DEF CON 23

WARNING STRONG CRYPTO

demonsaw

Crypto for Hackers

Eijah

v1.00
August 7th, 2015

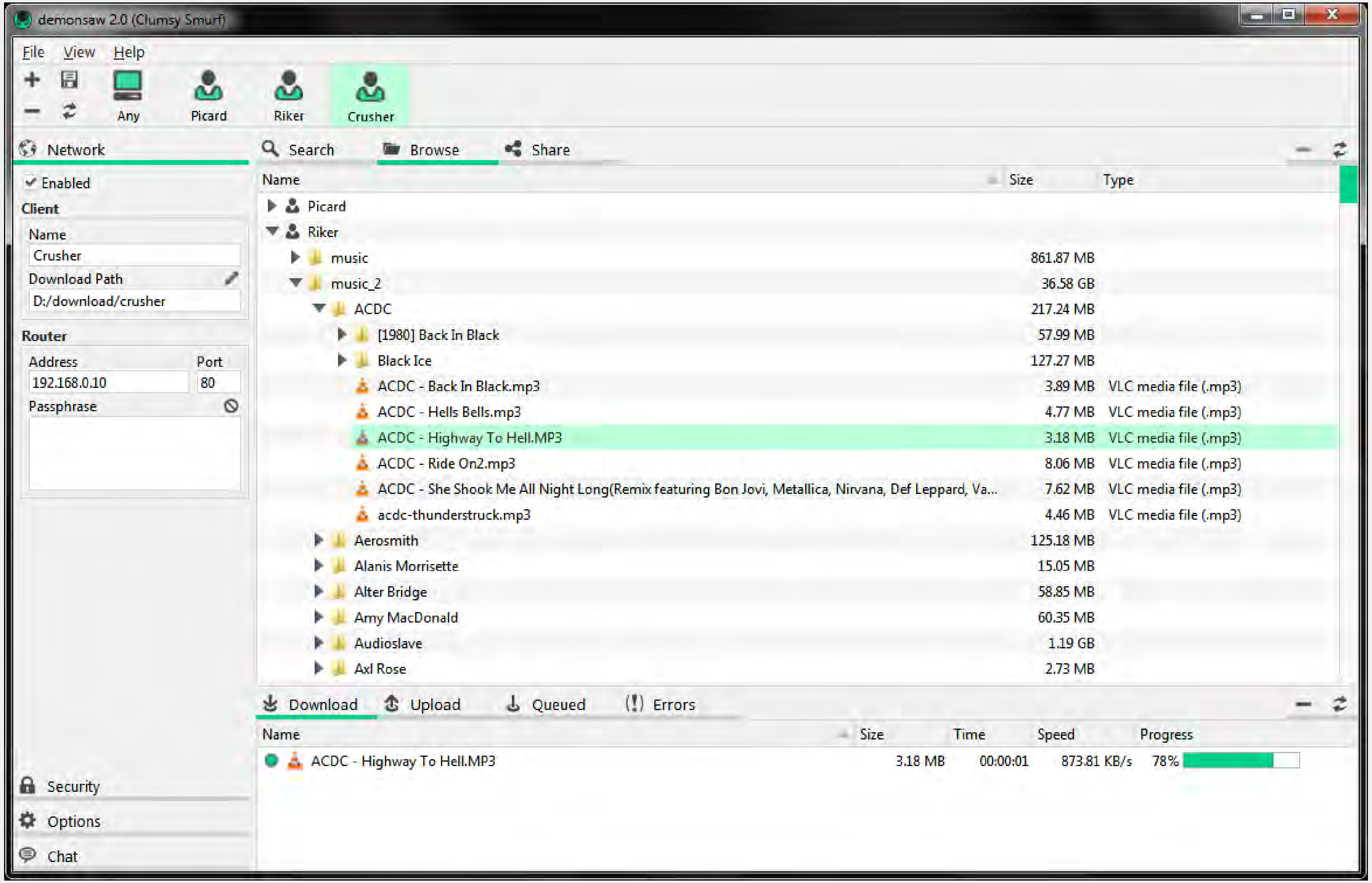
Hello World

“Shall we play a game?”

– Joshua/WOPR

Who am I?

- Founder
- Programmer
- Hacker



☑ Enabled

Client

Name: Crusher

Download Path: D:/download/crusher

Router

Address: 192.168.0.10 Port: 80

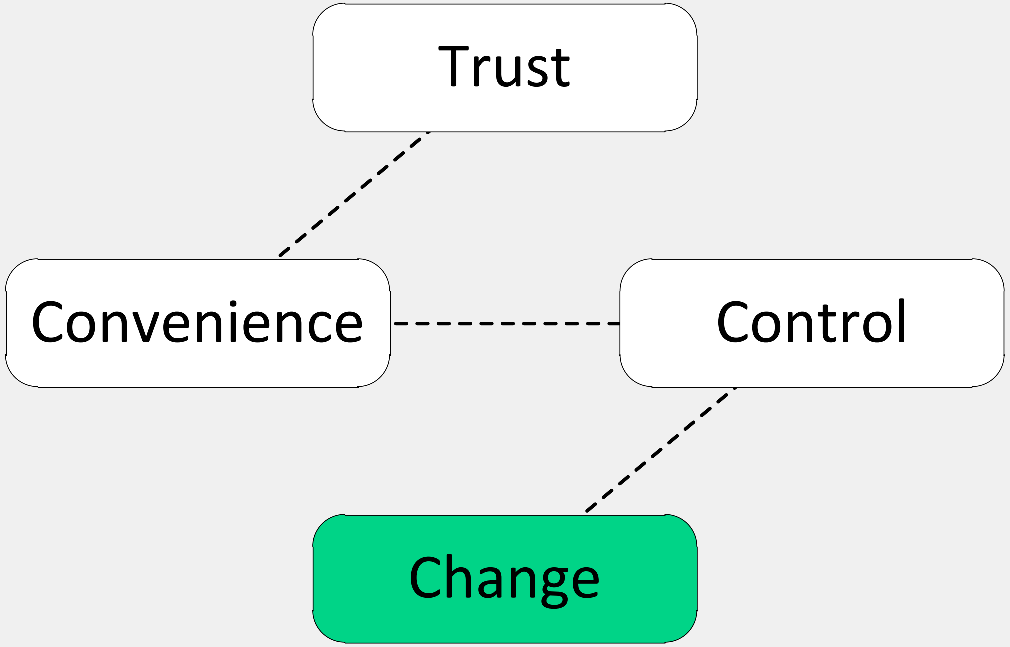
Passphrase:

Name	Size	Type
▶ Picard		
▼ Riker		
▶ music	861.87 MB	
▼ music_2	36.58 GB	
▼ ACDC	217.24 MB	
▶ [1980] Back In Black	57.99 MB	
▶ Black Ice	127.27 MB	
ACDC - Back In Black.mp3	3.89 MB	VLC media file (.mp3)
ACDC - Hells Bells.mp3	4.77 MB	VLC media file (.mp3)
ACDC - Highway To Hell.MP3	3.18 MB	VLC media file (.mp3)
ACDC - Ride On2.mp3	8.06 MB	VLC media file (.mp3)
ACDC - She Shook Me All Night Long(Remix featuring Bon Jovi, Metallica, Nirvana, Def Leppard, Va...	7.62 MB	VLC media file (.mp3)
acdc-thunderstruck.mp3	4.46 MB	VLC media file (.mp3)
▶ Aerosmith	125.18 MB	
▶ Alanis Morrisette	15.05 MB	
▶ Alter Bridge	58.85 MB	
▶ Amy MacDonald	60.35 MB	
▶ Audioslave	1.19 GB	
▶ Axl Rose	2.73 MB	

Name	Size	Time	Speed	Progress
● ACDC - Highway To Hell.MP3	3.18 MB	00:00:01	873.81 KB/s	78%

Last year at Defcon…

- Saving Cyberspace by Reinventing File Sharing
  - We’re losing out right to privacy and free speech
  - The abuse of power by the strong
- The more I thought about this…
  - Security, anonymity, privacy
  - Foundation of strong crypto
- But crypto is really difficult
  - Lifelong dedication
  - Can we filter out the noise?
  - Can we make it easy to understand?
- We can do anything if we put our minds to it



Importance of Crypto

"Know thy self, know thy enemy. A thousand battles, a thousand victories.“

– Sun Tzu, general and author of The Art of War

A World without Secrets

- Imagine for a moment…
- A dangerous and fragile world
- We cannot survive without privacy
  - People
  - Governments
  - Corporations
  - The irony
- In the news
- Why don't governments want us to protect our data?
- Lack of transparency doesn’t imply treachery

PEEK-A-BOO FACE PALM
It's so bad you had to peek to make sure that it really was that bad

A Formidable Ally

- AA856A1BA814AB99FFDEBA6AEFBE1C04
- Crypto is our strongest weapon
- Considered a military weapon in the USA until 1992
- Many different uses
  - Protect out secrets
  - Expose the secrets of others
- Poor crypto implementations
- A common denominator to the Internet

Know Thy Enemy

- In the past…
- Times have changed
- Understanding the weapons and attack vectors
- Betting everything on crypto
- Our mission
  - Understand crypto
  - Embrace it in our daily lives
  - Become more powerful than those who oppress us

Becoming More Powerful

- Technology as the deciding factor
- We are stronger than governments & corporations
- Crypto is a complex and difficult subject
- The secret
  - Ubiquitous
  - Pervasive
  - Easy
- The will of the people
- Battle cry for a new generation of hackers

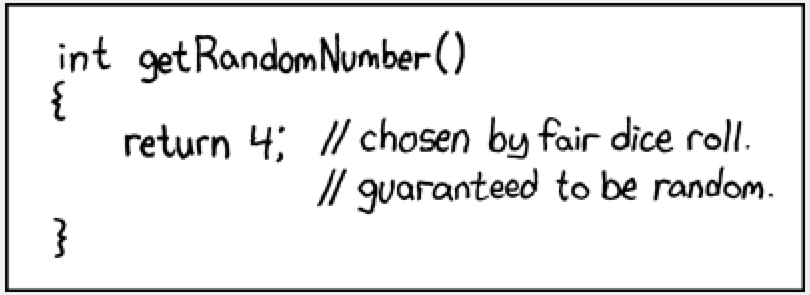
The Algorithms

“Encryption is the defense against the dark arts.”

– Edward Snowden

Terminology

- Crypto(graphy)
  - The practice and study of techniques for secure communication in the presence of third-parties.
- Cipher
  - An algorithm for performing encryption or decryption.
- Encryption, Decryption
  - The process of encoding messages or information in such a way that only authorized parties can read it (and vice versa).
- Plaintext, Cleartext
  - Unencrypted messages or information.
- Ciphertext
  - Unencrypted messages or information.
- Pseudorandom Function (PRF)
  - Efficient function that maps input and random seed to an output that looks random



```
int getRandomNumber()
{
    return 4;  // chosen by fair dice roll.
               // guaranteed to be random.
}
```

Terminology

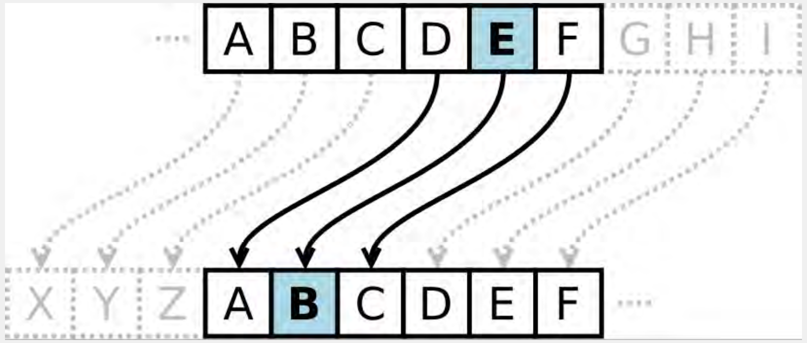
- Key
  - A parameter that determines the functional output of a cryptographic cipher.
- Hash (Function)
  - A 1-way cryptographic conversion function which is considered practically impossible to invert.
- (Message) Digest
  - The output of a hash function.
- Symmetric Encryption Algorithm
  - Algorithms that use the same cryptographic keys for both encryption of plaintext and decryption of ciphertext.
- Asymmetric Encryption
  - Algorithms that use different cryptographic keys for encryption of plaintext and decryption of ciphertext.

Crypto Libraries

- Crypto++
  - Free C++ class library of cryptographic schemes
  - http://www.cryptopp.com
- Democrypt
  - Open-source C++ wrapper around the most important Crypto++ algorithms.
  - Crypto foundation of demonsaw v2.0
  - http://www.demoncrypt.com
- Algorithms
  - Ciphers (AES)
  - Hash (MD5, SHA)
  - HMAC
  - Key Agreement Schemes (Diffie Hellman)
  - Password-based Key Derivation Functions (PBKDF2)

Ciphers

- Algorithm for performing encryption or decryption
  - Plaintext → ciphertext
  - Ciphertext → plaintext
- Usages
  - Symmetric, Asymmetric
  - Everywhere (Software, hardware, networking, databases, DRM, etc.)
- Algorithms
  - Rijndael (AES), Serpent, Twofish, RC6, MARS
  - 128, 192, 256 bit keys
- Notes
  - NIST AES Standardization Process



Ciphers

AES

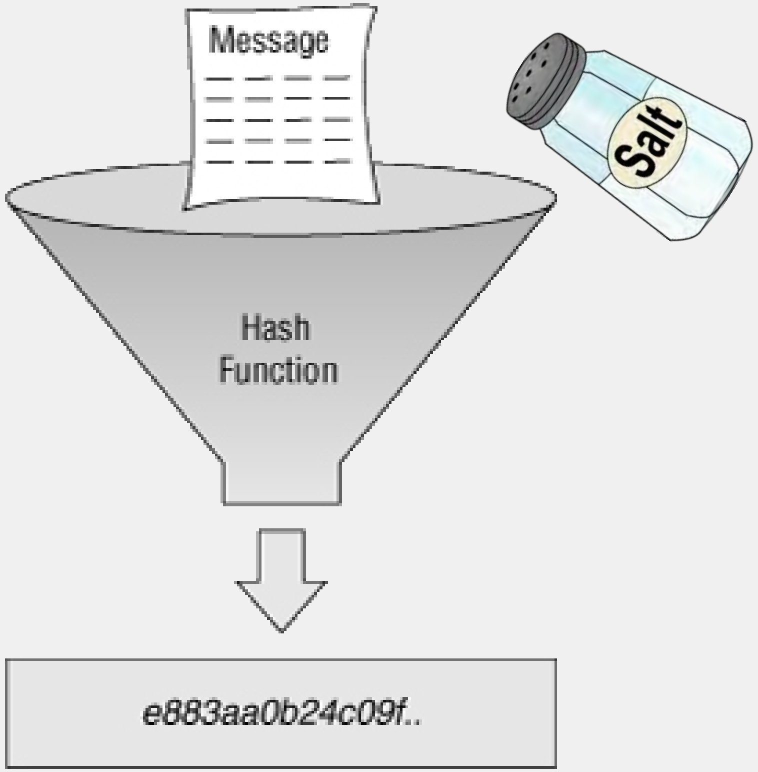
```
// Derive Key
pkcs5_pbkdf2_hmac_sha256 pbkdf;
pbkdf.set_salt("demonsaw 2.0");
string key = pbkdf.compute("Believe in the Right to Share”);

// AES
cipher.set_key(key);
string ciphertext = cipher.encrypt("The Cloud is a lie");
cout << "CIPHERTEXT: " << hex::encode(ciphertext) << endl;
// 542f25fcf9c8564433bee34d1122fab30c349c7d7ded1967c5ff3abac42f734b

string plaintext = cipher.decrypt(ciphertext);
cout << "PLAINTEXT: " << plaintext << endl;
// The Cloud is a lie
```

Hash Functions

- One-way conversion function
  - Message → (Message) Digest
  - Practically impossible to reverse engineer
  - Fixed sized output w/ optional salt
- Usages
  - Verify file integrity, hashing passwords, digital signatures
  - Checksums, keyed data structure indexes
- Algorithms
  - MD5, SHA-1, SHA-2, SHA-3
- Concerns
  - Collisions (limited key space)
  - Rainbow attacks
  - Length extension hacks



Hash Functions

SHA-256

MD5

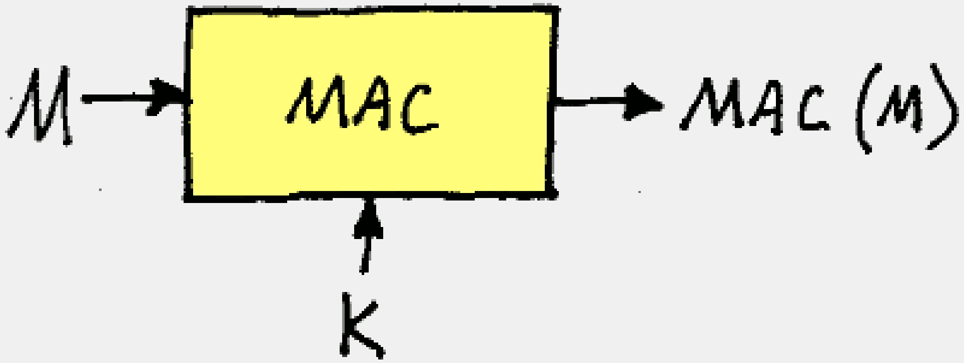
```
md5 md;
string md5_digest = md.compute("The Cloud is a lie");
cout << "MD5: " << md5_digest << endl;
// 759806471b250e2031c5257c01382a21
```

SHA512

```
sha256 sha;
string sha256_digest = sha.compute("The Cloud is a lie");
cout << "SHA256: " << sha256_digest << endl;
// 6aad0fcc90862e6b3c5cea078a0a35c0327f62671477fc5689abaa5f783c8cdf
```

Hash-Based Message Authentication Codes

- Hash function with a user-provided key
  - Message Authentication Code (MAC)
  - Provides authenticity & message integrity
  - Prevents rainbow attacks
  - Key is not in hash
- Usages
  - Can be used in place of hashes
  - Building block for other applications (PBKDF2)
  - Signing messages
- Algorithms
  - MD5, SHA-1, SHA-2, SHA-3
- Concerns
  - Strength of the input key



Hash-Based Message Authentication Codes

HMAC MD5

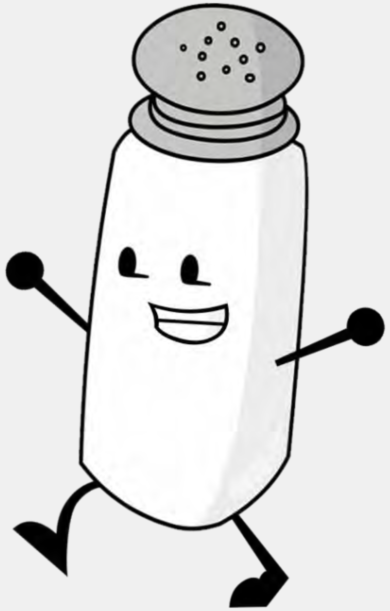
```
hmac_md5 hmac;
hmac.set_key("Believe in the Right to Share");
string md5_mac = hmac.compute("The Cloud is a lie");
cout << "HMAC MD5: " << hex::encode(md5_mac) << endl;
// 888e3e9cedd4f1a0d9a7c6e76af16afa
```

HMAC SHA512

```
hmac_sha256 hmac;
hmac.set_key("Believe in the Right to Share");
string sha256_mac = hmac.compute("The Cloud is a lie");
cout << "HMAC MD5: " << hex::encode(sha256_mac) << endl;
// cb1fa1e58e17a6b8c87e476e6725251e114b5cd51b20946facca15cc497595f1
```

Password-Based Key Derivation Functions

- Generating a key from a password/phrase
  - Convert user-friendly strings into keys
  - Choose PRF, salt, iterations, output size
- Usages
  - Mutual shared secret derivation
  - Input for other crypto algorithms
- Algorithms
  - PBKDF2
- Concerns
  - Computationally more intense
  - Character encoding is important



Password-Based Key Derivation Functions

PBKDF2 HMAC MD5

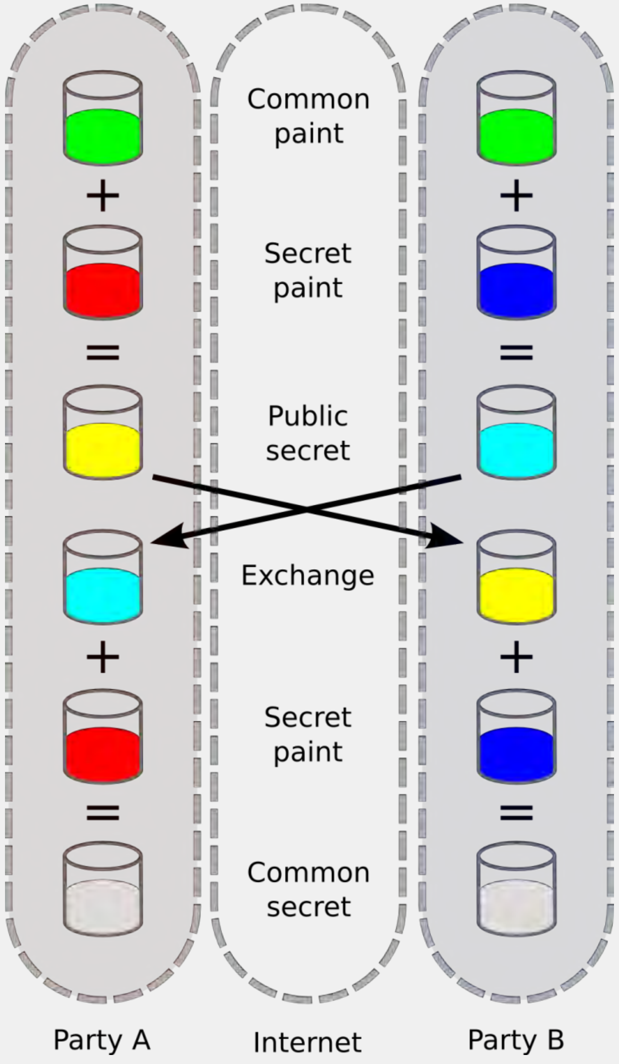
```
pkcs5_pbkdf2_hmac_md5 pbkdf;
pbkdf.set_salt("demonsaw 2.0");
string key = pbkdf.compute("Believe in the Right to Share");
cout << "PBKDF2 HMAC MD5: " << hex::encode(key) << endl;
// 0552acc1243e62c9c35acdcbc6714f30
```

PBKDF2 HMAC SHA512

```
pkcs5_pbkdf2_hmac_sha256 pbkdf;
pbkdf.set_salt("demonsaw 2.0");
string key = pbkdf.compute("Believe in the Right to Share");
cout << "PBKDF2 HMAC SHA256: " << hex::encode(key) << endl;
// b1403d5360549dc580eb9cc3cf46bc3a5dfe871a8ada19a37a4429a8e7e85e00
```

Key Agreement Schemes

- Generates secret key common to both parties
- Benefits
  - Same shared key created, without key exchange
  - Both parties influence the outcome
  - Insecure channel communication
- Usages
  - WPS, SSL/TLS, SSH, VPN
- Algorithms
  - Diffie-Hellman
- Notes
  - Asymmetric
  - Man-in-the-Middle attack
  - Unique key sizes



Key Agreement Schemes (128 bit)

Party A

```
diffie_hellman dh_1(128);
const auto& base_1 = dh_1.get_base();
const auto& prime_1 = dh_1.get_prime();
const auto& public_key_1 = dh_1.get_public_key();

cout << "Base: " << hex::encode(base_1) << endl;
cout << "Prime: " << hex::encode(prime_1) << endl;
cout << "Public Key: " << hex::encode(public_key_1) << endl;

// Base: 03
// Prime: 952908c5e136753c1c8b44411396ecf3
// Public Key: 3f19880e8bf951f94c6dc5578242dde5
```

Key Agreement Schemes (128 bit)

Party B

```
diffie_hellman dh_2(prime_1, base_1);
const bool status_2 = dh_2.compute(public_key_1);
const auto& public_key_2 = dh_2.get_public_key();
const auto& shared_key_2 = dh_2.get_shared_key();

cout << "Public Key: " << hex::encode(public_key_2) << endl;
cout << "Shared Key: " << hex::encode(shared_key_2) << endl;
// Public Key: 0a54116dc11c41ac6c2a3a95a9c61715
// Shared Key: 29cabdd82222c74e7dc44dea9b113a21
```

Party A

```
const bool status_1 = dh_1.compute(public_key_2);
const auto& shared_key_1 = dh_1.get_shared_key();

cout << "Shared Key: " << hex::encode(secret_key_1) << endl;
// Shared Key: 29cabdd82222c74e7dc44dea9b113a21
```

Key Agreement Schemes (2048 bit)

Base

```
02
```

Prime

```
e85d7232623aa7988a681b914ad0d4aa1d5ba17a8be374be808dc26ed988c5b8d7e0998382a6db54ed9a75a436f4b
fa17d732d355d3835b7ec9ba131ffe9e7652235f11a9f70a27d440ccf193d6609f98e86ce17000fdb04cdf2d74da2c1e1c5f
8b7ba0fafb5617e7e29f5509b3be2d7dadc4da9f4d9f4442325e978eeb6b2521e5bc097c6ef859cfd736e6413b144b9e48a0
440e905312054315e06d12aa881833672afa467ecc40ab9002db2fa9c9fee39e4c375957f45937fca6c8c9927c8a986d3ec8
9b7059fb3cd66fccfb69a94870afe6b81b190163e152f24895e936243869063ed9d818a02b3efff23812ecba5e07a3b564f2
76e5515a4fffd45bf87
```

Public Key (A)

```
1ae20832c2fd50afab8cb387ccdada3ae620b5f22555dde17863008d4f05ede1d9b762bbb1568641af6d4c5d
5f8f2cfa441660b386e77302f8885452f786385aafaf0c55802e10890ba2da3e16df2ebf3b0dbe466fce6713463dc0a498a8
cca2ee946dcb28517b1a7bb768175aa5cdf26c3bf1c54f92a1ee7fe06dfdb05884485353911 5be1f76e14ab7f6230268e033
9aa687b72f47836cde28876345ca390c2425a92f3bea053168bf70adc325363d3ffc66a0be7aac5438dc43d82343586ee096
a0a142292dbad376eedb960b65975870f2c796df07df7e78b3f16961ed33ff4690d3c9cd300a3d5ac4359a8440aa3a125a61
d9aba9a20fd5e960eceb965c
```

Key Agreement Schemes (2048 bit)

Public (B)

```
35c8abc9cac1e9ca365005b22ab98c8d1efa5656d99286333e5de37a793ba8f8c235886fa3f5c6b6164c662b
21b18ea03b901297a6be623dc8ec5dad106b2e7cd7ab9a339187ea4142f593e414c8992408e0bdede22d3bb51517801431ef
ce5f01b4f81a15c61acd948f03f9655242537e31e668ec998ce0ef1c11e99afcf467048934290bc1358cfc41b0b742954c1c
09a539ce2d1845a735b1ad5e12359b6d271195c0fca1b3b8b7135b05857b8f9c5b66f0517c1335eeab0f6916f1848abc6c33
15811af5af417a23c531f02bde7167d268494c009d39815c27d2e8610ac021c26e6a64729c1888dad19f9b026fa752039b8b
a18ce6e0285d8060b9b70c20
```

Shared (A, B)

```
980b1baeff1745794b384f46743d31b69b830b109e28f81aca96a3c38fe8538dd64ff835b830472a266eca8f
f82ede682c57b59c83640b86e0a46edd25923f7e089da9540cb73dd2db9ddde8514c782f9cd2dd5de6a08ed7cae357e1c4ff
fb6ecf386f979b2bdd1c755fb6b1efa049d3612c7d51d39185740a2cd3e788104af2391095d4c7b4b56b2d1b6460a665458d
874c8eaee1ec57abe0f7a5335e55f41e32e1c9077582dbb542f7d4b5481d651ca2f9d748731bf9a878b84d2ce822f68e2c6f
3a6aa712da5ed31a6beb7c4dd88930935330454fe809bed9564ffc5772d9e2caebadc749dc806990d9e682f57df33ac7d739
89fedefa71d73b18b2b26765
```

Securing our Future

“I am regularly asked what the average Internet user can do to ensure his security. My first answer is usually 'Nothing; you're screwed'.”

– *Bruce Schneier*

Demonsaw 2.0

- Demonsaw 1.x
  - Buggy, Windows-only, C#
  - Secure, Anonymous, Free, Everywhere?
- Demonsaw 2.0 Goals
  - Everywhere (Unified code base: C++ 11, Boost, Crypto++)
  - Simplify the interface
  - Increase security
  - Add more features
- Demonsaw 2.0 Features
  - Windows, Linux, OSX, Raspberry Pi
  - Secure chat
  - Social Encryption
  - Modern UI, opt-in features, command-line interface, customizable themes

Demo

Summary

“A hacker to me is someone creative who does wonderful things.”

– Tim Berners-Lee

Next Steps

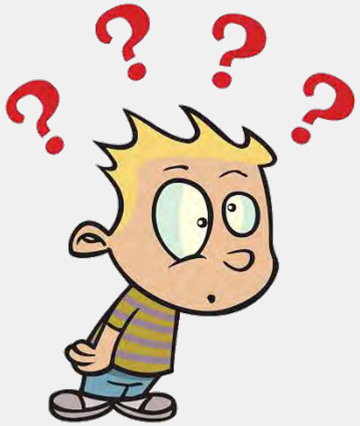
- Thank you for believing in the Right to Share
- The demonsaw promise
  - 100% free, no ads, no installs, no malware, no bundled software, no logging, no tracking, no bullshit
- Your continued support
  - Suggestions, bug fixes, beta testing
  - One person can make a difference
  - Email, Twitter
- The best is yet to come

Questions?

www.demonsaw.com

✉ eijah@demonsaw.com

@demon_saw



Eijah

References

- http://cryptopp.com/
- https://en.wikipedia.org/wiki/Export_of_cryptography_from_the_United_States
- https://en.wikipedia.org/wiki/Symmetric-key_algorithm
- https://en.wikipedia.org/wiki/Public-key_cryptography
- https://en.wikipedia.org/wiki/Advanced_Encryption_Standard_process

DEF CON 23

WARNING
STRONG
CRYPTO

demonsaw