Introduction to Modern Cryptography

Master of Logic

3rd Block: Feb/March 20~~16~~17

Outline of the Course

- Historical cryptography & principles of modern cryptography
- perfectly-secret encryption

Auguste Kerckhoffs

1835 - 1903

- Dutch linguist and cryptographer
- Kerckhoffs' principle:

"A cryptosystem should be secure even if everything about the system, except the key, is public knowledge"

- leader of Volapük movement

Claude Elwood Shannon

1916 - 2001

- Father of Information Theory
- Graduate of MIT
- Bell Labs

- juggling, unicycling, chess
- ultimate machine

Modern Cryptography

- "scientific study of techniques for securing digital information, transactions and distributed computations"
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Edward Joseph Snowden

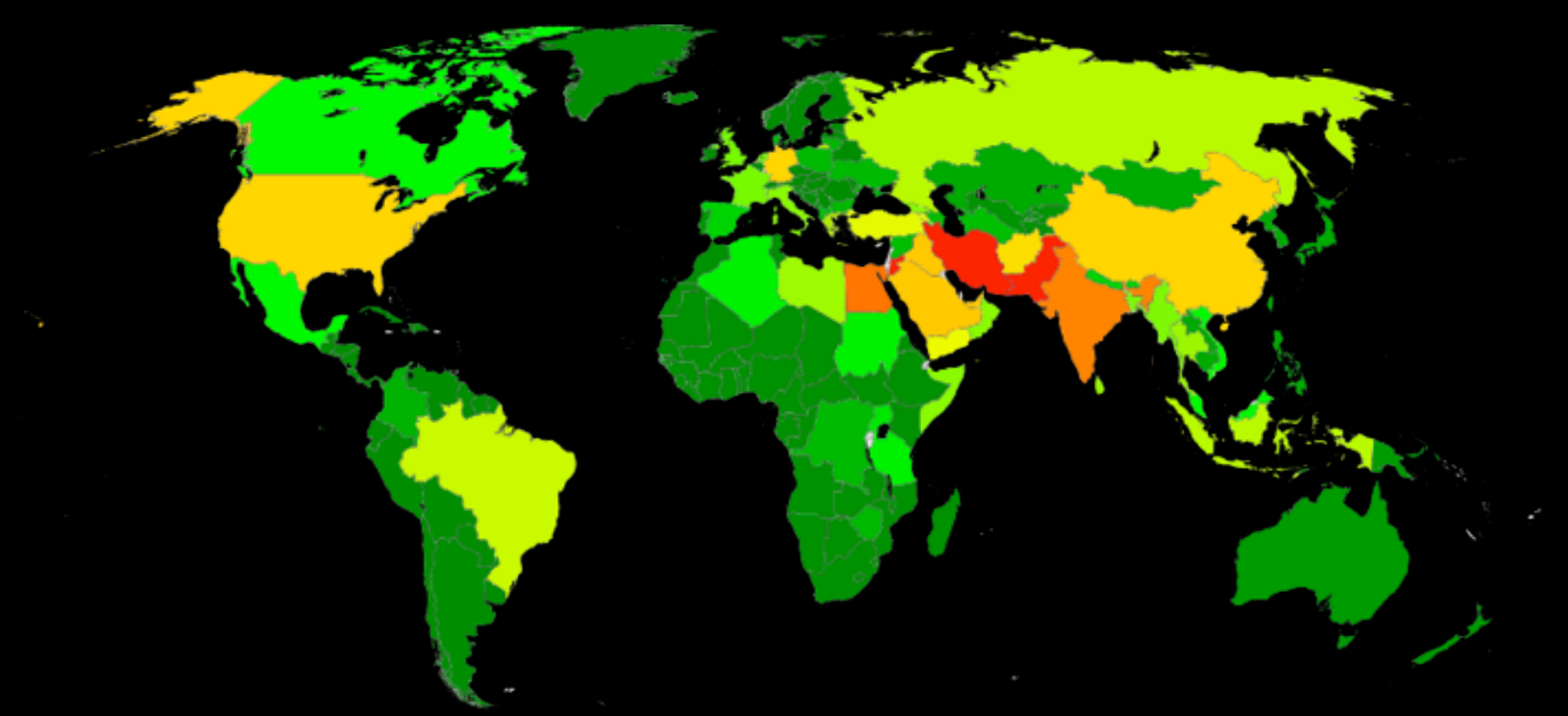
1983 -

- former CIA employee and NSA contractor
- whistleblower
- on (temporary) asylum in Russia

- Traitor or Hero?

Politics of Cyberwar

- In 2013, Snowden leaked many thousand top secret documents to various media, documenting a
- mass surveillance programs by secret services from all over the world



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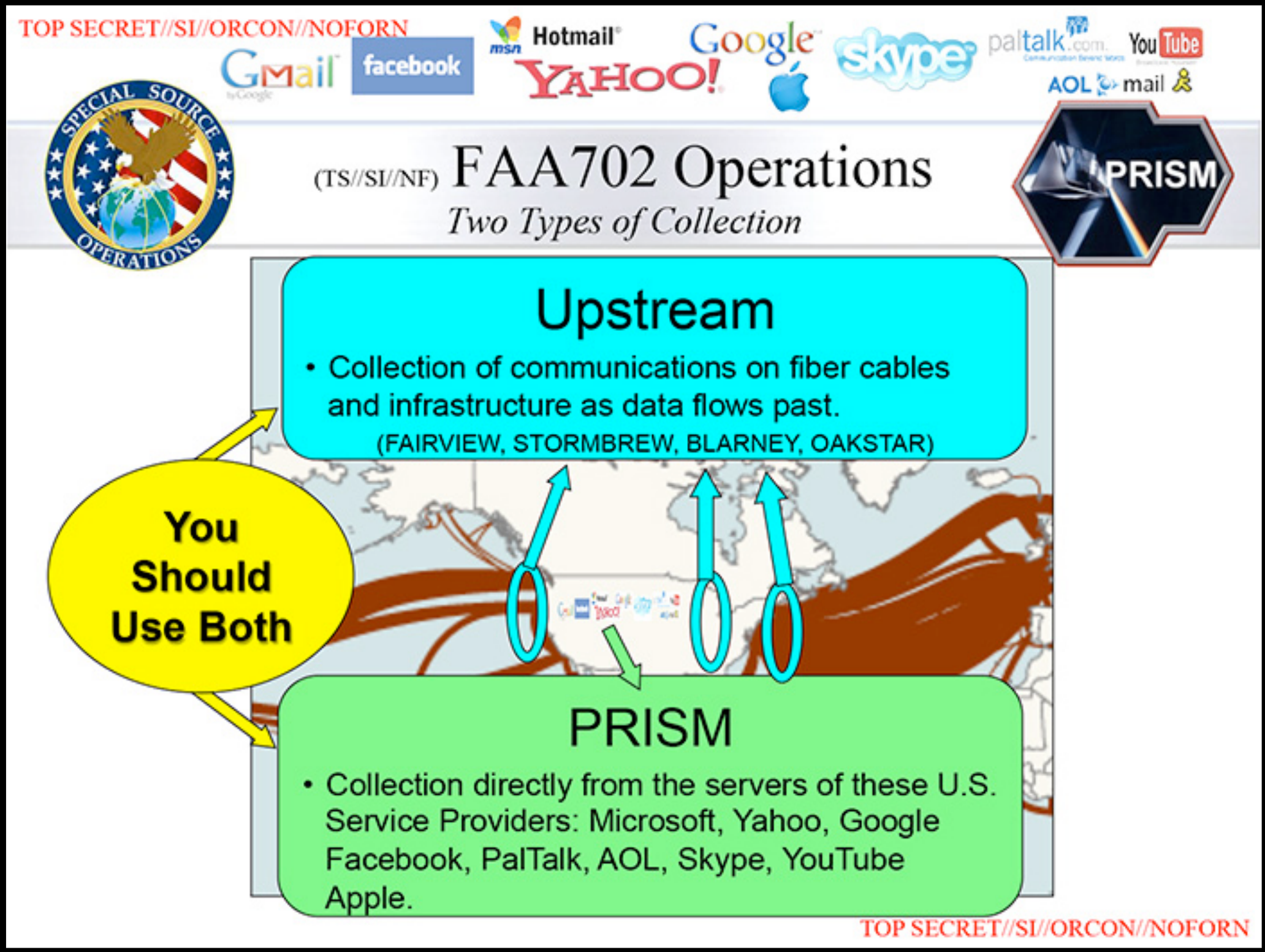

Outline of the Course II

	secret key	public key
confidentiality	private-key encryption	public-key encryption
authentication	message authentication codes (MAC)	digital signatures

Outline of the Course II

- reduction proofs
- pseudorandomness
- block ciphers: DES, AES

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Outline of the Course II

- algorithmic number theory
- key distribution, Diffie-Hellmann
- RSA

- reduction proofs
- pseudorandomness
- block ciphers: DES, AES

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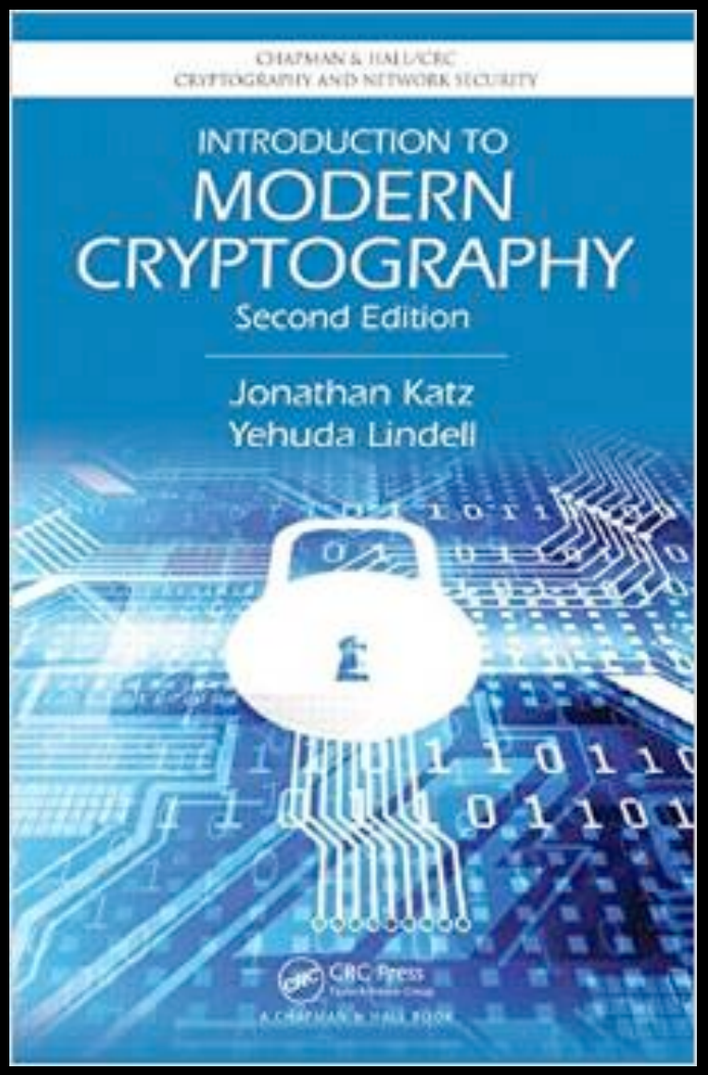
Fun Stuff

- bitcoin (guest lecture by Marc Stevens, CWI)
- zero-knowledge proofs
- multi-party computation (secret sharing, bit commitment, oblivious transfer)
- electronic voting and auctions
- quantum cryptography
- position-based cryptography
- ...

Jonathan Katz

Yehuda Lindell



- 3 Basic Principles of Modern Cryptography

1. Formulation of Exact Definitions

- "a cryptographic scheme is secure if no adversary of a specified power can achieve a specified break"

example: encryption

2. Reliance on Precise Assumptions

- unconditional security is often impractical
  (unfortunate state of computational complexity)
- validation of assumptions (independent of cryptography)
  example: factoring
- allows to compare crypto schemes

3. Rigorous Proofs of Security

- Intuition is not good enough. History knows countless examples of broken schemes
- bugs vs security holes
  software users vs adversaries
- reduction proofs: Given that Assumption X is true, Construction Y is secure.
  Any adversary breaking Construction Y can be used as subroutine to violate Assumption X.

Questions ?

Python Programming Project:
BibTeX Parser

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- Goal: creating the "perfect" bibtex file (for articles in a certain research domain, such as quantum cryptography)
- https://github.com/sciunto-org/python-bibtexparser
- extensions to this parser:
  - create alphastyle citation keys
  - look up article information from crossref, dblp, arXiv
  - provide various bibtex file formats
  - create a website where articles can be looked up "on the fly"
  - …