Cryptography – the Art of Secret Writing – From Old to New

Renate Scheidler

Centre for Information Security and Cryptography

Fields Institute, Toronto, November 18, 2006

What is Cryptography?

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κρυπτοζ – **hidden**

γραφειν – **to write**

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Encyclopedia Britannica online **defines it as**

"The practice of the enciphering and deciphering of messages in secret code in order to render them unintelligible to all but the intended receiver."

Cryptography

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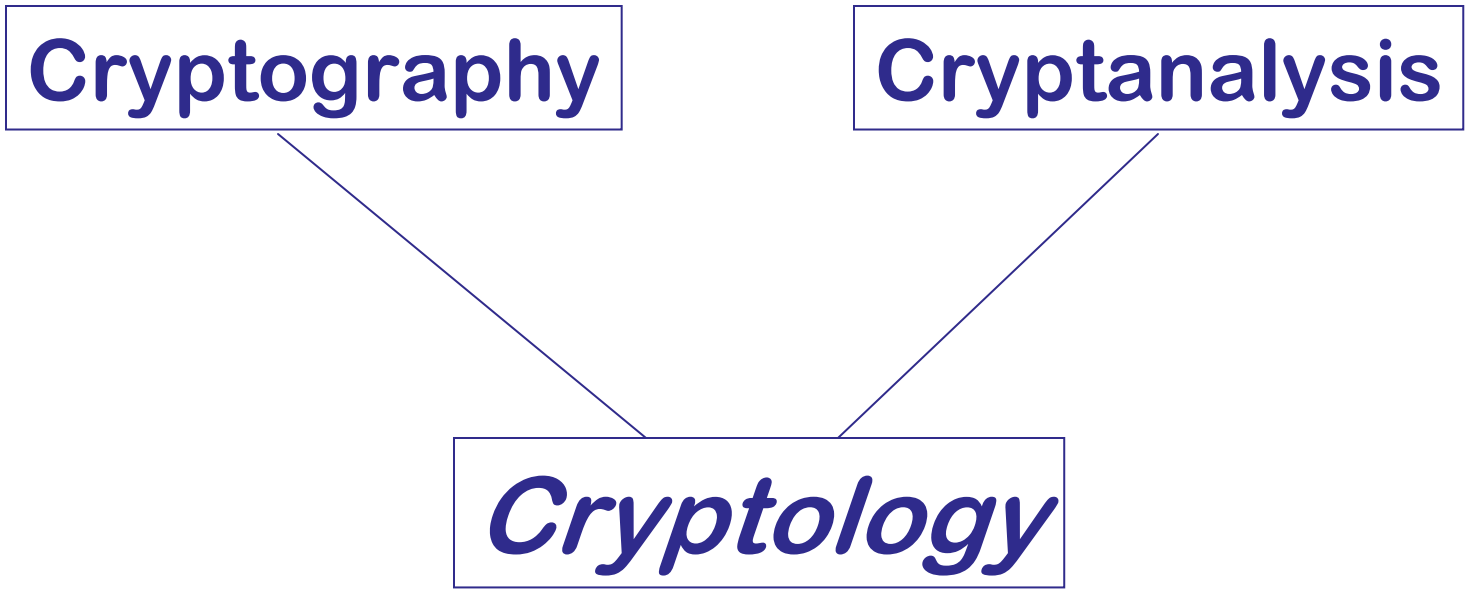
Cryptanalysis


Cryptography
Cryptanalysis
Cryptology

Conventional (One Key) Cryptosystem

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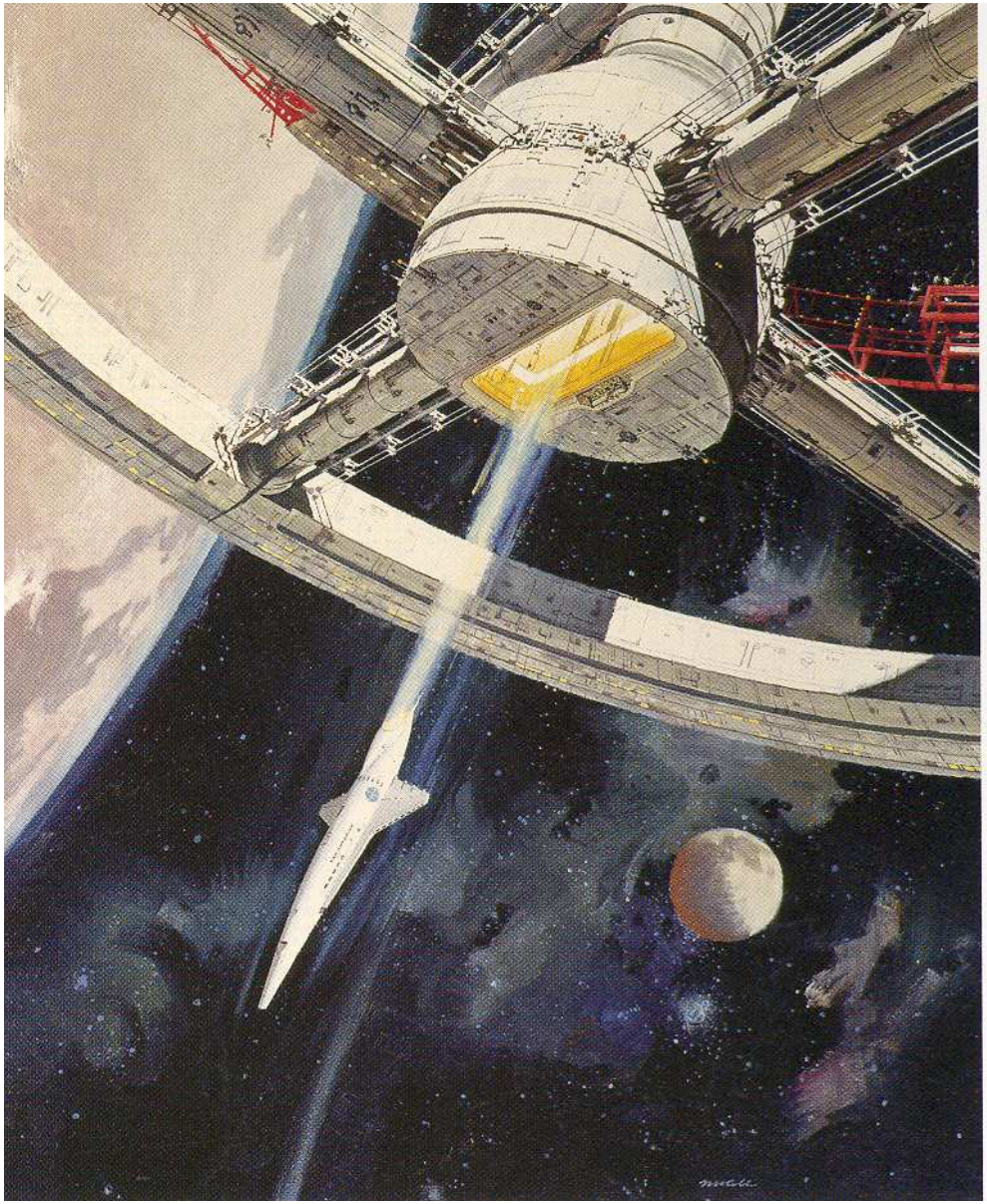

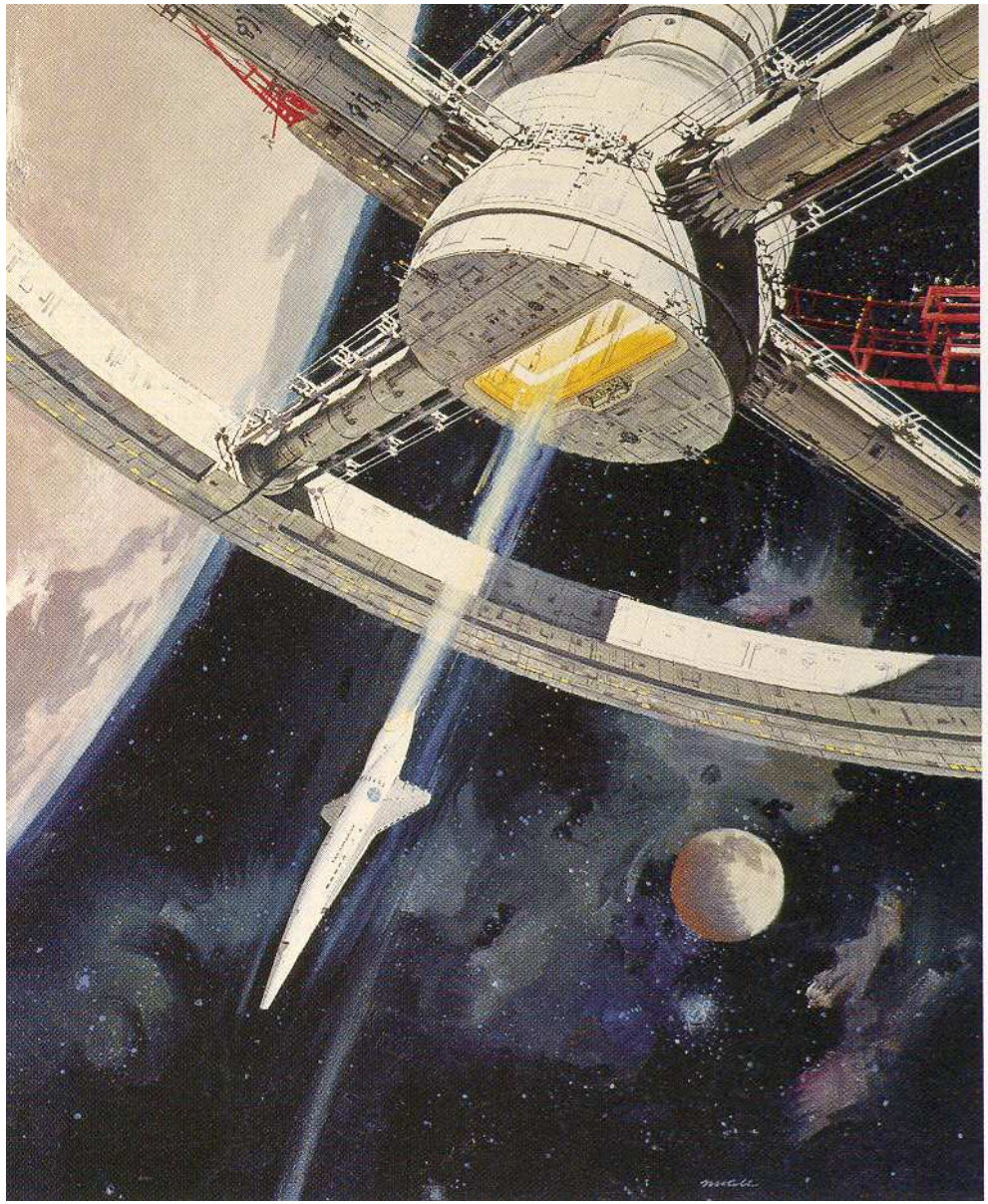

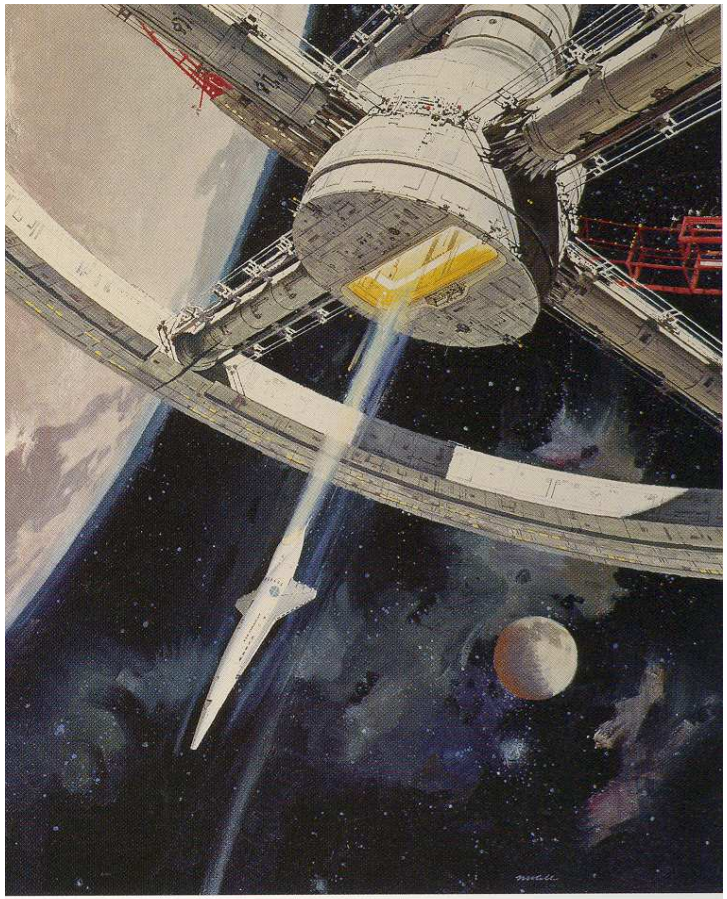

STANLEY KUBRICK'S

2001:

a space odyssey

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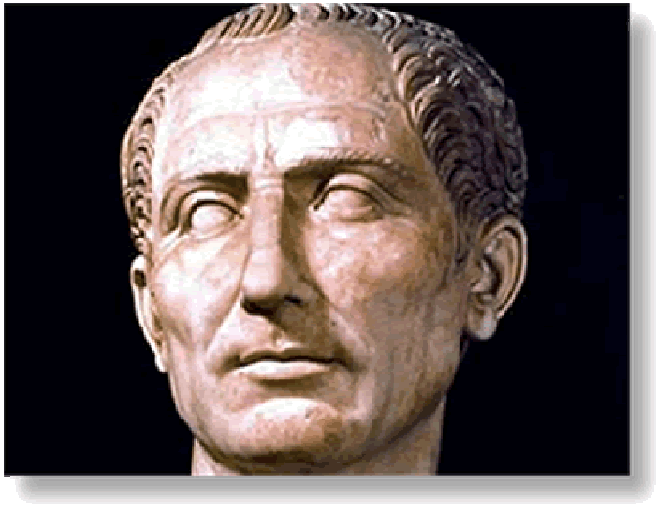

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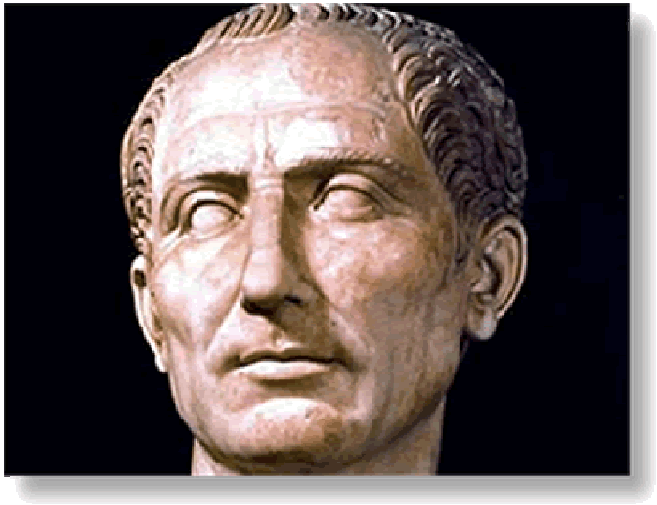

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This particular cipher is therefore sometimes called Caesar Cipher.

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Modern ciphers are *combinations* of the two types (*C. Shannon*, 1949)

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More instrumental code breaking efforts in Great Britain in the 1930s by A. Turing.

Modern Ciphers

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  NIST (NBS) 1977
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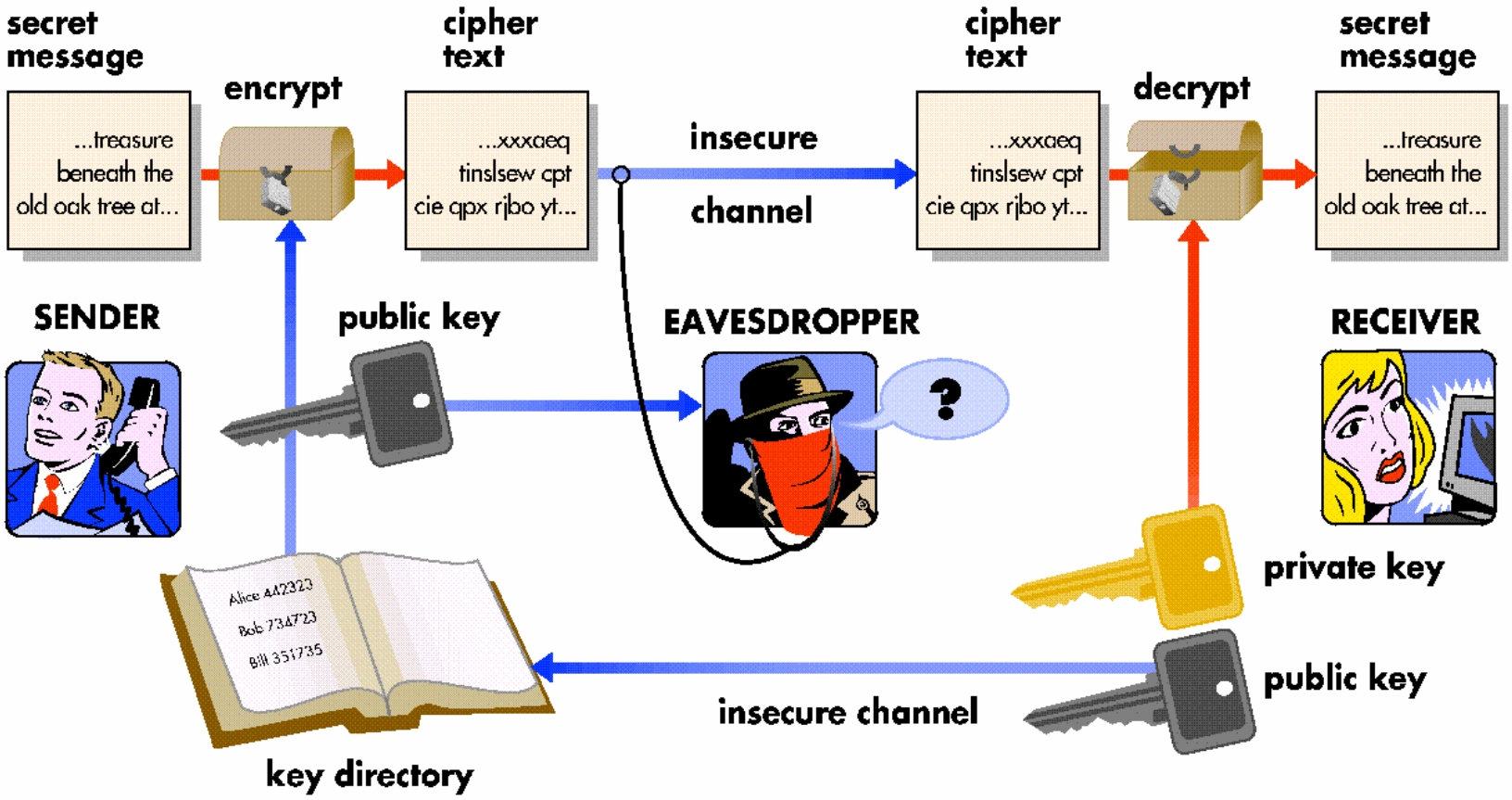

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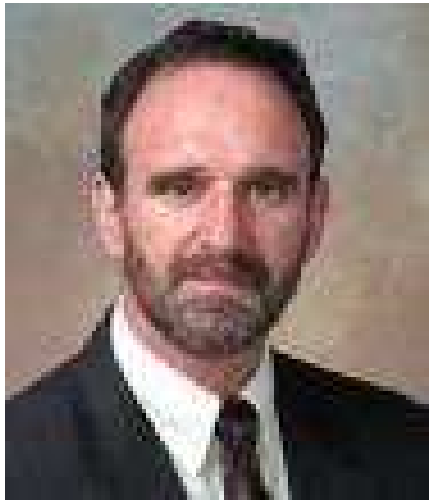

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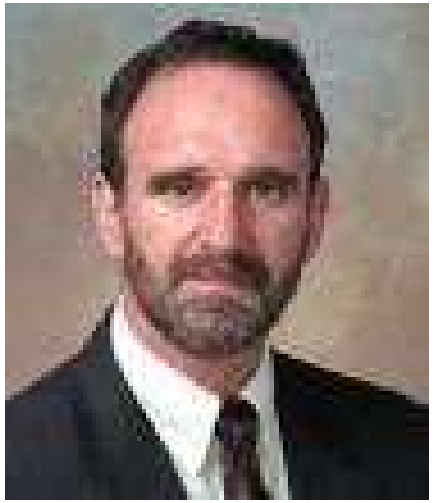

It was also invented (in secret) a few years earlier by J. Ellis at GCHQ Great Britain

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- Most of the time, the underlying problem stems from **number theory**.

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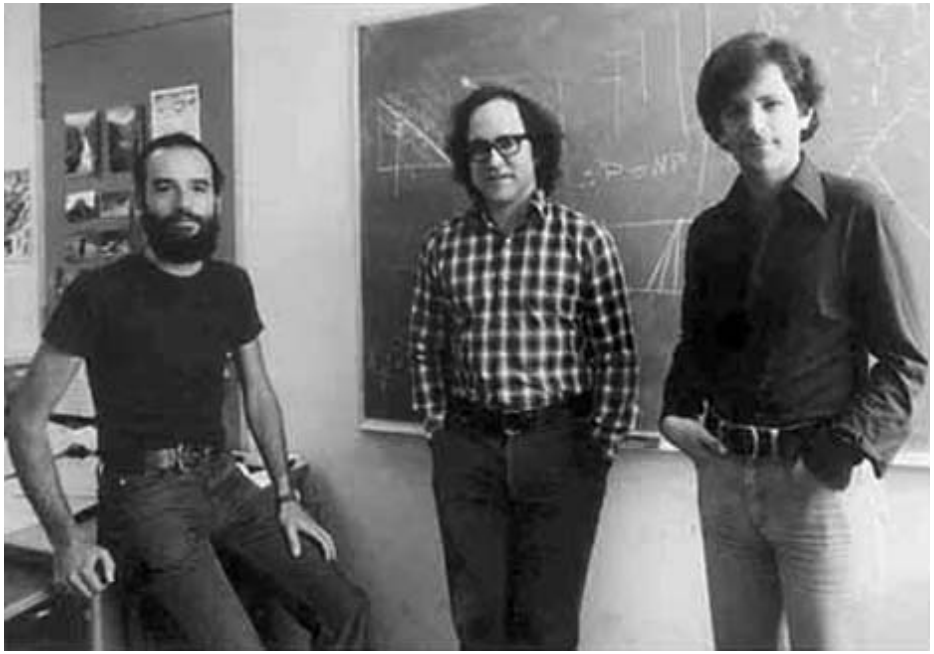

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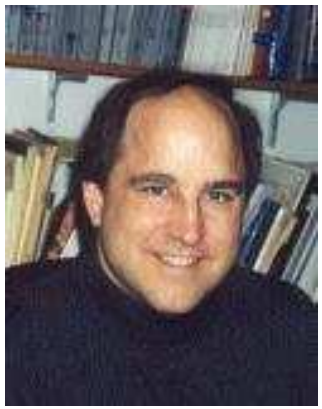

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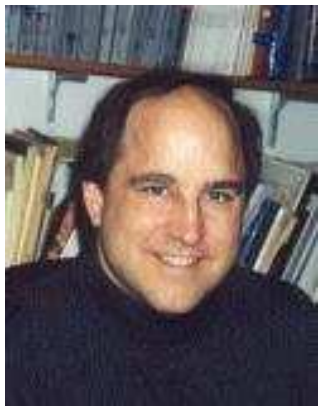

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E.g. 787061080478274202283
= 56409643 x 13952598148481

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- In the context of encryption, they are therefore predominantly used for cryptographic key exchange, whereas bulk encryption is done with conventional systems, such as AES.

Key Establishment Protocol

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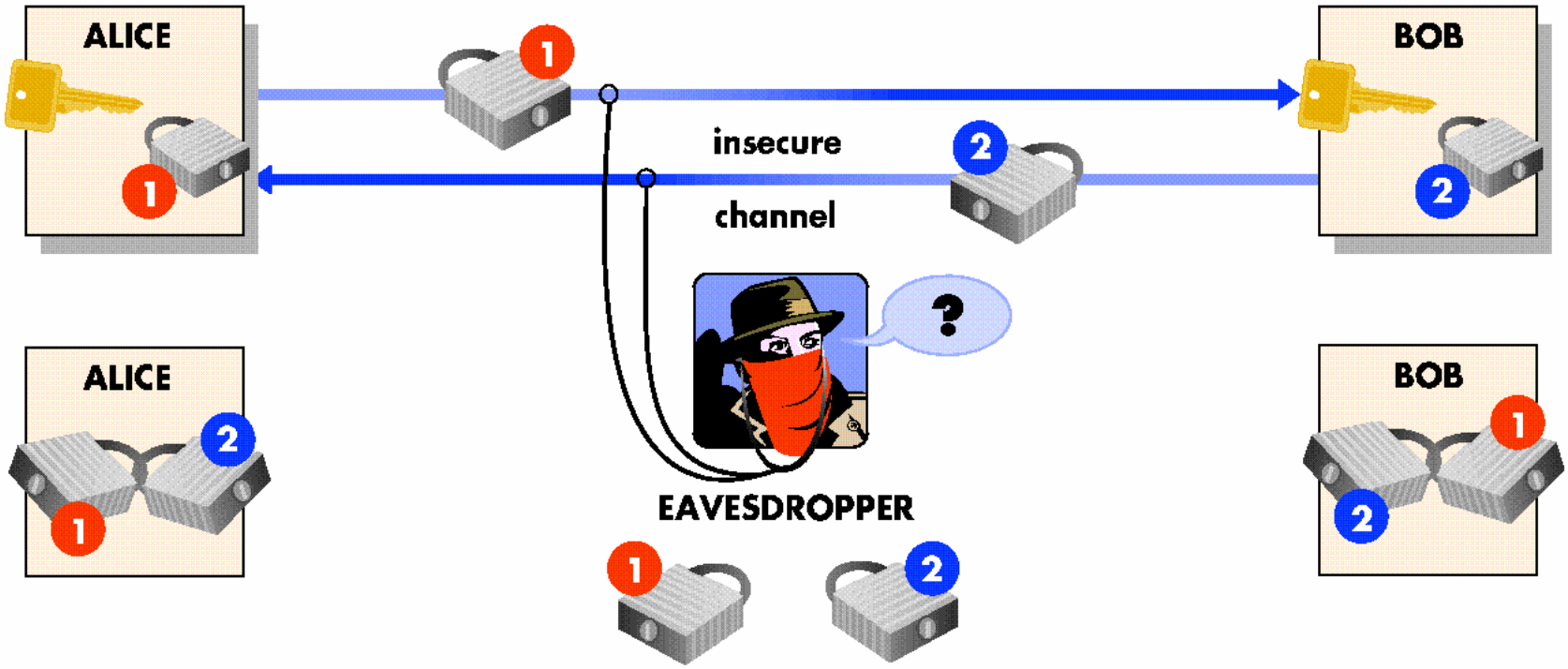

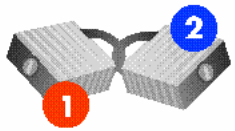

THE SECRET KEY IS: Two locks locked together.
Eavesdropper gets two locked locks & cannot open them.

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- The security of DH and ECC is based on the presumed difficulty of the **Discrete Logarithm Problem** (DLP) for **finite fields** and **elliptic curves**, respectively.

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- **Non-repudiation** - preventing an entity from denying previous commitments or actions.

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- hacked computers
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Whose fault is it? Is cryptography to blame?

From Cryptography to Security

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Cryptographic Primitive

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Protocol

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Implementation

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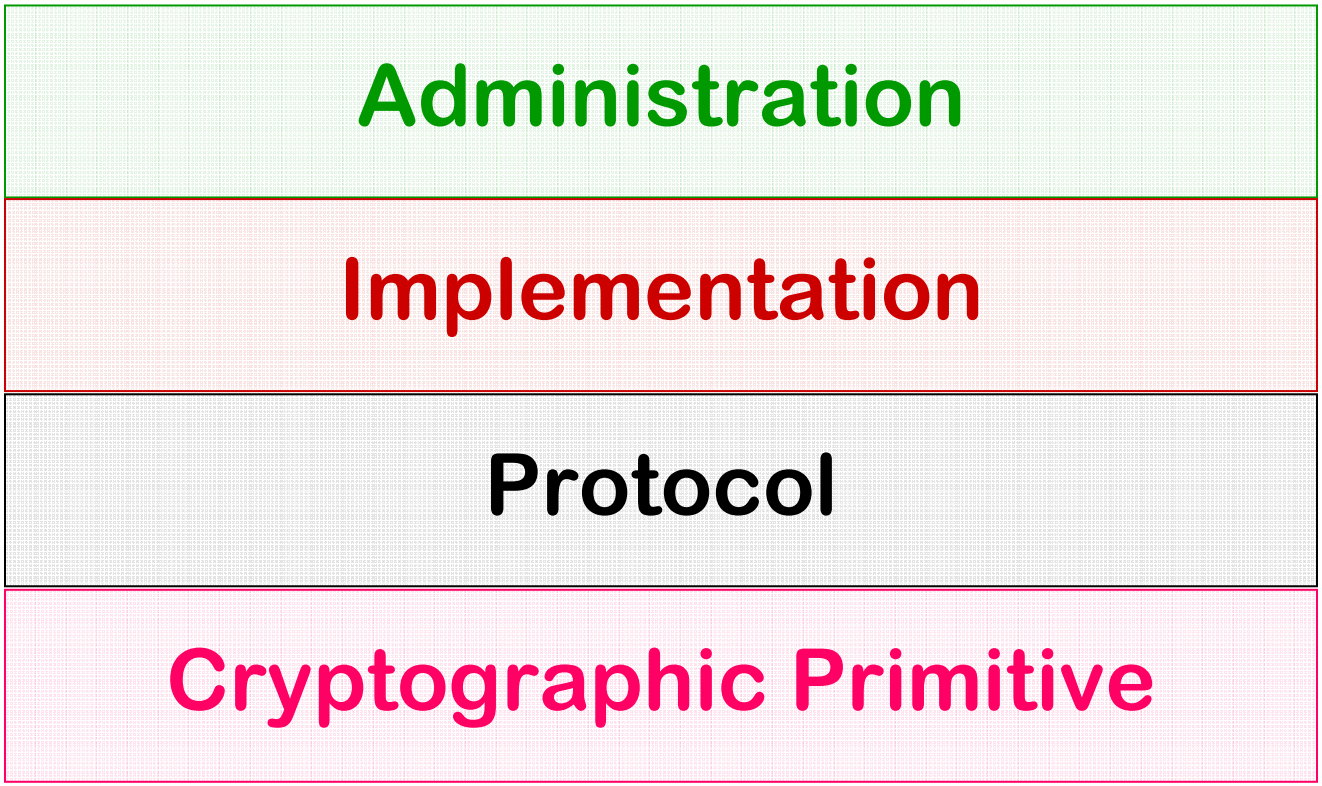

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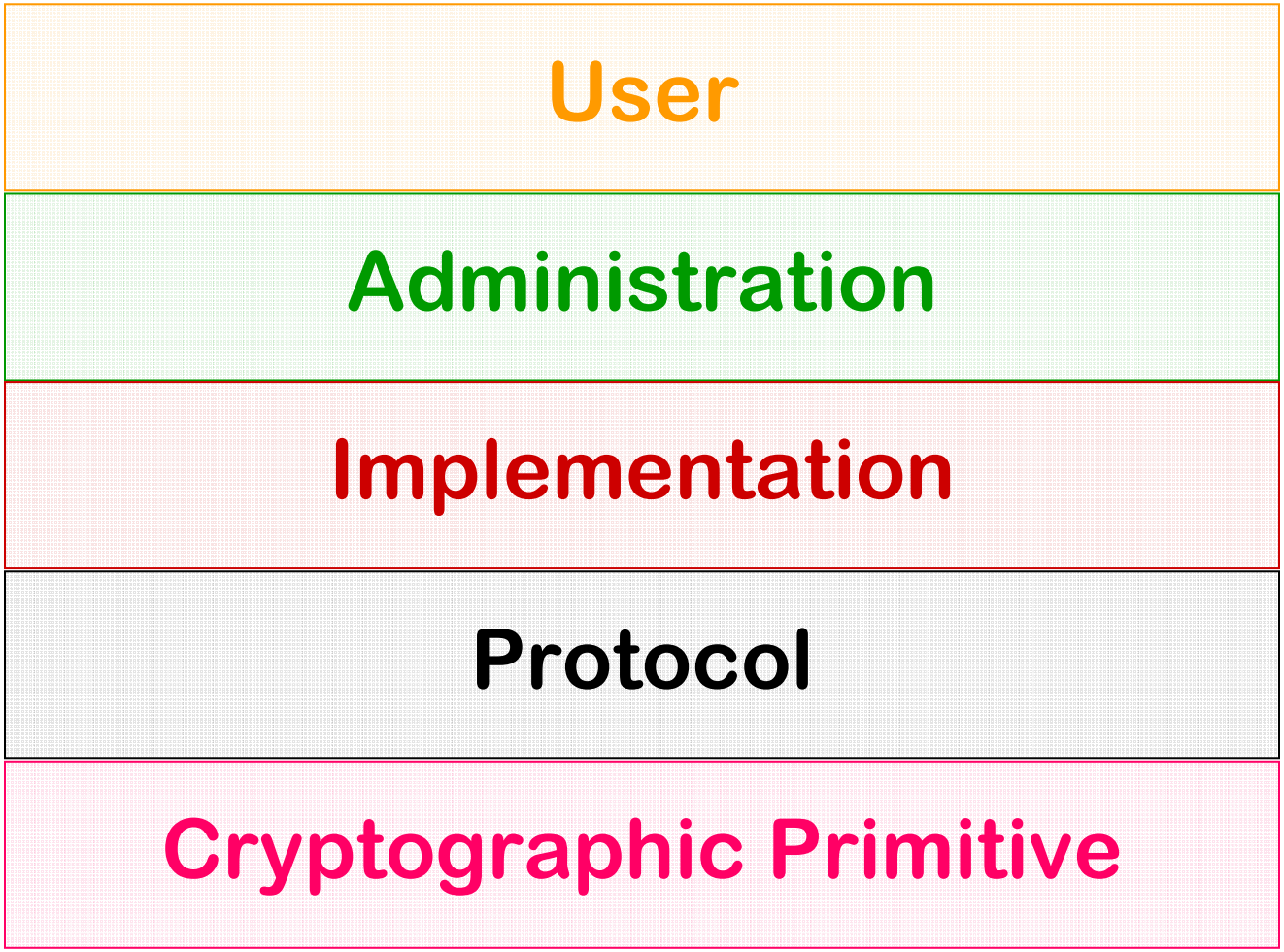

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- **Hash functions** are used to prevent the forgery of digital signatures.
- In February 2005, **X. Wang** and **H. Yu** of Shandong University China and **Y. L. Yin**, an independent security consultant in the US, found a collision in SHA-1 2000 times faster than exhaustive search.

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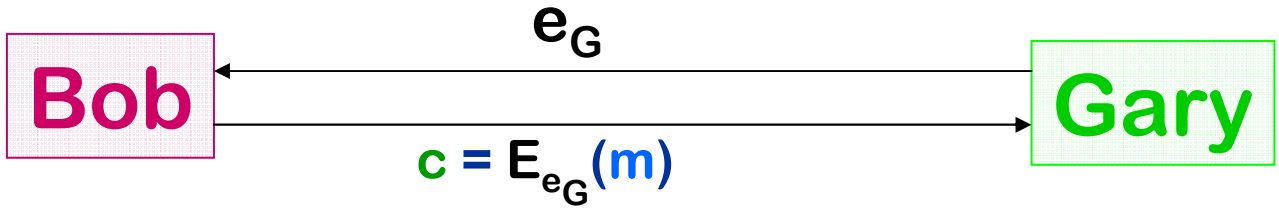

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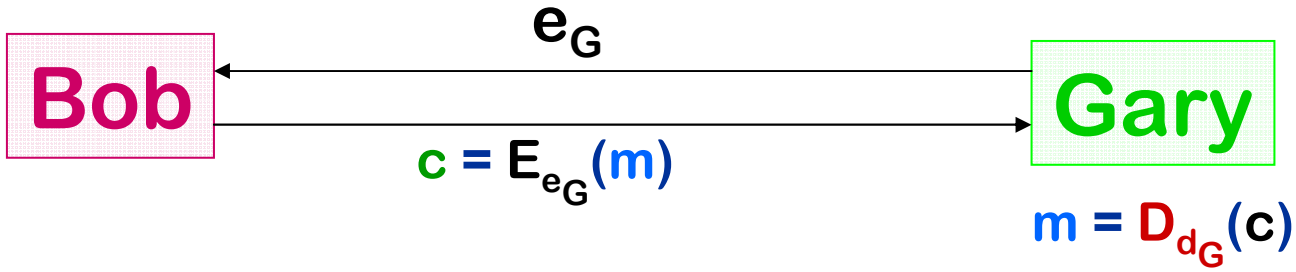

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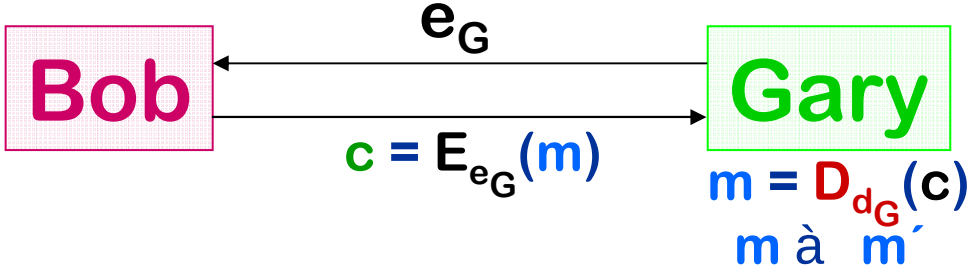

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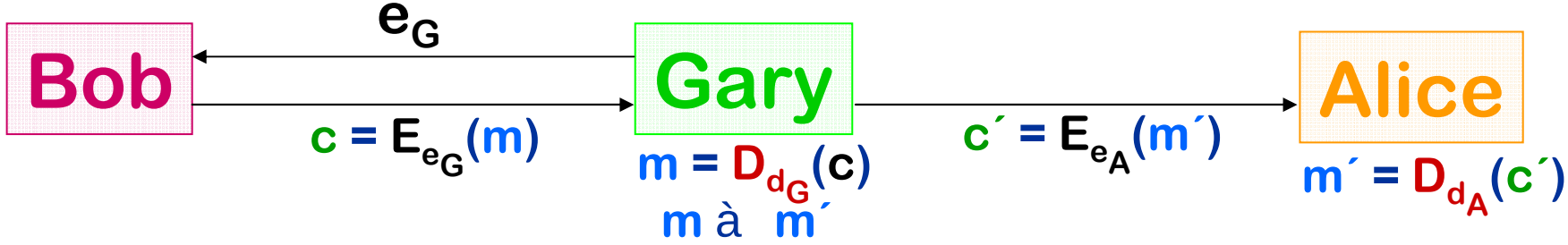

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- When using a pseudo-random bit generator, the program fails to start with a new seed each time.

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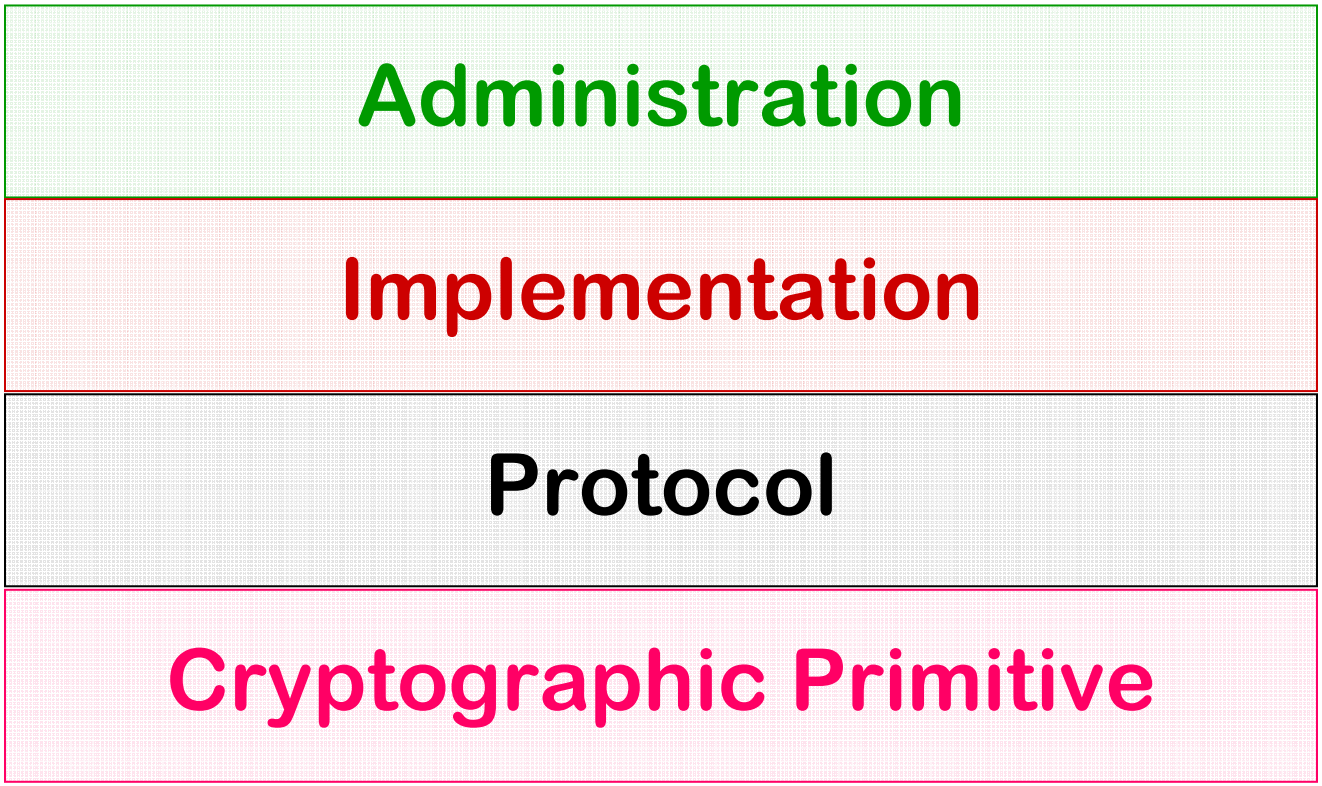

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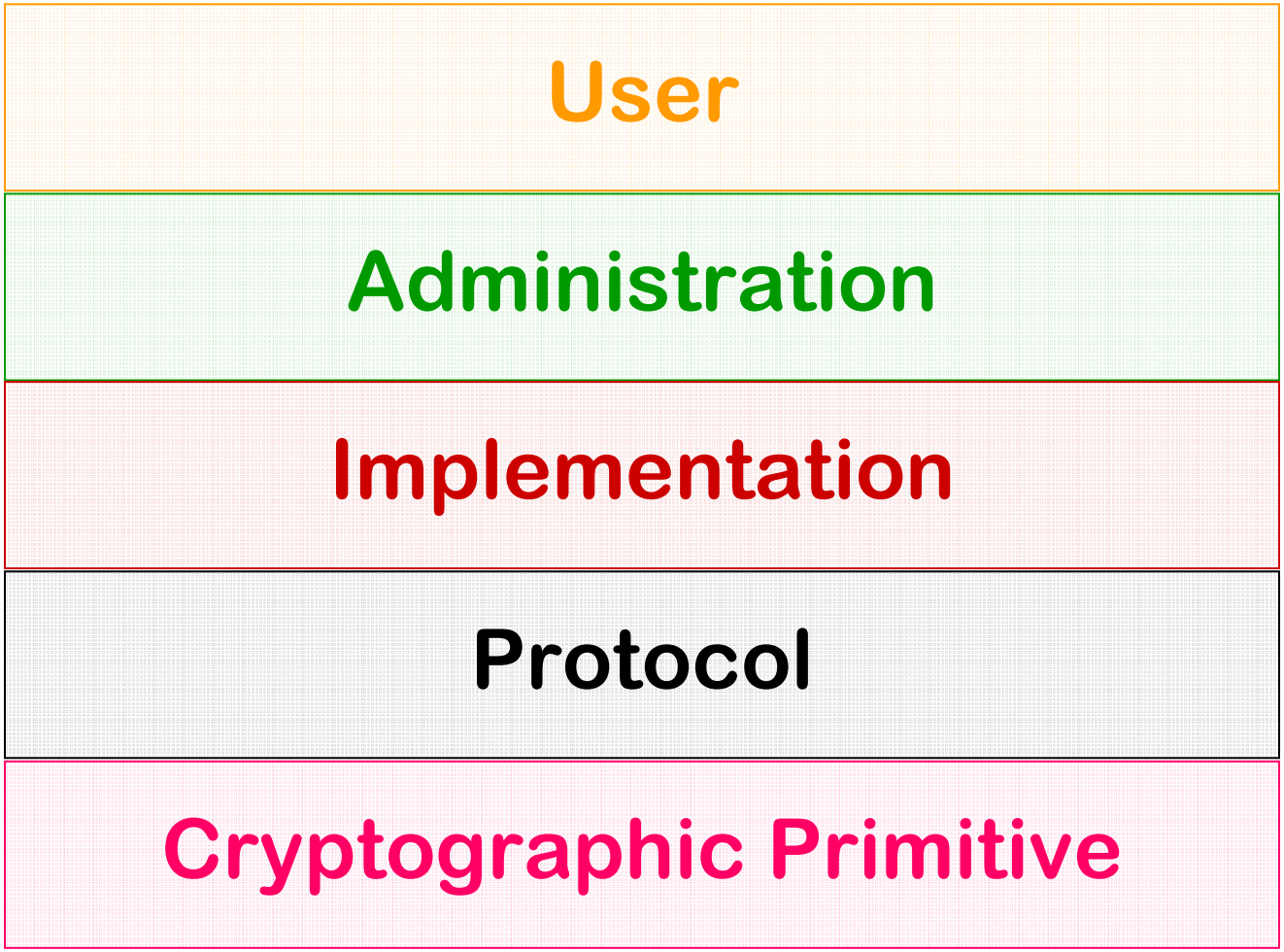

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- carelessness with personal records and mail (buy a shredder!)

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CSI/FBI Survey 2005, www.gocsi.com

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And what about all this quantum stuff that everyone talks about?

- **Quantum cryptography** develops cryptographic systems whose security is based on the **laws of nature** rather than hard mathematical problems.
- **Quantum information science** designs techniques for breaking traditional public key cryptosystems. A **quantum computer** would break every single public key cryptosystem currently in use.

Recreational Reading

- **David Kahn**, ***The Code Breakers***
  History up to World War II – a real classic, originally appeared in 1967
- **Simon Singh**, ***The Code Book*** **- The Evolution of Secrecy from Mary Queen of Scots to Quantum Cryptography**
  Doubleday 1999
  www.simonsingh.net
- **Neal Stephenson**, ***Cryptonomicon***
  Avon Books 1999 – a novel