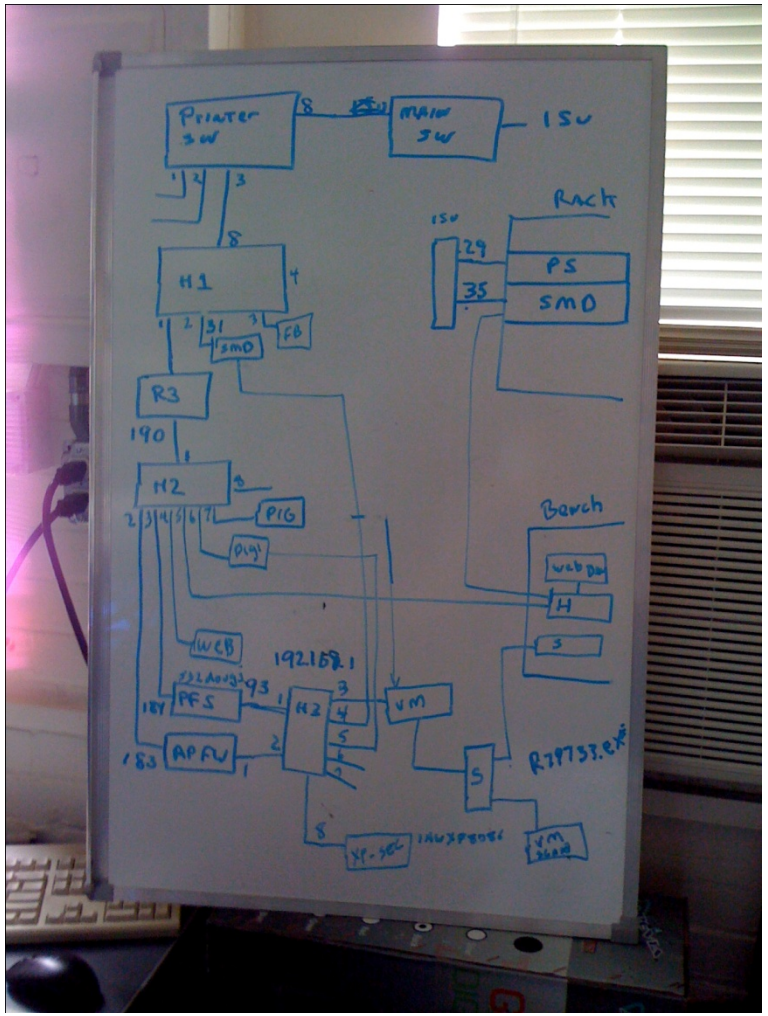
Information Warfare Course (ISU CprE 532)

- Professor gave me the IP addresses of his computers to hack for the course project
- Computer have “flags”
  - Text files whose contents that prove you gained access
- What did I do?
  - Remember that hackers try to be lazy.

Information Warfare Course (ISU CprE 532)

- Physical Break-in Story





Ethical Concerns

- Disclaimer: The content in this course was created for educational purposes only.
- Consider the consequences of your actions. *Remember that every action may have unforeseeable consequences.*

Daily Overview

- Day 1: Binary Exploitation
- Day 2: Web Application Security
- Day 3: Fundamentals of Program Analysis
  - Bug Hunting and Malware Analysis
- Day 4: Threat Modeling and Real Time Awareness
  - Bugs Vs. Malware, A/V Evasion, Log Analysis, Future Directions
- Day 5: Team Competition!
  - Attack and Defend Vulnerable Video Service (like YouTube)

General Plan

- Focus on getting hands on experience!
- If labs are completed early we can explore more advanced topics
- I will adapt materials to you
- Form teams on Tuesday
  - Balance teams based on experience
  - Study buddies before competition
  - Teammates during competition
  - May develop specialized roles
  - Start preparing as a team for competition

Competition Environment

- Every team gets one AWS web server instance
- Every team attacks and defends at the same time!
- Every teammate gets a local copy of the code
  - Analysis and attack tools already installed
- Open ended competition
  - Mix of easy, difficult, and unsolved problems
  - Write reports to earn points
  - Teams can start to work on competition early
  - Have fun! Share some memes ☺

Ice Breaker Exercise: EIL5 “Programming”

- Explain It Like I’m Five (EIL5): How do computer programs work?
- Can your explanation intuitively address:
  - Complexity of software
  - Programming bugs
  - Security issues