# SSH libraries : What they can do for you

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# Who am I ?

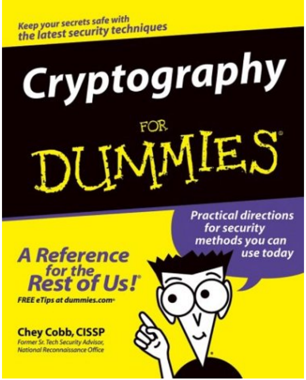
DEFCON 18

libssh

Belnet
dedicated connectivity

# Some cryptographic transport protocols

- SSL
- TLS
  - Actually, TLS 1.0 = SSL 3.1
- SSH-1
- SSH-2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Chey Cobb, CISSP
Former Sr. Tech Security Advisor, National Reconnaissance Office

# SSL/TLS

- Secure Socket Layer/Transport Layer Security
- Initially (poorly) developed by Netscape
- Widely used for online applications (https, ftps, imaps, ...)
- Based on X.509 certificates for both servers and clients.
- Many implementations (OpenSSL, GNU/TLS, NSS, YaSSL, MS Windows, ...)

# SSH

- Secure SHell.
- Initially developped by Tatu Ylönen, but then lots of development by OpenSSH team.
- Defined in RFCs (RFC4250-4256).
- Many features :
  - Secure transport
  - Authentication
  - Shell/terminal handling
  - File transfer/remote file system (SFTP)

# What about security

- Integrity
  - Tampering is detected
- Availability
  - No shutdown of connection possible
- Confidentiality
  - Nobody can eavesdrop communication
  - You are sure of the identity of the remote side

- Integrity
  - Strong HMAC detect any change
- Availability
  - Transport protocols run over TCP
  - No protection against a forged RST packet
- Confidentiality
  - Strong ciphers
  - Strong key exchange
  - Authentication of key exchange

# What about security - Authentication (1)

- Avoid MiM
- Client must ensure authenticity of the server

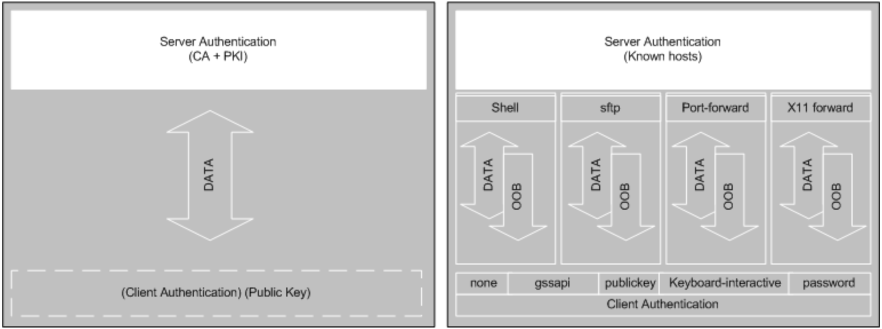
| | TLS | SSH |
|---|---|---|
| Trust | X.509 certs | Server key hashes |
| Key exchange | Diffie-Hellman, RSA | DH, ECDH, ECMQV |
| Key types | RSA, DSA | RSA, DSA, ECDSA |
| Verification | Trust chain | Known host file |
| Authority | PKI (home CA) | Local authority |
| | | in-DNS hashes + DNSSEC |
| Authority | 3rd party CA | - |

# What about security - Authentication (2)

- Avoid MiM
- Client must ensure authenticity of the server
- Servers must authenticate clients

| | TLS | SSH |
|---|---|---|
| Key pairs | X.509 Self-signed | Client public key |
| Crypto token | PKCS #11 | PKCS #11 |
| | w/ X.509 CA, self-signed | w/ X.509 CA, public key |
| Password | Application | Password |
| OTP/Challenge | Application | Keyboard-interactive |
| 2-factors auth. | Application | Partial authentication |
| SSO | Application | gss-api, Kerberos |

# Little comparison



# Which one to choose ?

- SSL/TLS is a Transport protocol
- Symmetric client/server
- How do you authenticate your servers ?
  - Is it acceptable that China can forge valid certificates ?
- Ideal for REST-based/HTTP protocol

- SSH is an Application protocol
- Asymmetrical
- Very simple host authentication model
- Guarantee to find OpenSSH everywhere
- Ideal for multi-channels communication, system protocols
  - What about IMAP over SSH ?

# Existing SSH libraries

| Name | Language | OS | License |
|---|---|---|---|
| libssh | C | Unix, Windows | LGPL |
| libssh2 | C | Unix, Windows | BSD |
| Granados | C# | .NET | Apache |
| Net::SSH | Ruby | Ruby | MIT |
| SSH.NET | C# | .NET | BSD based ? |
| JSch | Java | JVM | BSD |
| sshj | Java | JVM | Apache |
| ne7ssh | C++ | Linux | QPL |
| paramiko | Python | Python VM | LGPL |

# Some history

- Started as SSH PoC in 2003
- Server part developped in 2005 with Google SoC
- Andreas joined me in 2008
- Now libssh is around 33K LOC (OpenSSH 5.8p1 is  100K)
- Used by many F/OSS projects, including KDE

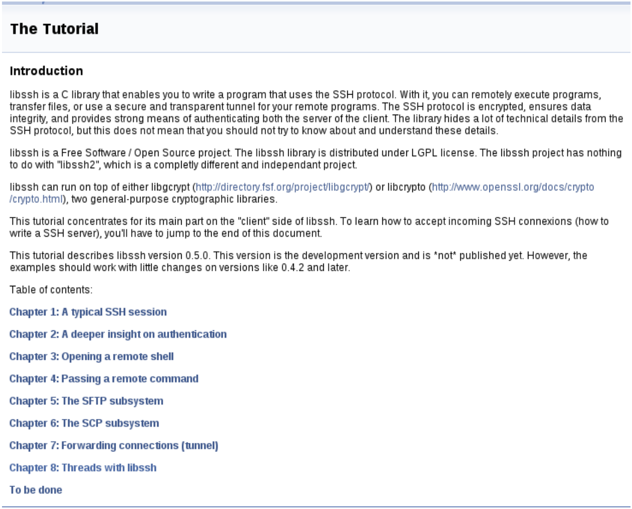
# Features

- Client-side, Server Side
- SSH2, SSH1 for client
- Authentication using password, keyboard-interactive, publickey (including with SSH Agent)
- Depends either on OpenSSL or GCrypt
- Runs on Windows, Unix, VMS !
- SCP, SFTP, Compression, Forwarding, ...

# Documentation

- Critical for a library
- All API carefully documented with Doxygen
- Look by yourself ! *http://api.libssh.org/*
- Tutorial explaining most basic operations
- *examples/* directory, plenty of working code

# Documentation



## The Tutorial

### Introduction

libssh is a C library that enables you to write a program that uses the SSH protocol. With it, you can remotely execute programs, transfer files, or use a secure and transparent tunnel for your remote programs. The SSH protocol is encrypted, ensures data integrity, and provides strong means of authenticating both the server of the client. The library hides a lot of technical details from the SSH protocol, but this does not mean that you should not try to know about and understand these details.

libssh is a Free Software / Open Source project. The libssh library is distributed under LGPL license. The libssh project has nothing to do with "libssh2", which is a completly different and independant project.

libssh can run on top of either libgcrypt (http://directory.fsf.org/project/libgcrypt/) or libcrypto (http://www.openssl.org/docs/crypto/crypto.html), two general-purpose cryptographic libraries.

This tutorial concentrates for its main part on the "client" side of libssh. To learn how to accept incoming SSH connexions (how to write a SSH server), you'll have to jump to the end of this document.

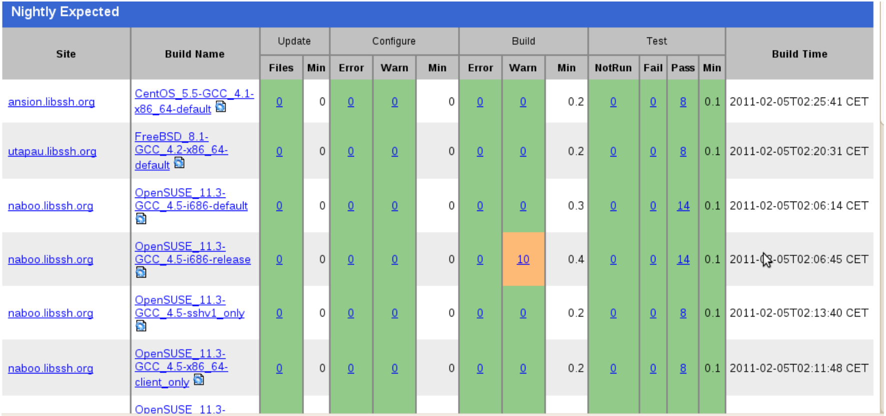
This tutorial describes libssh version 0.5.0. This version is the development version and is *not* published yet. However, the examples should work with little changes on versions like 0.4.2 and later.

Table of contents:

# Development model

- Own infrastructure
- git, redmine, mailing list, website, test center
- Around 10 total contributors, 3 or 4 regular commiters
- Testcase based development, with nightly builds
- Look by yourself ! *http://test.libssh.org/*

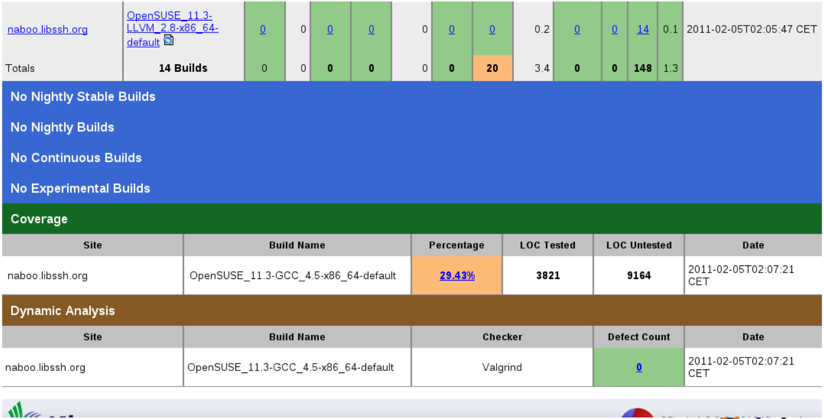
# Test dashboard



Nightly Expected

| Site | Build Name | Update | | Configure | | | Build | | | Test | | | | Build Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Files | Min | Error | Warn | Min | Error | Warn | Min | NotRun | Fail | Pass | Min | |
| ansion.libssh.org | CentOS_5.5-GCC_4.1-x86_64-default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 8 | 0.1 | 2011-02-05T02:25:41 CET |
| utapau.libssh.org | FreeBSD_8.1-GCC_4.2-x86_64-default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 8 | 0.1 | 2011-02-05T02:20:31 CET |
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-i686-default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 | 14 | 0.1 | 2011-02-05T02:06:14 CET |
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-i686-release | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0.4 | 0 | 0 | 14 | 0.1 | 2011-02-05T02:06:45 CET |
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-sshv1_only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 8 | 0.1 | 2011-02-05T02:13:40 CET |
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-x86_64-client_only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 8 | 0.1 | 2011-02-05T02:11:48 CET |
| | OpenSUSE_11.3- | | | | | | | | | | | | | |

# Test dashboard



| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| naboo.libssh.org | OpenSUSE_11.3-LLVM_2.8-x86_64-default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 14 | 0.1 | 2011-02-05T02:05:47 CET |
| Totals | **14 Builds** | 0 | 0 | **0** | **0** | 0 | **0** | **20** | 3.4 | **0** | **0** | **148** | 1.3 | |

**No Nightly Stable Builds**

**No Nightly Builds**

**No Continuous Builds**

**No Experimental Builds**

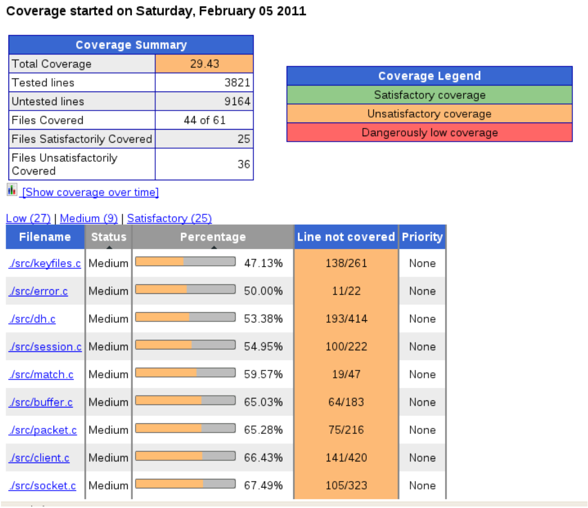
**Coverage**

| Site | Build Name | Percentage | LOC Tested | LOC Untested | Date |
|---|---|---|---|---|---|
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-x86_64-default | **29.43%** | **3821** | **9164** | 2011-02-05T02:07:21 CET |

**Dynamic Analysis**

| Site | Build Name | Checker | Defect Count | Date |
|---|---|---|---|---|
| naboo.libssh.org | OpenSUSE_11.3-GCC_4.5-x86_64-default | Valgrind | **0** | 2011-02-05T02:07:21 CET |

# Test dashboard



**Coverage started on Saturday, February 05 2011**

| Coverage Summary | |
|---|---|
| Total Coverage | 29.43 |
| Tested lines | 3821 |
| Untested lines | 9164 |
| Files Covered | 44 of 61 |
| Files Satisfactorily Covered | 25 |
| Files Unsatisfactorily Covered | 36 |

[Show coverage over time]

| Coverage Legend |
|---|
| Satisfactory coverage |
| Unsatisfactory coverage |
| Dangerously low coverage |

Low (27) | Medium (9) | Satisfactory (25)

| Filename | Status | Percentage | Line not covered | Priority |
|---|---|---|---|---|
| ./src/keyfiles.c | Medium | 47.13% | 138/261 | None |
| ./src/error.c | Medium | 50.00% | 11/22 | None |
| ./src/dh.c | Medium | 53.38% | 193/414 | None |
| ./src/session.c | Medium | 54.95% | 100/222 | None |
| ./src/match.c | Medium | 59.57% | 19/47 | None |
| ./src/buffer.c | Medium | 65.03% | 64/183 | None |
| ./src/packet.c | Medium | 65.28% | 75/216 | None |
| ./src/client.c | Medium | 66.43% | 141/420 | None |
| ./src/socket.c | Medium | 67.49% | 105/323 | None |

# Some samples - Connect to SSH

```
#include <libssh/libssh.h>
...
ssh_session session = ssh_new();
int r;
ssh_options_set(session, SSH_OPTIONS_HOST, "localhost");
ssh_options_set(session, SSH_OPTIONS_USER, "aris");
r=ssh_connect(session);
if(r==SSH_OK){
  // connected
  ssh_disconnect(session);
}
ssh_free(session);
```

# Some samples - Check known host

```
int r = ssh_is_server_known(session);
switch (r) {
  case SSH_SERVER_KNOWN_OK:
    break; /* ok */
  case SSH_SERVER_KNOWN_CHANGED:
  case SSH_SERVER_FOUND_OTHER:
    break; /* not ok */
  case SSH_SERVER_FILE_NOT_FOUND:
  case SSH_SERVER_NOT_KNOWN:
    hexa = ssh_get_hexa(hash, hlen);
    [...] // show hash and ask agreement
    ssh_write_knownhost(session);
}
```

## Some samples - Authenticate

```
int rc = ssh_userauth_autopubkey(session, NULL);
if(rc==SSH_AUTH_SUCCESS)
  // good !
if(rc==SSH_AUTH_PARTIAL)
  // two factor authentication
rc = ssh_userauth_password(session, NULL, "hunter2");
```

# Some samples - Execute a command

```
ssh_channel channel = ssh_channel_new(session);
int r;
char buffer[256];
ssh_channel_open_session(channel);
ssh_channel_request_exec(channel, "ls -l /");
do {
  r=ssh_channel_read(channel, buffer, sizeof(buffer), 0);
  write(1, buffer, r);
} while (r>0);
ssh_channel_close(channel);
ssh_channel_free(channel);
```

# Future of libssh

- Goal : become 100% all-purpose SSH library
- Fully asynchronous, callbacks based
  - Fully nonblocking API
  - Integration with other mainloops (libevent, QT, boost, ...)
- Support for gss-api and PKCS #11
  - Technicaly, PKCS #11 already supported by SSH Agent
  - We work on pki classes especially for SSH
- Better support for server-side SSH

# Thanks for your attention

Any question ?