Debian/GNU Linux Remote Services

Secure Shell, Virtual Network Computing , Remote Desktops

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Remote Login Services

Application services to use remote hosts interactively

- Scenario: remote host offers interesting services:
  - Resources (CPU, memory, disk) provided by remote host
  - Files located on remote host
  - Programs installed on remote host
- Goal: use these remote services from local host
  - Use local host as a terminal to login to remote host
  - Run programs/commands on remote host
  - See output on local host (either Ascii terminal output or graphical output by X clients or some other way (vnc,rdp))
- Relevant protocols/systems:
  - TELNET (TCP/IP); rsh/rlogin (Unix/Linux), outdated
  - SSH suite: ssh/slogin (secure shell, secure login)
  - X-Windows X11 (network-transparent GUI)
  - Real VNC (virtual network computing/console)
  - MS Windows Terminal Server (remote desktop)

The Remote Login Server - an application program

SSH Server

Process

- Master server waits for new connection requests SSH: port 22
- For each connection, it spawns a slave server to handle the connection
- Multiple sessions (from the same or different clients) may be active at the same time
- Slave server handles the connection
  - transfers data from local keyboard to remote host and outputs data from remote host on the local display
- OS must provide pseudo terminal for the slave server
  - Entry point to transfer characters to OS as if they came from a keyboard

Telnet is outdated

SSH is the successor

TELNET and Rsh/Rlogin outdated - because of security problems

- All data are transferred in clear text
- Any listener between client and remote server can read everything
  - True for any unencrypted connection, think on http !
- telnet-ssl replaces telnet/rlogin

Replacement: Secure Shell (ssh, slogin)

- SSH suite is the modern replacement of TELNET and rlogin
- standard protocols for secure remote access over IP networks (RFCs: 4251-5254)
- All data are encrypted before they are transferred via IP
- Commercial implementations: `www.ssh.com` (MS Windows)
- Free implementations: `www.openssh.org`, `www.putty.org`, `www.winscp.net`,etc.

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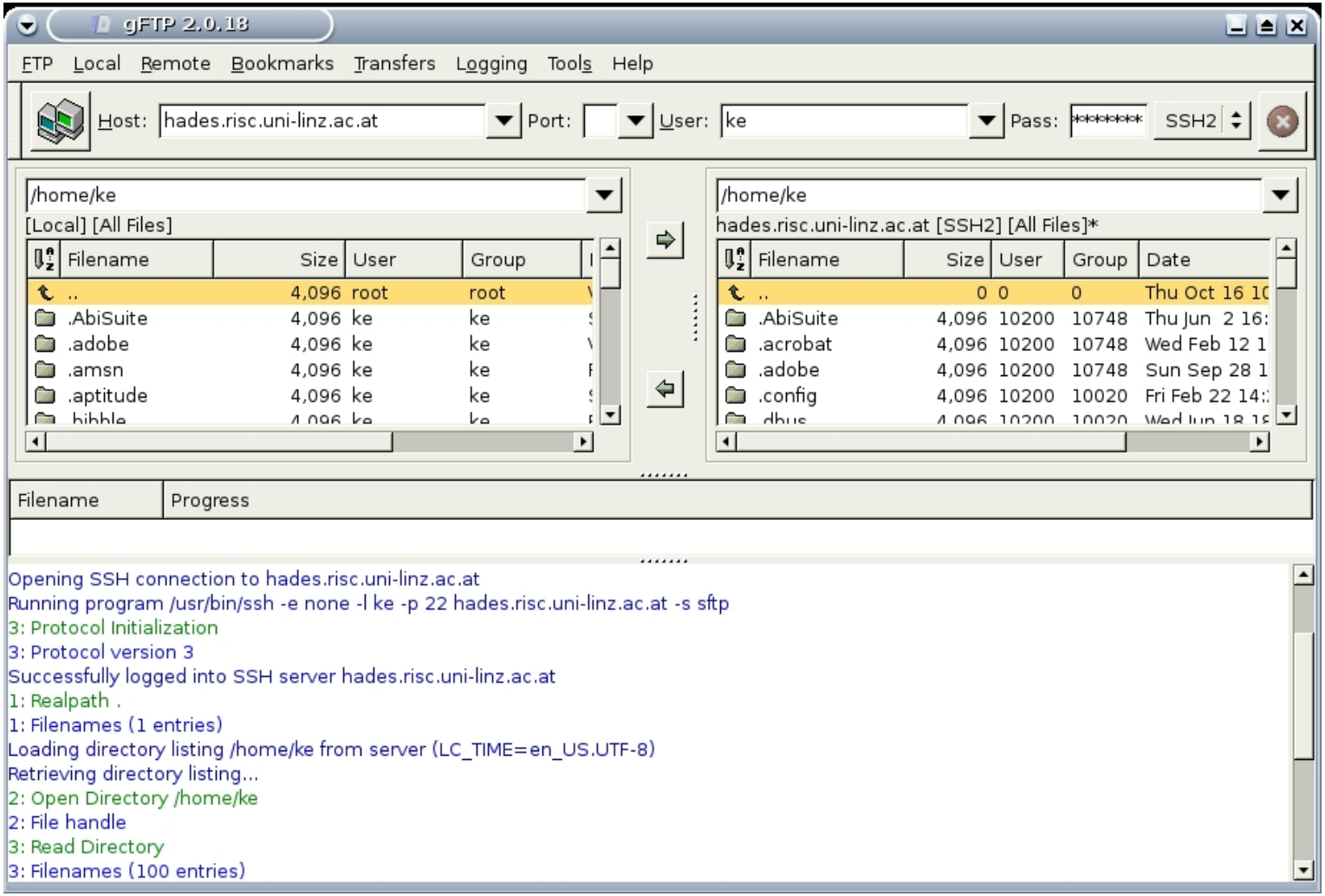
File Services

File transfer, File sharing

Application services to access files on remote hosts

- File transfer
  - Files are copied from one host to another
  - sftp (secure ftp), scp (secure remote copy)
  - Graphical tools: gftp, (kasablanca, etc.)
- File sharing
  - Files are accessed from a central server
  - Files are stored and backuped on central file server
  - Client applications operate on remote files like on local files
  - Transparent file access is provided by network file systems
  - NFS (Network File System), SMB (Server Message Blocks)

FTP with gftp



NFS (Network File System)

NFS: access to remote files

- Developed by Sun Microsystems
- Used in many Intranets to interconnect file systems
- Mainly for Unix/Linux computers
- Remote file system can be accessed like local files
  - A remote file system is mounted to an empty local directory
  - Files below this directory can be used like local files
  - No special file transfer commands needed, no file duplication arises
- Implemented on top of UDP

For security reasons, only used within an administrative domain

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SSH features

The SSH suite

SSH - a client-server solution for network security

- client-server solution for network security
  - encryption: all data will encrypted before sending from localhost to remote computer and vice verse
  - transparent for the user (does not notice background activities)
  - client side: login; authentication; data transfer, command execution

SSH features

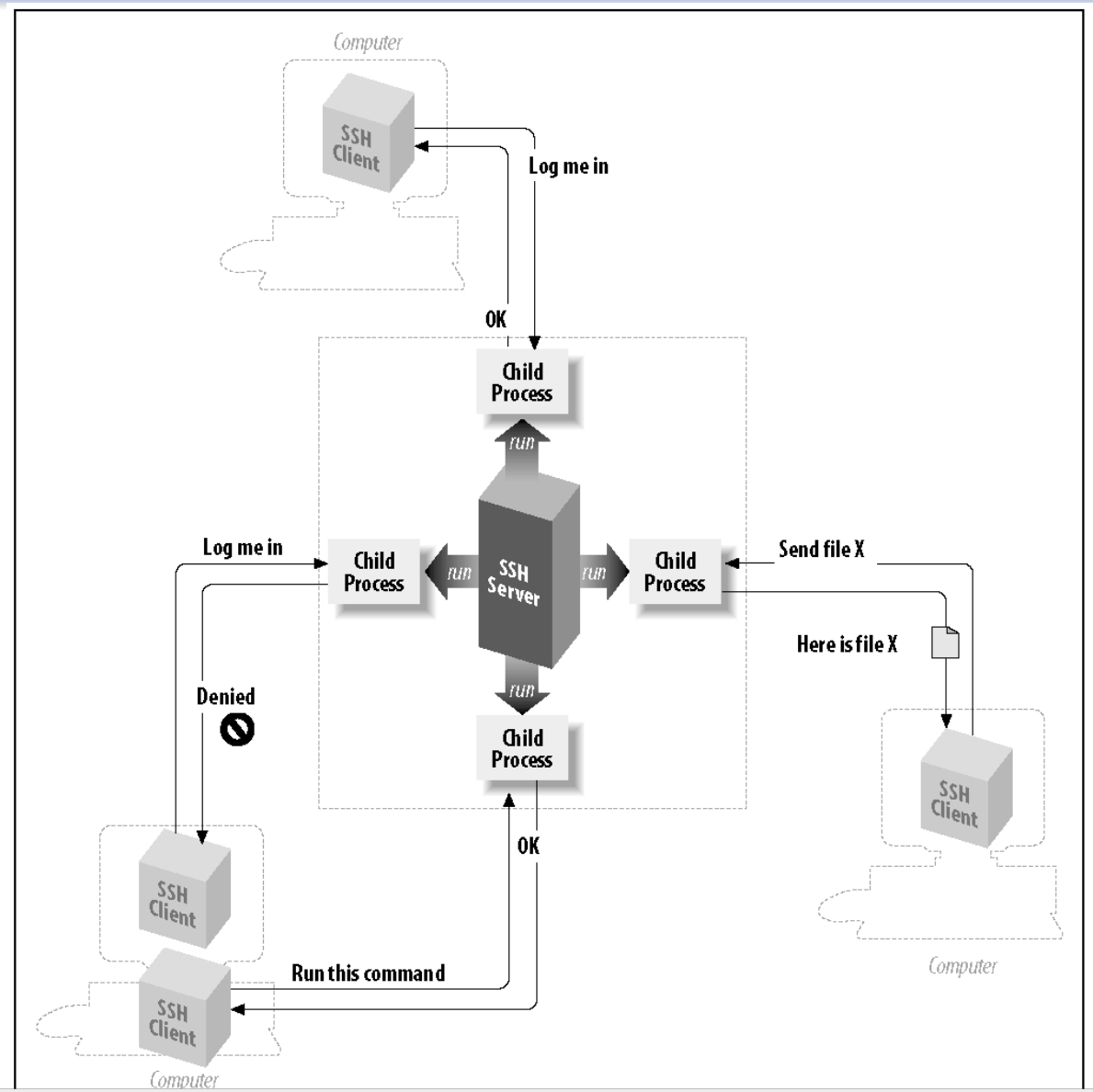
- it is a protocol: describes how to conduct secure communication over a network
- full, secure replacement for FTP and Telnet and the UNIX r-series of commands: rlogin, rsh, rcp, rexec
  - creates a secure channel for running a shell on the remote computer
  - sftp, scp is integrated in the protocol
- supports more authentication methods: password, public key, certificate, smart card, PAM and SecurID

SSH features

Security

- uses multiple high security algorithms and strong authentication methods
  - prevents such security threats as identity spoofing and man-in-the-middle attacks
  - man-in-the-middle attack: changing the IP in the packet you communicate with the remote computer, stating: I'm the remote computer
- Transparent and automatic tunneling of X11 connections
- Port forwarding or SSH tunneling: for arbitrary TCP/IP-based applications, such as e-mail
- Multiple channels that allow to have multiple terminal windows and file transfers going through one secure and authenticated connection

The base services of SSH



Complete Structure of the SSH protocol

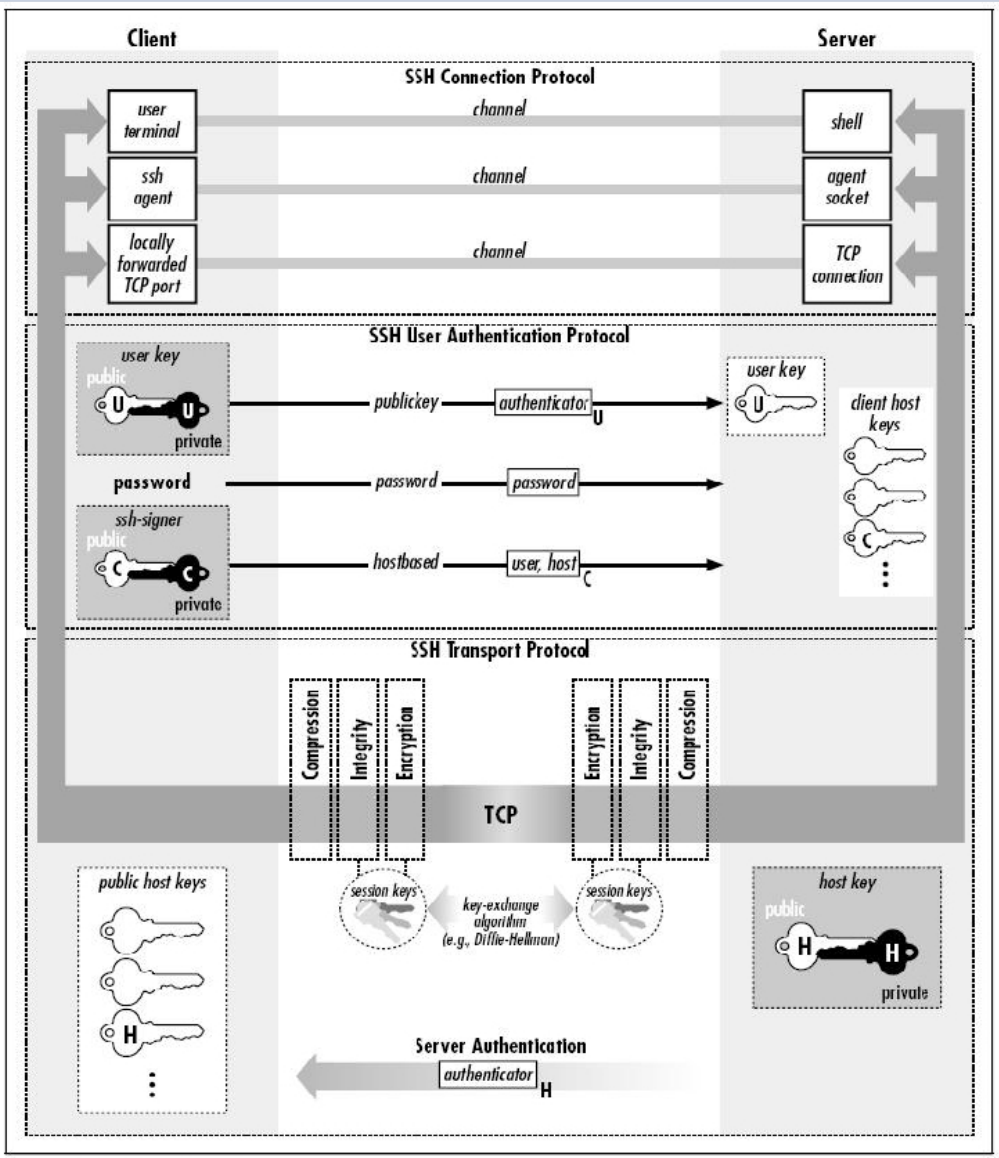


Figure 3-4. SSH-2 architecture

The structure of the SSH-2 Protocol

Very clean 3-layer internal architecture (RFC 4251)

- Transport Layer (RFC 4253)
  - initial key exchange, server authentication, data confidentiality, data integrity, compression, key re-exchange (algorithm negotiation, session-ID, privacy)
- User Authentication Layer (RFC 4252)
  - Client Authentication: provides various authentication methods (public key, host bases, password, etc.)
- Connection Layer (RFC 4254)
  - defines the logical channels and the requests to handle the services like: secure interactive shell session, X11 forwarding, TCP/IP forwarding (channel multiplexing, pseudo terminals, flow control, remote program execution, authentication agent forwarding, terminal handling, etc.)

The Components of the SSH suite

SSH binary programs, scripts

```
uhu:~> dpkg -L openssh-client | grep bin
/usr/bin
/usr/bin/ssh
/usr/bin/scp
/usr/bin/ssh-add
/usr/bin/ssh-agent
/usr/bin/ssh-keygen
/usr/bin/ssh-keyscan
/usr/bin/sftp
/usr/bin/ssh-vulnkey
/usr/bin/ssh-copy-id
/usr/bin/ssh-argv0
/usr/bin/slogin
uhu:~>
```

The Components of the SSH suite

SSH man page

```
uhu:~> ssh --help
usage: ssh [-1246AaCfgKkMNnqsTtVvXxY] [-b bind_address]
           [-c cipher_spec]
           [-D [bind_address:]port] [-e escape_char] [-F configfile]
           [-i identity_file] [-L [bind_address:]port:host:hostport]
           [-l login_name] [-m mac_spec] [-O ctl_cmd] [-o option]
           [-p port]
           [-R [bind_address:]port:host:hostport] [-S ctl_path]
           [-w tunnel:tunnel] [user@]hostname [command]
uhu:~>
```

The SSH suite

SSH parameters

Parameter of SSH

- If command is specified, it is executed on the remote host instead of a login shell.
- default locations of configuration files
  - configuration file: ~ /.ssh/config
  - private key: ~ /.ssh/id_rsa ~ /.ssh/id_dsa
- Parameters:
  - -p port (to connect to on the remote host)
  - -v Verbose mode to debug problems and see the progress of connection
  - -l username (ssh -l sysadmin atlantis)
  - username@hostname (ssh sysadmin@atlantis)
  - -X (X11 forwarding: ssh -X sysadmin@gorilla)

The SSH suite

SSH examples

```
hades:sysadmin!8> ssh ke@bullfinch
ke@bullfinch's password:
Linux bullfinch 2.6.24-etchnhalf.1-686 #1 SMP Thu Nov 5 02:25:56 UTC 20
......... deleted ........
No mail.
Last login: Sat Nov 21 17:45:11 2009 from hades.risc.uni-linz.ac.at
Sat Nov 21 17:45:12 CET 2009
bullfinch>

hades:sysadmin!12> ssh gonzales who
cschneid pts/2        Nov 18 12:11 (ozelot.risc.uni-linz.ac.at)
cschneid pts/3        Nov 19 15:33 (ozelot.risc.uni-linz.ac.at)
cschneid pts/4        Nov 18 13:52 (ozelot.risc.uni-linz.ac.at)
cdoench  pts/5        Nov 20 09:50 (dog.risc.uni-linz.ac.at)
mkauers  pts/6        Nov 21 12:01 (fennek.risc.uni-linz.ac.at)
hades:sysadmin!13>
```

The SSH suite

ssh with command

X11 forwarding wird activated

```
hades:sysadmin!13> ssh -X gonzales
Linux gonzales 2.6.26-2-amd64 #1 SMP Thu Nov 5 02:23:12 UTC 2009 x86_64
Last login: Fri Nov 20 15:24:10 2009 from tc14.risc.uni-linz.ac.at
gonzales:sysadmin!1>
gonzales:sysadmin!1> mathematica &
[1] 18455
gonzales:sysadmin!2> kill -TERM 18455
gonzales:sysadmin!3>
```

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SSH tunneling

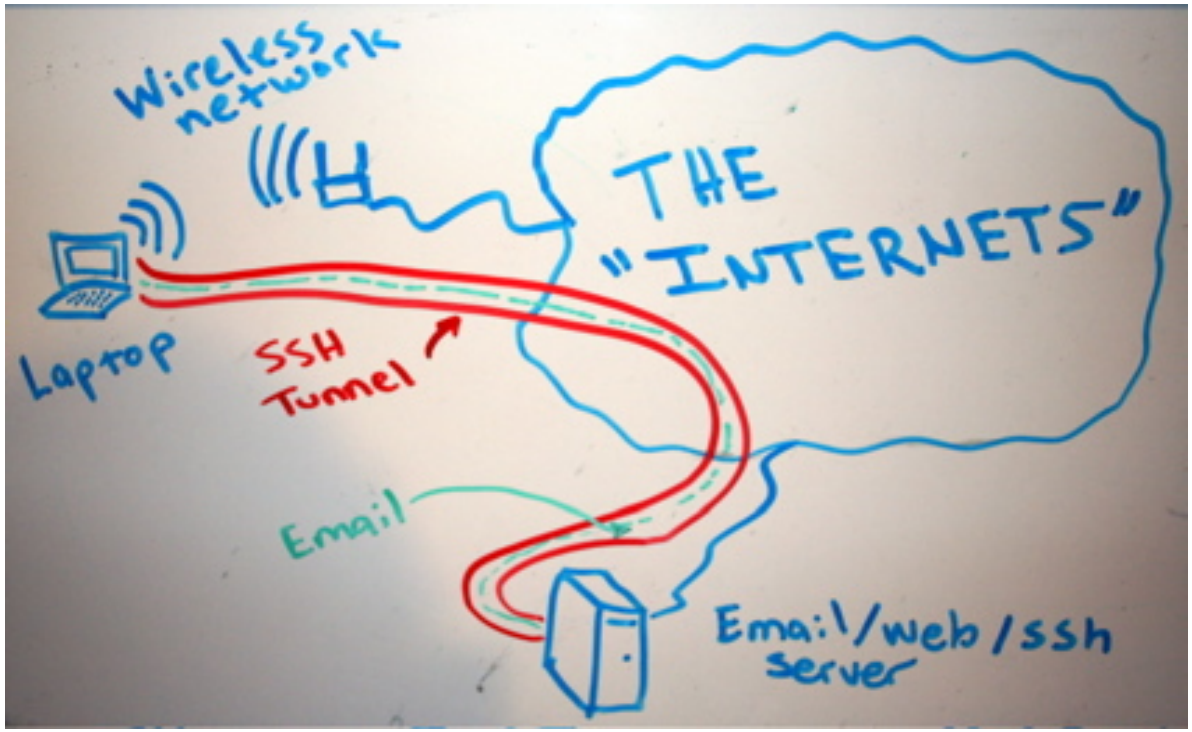
What is an SSH tunnel

- tunnel is a networking term, means a connection, usually encrypted
- connects two computers together across another usually untrusted network

Why do we need it - the Internet is very insecure !

- your laptop/home computer connects to another computer without encryption
- some protocols do have encryption built in, some do not
  - your email client, your ftp program, VNC client, etc.
- Never use clear text connections !
  - definitively not for login/password data!
- always configure SSH tunnel for your connections!

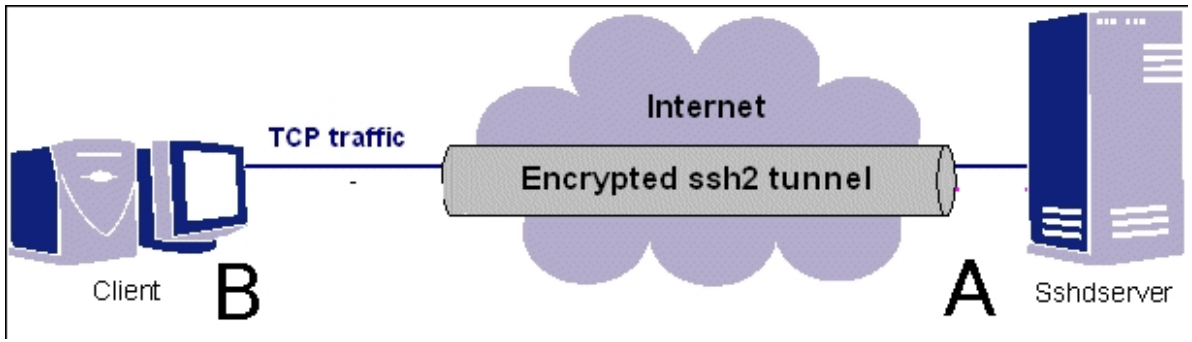
Secure WLAN connection through the Internet



SSH tunnel through the Internet

SSH Tunnel Topology

- Client B (laptop, PC at home, etc) connects using local ports
- Server A running the sshd server program
  - mail server: port 25 smtp; VNC server: port 5901
- through an SSH tunnel - encrypted connection !



How to make SSH tunnel in Linux

basic version:

- ssh -L localport:hostname:hostport hostname
  - Specifies that the given port (localport) on the local (the client) host is to be forwarded to the given host (hostname) and port (hostport) on the remote side (hostname).
  - ssh -L 22000:bullfinch.risc.uni-linz.ac.at:143 bullfinch.risc.uni-linz.ac.at
- ssh -L localport:hostname:hostport remotehost
  - Specifies that the given port (localport) on the local (the client) host is to be forwarded to the given host (hostname) and port (hostport) on the remote side (remotehost).
  - ssh -L 20000:grizzly.risc.uni-linz.ac.at:143 bullfinch.risc.uni-linz.ac.at
  - hostname and remotehost may be different !

How to make SSH tunnel in Linux

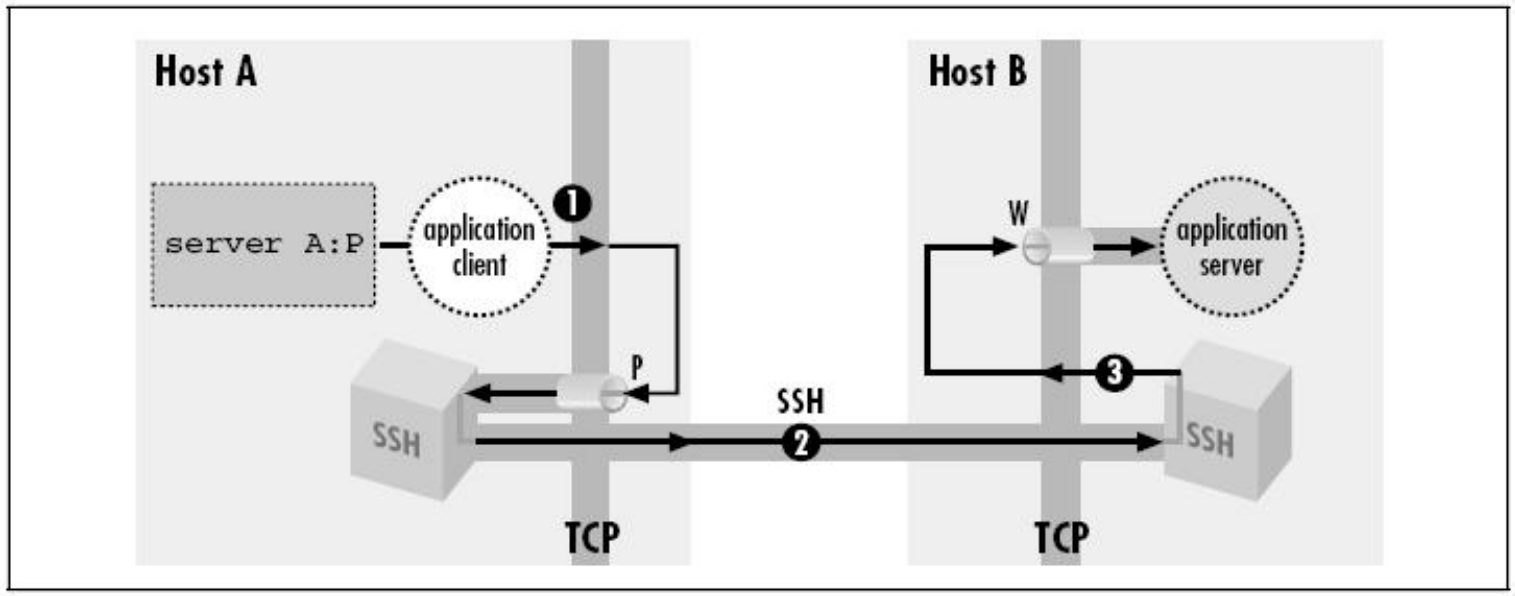
full version

- ssh -f -N -L localport:host:hostport sshd-server-computer
  - B: local computer, C: host, A: sshd-server-computer
- -N is for portforwarding (do not execure command)
- -f go into background
- you can use more -L option in one command, (create more tunnels!)

SSH Tunnel - Port forwarding

Window SSH client from www.ssh.com

Port forwarding



SSH Tunnel - Port forwarding

examples for more tunnels

Tunnels for narwal (VNC) and crutch (RDP)

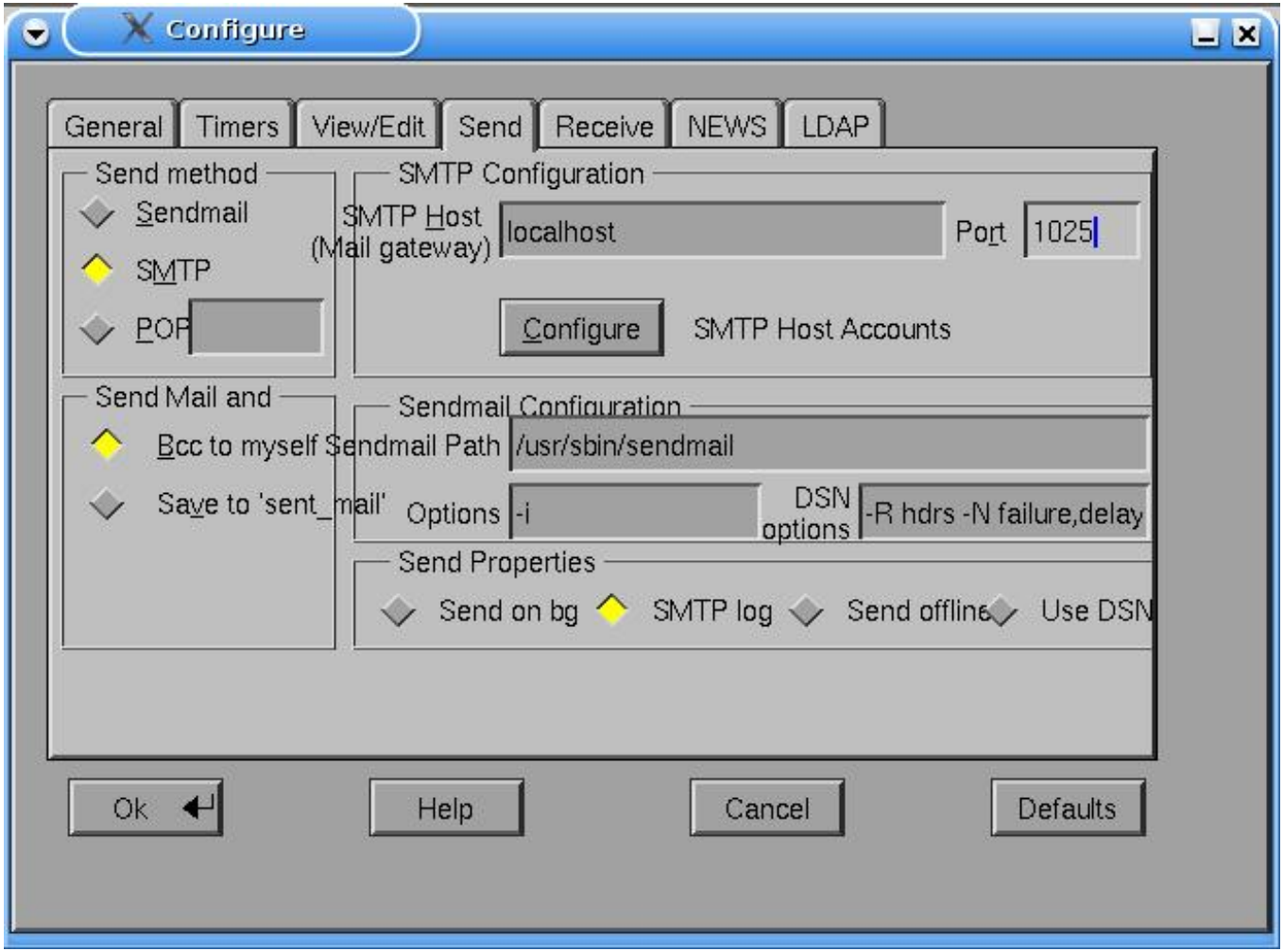
- shell aliases: narwal and crutch

```
uhu:~> which narwal
narwal:   aliased to
      ssh -f -N -L 5901:localhost:5901 narwal.risc.uni-linz.ac.at
uhu:~>

uhu:~> which crutch
crutch:   aliased to
      ssh -f -N -L 3389:crutch.risc.uni-linz.ac.at:3389
       homer.risc.uni-linz.ac.at
uhu:~>
```

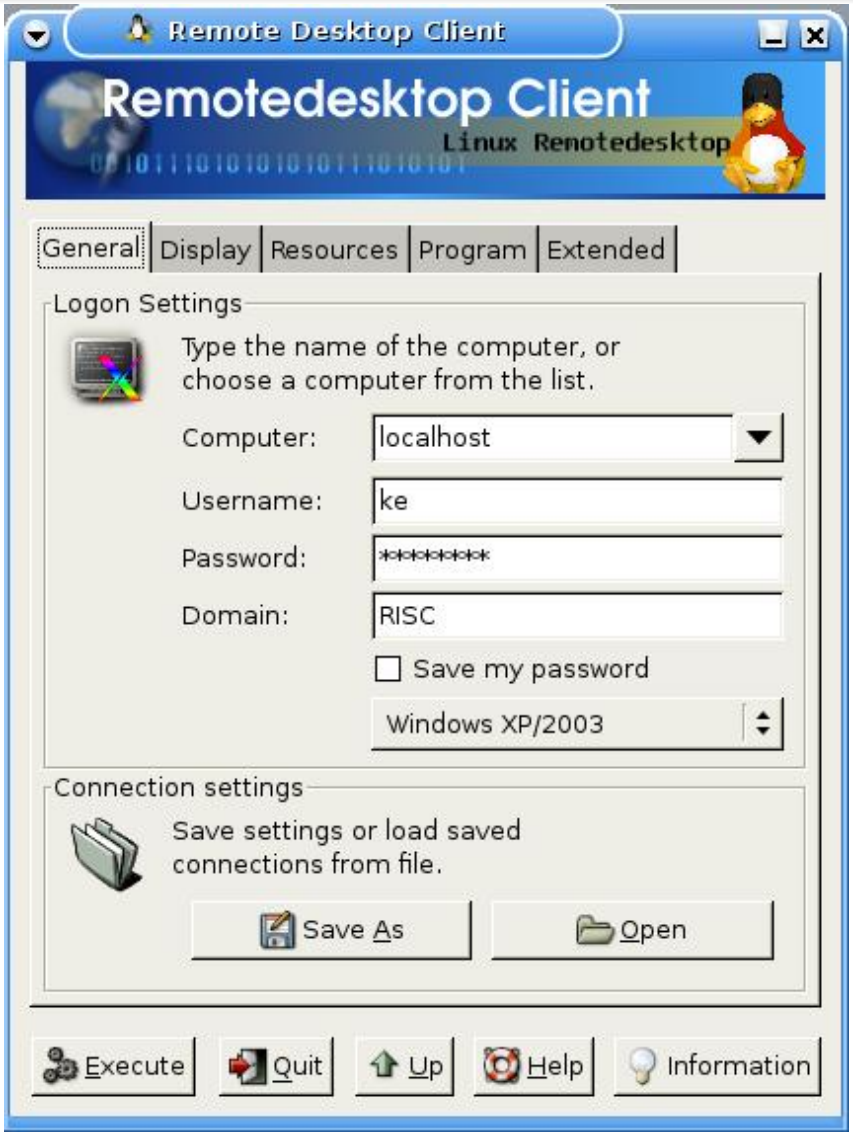
SSH Tunnel - Port forwarding

examples: sending email with stmp by tunneling from laptop to homer



SSH Tunnel - Port forwarding

examples: rdp tunneling from laptop to crutch though homer



SSH Tunnel - Port forwarding

examples for more tunnels

Tunnels

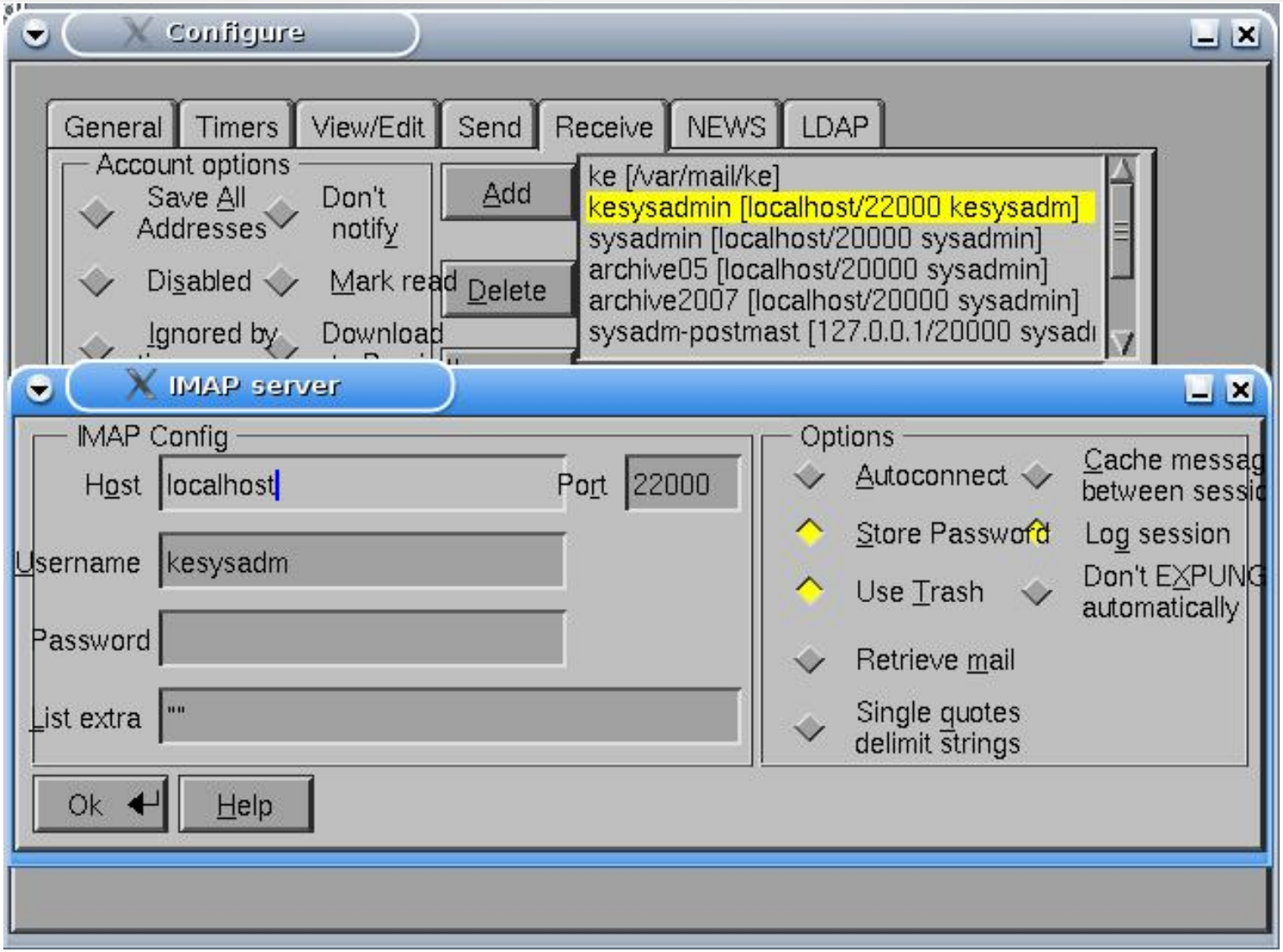
- shell alias: bt (bullfinch tunnel)

```
uhu:~> which bt
bt:       aliased to
     ssh -f -N
         -L 20000:grizzly.risc.uni-linz.ac.at:143
         -L 2222:bullfinch.risc.uni-linz.ac.at:995
         -L 1025:homer.risc.uni-linz.ac.at:25
         -L 4444:localhost:444
     bullfinch.risc.uni-linz.ac.at
```

- sysadmin:imap, kerdei:pop3s kerdei:smtp, sysadmin:apache2-ssl

SSH Tunnel - Port forwarding

examples: more IMAP connections through the same tunnel

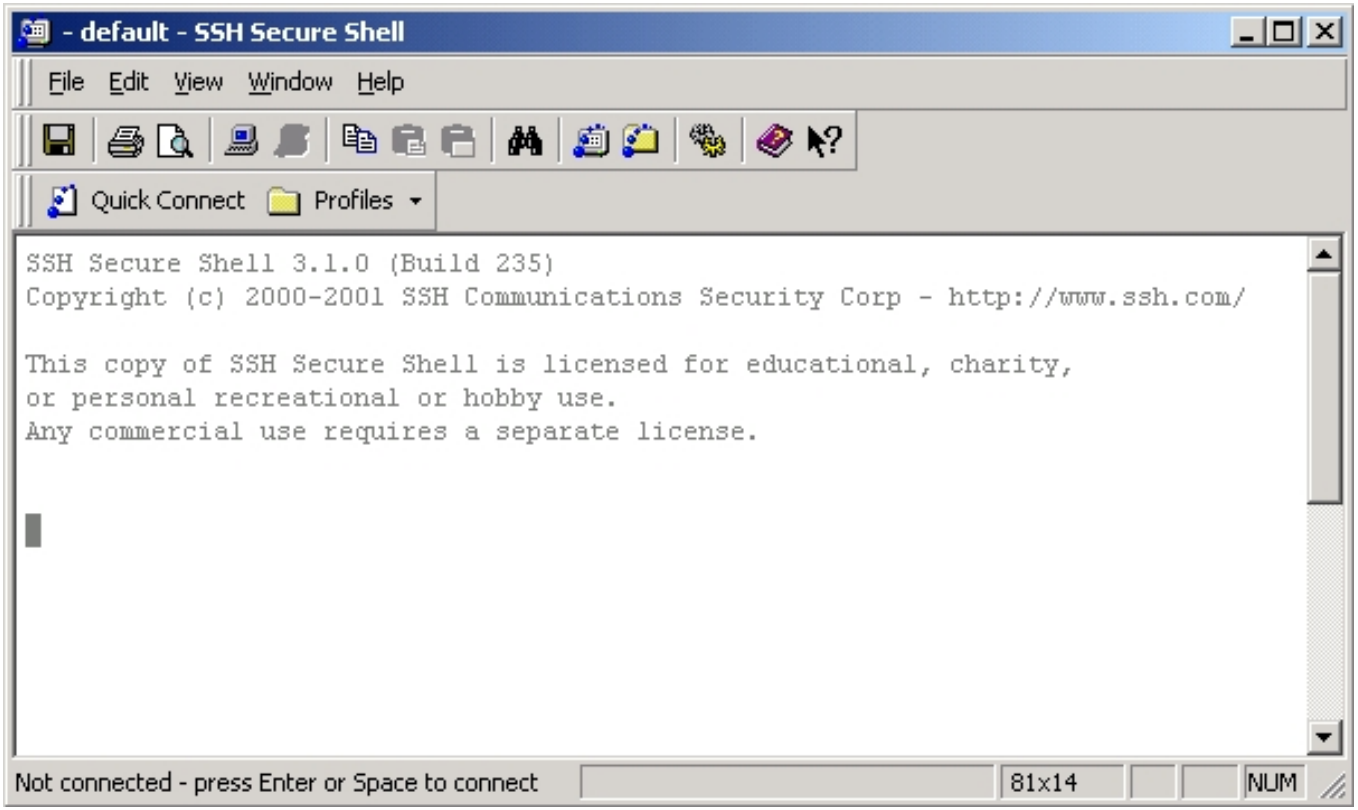


SSH Tunnel - MS Windows

SSH Shell from ssh.com

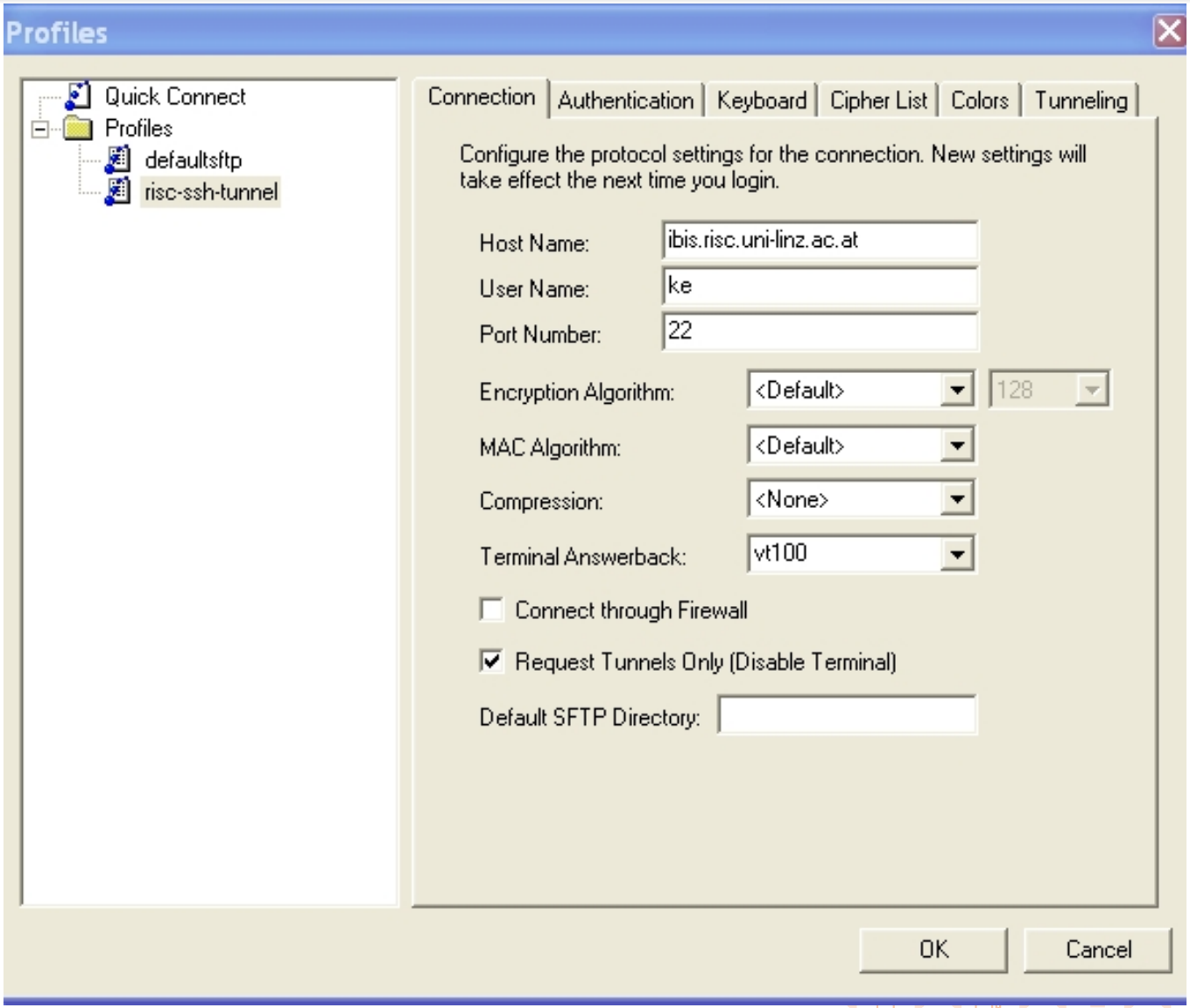
Windows SSH-Client (ssh.com) not anymore public at TU-Wien:

- https://www.risc.jku.at/internals/userinformation/completeguide/userguide 3.2.9.exe



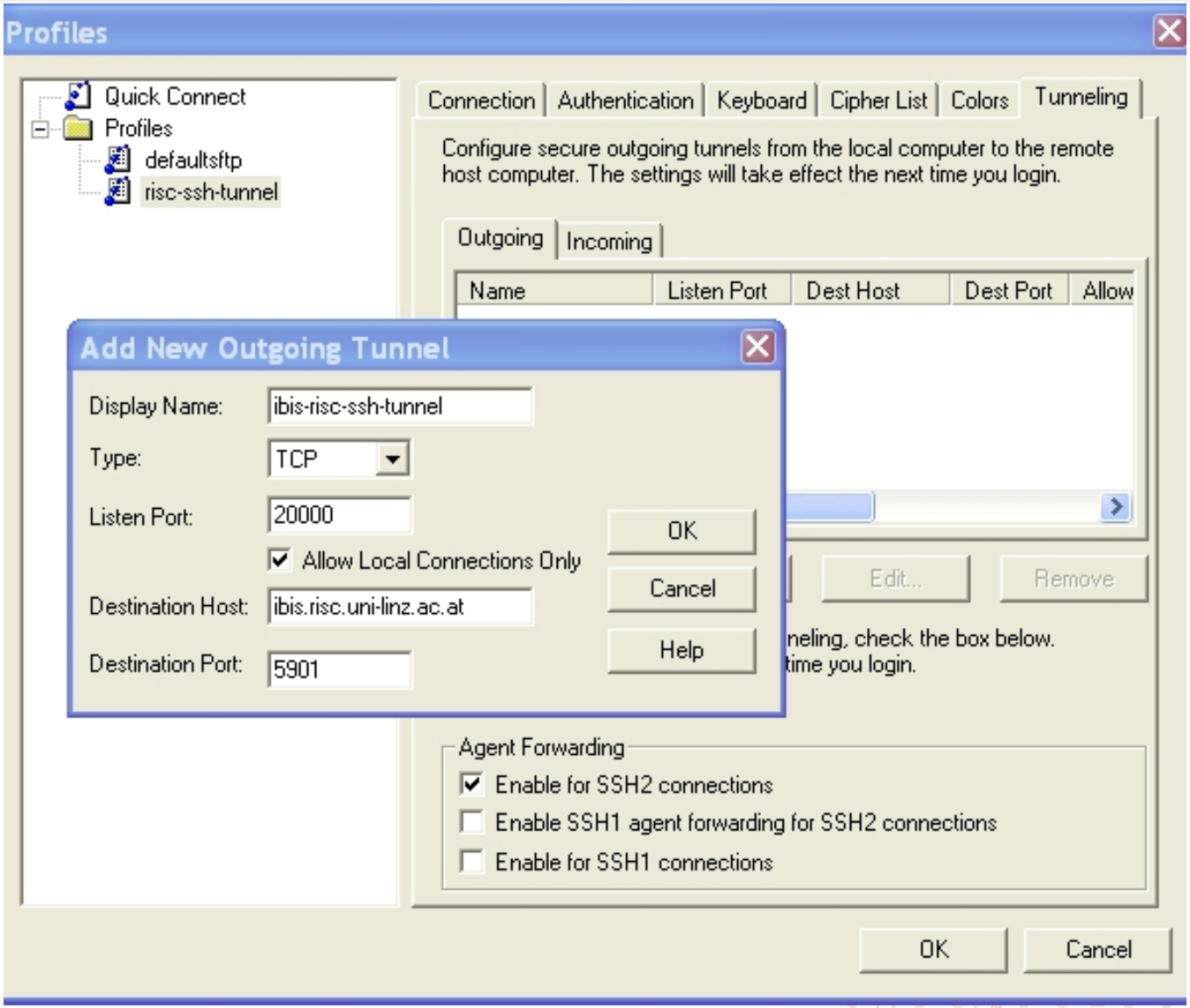
SSH Tunnel - MS Windows

Connection configuration



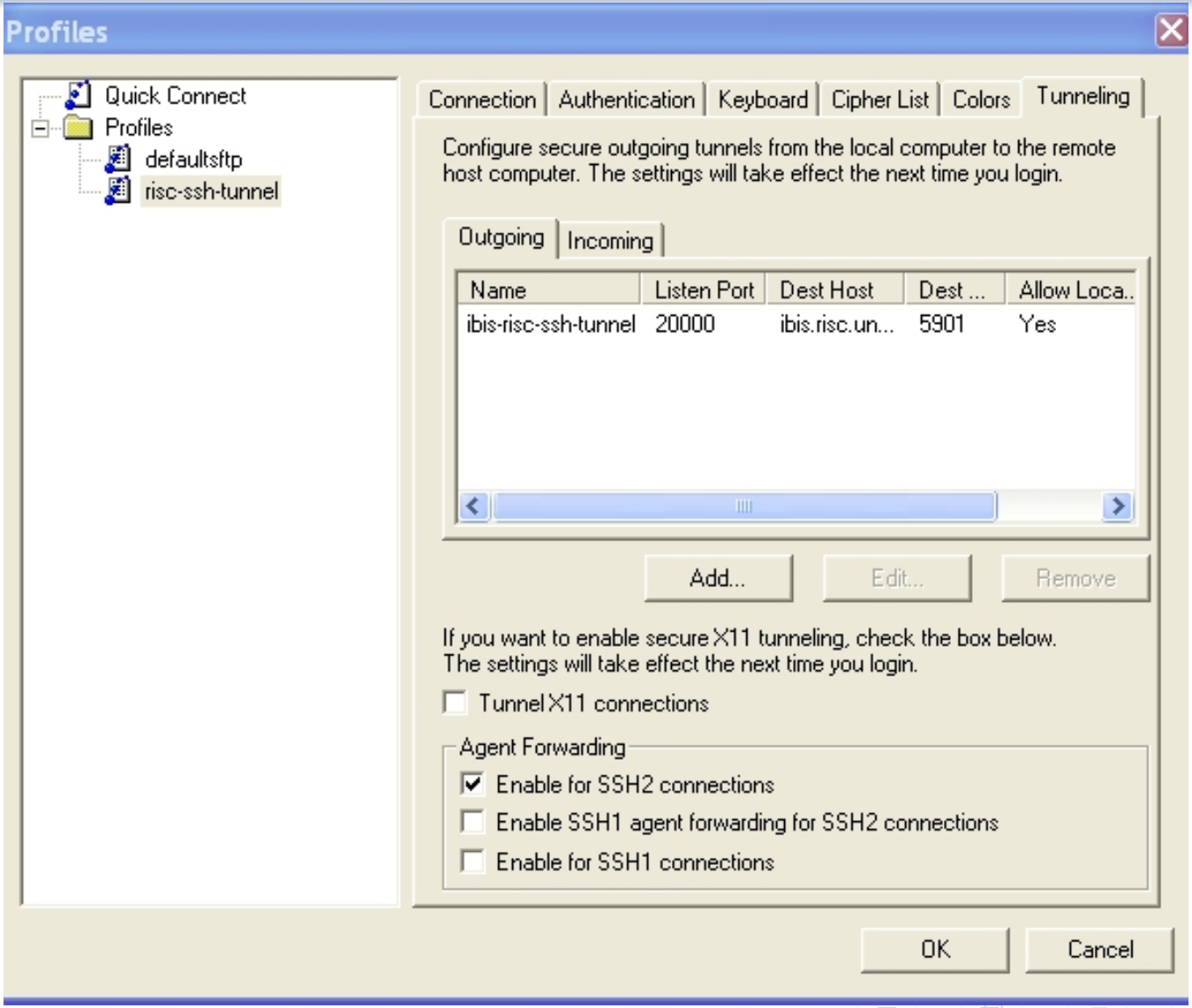
SSH Tunnel - MS Windows

Configuring ports



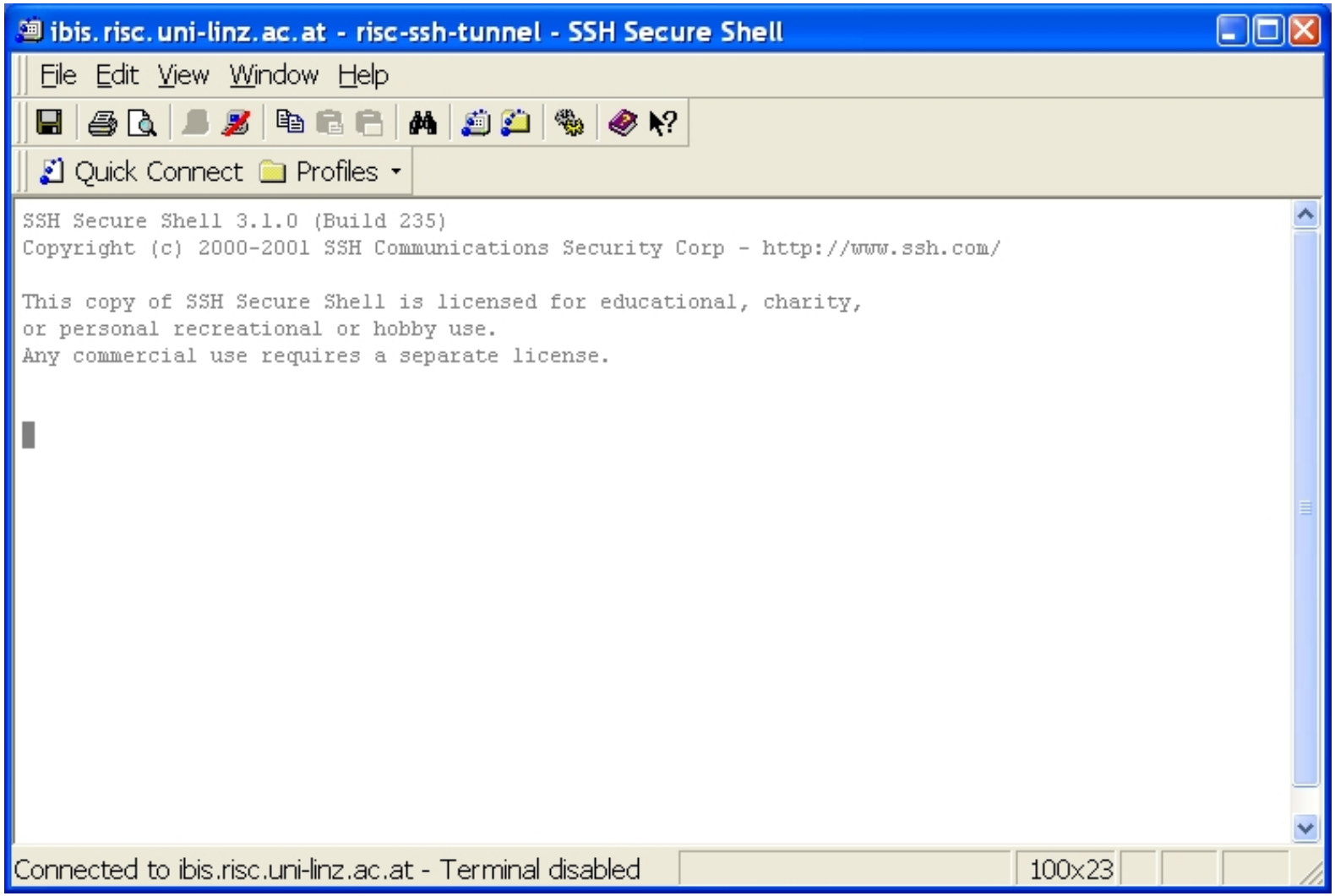
SSH Tunnel - MS Windows

Established tunnel



SSH Tunnel - MS Windows

Established tunnel



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Remote login without passwd by SSH

How to set up

Basics of the authentication

- SSH authentication methods
  - password authentication; private key authentication
- private key authentication
  - Create a private key - public key pair with ssh; set the passphrase for the private key !
  - Copy the public key to the remote computer
  - Configure the authentication agent: ssh-agent
  - use ssh-add command to add your identity to the `ssh-agent`
- Customizing the authentication
  - installing ssh-askpass
  - Starting `ssh-add` by an icon

Remote login with SSH

create a public key

Create public key

- Create a public key: ssh-keygen -t dsa
  - always USE a passphrase
  - without passphrase: if your private key is stolen your identity is stolen
  - choose it different from your password, choose a long one
  - it must as save as your password, it can be more save (less restriction)

```
bienenfresser:~> ssh-keygen -t dsa
Generating public/private dsa key pair.
Enter file in which to save the key (/home/ke/.ssh/id_dsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ke/.ssh/id_dsa.
Your public key has been saved in /home/ke/.ssh/id_dsa.pub.
The key fingerprint is:
a8:00:0e:39:b9:5e:30:a0:c7:70:cd ke@bienenfresser
bienenfresser:~>
```

Remote login with SSH

copy public key

Copy public key

- copy the public key to the RISC computer
- add to .ssh/authorized_keys file

```
bienenfresser:~> cat .ssh/id_dsa.pub |
   ssh goose.risc.uni-linz.ac.at 'cat - >>.ssh/authorized_keys'

   ke@goose.risc.uni-linz.ac.at's password:
bienenfresser:~>
```

- you will be asked for your password on the remote computer
- check that it works:
  - ssh -X goose.risc.uni-linz.ac.at
  - passphrase will be asked for

Remote login with SSH

ssh-add ssh-agent

ssh-agent

- Authentication agent, ssh-agent
  - saves the identity value (private key) in the memory
  - supports authentication requests from SSH
  - started by login in KDE, GNOME

ssh-add

- transfers the identification (.ssh/id_dsa) to ssh-agent
- asks for the passphrase, to decrypt the private key

```
bienenfresser:~> ssh-add .ssh/id_dsa
Enter passphrase for .ssh/id_dsa:
Identity added: .ssh/id_dsa (.ssh/id_dsa)
bienenfresser:~>
```

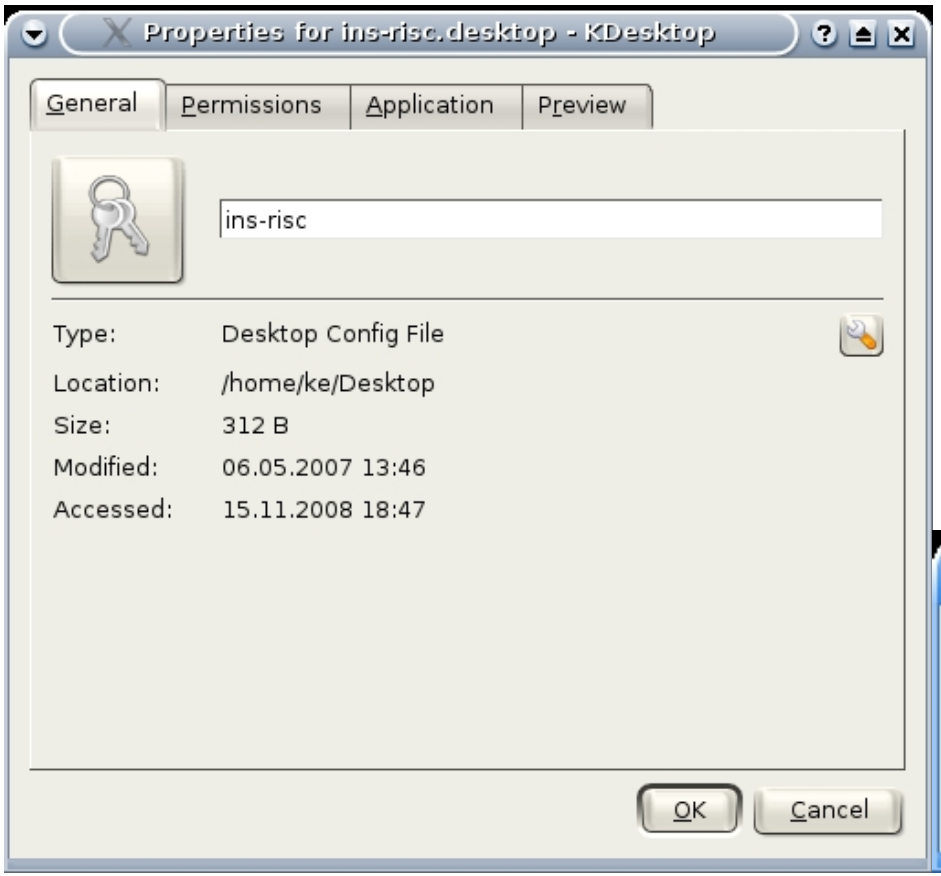
- will invoke ssh-askpass, if get a zero in standard input

Customizing ssh-add

icon for ssh-add

Create a small script in i.e. /usr/local/bin/ or ~ /bin

```
#!/bin/csh
cat /dev/null | ssh-add .ssh/id_dsa
```



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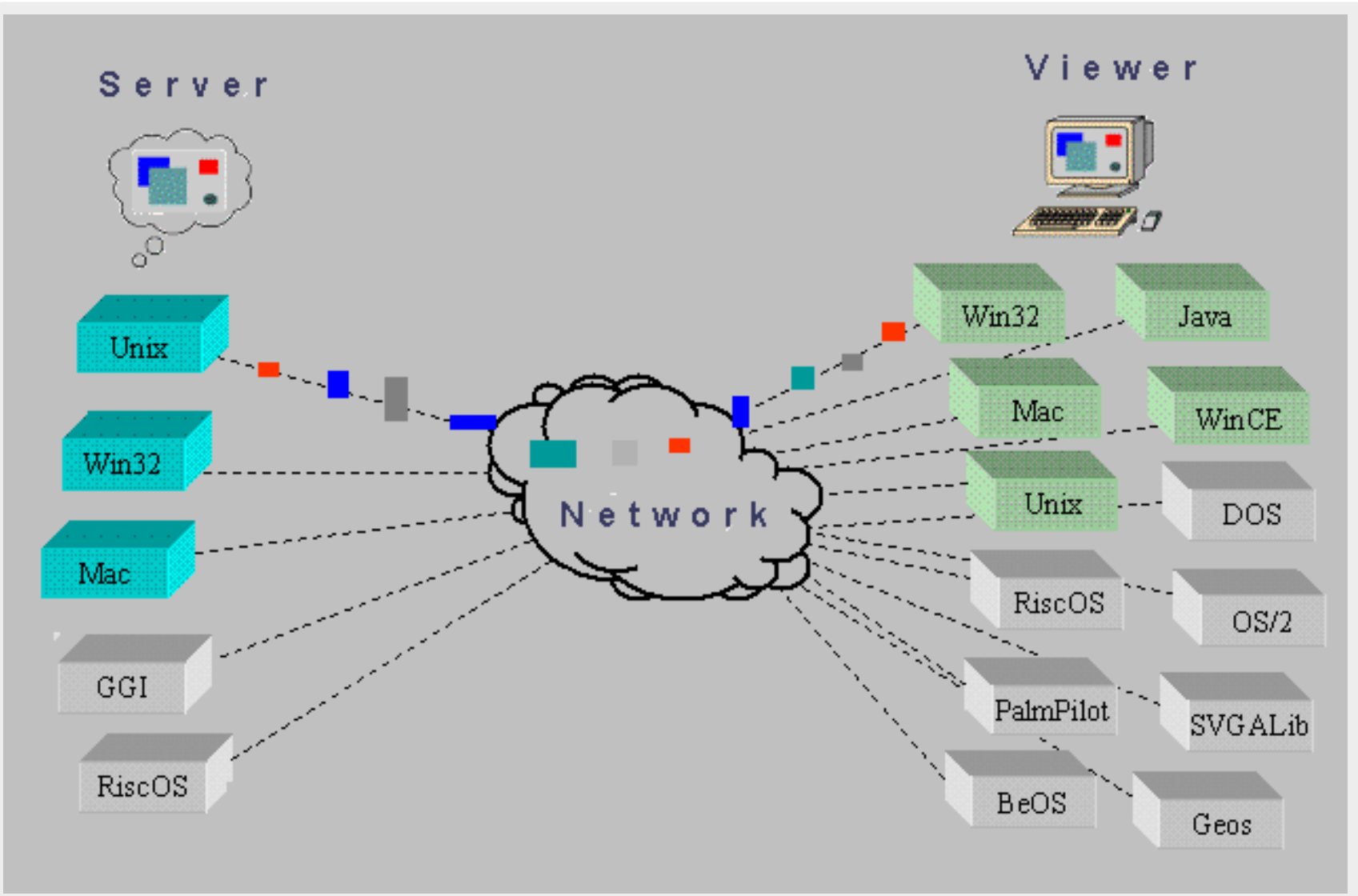
VNC (Virtual Network Computing)

referred as Virtual Network Console, too



VNC - Virtual Network Computing

Basic Features

VNC is a free platform-independent application

- is a Client-Server architecture based on the RFB protocol
- is a graphical desktop sharing system
  - without the need of X on the client side
- transmits the keyboard and mouse events from one computer to another
- relays the graphical screen updates back in the other direction
- is not a secure protocol
  - passwords are not sent in plain-text
  - crack could be successful if both the encryption key and encoded password are sniffed from a network
- always use VNC through an SSH tunnel !
- Open source tool: `http://www.realvnc.com`

VNC - Virtual Network Computing

Basic terminology

Framebuffer (FB)

- is a video output device that drives a video display from a memory buffer containing a complete frame of data
- the information in the buffer consists of color values for every pixel on the screen
- total memory required for the FB depends on the resolution, and on the color depth
- a FB device driver was created for X11: XF86 FBDev as standard part of XFree86
- FBDev is basic driver in X, without using the features of the GPU

VNC - Virtual Network Computing

RFB Protocol

Remote Framebuffer (RFB) protocol

- is a simple protocol for remote access to graphical user interfaces
- it works at the framebuffer level, it is applicable to all windowing systems and applications, including X11, Windows and Macintosh.
- to the basic features a lot of extensions added
  - file transfers
  - more sophisticated compression
  - security techniques
- seamless cross-compatibility
  - between the many different VNC client and server implementations
- clients and servers negotiate using
  - the best RFB version
  - most appropriate compression and security options

RealVNC, Ltd.

- continues development of VNC and to maintain the RFB protocol

VNC - Virtual Network Computing

VNC Server

VNC Server features

- runs on the remote computer !
- does not have a physical display! (does not bind to a display)
- consists of two servers on Linux/Unix OS
  - Framebuffer Server: to communicate remotely with the VNC client
  - X Server: to communicate locally (on the remote computer) with the X-clients, presenting itself as a real X-Server
  - the X-server part fills up the framebuffer with the output from the X-clients
  - the FB-server part transfers the content of the FB to VNC-client(s)
- the session information will be kept in the server side
  - if you disconnect from the VNC server it will not close the session
  - Disconnecting from VNC server behaves like locking the session and switching off the monitor
- you have explicitly kill the VNC server after your work !

VNC - Virtual Network Computing

VNC Server II

VNC Server features

- by default uses TCP ports 5900 through 5906
  - each port corresponds to a separate screen (:0 to :6)
- uses ports 5800 through 5806 for java connections
  - allowing clients to interact through a Java-enabled web browser
- Xvnc is the Unix VNC server, it is based on standard X server
- any number of Xvnc server can be started (think on resources!)
- more clients can connect to the same server
- VNC need more/high bandwidth because of tranferring screenshots

VNC - Virtual Network Computing

Starting the VNC Server

Starting the VNC server

- log in by ssh to a RISC computer, e.g. gepard:
  - ssh -l username gepard.risc.uni-linz.ac.at
  - uhu> ssh -l guestuser gepard.risc.uni-linz.ac.at
- start the VNC server by the command:
  - gepard:1> vncserver -geometry 1024x768 -depth 24
- You will see something similar in the screen (it just ask a session password at the first run):

```
You will require a password to access your desktops.

Password:
Verify:
New 'X' desktop is gepard:1

Starting applications specified in /etc/X11/Xsession
Log file is /home/yourusername/.vnc/gepard:1.log
```

VNC - Virtual Network Computing

Starting the VNC server

Starting Server

- You have to memorize the server name and the screen number - after the computer name (in this case it is ":1")
  - The port number will be 5901 (5900+screen number)
- You have to shutdown the VNC server, after you do not need it:
  - gepard:3> vncserver -kill :1

    ```
    Killing Xvnc4 process ID 2693
    gepard:4>
    ```
- The configuration and log data for the VNC server are stored in the
  - /home/<username>/.vnc/ directory
- The VNC server asks for the password at the first time only
- If you forgot the password for the VNC server, remove or change it:
  - rm /home/<username>/.vnc/passwd
  - vncpasswd /home/<username>/.vnc/passwd

VNC - Virtual Network Computing

Starting the VNC client

Starting the VNC Client

- create an ssh tunnel on your local computer to the vnc server:

```
     ssh -f -l username -N -L 5901:localhost:5901 srvname
uhu> ssh -f -l guestuser -f -N -L 5901:localhost:5901 gepard.risc.u
```

- start the VNC client on your local computer

```
uhu> xvncviewer localhost:1
```

- best solution is to use a shell alias, e.g. for the tcsh in /home/username/.cshrc :
  - gepardtunnel alias "ssh -f -l username -N -L 5901:localhost:5901 gepard.risc.uni-linz.ac.at "
  - source /home/username/.cshrc
  - activate the tunnel in the command line by gepardtunnel
- Security Risk
  - your password can be stolen using xvncclient without ssh tunnel !
  - hacker get full access to your home directory

VNC - Virtual Network Computing

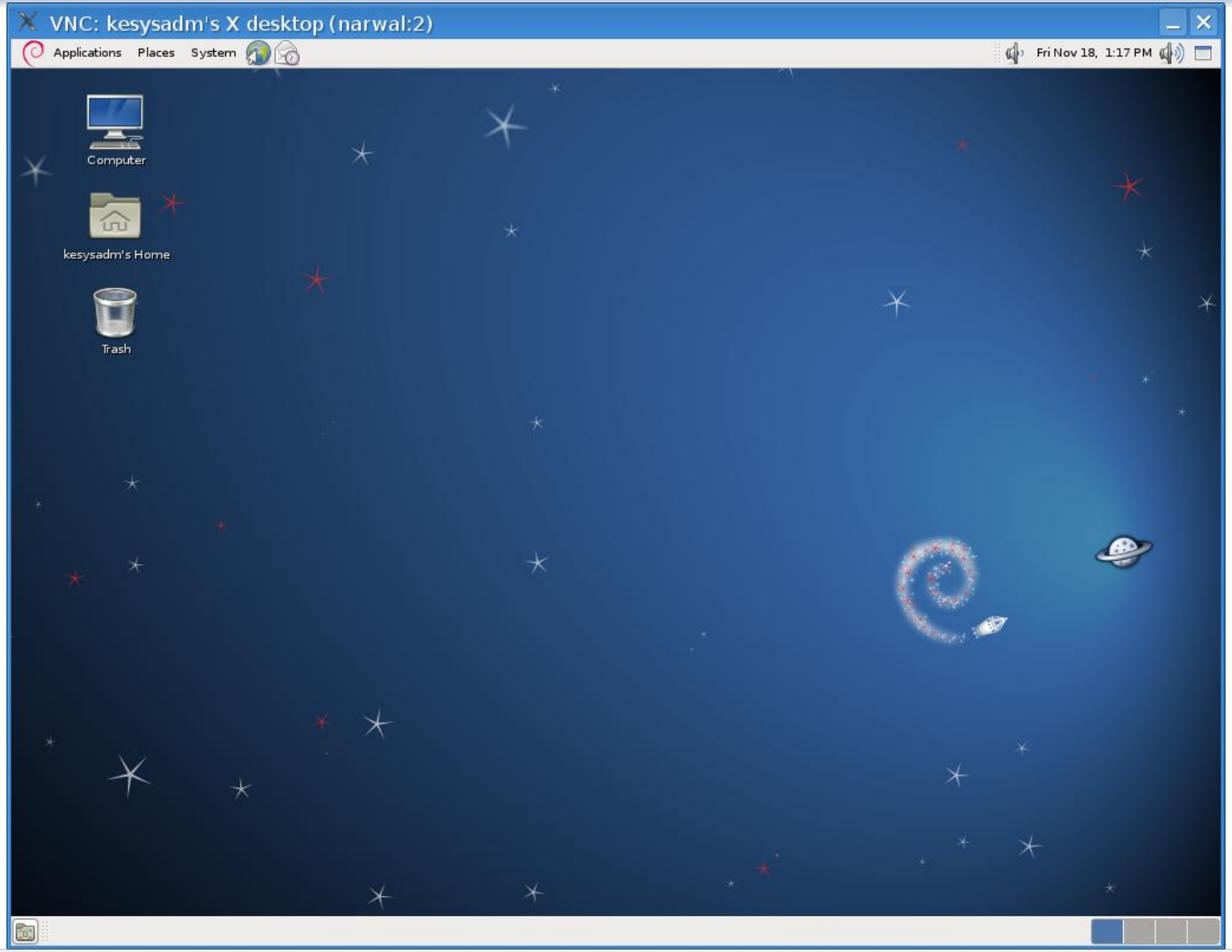
VNC server and client starting

Configuration of the `vncserver` at RISC

- configuration of the vncservers at RISC with option -localhost
  - this means, that the vncserver accepts connections only from localhost (127.0.0.1)
  - with other words: you MUST use ssh tunnel to the host where the vncserver is running (otherwise you'll get error: connection refused).
- example: assumed, you started the vncserver on the computer speedy.risc.uni-linz.ac.at, you need the follwoing ssh-tunnel:
  - `ssh -f -l username -N -L 5901:localhost:5901 speedy.risc.uni-linz.ac.at`
  - localhost will be replaced by 127.0.0.1, and this is the IP from which the vncserver accepts connections.

VNC - Virtual Network Computing

VNC Client - xnvcviewer



VNC - Virtual Network Computing

VNC Server - default xstartup file

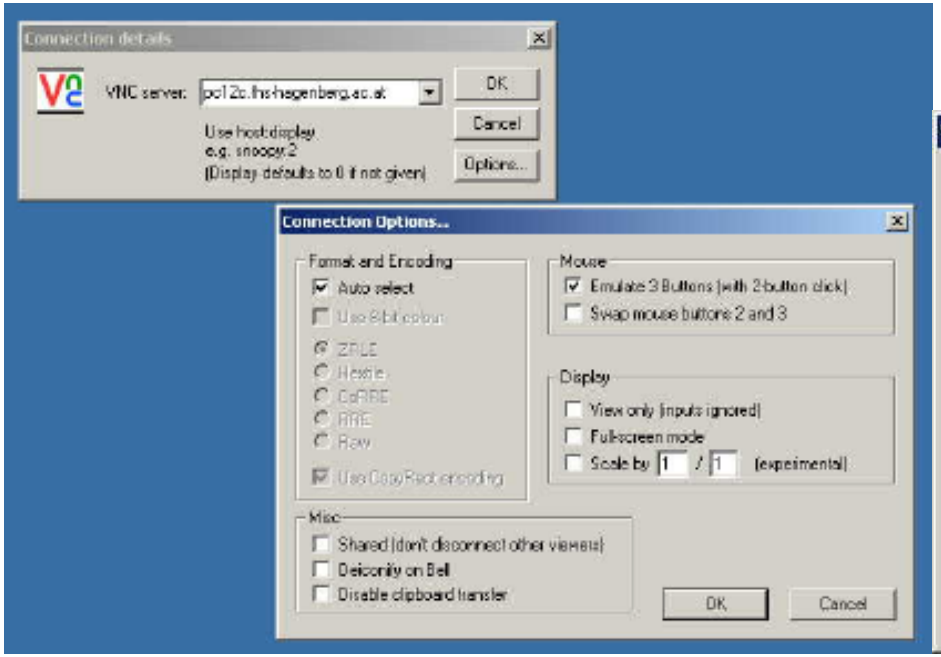
xstartup file

```
#!/bin/sh

xrdb $HOME/.Xresources
xsetroot -solid grey
#x-terminal-emulator -geometry 80x24+10+10 -ls -title "$VNCDESKTOP Desk
#x-window-manager &
# Fix to make GNOME work
export XKL_XMODMAP_DISABLE=1
/etc/X11/Xsession
```

Real VNC

Using VNC under MS Windows



Demonstration VNC client

Now make a short demonstration

how VNC works through a tunnel

Agenda

Remote Desktop Protocol

Microsoft Windows

Windows NT/2000: Terminal Services extension

- Remote Desktop Protocol (RDP) developed in the mid 1990's by Microsoft
  - RDP client computer (Windows/Unix) opens a remote desktop session on a Windows NT/2000 server with terminal services extension
  - In client window, user sees another desktop running on the server
  - Introduced by Windows NT Terminal Server Edition
  - Installed at RISC in 1999 for MS Office Compatibility goals
  - The first MS Windows Multiuser OS !
- Windows XP:
  - Provides builtin RDP service functionality
- Windows 2003 Server: successor of NT/2000 Terminal Server Editon

Remote Desktop Protocol

crutch - the RISC Windows 2003 server

crutch: Linux - Windows integration

- Supporting the RISC users for some MS Windows applications
  - for software available only on MS Windows
- Microsoft Software
  - OpenOffice and MS-Office are not fully compatible
  - MS Office is available in the (near) last version on crutch
- Adobe Software
  - Adobe Acrobat 9 Pro Extended (2 concurrent licenses)
  - Adobe Photoshop Lightroom 2.1 (1 concurrent license)
- Other Software
  - ACDSee 8 (image management and manipulation sw)
  - Canon DPP (Digital Photo Professional, for Canon DSLR RAW images)
- Configuration of crutch
  - the riscwide home directory is available (scratch,too)

Remote Desktop Protocol

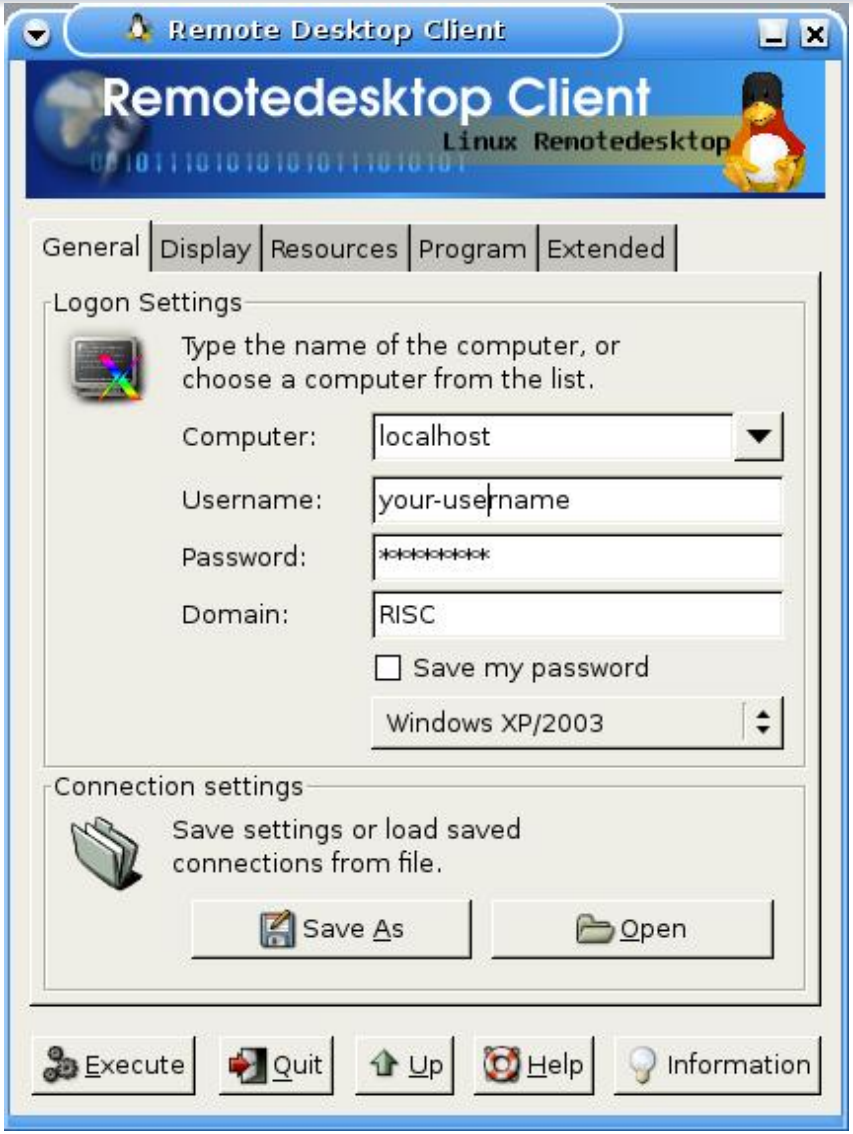
crutch - the RISC Windows 2003 server

RDP ports, connections

- How to connect through an SSH tunnel to crutch
  - RDP uses the port 3389
  - the Windows-2003 server has no SSH server implementation
  - you have to connect to a Linux computer at RISC with SSH and make the tunnel through this computer to crutch
- ssh -l username -f -N -L 3389:crutch.risc.uni-linz.ac.at:3389 gepard.risc.uni-linz.ac.at
  - this is an SSH connection from your computer to gepard
  - the tunnel runs from your computer through gepard to crutch
  - the tunnel section between gepard and crutch is not secure
- Configuration of grdesktop
  - define localhost in the General options for the field Computer

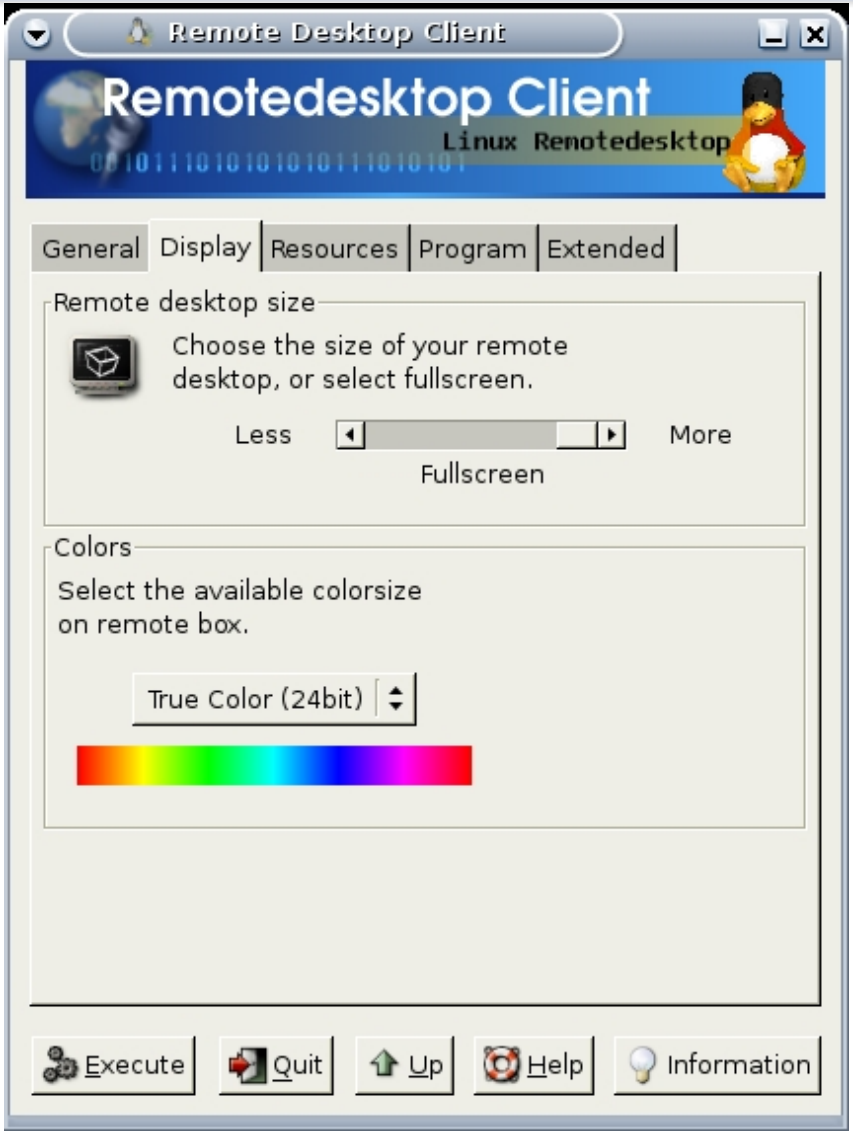
GRDesktop - Configuration

Gnu RDP Client



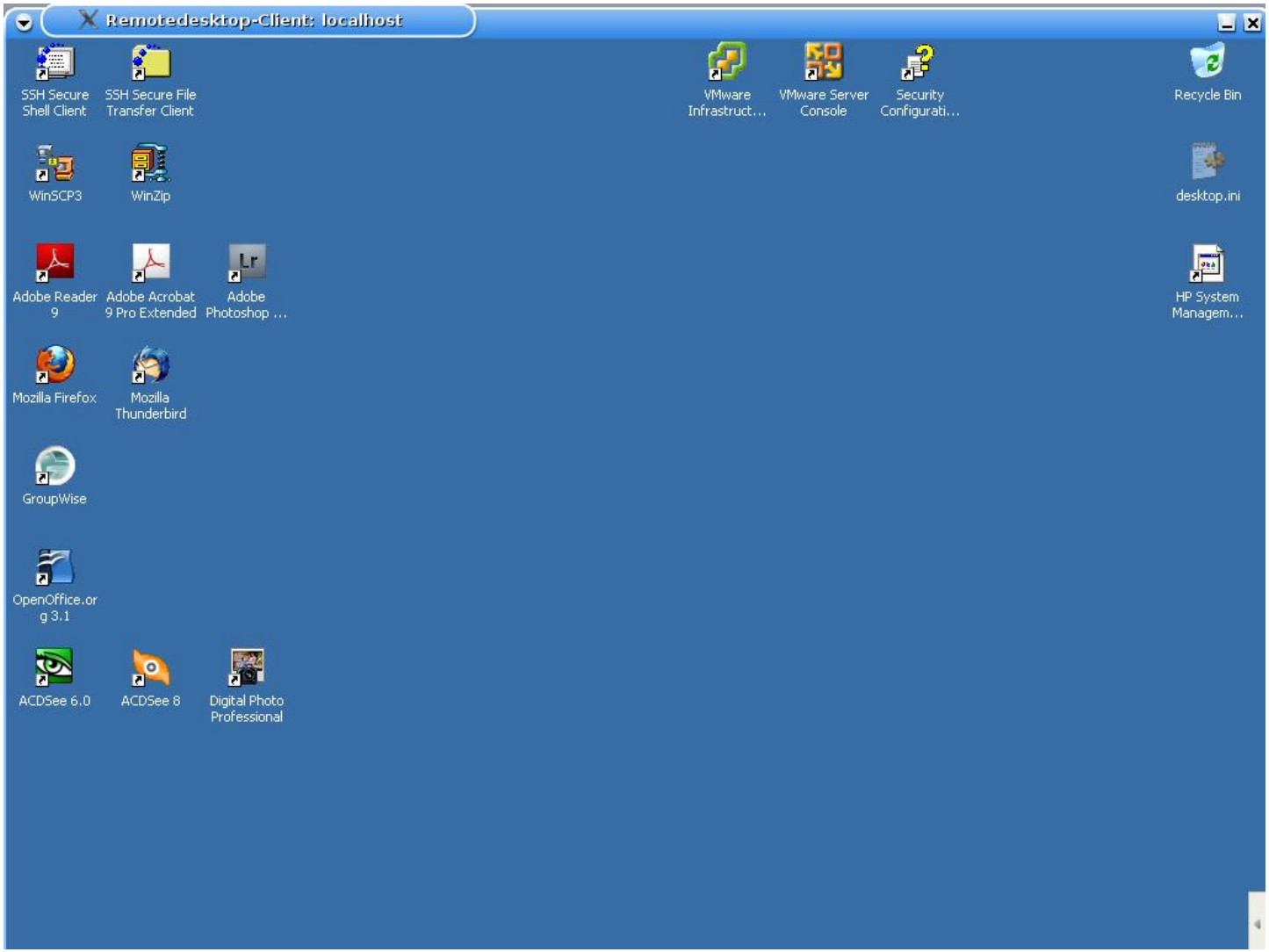
GRDesktop - Configuration

Gnu RDP Client



GRDesktop

Main screen



End of Remote Services, Desktops

Thanks for your attention !