Debian/GNU Linux Networking Basics of the Networking

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Károly Erdei — Debian/GNU Linux Networking

1 Computer Networks

- 2 Internet
- 3 Ethernet
- 4 Internet Protocols
- 5 Models
- 6 TCP
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Computer Networks Transmission Principles

Broadcasting networks

- transmission medium shared by all network participants (hosts)
- one machine sends short messages (packet)
- Broadcasting: all other machines receive the package sent
- Example: Radio, television, GSM, Ethernet

Point-to-point networks

- Multiple connections between individual pairs of machines
- Message from one machine to another
- Message must be routed from source to destination
- Example: Telephone system, Internet

Range of Networks

Ranges

- LAN Local Area Network: Room (10 m), building (100 m), campus (1000 m)
- MAN Metropolitan Area Network: City (10 km) Metronet-Hgb
- WAN Wide Area Network: Country (100 km), continent (1000 km)
- Internetwork Combination or network of networks: Planet (10K km)
- PAN Personal Area Networks 1-10 m, (using Bluetooth units)

LAN

- Private network within building or complex of buildings
- Connection based on cables (hosts are attached via network cards)
- Transmission speed 0.1–1 Gbps
- Various topologies: Bus-based (Ethernet), Wireless (WLAN)

Range of Networks

Internetwork:

- Connects multiple WANs/LANs across the globe
- LANs/WANs connected to Internetworks by routers or gateways
- Each attached network may have different protocol
 - Protocol = language spoken by computers on network
- Any computer in any network can communicate with any other computer in any other network independently of physical network technologies
- Communication based on higher level protocols





3 Ethernet

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The Internet

- A worldwide internetwork that uses the TCP/IP protocol suite
- It is a packet switching network (data will be splitted in packets)

Various groups of networks

- Backbones: large networks for connecting other networks (GEANT2)
- Regional networks: e.g. connecting universities (ACOnet)
- Commercial networks: privately owned for paying users (LIWEST)

Lot of services

- Application level: World Wide Web, eMail, file transfer, remote login
- Network level: connectionless packet delivery (UDP), reliable stream transport (TCP)

History of the Internet

From The Beginnings till Today

- Late 60s: numerous networks based on different technologies
- Early 70s: DARPA (US Defense Advanced Research Proj. Agency)
 - 1978: TCP/IP in its current form
 - 1983: ARPANET is the backbone of the Internet (research sites)
- 1983: TCP/IP for the operating system BSD Unix
 - Berkeley Software Distribution (University of California at Berkeley)
 - TCP/IP spreads among universities and research centers
- 1986: NSFNET connection with ARPANET and EBONE (Europe)
- 1993: World Wide Web, Service on top of the Internet
- 1995: Commercialization of the Internet
- 2000: Internet as a universal medium (Internet Access trough ISPs)

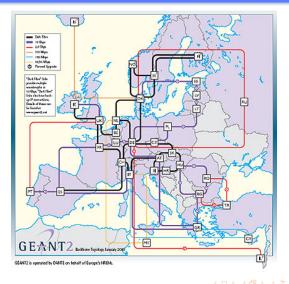
Today the Internet is a collection of commercial networks

Organisation of the Internet

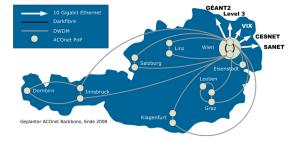
Internet Architecture Board (IAB)

- Internet Engineering Task Force (IETF)
 - Decisions about protocols, procedures, conventions
- Request for Comments (RFCs)
 - Series of reports that defines the (history of) Internet protocols
- Internet Standards
 - Defines the official Internet protocols
 - References the RFCs that define a current standard
 - Update of standards: other RFCs will be referenced
- Examples of Internet Standards:
 - IP Internet Protocol: STD 5
 - TCP Transmission Control Protocol: STD 7
 - DNS Domain Name System: STD 13
 - SMTP Simple Mail Transfer Protocol: STD 10

GEANT2 - Pan-European Education/Research Network



Computer Networks Internet Ethernet Internet Protocols Models TCP TCP Check Network Connect ACOnet - Austrian Academic Computer Network



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Ethernet The communications medium

Ethernet

- is a family of frame-based computer networking technologies for local area networks (LANs)
 - a data packet on the wire is called a frame
- defines a number of wiring and signaling standards for the Physical Layer (OSI model)
- uses the Media Access Control (MAC) address to identify nodes
- allows communication of computers over a shared coaxial cable acting as a broadcast transmission medium
- all generations of Ethernet share the same frame formats
 - the same interface for higher layers
 - and can be readily interconnected

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Ethernet MAC addresses

MAC / physical / hardware Address

- each Ethernet station is given a single 48-bit unique MAC address
- is used both to specify the destination and the source of each data packet
- is six groups of two hexadecimal digits, separated by or :
 - first three octets identify the organization
 - arbitrary but unique next three octets assigned by the organisation
- is used/valid only in LAN (network segment)

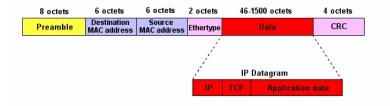
technologies which use MAC address

Ethernet, 802.11 wireless networks, Bluetooth

Special MAC addresses:

- broadcast address: ff:ff:ff:ff:ff:ff:ff
 - packets sent to this address are received by all stations on the local network

Ethernet The frame structure



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Ethernet - MAC address How to find a local MAC addresses

Linux - command line with /sbin/ifconfig

```
uhu: ~> /sbin/ifconfig eth0
eth0 Link encap:Ethernet HWaddr 00:16:41:16:6D:5D
inet addr:192.168.1.115 Bcast:192.168.1.255 Mask:255.255.25
....
uhu: ~> /sbin/ifconfig eth1
eth1 Link encap:Ethernet HWaddr 00:16:6F:BA:3E:01
```

```
UP BROADCAST MULTICAST MTU:1500 Metric:1
```

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MS Windows - fastest way

■ in DOS Window by means of ipconfig /all

Linux - all units in the network segment

arp -a (only one line listed as example):

 crutch.risc.uni-linz.ac.at (193.170.37.76) at 00:16:35:37:5C:EC [ether] on eth0

Ethernet - MAC address

How to find a local MAC addresses - Linux with gnome-nettool

	Network	: Tools - Devices	<@prometheus	a)			
<u>T</u> ool <u>E</u> dit	<u>H</u> elp						
Devices Ping Netstat Traceroute Port Scan Lookup Finger Whois							
Network device: Ether		net Interface (eth0)			<u> </u>		
IP Information							
Protoco	ol IP Add	ress	Netmask / Prefix	Broadcast		Scope	
IP∨4	193.17	70.37.80	255.255.255.0	193.170.3	7.255		
IP∨6	fe80::2	213:20ff:fe75:4402	64			Link	
Interface Information Interface Statistics							
		s: 00:13:20:75:44:			1.5 Gi	- 1	
Multicas	st:	Enabled		d packets:		100	
MTU:		1500	Transmissi		0		
Link spe	ed:	not available	Received b	-	893.2	MiB	
State:		Active	Received p		25697	788	
			Reception	errors:	0		
			Collisions:		0		
		,				· • · · · -	



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Internet Protocols

Connectionless and Connection-oriented protocols

Connectionless protocol

- communication between two network point in which message can be sent without prior arrangement
- the transmitting device sending the message:
 - does not ensures first recipient is available and ready to receive data
 - simply sends the message to the recipient address
- often problems with transmission
- examples: IP, UDP, ICMP, IPX

Connection-oriented protocol

delivers a stream of data in the same order as it was sent

- first a communication section will be established
- data stream will be send by handshaking
- packet retransmission by error, data lost, etc.
- examples: TCP

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phone call: user must dial first and get answer before transmitting

IP - The Internet Protocol

Features of IP

- A standard protocol (STD 5)
 - Includes ICMP Internet Control Message Protocol (used by ping)
- No delivery guarantuees
 - Connection-less
 - Unreliable: packets may be lost, duplicated, reordered
 - Best-effort: however, we do our best to deliver a packet
 - packets oriented
- Data from an upper layer protocol is encapsulated inside one or more packets
- IP can be used over a heterogeneous network
 - Ethernet, ATM, FDDI, Wi-Fi, token ring, etc.
- Core functionality
 - defines IP addresses und subnetting
 - defines routing in the network

IP Addressing

RFC 1166: Internet Numbers

- An IP address is a 32 bit unsigned integer
 - There exist $2^{32} \approx 4$ billion IP addresses
- Representation in dotted decimal notation
 - X.X.X.X; Each X is a decimal number, a byte of the address
- Example: 128.10.2.30: 10000000 00001010 00000010 0011110
- Each Internet host has (at least) one Internet address
- IP addresses are divided in classes: Class A, B, C
 - IP address splitted in network and host part (bytes:1/3;2/2;3/1)

Class	Lowest Address	Highest Address
А	1.0.0.0	126.0.0.0
В	128.1.0.0	191.255.0.0
С	192.0.1.0	223.255.255.0

Reserved IP Addresses Special addresses

Some addresses are reserved for special purposes

- net.0: the "network" address (not a particular host) 193.170.37.0
- default gateway: an address in this network: 193.170.37.1
- broadcast address: net.255
 - B-net.255.255: broadcast in class B network: 140.78.255.255
 - C-net.255: broadcast in class C network: 193.170.37.255
- 0.0.0.0: "this" host
- 127.0.0.1: loopback (not sent across network, for testing local IP setup)

The original IP class scheme became too unflexible

- For each physical network, an address range has to be allocated;
- The address range is badly utilized; not all IP is assigned to hosts

Solution: IP subnetting

- Entire network appears as single IP network to the outside world
- Idea: host address -> subnet address: host address
- IP address: network address: subnet address: host address

Implementation by subnet masks

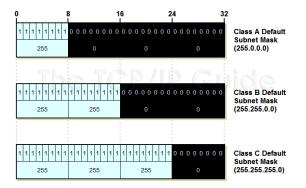
- For each subnet, a 32 bit subnet mask is chosen
 - Bit 1 in mask: corresponding bit in address is part of (sub)network address
 - Bit 0 in mask: corresponding bit in address is part of host address

Routers route today subnets with netmasks

IP network classes are obsolete

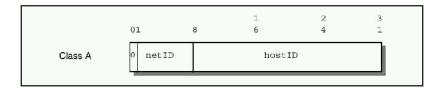
Default Subnet Mask

Graphical representation

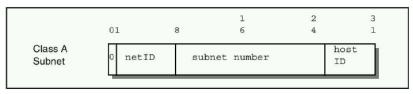


IP Addresses with Subnets

Without subnet:



With subnet:



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IP Datagram Structure

Version	Header Length	Type of Service	Datagram Length		
ID			Offset		
TTL		Upper Layer Protocol	Checksum		
Source IP Address					
Destination IP Address					
Options					
Data					

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Routers Features

Router: a networking device

- a computer whose software and hardware are usually tailored to the tasks of routing and forwarding packets
- transfers packets only across networks using similar protocols
- contains a specialized operating system (e.g. Cisco's IOS)
- has multiple network connections
 - multiple physical networks are connected to a router
 - from the point of view of each network, the router is part of this network
- Types of routers
 - inside enterprises; enterprises and Internet; ISP enterpise; SOHO: small office home office
 - small units (DSL router) ISPs big multiprocessor unit

Node in a network that serves as access point to another network

Routers and Gateways How they works

How Routing works

- IP packet routing based on routing tables
 - hard-coded static routes
 - by exchanging routing protocol information with other routers
- protocols
 - BGP Border Gateway Protocol; eBGP
- Standard PC can act as a router with appropriate software

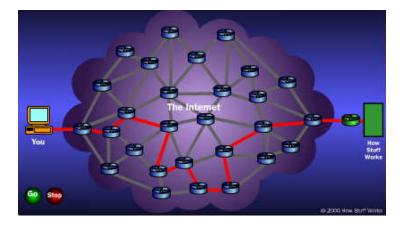
Gateway

- a networking device that converts protocols among networks
- accepts a packet formatted for one protocol (AppleTalk) and converts it to a packet formatted to another protocol (TPC/IP)

Default gateway

node in a network that is choosen when the IP address not in the routing table of the host

Routers, packets A route of a packet in the Internet



Private Networks - Private IP Addresses

The addresses, which can be used by everyone

Private Internet Addresses

RFC 1918: address allocation for private Internets

- May be used internally in any organization
- routers have to discard any packets with a private IP address in the IP header
- gives security for private networks they are not available from the Internet

Examples

private class A network: 10.0.0.0 - 10.255.255.255

Huge address range for communication within an organization

- Home network: 192.168.0.0 192.168.255.255
 - Cable/DSL router: 192.168.1.1

How to connect network with private addresses to the Internet?

Internet Protocol - ICMP based applications

Ping and Traceroute

ping

```
simplest version: ping hostname
```

PING kernel.risc.uni-linz.ac.at (193.170.37.225) 56(84) bytes of da 64 bytes from kernel.risc.uni-linz.ac.at (193.170.37.225): icmp_seq=1 ttl=245 time=25.0 ms 64 bytes from kernel.risc.uni-linz.ac.at (193.170.37.225): icmp_seq=2 ttl=245 time=26.3 ms --- kernel.risc.uni-linz.ac.at ping statistics ---2 packets transmitted, 2 received, 0% packet loss, time 999ms rtt min/avg/max/mdev = 25.021/25.705/26.389/0.684 ms

traceroute

- simplest version: traceroute hostname
- try it yourself this command

Internet Protocol - ICMP based applications

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<u>F</u> ile	<u>E</u> dit <u>V</u> iew <u>T</u> erminal Ta <u>b</u> s <u>H</u> elp
had	es:sysadmin!3>
had	es:sysadmin!3>
had	es:sysadmin(3> traceroute www.bme.hu
tra	ceroute to www.bme.hu (152.66.115.35), 30 hops max, 40 byte packets
1	net37-gtw (193.170.37.1) 0.479 ms 2.601 ms 0.439 ms
2	jkuc3hb1.edvz.uni-linz.ac.at (140.78.222.1) 0.480 ms 0.474 ms 0.490 ms
3	jkuc6bb1.edvz.uni-linz.ac.at (140.78.200.140) 0.594 ms 0.568 ms 0.576 ms
4	Linz.ACO.net (193.171.22.25) 0.816 ms 0.738 ms 0.599 ms
5	linz2.aco.net (193.171.15.10) 1.076 ms 0.991 ms 0.980 ms
6	wien21.aco.net (193.171.15.5) 4.465 ms 4.418 ms 4.432 ms
7	aconet.rtl.vie.at.geant2.net (62.40.124.1) 8.908 ms 4.411 ms 4.444 ms
8	so-3-0-0.rt1.bud.hu.geant2.net (62.40.112.14) 9.237 ms 9.201 ms 9.181 ms
9	hungarnet-gw.rtl.bud.hu.geant2.net (62.40.124.102) 9.445 ms 9.331 ms 9.347 m
10	c6513-tengbeth13-3.vh.hbone.hu (195.111.97.242) 181.798 ms 219.094 ms 9.366 m
11	sup720-tengbeth2-1.bme.hbone.hu (195.111.97.102) 9.434 ms 9.405 ms 9.403 ms
12	tge8-1.taz.bme.hu (152.66.0.125) 9.438 ms 9.381 ms 9.419 ms
13	torpapa.eik.bme.hu (152.66.115.35) 9.319 ms 9.303 ms 9.294 ms
had	es:sysadmin14>

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OSI Model - TCP/IP Model OSI: 7 layers - TCP/IP: 4 levels

OSI - Open System Interconnect (general networking)

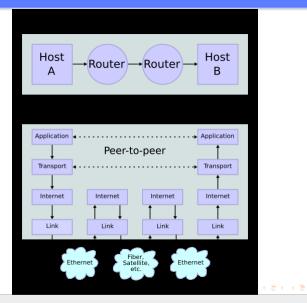
- 1: Physical Layer: sending raw bits
 - bit by bits delivery, how a bit as a signal looks like
- 2: Data Link Layer: transfers data between network nodes
 - Ethernet protocol; MAC address; local network delivery
- 3: Network Layer: transfer data packets from source to destination
 - via one or more networks using unique addresses and routing (IP level)
- 4: Transport Layer: delivering data to the applications on hosts
 - forming data packets, adding source, destination ports (TCP, UDP)
- 7: Application Layer: running programs on host

TCP/IP Model - 4 layers

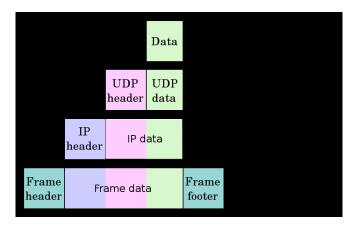
Link, Internet, Transport, Application Layers

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TCP Model - packets route

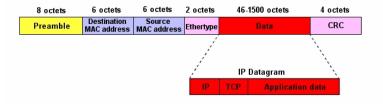


TCP Model - packets encapsulation



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TCP Model - encapsulation The Ethernet frame structure



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TCP - Transmission Control Protocol

Transport layer services

- Connection oriented
 - for data delivery first a connection must be established
- Same Order Delivery
 - data will arrive in the same order it has been sent
- Reliable data transmission
 - retransmit corrupted packages; error detection code, packet acknowledgement
- Byte orientation: not packages, but stream of byte sent
- Introducing the term port
 - port addresses multiple entities on the same location

TCP - Ports

The problem of the applications on a host to communicate

- more programs run on a computer
 - sendmail, webserver, name server, ftp-, pop server, etc.
- the computer has one unique IP address
- how to deal with the application, how to differ them
- introducing ports is the solution
 - analogy: postal address as IP address; appartement number or name is the port number

Ports

to each services in the Internet/Computer a port is assigned

- ports are identified by the port number
- see in Linux the /etc/services file for numbers/services allocation
- port number is a part of TCP packets header
- a program implement a service
 - the program LISTEN on the port for a communication

Computer Networks	Internet Ethernet	Internet Protocols	Models	ТСР	TCP (Check Network	Connecti
TCP - Unix por	Ports t in /etc/services						
ftp-data	20/tcp						
ftp	21/tcp			щ			
ssh	22/tcp			#	22H H	lemote Logi	n Prot
telnet	23/tcp						
smtp	25/tcp	mail					
whois	43/tcp	nicna	ne				
domain	53/tcp			#	name-	domain ser	ver
domain	53/udp						
finger	79/tcp						
WWW	80/tcp	http		#	World	lWideWeb HI	TP
WWW	80/udp			#	Hyper	Text Trans	fer Pr
рорЗ	110/tcp	pop-3		#	POP v	version 3	
imap2	143/tcp	imap		#	Inter	im Mail Ac	cess P
https	443/tcp			#	http	protocol c	ver TL
https	443/udp						
ftps	990/tcp						
telnets	992/tcp			#	Telne	et over SSL	
imaps	993/tcp			#	IMAP	over SSL	
pop3s	995/tcp		4	□ ▶ #	POP-3	over SSL	৩৫৫

TCP - Transmission Control Protocol Example: Sending email per smtp port (1)

```
hu: ~> telnet bullfinch 25
Trying 193.170.37.222...
Connected to bullfinch.risc.uni-linz.ac.at.
Escape character is '^]'.
220 bullfinch.risc.uni-linz.ac.at ESMTP Sendmail 8.13.8/8.13.8/Debian-3
Mon, 3 Nov 2008 15:19:26 +0100; (No UCE/UBE) logging access from: i
uhu37.risc.uni-linz.ac.at(OK)-ke@uhu37.risc.uni-linz.ac.at [193.170.37.
helo ich-bin-s
250 bullfinch.risc.uni-linz.ac.at Hello ke@uhu37.risc.uni-linz.ac.at
[193.170.37.115], pleased to meet you
mail from: k.erdei@risc.uni-linz.ac.at
250 2.1.0 k.erdei@risc.uni-linz.ac.at... Sender ok
rcpt to: karoly.erdei@jku.at
250 2.1.5 karoly.erdei@jku.at... Recipient ok
```

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TCP - Transmission Control Protocol Example: Sending email per smtp port (2)

```
data
354 Enter mail, end with "." on a line by itself
this is an email sent by telnet 25 command from the laptop to the mail
server bullfinch.risc... demonstrating how smtp works
.
250 2.0.0 mA3EJQr4014077 Message accepted for delivery
quit
221 2.0.0 bullfinch.risc.uni-linz.ac.at closing connection
Connection closed by foreign host.
uhu:~>
```

TCP - Transmission Control Protocol Example: Downloading file from the WWW server

Telnet to port 80 on the Web server

hades:www!11> telnet www 80
Trying 193.170.37.138...
Connected to crow.risc.uni-linz.ac.at.
Escape character is '^]'.
GET http://www/proba.txt

Hello! This is a test file. To get it per port access with telnet. It succeeded to get this file per port access from the web server. Great!

Connection closed by foreign host. hades:www!12>

TCP Datagram Structure

Source Port	Destination Port					
Sequenc	e Number					
Acknowledge	ement Number					
Flags	Receiver Window Size					
Checksum	Urgent Data					
Ор	Options					
Data						

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UDP - User Datagramm Protocol

UDP what is it

- UDP is a minimal message-oriented Transport Layer protocol
- main features
 - unreliable; not ordered; lightweight; datagrams
 - urreliable: data may be lost, arrive duplicated, etc.
- comparing to TCP, which is:
 - reliable; ordered; heavyweight; streaming
- faster and more efficient as TCP for some application
- services using UDP:
 - DNS (Domain Name System); IPTV
 - VoIP (Voice over IP) the internet telephony
- data structure
 - source port; destination port; length; checksum; data

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DHCP - Dynamic Host Control Protocol

Client - Server application

DHCP protocol is used to obtain parameters necessary for IP networking

DHCP Client - Server communication flow

- client: broadcasts a DHCPDISCOVER request
 - Asks for a DHCP server on the network segment
 - Asks for a lease and for an IP address
 - Lease: the length of time for the allocation is valid
- server: sends a DHCPOFFER message
 - Checks if the MAC of client is registered
 - Marks an IP from the spool
- client: broadcasts a DHCPREQUEST on the network
 - The IP of the server is in the packet
- server: sends the client the data
 - Reservers the IP for the time of the lease
 - Other servers delete the mark for the IP

DHCP - Dynamic Host Control Protocol

DHCP server

- has a pool of IP addresses
- manages other network parameters for networking by client
 - options are widely configurable
- checks the MAC of the client, if configured
- lease time is configurable (max;min)

Client requests periodically

- Client has to request again before lease time is over
 - a new IP or request the same IP
- By booting must suspend other processes
 - without IP no network connection

DHCP - Dynamic Host Control Protocol

ct DHCP Server data table

Assigned data by DHCP server at RISC

- Network configurations parameter at RISC
 - IP Address
 - Lease
 - Domain Name (risc.uni-linz.ac.at)
 - Default Gateway address (193.170.38.1)
 - Name server IP address (193.170.37.225)
 - Name server IP address (193.170.37.224)
 - WINS servers (phoebe.risc.uni-linz.ac.at)
 - WINS servers (samba-dc1.risc.uni-linz.ac.at)
 - NTP servers (time.risc.uni-linz.ac.at)
 - SMTP server (mail.risc.uni-linz.ac.at)
 - POP server (pop.risc.uni-linz.ac.at)

NAT - Network Address Translation

How NAT works

general definition

 a technique that hides an entire address space, usually consisting of private network addresses (RFC 1918), behind a single IP address in another, (often) public address space.

implemented in a router - connected to private/public network

- uses translation tables to map/remap the addresses
- translation table are created by the outgoing requests
- rewrites the outgoing IP packets as sent from the router
- Assigns to each connection a different source port
- NAT introduces complications in communication, performance
 - it has to rewrite checksum, reassemble packets, fragment them again, etc.
- The NAT box the Internet router
 - for SOHO Network (Small Office Home Office)
 - Cable/DSL router: a firewall is always integrated

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Checking Network Connections

gnome-nettool, devices

	Netwo	rk Tools - Device:	; <@prometheus				
<u>T</u> ool <u>E</u> dit	<u>H</u> elp						
Devices F	Ping Net	stat Traceroute P	ort Scan Lookup I	Finger Whois			
<u>N</u> etwork	Network device: Ethernet Interface (eth0)						
IP Inform	nation						
Protoc	ol IP Ac	ldress	Netmask / Prefix	Broadcast	Scope		
IP∨4	193.	170.37.80	255.255.255.0	193.170.37.25	5		
IPv6	fe80	::213:20ff:fe75:4402	64		Link		
Interfac			Interface S				
		ess: 00:13:20:75:44		,			
Multica	ist:	Enabled		d packets: 218	7400		
MTU:		1500		on errors: 0			
Link sp	eed:	not available	Received b	·	2 MiB		
State:		Active	Received p		9788		
			Reception	errors: 0			
			Collisions:	0			
					· · · · · · -		

Checking Network Connections

gnome-nettool, ping, LAN

•		🗿 Network Too	ils - P	ring <	@prometheus>				
To	ol <u>E</u> d	it <u>H</u> elp							
De	Devices Ping Netstat Traceroute Port Scan Lookup Finger Whois								
N	Network address: compute								
S	end:	Or	ily 5	÷	requests 🔿 Unlimit	ed requests			
							2 Ping		
E	Bytes	Source	Seq	Time	Units				
	54	193.170.37.220	1	4.01	ms				
	54	193.170.37.220	2	0.288	ms				
	54	193.170.37.220	3	0.210	ms				
	54	193.170.37.220	4	0.391	ms				
	54	193.170.37.220	5	0.307	ms				
, D	ound	Trip Time Stat	ictics	Tra	smission Statistic	r			
n		num: 0.21 ms	istics		ackets transmitted: 5				
		age: 1.54 ms			ackets received: 5				
		mum: 4.01 ms)%			
							11		

Checking Network Connections

gnome-nettool, ping, remote

•	🕘 Network Too	la - F	≻ pniv	@prometi	ene>		
<u>T</u> ool <u>E</u> o	lit <u>H</u> elp						
Devices	Ping Netstat T	racer	oute P	ort Scan L	ookup F	inger Whois	
blotwor	k address: www.	unii da	on of				
Send:	Or	ly 5	÷	requests (🔾 Unlim	ited requests	
							e Ping
Bytes	Source	Seq	Time	Units			
64	131.130.1.78	1	4.16	ms			
64	131.130.1.78	2	4.13	ms			
64	131.130.1.78	3	4.18	ms			
64	131.130.1.78	4	4.12	ms			
64							
			-				
	Trip Time Stat	ISTICS		nsmission ackets tran:			
	num: 4.09 ms					-	
	age: 4.14 ms			ackets rece		5	
Maxi	mum: 4.18 ms		Pa	ackets loss:		0%	

Checking Network Connections

gnome-nettool, traceroute

ool E	Network Tools - Traceroute ⊲ dit Help	@prometheus>					
evice	s Ping Netstat Traceroute Port Sca	an Lookup Finger	whois				
	rk address: www.bme.hu			.			
				HTrace 🖓			
Нор	Hostname	IP	Time 1	Time 2			
1	net37-gtw	193.170.37.1	0.453	0.429			
2	jkuc3hb1.edvz.uni-linz.ac.at	140.78.222.1	0.498	0.503			
з	jkuc6bb1.edvz.uni-linz.ac.at	140.78.200.140	0.632	0.575			
4	Linz.ACO.net	193.171.22.25	0.586	0.575			
5	linz2.aco.net	193.171.15.10	1.064	1.005			
6	wien21.aco.net	193.171.15.5	4.477	4.430			
7	aconet.rt1.vie.at.geant2.net	62.40.124.1	4.446	5.584			
8	so-3-0-0.rt1.bud.hu.geant2.net	62.40.112.14	41.474	9.231			
9	hungarnet-gw.rt1.bud.hu.geant2.net	62.40.124.102	9.410	9.422			
10	c6513-tengbeth13-3.vh.hbone.hu	195.111.97.242	9.468	9.454			
11	sup720-tengbeth2-1.bme.hbone.hu	195.111.97.102	9.501	9.439			
12	tge8-1.taz.bme.hu	152.66.0.125	9.441	9.417			
				9.303			

Network Connections - Routing

🕏 🤇 🔛 Network Tool	s - Netstat ⊲	@prometheus	>					
<u>T</u> ool <u>E</u> dit <u>H</u> elp								
Devices Ping Netstat Tra	aceroute Port	Scan Lookup F	inger Whois					
Display: Routing Table Information								
O Active Netwo	rk Services							
O Multicast Info	rmation							
				Netstat				
Destination	Gateway	Netmask	Interface					
193.170.37.0	0.0.0.0	255.255.255.0	eth0					
0.0.0.0	193.170.37.1	0.0.0	eth0					
fe80::		64	eth0					
::1		128	lo					
fe80::213:20ff:fe75:4402		128	lo					
ffoo::								

Network Connections - Active Services

	Network Tools - N	letstat ≺@p	rometheus>	
ool <u>E</u> dit	<u>H</u> elp			
evices Pi	ng Netstat Tracero	oute Port Sca	n Lookup Finger Whois	
Display: () Routing Table Info	motion		
	Active Network Se			
	-			
C) Multicast Informat	ion		
				Anter Netstat
Protocol	IP Source	Port/Service	State	^
tcp	0.0.0	512	LISTEN	
tcp	127.0.0.1	2208	LISTEN	
tcp	0.0.0	513	LISTEN	
tcp	0.0.0	2049	LISTEN	
tcp	0.0.0	514	LISTEN	
tcp	0.0.0	548	LISTEN	
tcp	0.0.0	57253	LISTEN	
tcp	0.0.0	587	LISTEN	
tcp	193.170.37.80	427	LISTEN	
tcp	127.0.0.1	427	LISTEN	

Network Connections - Active Services

	Network Tools - N	leisiai ≺@p	rometheus>	
ool <u>E</u> dit	<u>H</u> elp			
evices P	ing Netstat Tracero	oute Port Sca	n Lookup Finger Whois	
Dienlau				
	 Routing Table Info 			
	 Active Network Set 			
	 Multicast Informat 	tion		
				// Netstat
Protocol	IP Source	Port/Service	State	^
tcp	0.0.0.0	113	LISTEN	
tcp	0.0.0	787	LISTEN	
tcp	0.0.0	21	LISTEN	
tcp	0.0.0	22	LISTEN	
tcp	127.0.0.1	35990	LISTEN	
tcp	0.0.0	23	LISTEN	
tcp	0.0.0.0	631	LISTEN	
tcp	0.0.0	43032	LISTEN	
tcp	0.0.0	952	LISTEN	
tcp	0.0.0	632	LISTEN	•
				//

Network Connections - Active Services

dp 0.0.0.0 719 dp 0.0.0.0 10080 dp 0.0.0.0 5353 dp 0.0.0.0 631 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123		Network Tools - N	leisiai ≺@p	rometheus>	
splay: ○ Routing Table Information	ool <u>E</u> dit	<u>H</u> elp			
 O Active Network Services Multicast Information 	evices Pi	ing Netstat Tracero	oute Port Sca	n Lookup Finger Whois	
 O Active Network Services Multicast Information 	Display: (C Routing Table Info	rmation		
Multicast Information Pott/Service State Image: rotocol IP Source Port/Service State Idp 0.0.0.0 719 Image: rotocol Image: rotocol <td< td=""><td></td><td></td><td></td><td></td><td></td></td<>					
IP Source Port/Service State dp 0.0.0.0 719 dp 0.0.0.0 10080 dp 0.0.0.0 10383 dp 0.0.0.0 10380 dp 0.0.0.0 111 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 127.0.0.1 123 dp 0.0.0.0 767		-			
rotocol IP Source Port/Service State 1 dp 0.0.0.0 719 dp 0.0.0.0 5353 dp 0.0.0.0 5353 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 767	() Multicast informat	lion		
dp 0.0.0.0 719 dp 0.0.0.0 10080 dp 0.0.0.0 5353 dp 0.0.0.0 631 dp 0.0.0.0 631 dp 103.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 767					Netstat
dp 0.0.0.0 719 dp 0.0.0.0 10080 dp 0.0.0.0 5353 dp 0.0.0.0 631 dp 0.0.0.0 631 dp 103.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 767					
dp 0.0.0.0 10080 dp 0.0.0.0 5353 dp 0.0.0.0 111 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 767	Protocol	IP Source	Port/Service	State	-
dp 0.0.0.0 5353 dp 0.0.0.0 111 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 767	udp	0.0.0	719		
dp 0.0.0.0 111 dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 0.0.0.0 123 dp 0.0.0.0 123 dp 0.0.0.0 123 dp 0.0.0.0 767	udp	0.0.0	10080		
dp 0.0.0.0 631 dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 123 dp 0.0.0.0 767	udp	0.0.0	5353		
dp 0.0.0.0 46841 dp 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 123 dp 0.0.0.0 767	udp	0.0.0	111		
. 193.170.37.80 123 dp 127.0.0.1 123 dp 0.0.0.0 123 dp 0.0.0.0 767	udp	0.0.0.0	631		
dp 127.0.0.1 123 dp 0.0.0.0 123 dp 0.0.0.0 767	udp	0.0.0	46841		
dp 0.0.0.0 123	udp	193.170.37.80	123		
idp 0.0.0.0 767	udp	127.0.0.1	123		
dp 0.0.0.0 767	udp	0.0.0.0	123		
	udp	0.0.0	767		-
	•	· ··			
					//

Network Connections - portscan

gnome-nettool, local

۲		2 Ne	iwork Tools - Port Scan ≺@prometheus>		١											
Ţo	ol <u>E</u> o	lit <u>H</u> e	lp													
De	evices	Ping	Netstat Traceroute Port Scan Lookup Finger Whois													
N	letwo	rk addr	ess: prometheus													
	lormoi	it diddi														
				Scan 🖉												
E			Service													
Ľ		open														
		open														
			telnet													
	25	open	smtp													
	79	open	finger													
	111	open	sunrpc													
		open														
			unknown													
		open														
		open	-													
		open														
			afpovertcp													
			submission													
		open	unknown													
			unknown													
			unknown													
		open														
		open		-											★ 注入 ★ 注入	★ E > < E >
							_	_	_	_	_	_	 	 		

Network Connections- portscan

gnome-nettool, remote

•	🙁 Nei	twork Tools - Port Scan <@prometheus>						
<u>T</u> ool <u>E</u>	dit <u>H</u> e	elp						
Devices	Ping	Netstat Traceroute Port Scan Lookup Finger Whois						
Netwo	Network address: www.bme.hu							
<u>_</u>								
			an 🖉 Scan					
Port		Service						
	open							
	open							
	open							
	open							
	open							
	open							
3306	open	mysql						
]						

1 Computer Networks

- 2 Internet
- 3 Ethernet
- 4 Internet Protocols
- 5 Models
- 6 TCP
- 7 TCP



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Connecting Computers to the Network

Connecting automatically by DHCP

- the most confortable solution
 - if DHCP server is available for the domain, for the LAN segment
 - if the DHCP server is not restricted to known hosts
 - the hardware address (MAC address) of ethernet/wireless interface needed for access

Connecting manually with fixed IP address

- this solution always works (local help (IP) needed)
- needs more knowledge about the OS, configuration files, etc.
- the only possibility if no DCHP server available

Connecting Computers to the Network $\mathsf{Using\ DHCP}$

Linux Configuration with network-admin

		👻 🥂 🤲 Interface	properties 🛛 🗙
• Network settings		Connection	
Location:		Interface name: eth0	
Connections General DNS Hosts		\blacksquare Enable this connection	
Wireless connection	Properties	Connection setting	s
	🍰 🛆 ctivate	Configuration:	DHCP 두
The interface eth0 is active	8 Deactivate	IP address:	192.168.1.115
Modem connection The interface ppp0 is not configured		<u>S</u> ubnet mask:	255.255.255.0
		<u>G</u> ateway address:	192.168.1.1
Default gateway device: eth0	<u>Cancel</u>	🔯 <u>H</u> elp	¥ <u>C</u> ancelOK

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Connecting Computers to the Network by DHCP for MS Windows

	nternet Protocol (TCP/IP) Properties ?
cal Area Connection Properties	General Alternate Configuration
General Connect using:	You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Intel(R) PR0/100 VE Network Connection Configure	 Obtain an IP address automatically
Components checked are used by this connection:	Use the following IP address: IP address: Submet mask:
File and Printer Sharing for Microsoft Networks Internet Protocol (TCP/IP)	Subnet mask: Default gateway:
Install Uninstall Properties	O Dbtain DNS server address automatically O Use the following DNS server addresses:
Description Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.	Preferred DNS server:
Show icon in taskbar when connected	Advanced
OK Cancel	OK Cance

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Connecting Computers to the Network

Using fixed IP addresses

Linux Configuration with network-admin

		👻 🥂 Interface	properties 📃 🗙
• 🔄 Metwork settings		Connection	
Location:		Interface name: eth0	
Connections General DNS Hosts		Enable this connection	
Wireless connection	<u>g</u> Properties	Connection setting	s
Ethernet connection The interface eth0 is active	Activate	Configuration:	Static IP address 🔻
Modem connection		IP address:	192.168.1.115
The interface ppp0 is not configured		<u>S</u> ubnet mask:	255.255.255.0
		<u>G</u> ateway address:	192.168.1.1
Default gateway device: eth0	<u>Cancel</u>	🔯 <u>H</u> elp	K CancelOK

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Connecting Computers to the Network

The Name Server

Configuration in Linux with network-admin

•	Network settings	
Location:	liwest	•
Connectio	ons General DNS Hosts	
DNS S	ervers	
212.3	33.55.5	🕁 🛧
212.3	33.32.160	Pelete
		Delete
	D	
	i Domains liwest.at	💠 Add
		Delete
	1	
🔯 <u>H</u> elp		💥 <u>C</u> ancel 🥔 <u>O</u> K

Connecting Computers to the Network by static IP for MS Windows

ocal Area Connection Properties	x
General	Internet Protocol (TCP/IP) Properties
Connect using:	General You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for
Components checked are used by this connection: Components checked are used by this connection: Configure Configure Confi	the appropriate IP settings. © Dbain an IP address automatically © Use the following IP address IP address: 10410130 Sybmet mask: 2552550 Default gateway: 10410254
I Install Uninstall Properties	Obtain DNS server address automatically Use the following DNS server addresses:
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.	Preferred DNS server: 10401 Alternate DNS server: 1020301
Show icon in taskbar when connected	Adyanced
OK Cancel	OK Cancel

Connecting Computers to the Network

Linux computer with Fixed IP addresses

Manual (command line) solution

- Changing the appropriate files
- Files responsible for connection:
 - /etc/network/interfaces
 - /etc/hosts
 - /etc/resolv.conf
- Other files for the host configuration
 - /etc/hostname
- File /etc/hosts
 - 127.0.0.1 localhost
 - 193.170.37.225

kernel.risc.uni-linz.ac.at kernel

- File /etc/hostname
 - kernel

Connecting Computers to the Network By fixed IP address

File /etc/network/interfaces for fixed IP address

This file describes the network interfaces available on your system # and how to activate them. For more information, see interfaces(5). # The loopback network interface auto lo iface lo inet loopback

The primary network interface
allow-hotplug eth0
auto eth0
iface eth0 inet static

address 193.170.37.115 netmask 255.255.255.0 broadcast 193.170.37.255 network 193.170.37.0 gateway 193.170.37.1

(日) (종) (종) (종) (종) (종)

Connecting Computers to the Network Using DHCP

File /etc/network/interfaces

This file describes the network interfaces available on your system # and how to activate them. For more information, see interfaces(5). # The loopback network interface auto lo iface lo inet loopback

The primary network interface
allow-hotplug eth0
auto eth0
iface eth0 inet dhcp

Linux Configuration, on Command line

- change the /etc/network/interfaces file
- stop and start the interface: ifdown eth0; ifup eth0
- you will see the messages in the command line from ifup command

Connecting Computers to the Network Using DHCP

File /etc/resolv.conf

 for fixed IP configuration it consist the nameservers and domain name

search risc.uni-linz.ac.at
nameserver 193.170.37.224
nameserver 193.170.37.222
nameserver 193.170.37.138

- for DHCP connection it will be created by DHCP
- the contents is the same as above

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slide will be added later!

Thanks for your attention !

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