The Nature of Cyber Security

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The Environment

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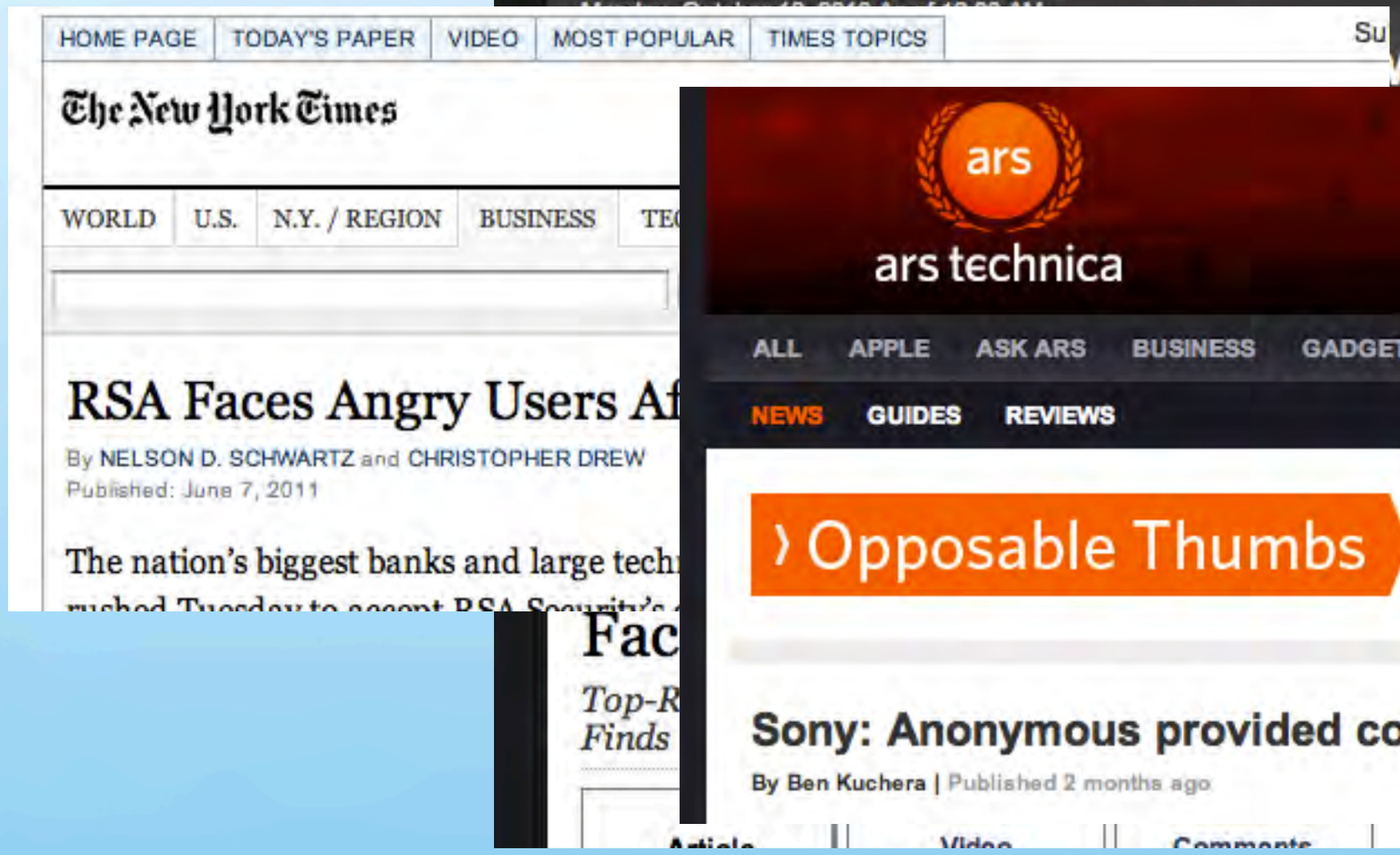

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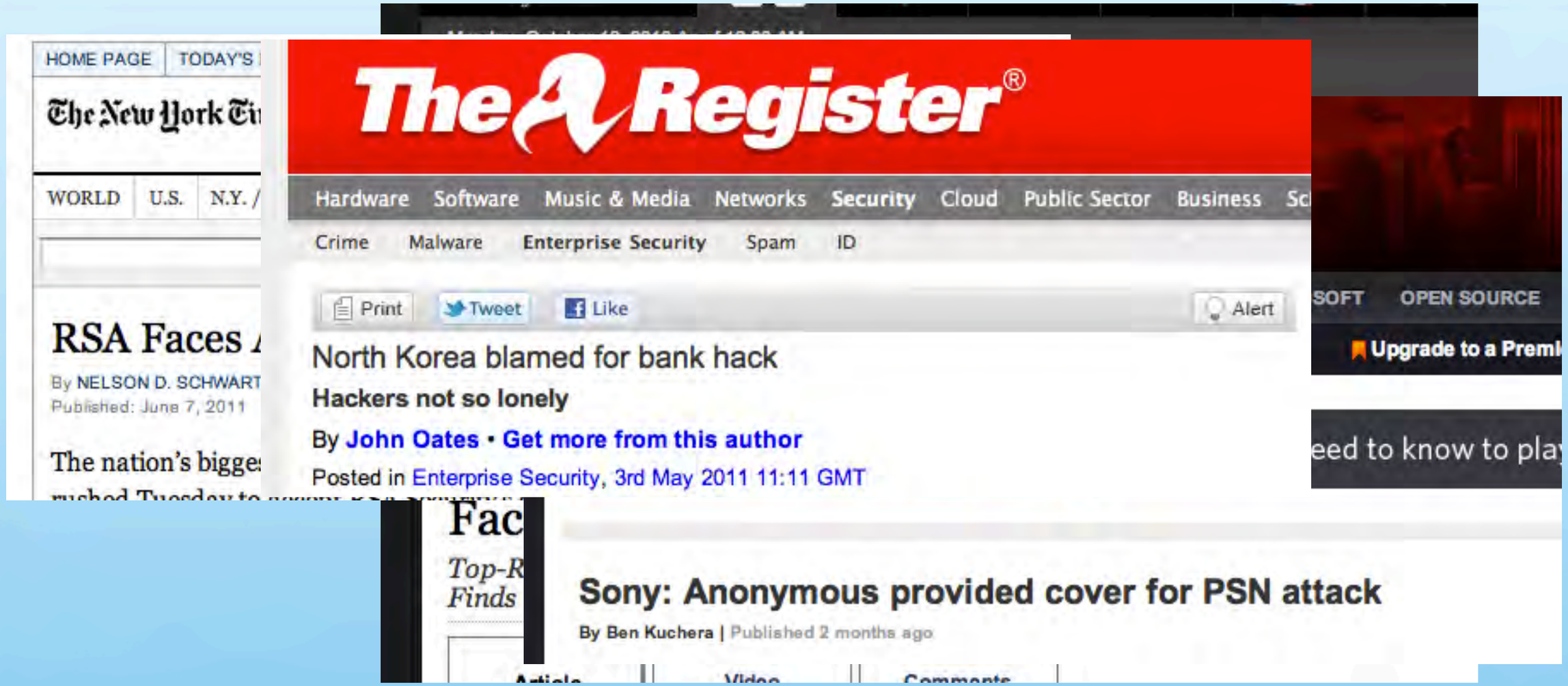

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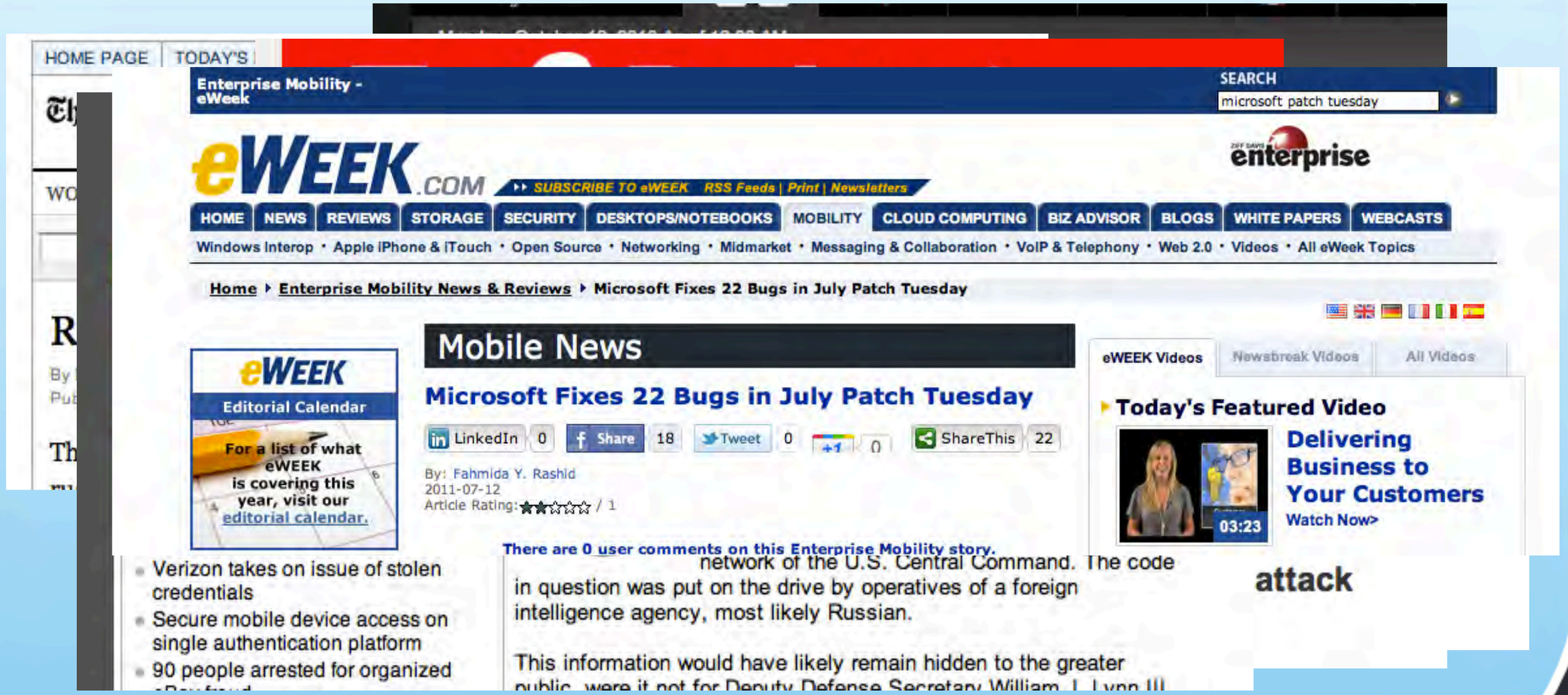

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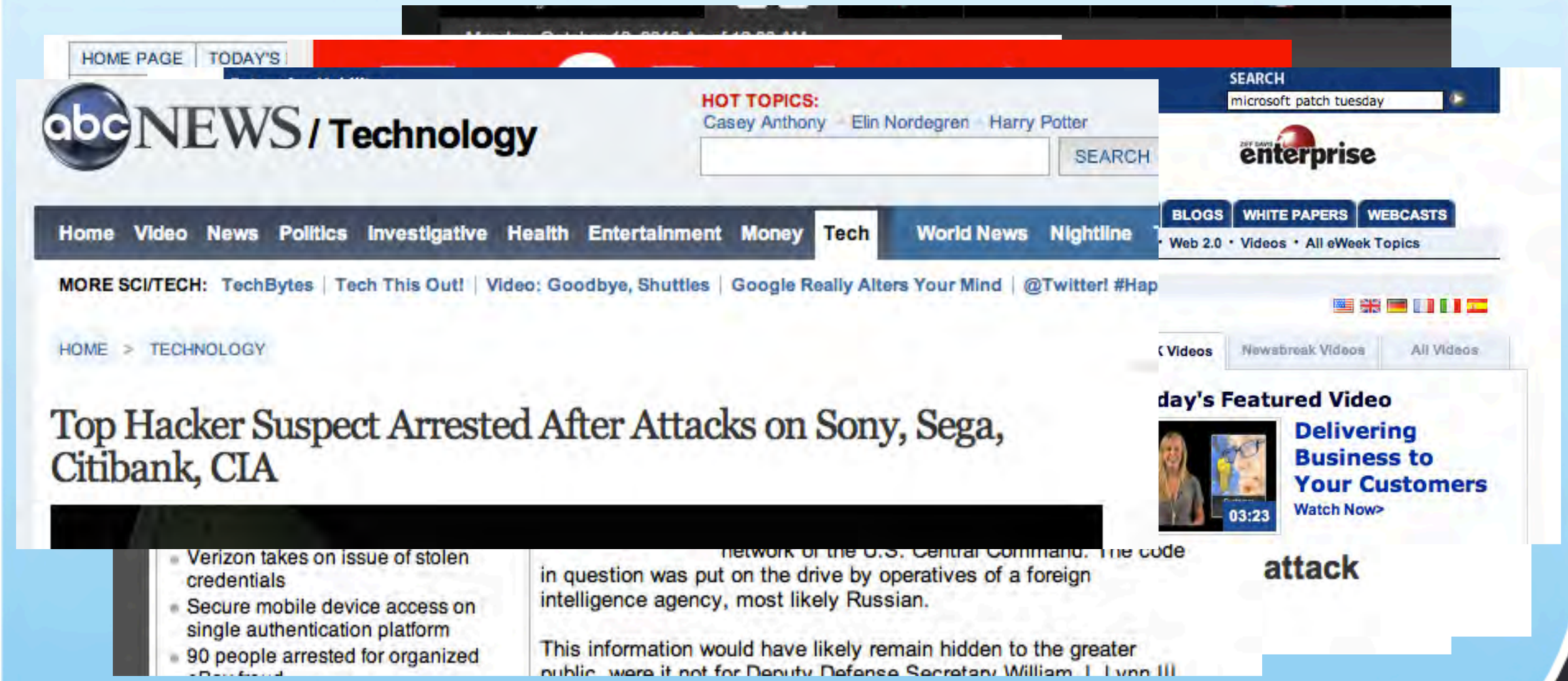

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And hundreds of other incidents this year alone.

These are becoming so common that they aren't even reported as regular news.

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The Magnitude

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Sources: ISS, NIST, FBI, McAfee Corp.

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- Despite aggressive actions, SPAM still outweighs normal email by a ratio of 3 to 1

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  - Almost 1 million new password-theft Trojans
  - Over 1.2 million unique fake antivirus programs

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  - New botnet infections fell to “only” 3 million per month.
  - 1.2% of searches & 49% of trending terms led to malicious WWW sites.
  - 2500 new phishing sites per day.

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Clearly, there is a problem

Sources: U.S. Department of Commerce

Clearly, there is a problem

- But it isn't new!
- Some of us have been sounding the alarm for over 20 years.
- Spending on cyber security in the U.S. alone exceeds $8 billion a year but we are still falling behind.

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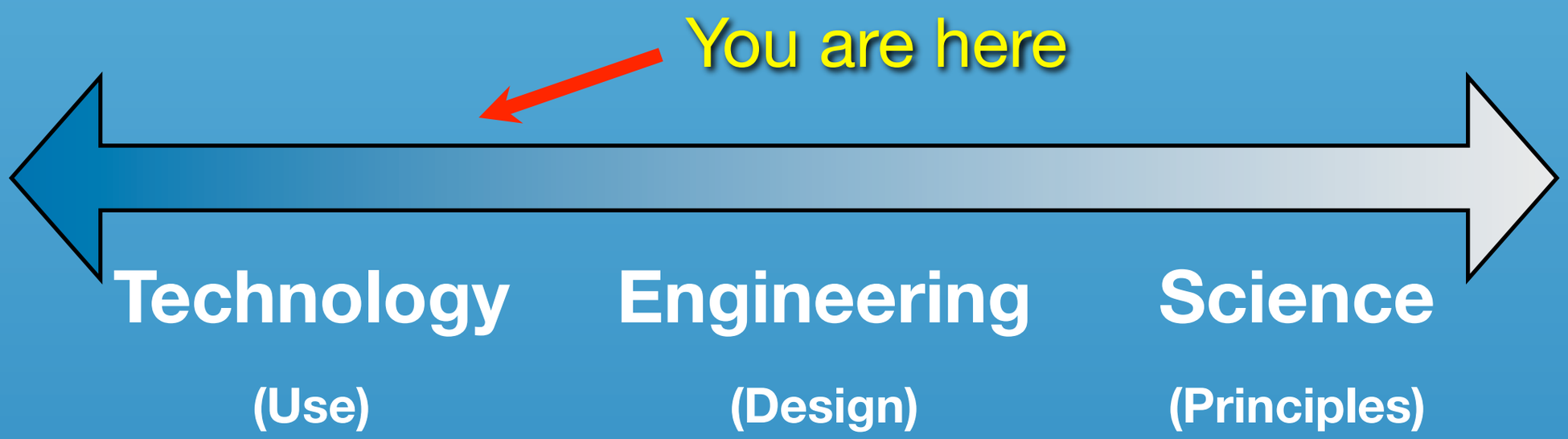
Sources: U.S. Department of Commerce

One contention

Our approach has been based on *ad hoc* practice rather than formal science



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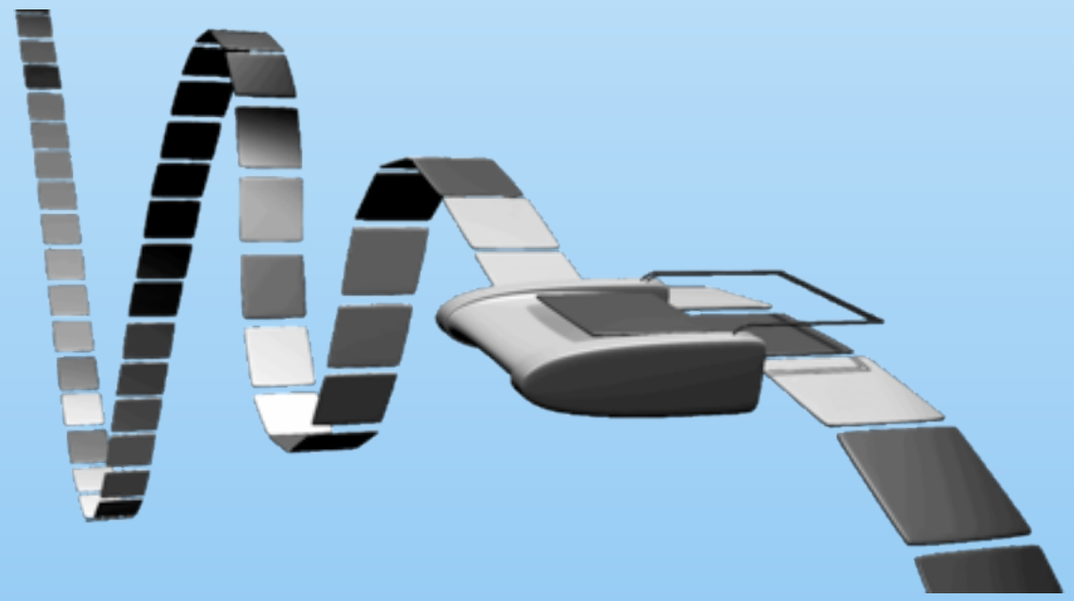
Hey, we do science! …don't we?

- Science is the formulation of hypotheses, experimentation, and analysis
- Experiments must be repeatable and subject to refutation



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CERIAS

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How often do you see accounts of experiments redone by others?

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When did you last see negative results published?

How often do you see accounts of experiments redone by others?

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How many security papers have you seen with a formal null hypothesis, full listing of procedures and equipment, and statistical analysis of data?

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Characteristics of a Science

- Common, precisely defined terms.
- Standard references that everyone in the field knows and cites.
- Standard, independent units of measure.
- Science uses prior results and builds on known foundations.
- Predictive rather than reactive.

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Common, precisely defined terms?

Virus Spam Hack
Phishing Privacy
Cyberwar

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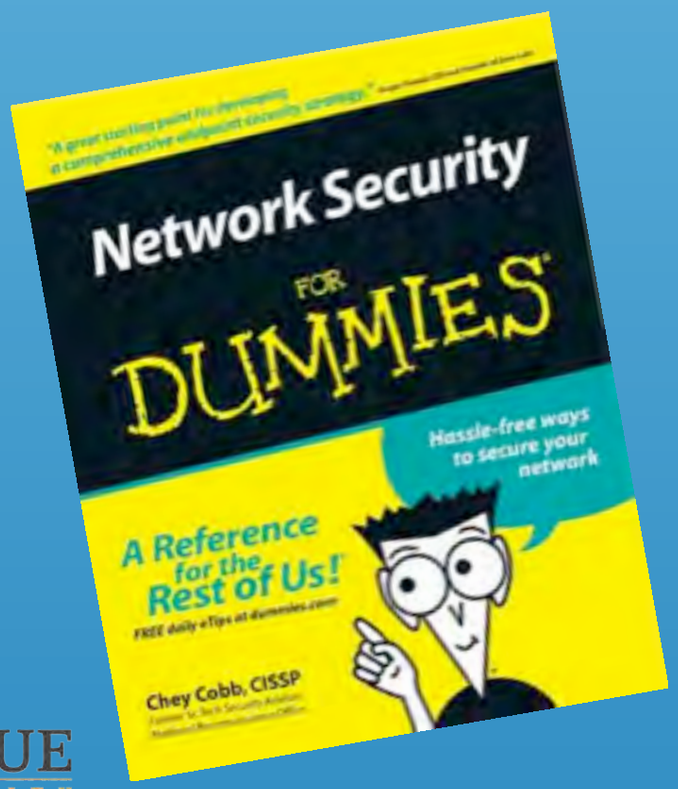
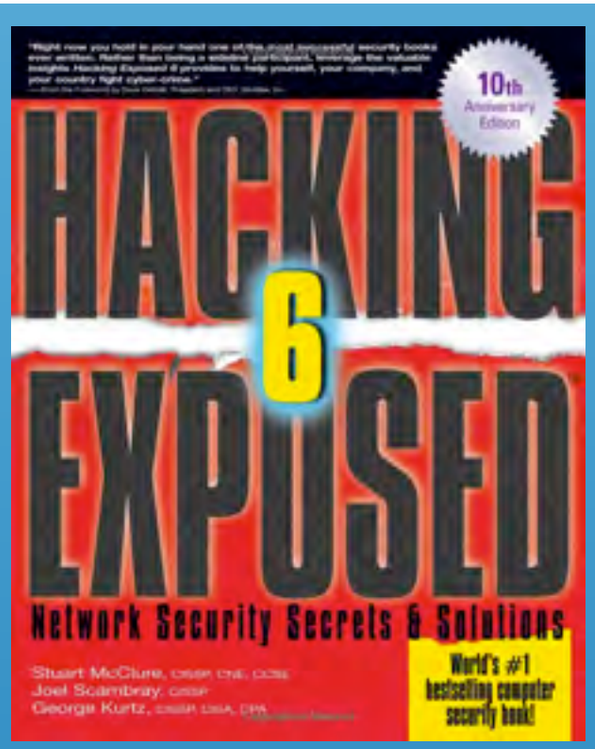
Standard references that everyone in the field knows and cites?





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Standard, independent units of measure?

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- What is a unit of confidentiality?

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- How much privacy gain from quitting Facebook?

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Standard, independent units of measure?

- What is a unit of confidentiality?
- How much privacy gain from quitting Facebook?
- If I delete a file, its confidentiality goes to 100% but availability goes to 0% — not independent.

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Science uses prior results and builds on known foundations?

- 8000+ new vulnerabilities per year?
  - Buffer overflows — still? (identified in 1960s)
  - Weak passwords — still? (identified in 1950s)
- 2011 cellphones with viruses? (identified in 1980s)

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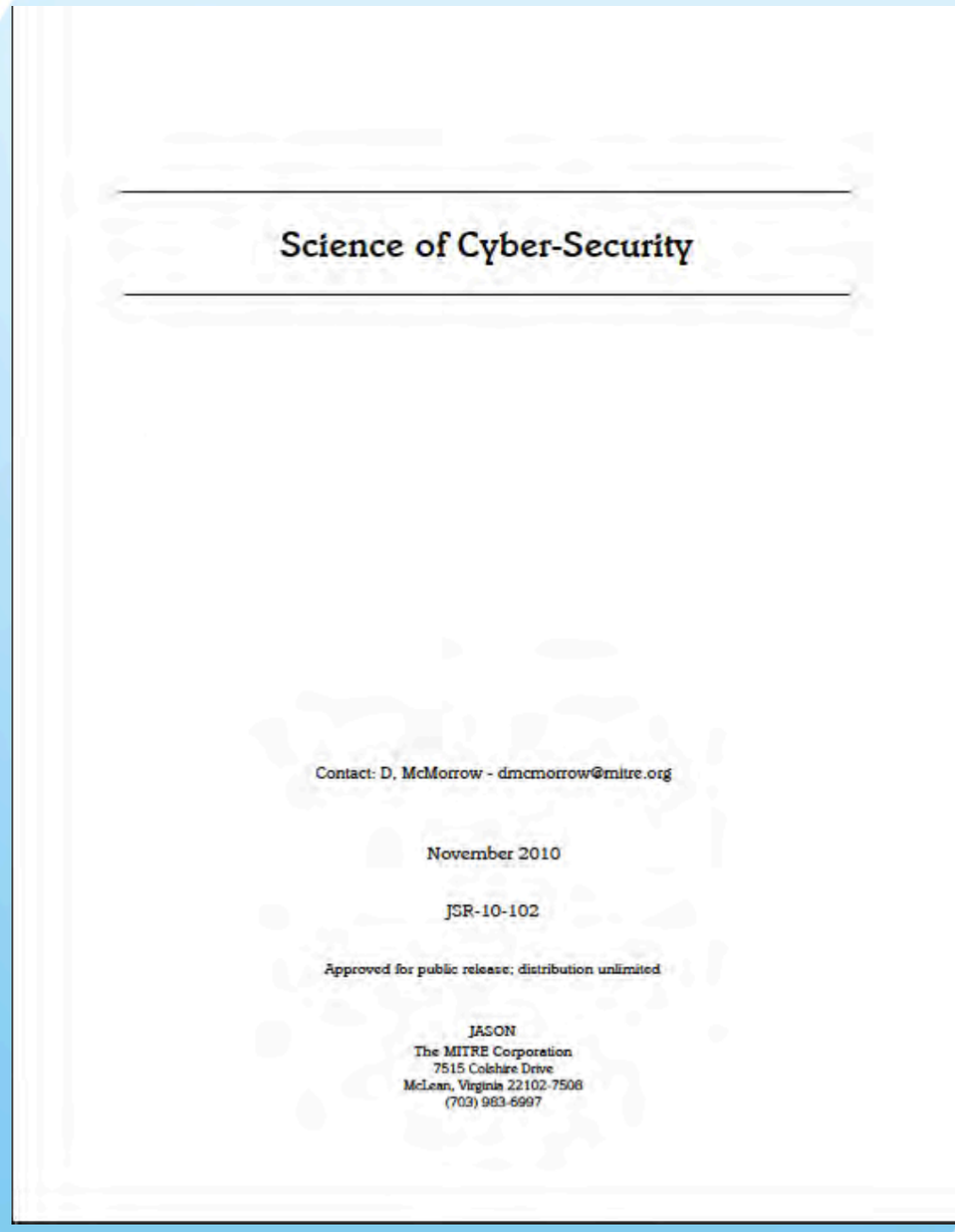
Predictive rather than reactive?

- Culture of “penetrate and patch” is pervasive
- Common tools such as intrusion detection and data exfiltration are all reactive
- We don’t learn from the past, so never mind the future.

One View

- Focus on terms, but not principles or metrics.
- Bias towards model checking.
- (Typical) suggestion of large centers.
- Still focused on technology.



Science of Cyber-Security

Contact: D. McMorrow - dmcmorrow@mitre.org

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But what **is** Cyber Security?

What are the real challenges? How do we define the field?

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Basic observation

(Spaf's 1st Axiom of Cyber Security):

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Basic observation

(Spaf's 1st Axiom of Cyber Security):

Without computers, we would have no cyber abuse.

And without people, we would have no cyber abuse.

Thus, focusing on the technology is only part of the solution.

We need to change the way we look at the field.

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Cyber Security May Include

- Psychology
- Human factors
- Economics
- Education
- Risk management
- Organizational management
- Criminology
- Computer architecture
- Physical plant protection
- Disaster recovery/continuity
- … and more

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Example

1	123456	11	Nicole
2	12345	12	Daniel
3	123456789	13	babygirl
4	Password	14	monkey
5	iloveyou	15	Jessica
6	princess	16	lovely
7	rockyou	17	Michael
8	1234567	18	Ashley
9	12345678	19	654321
10	abc123	20	Qwerty

Our systems were designed by experts — but for experts. We don't consider how novices view what we have built. No wonder they misuse it.

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Need clear warnings

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Inexpensive can be expensive

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And not everything is Security

- About those 8000+ flaws per year…
- Those are only the *security-related* flaws. How about all the *other* flaws in the software?
- Software engineering is the field to address this issue.

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So, what else?

- Most physical sciences have observable constants and phenomena. What would be the equivalent of Planck’s constant, or Avogadro's number?
- Most social sciences use stochastic methods on semi-static entities. Cyber changes too quickly.
- Much of what happens depends on human intent.

Thus, it isn’t obvious that there can be a true science of cyber security. But we can certainly do better.

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Takeaway #1

There is a limit to how much we can improve our defenses simply by developing technology.

- The technology will be used by humans: humans who are uninformed, in a hurry, tired, clumsy, and make mistakes.
- The technology will also be used by humans who intend to circumvent, misuse and abuse it.

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Takeaway #2

We have a lot to do to formalize and mature the field of cyber security.

- We can start by requiring at least basic scientific rigor in research.
- We need to stop being sloppy with our terminology.
- We can start asking that results be replicated, and negative results be shared.

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Takeaway #3

We should think carefully about what basic cyber security properties are, and how to measure them.

- The traditional *Confidentiality, Integrity, Availability* model doesn't fit the bill.
- We will need to consider human factors and economics issues as components.

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Takeaway #4

Cyber Security is not independent of other aspects of computing.

- We need to improve our software engineering, our operating systems, our human factors, our network protocols, …
- This has implications for education in the field, too.

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Takeaway #5

Cyber Security is not independent of other aspects of society.

- Pure defense is never enough. We need to improve our methods of investigation and prosecution to stop offenders and discourage abuse.
- We need to understand that our computing is used in places and cultures different from our own, and by people different than us.

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Takeaway #6

If we aren't willing to make a significant investment to start from new foundations, it is certain that things will get worse.

- We are using artifacts we don't completely understand, purchased because of cost concerns, often developed in haste, with characteristics we can't measure, and a long history of flaws. This will not end well.

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Thank

You!

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