
KTH
VETENSKAP
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IK1550 & IK1552
Internetworking/Internetteknik
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School of Information and Communication Technology (ICT), KTH Royal Institute of Technology
IK1550/IK1552 Spring 2014, Period 4
2014.04.23
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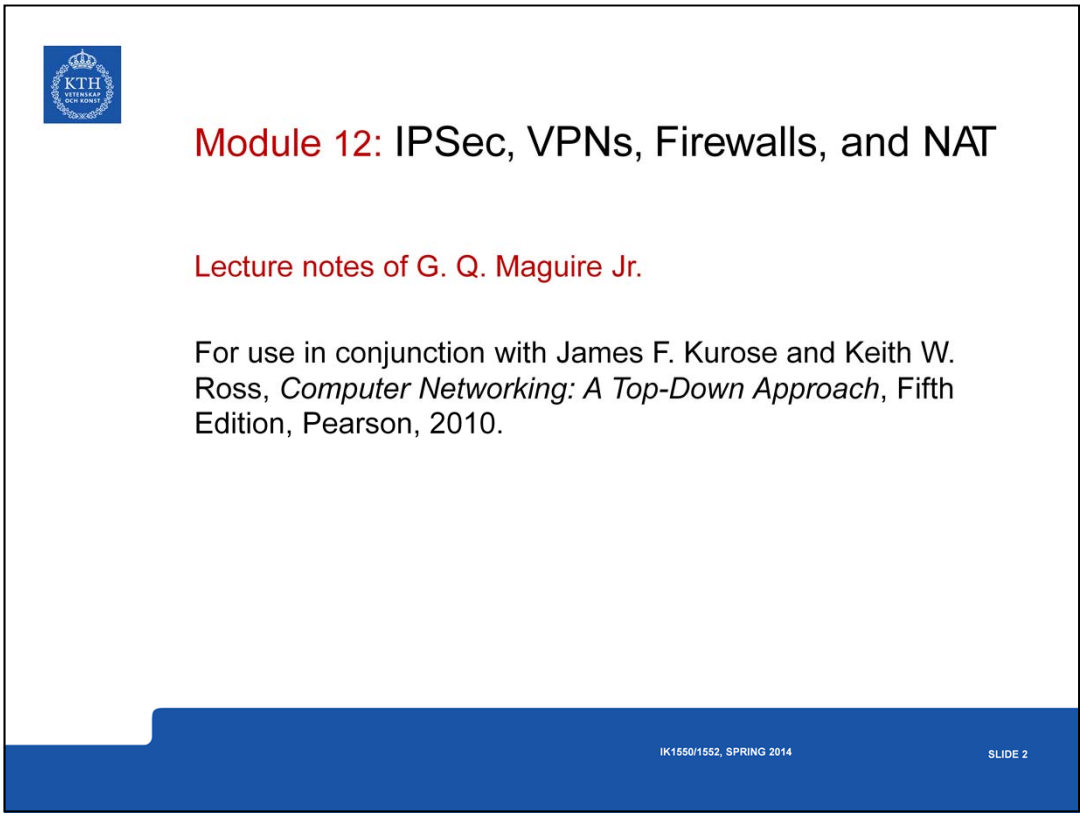
Module 12: IPSec, VPNs, Firewalls, and NAT
Lecture notes of G. Q. Maguire Jr.
For use in conjunction with James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Fifth Edition, Pearson, 2010.
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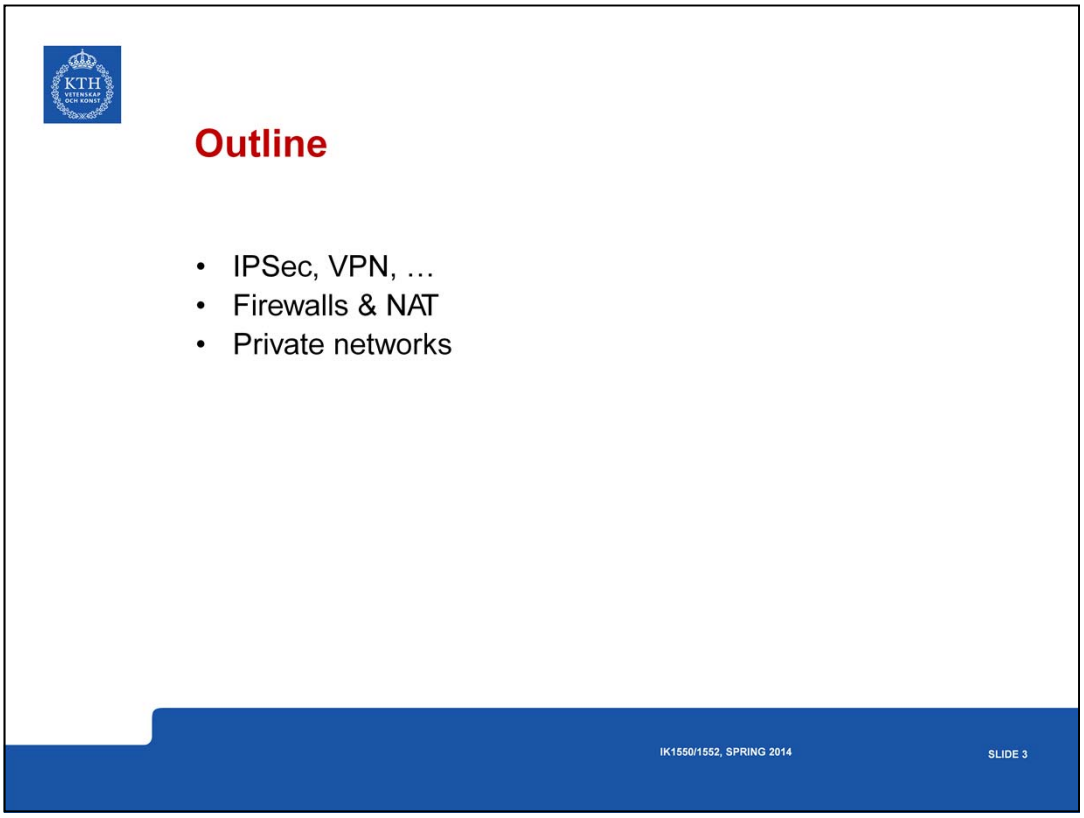
SLIDE 2


Outline
• IPSec, VPN, …
• Firewalls & NAT
• Private networks
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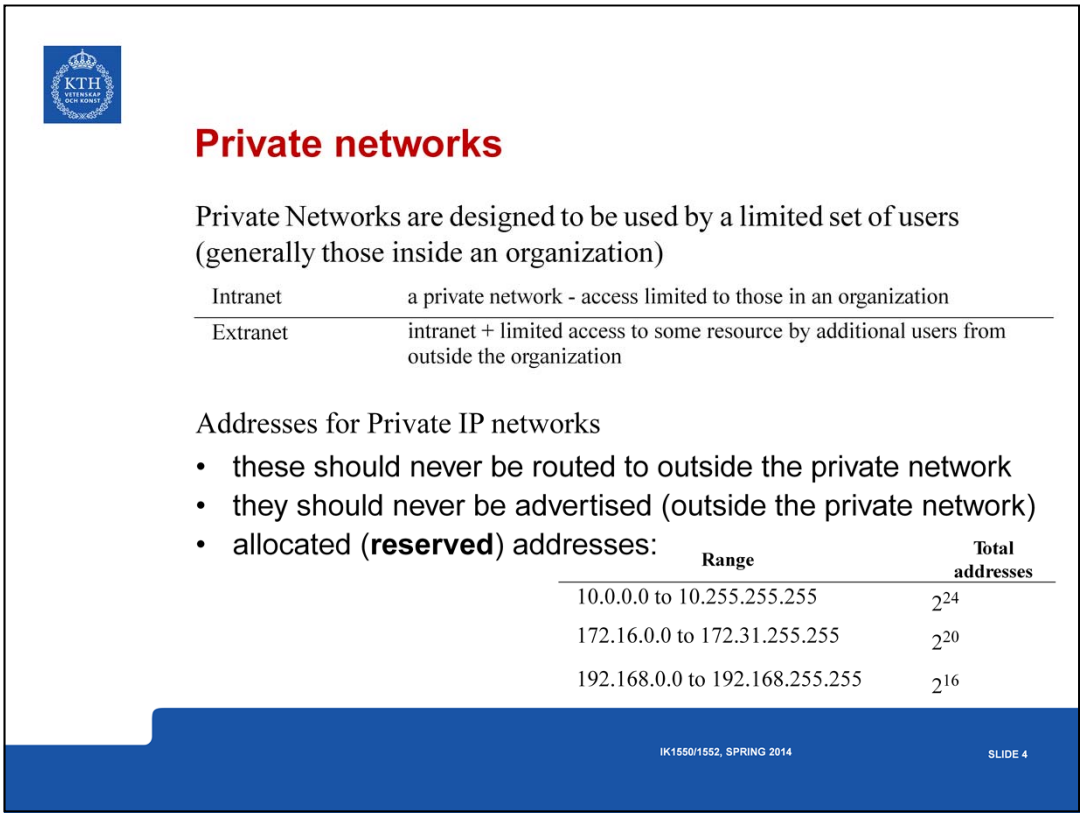
SLIDE 3



Private networks

Private Networks are designed to be used by a limited set of users (generally those inside an organization)

Intranet	a private network - access limited to those in an organization
Extranet	intranet + limited access to some resource by additional users from outside the organization

Addresses for Private IP networks

- these should never be routed to outside the private network
- they should never be advertised (outside the private network)
- allocated (**reserved**) addresses:

Range	Total addresses
10.0.0.0 to 10.255.255.255	2^{24}
172.16.0.0 to 172.31.255.255	2^{20}
192.168.0.0 to 192.168.255.255	2^{16}

Virtual Private networks (VPNs)

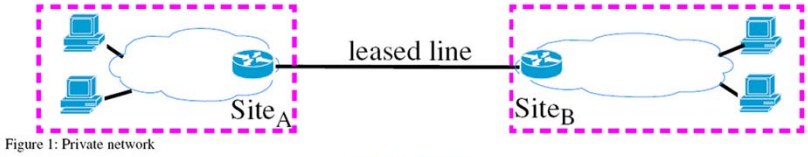


Figure 1: Private network

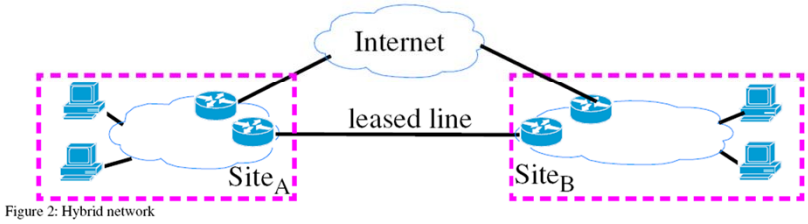
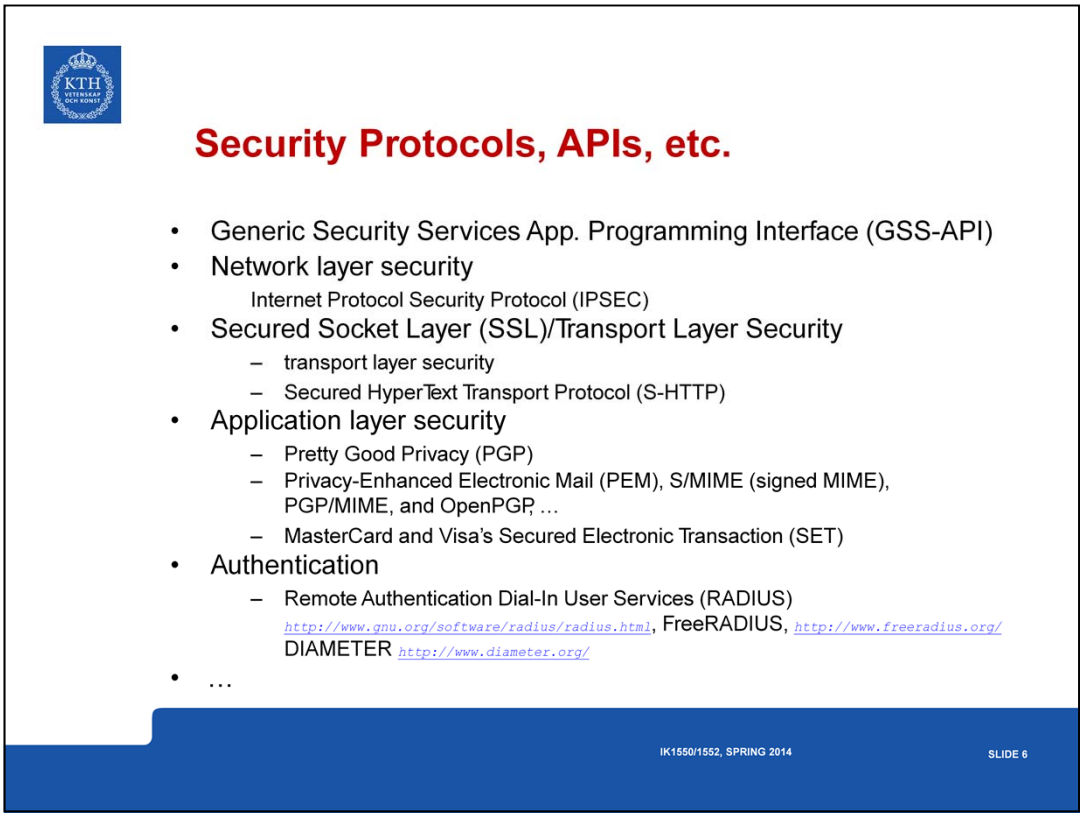


Figure 2: Hybrid network

Figure 3: Virtual Private network



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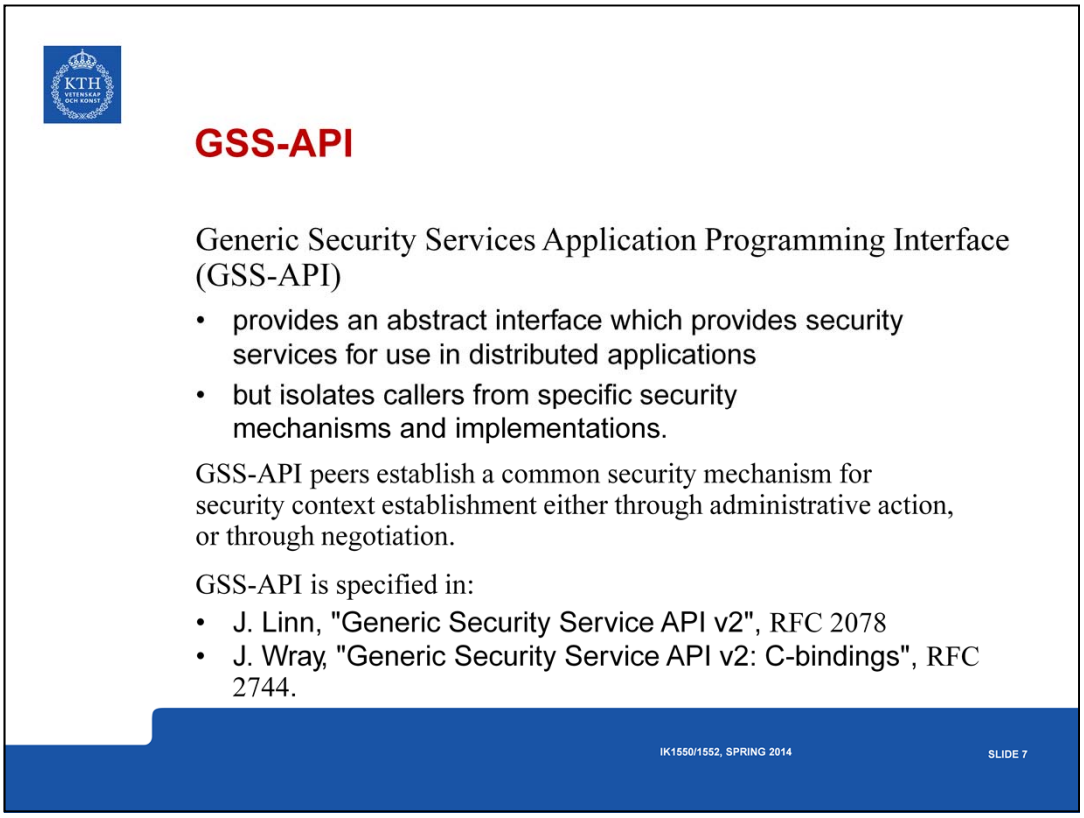
http://www.imc.org/smime-pgpmime.html



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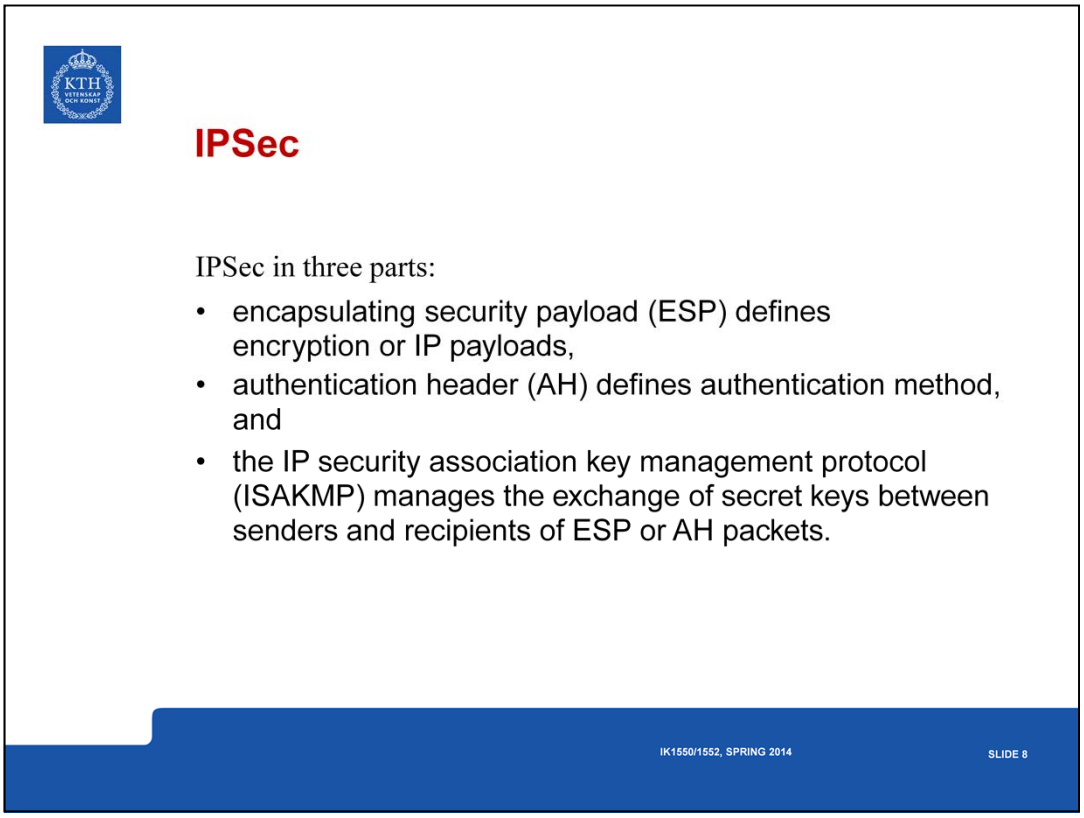
IPSec
IPSec in three parts:
• encapsulating security payload (ESP) defines encryption or IP payloads,
• authentication header (AH) defines authentication method, and
• the IP security association key management protocol (ISAKMP) manages the exchange of secret keys between senders and recipients of ESP or AH packets.
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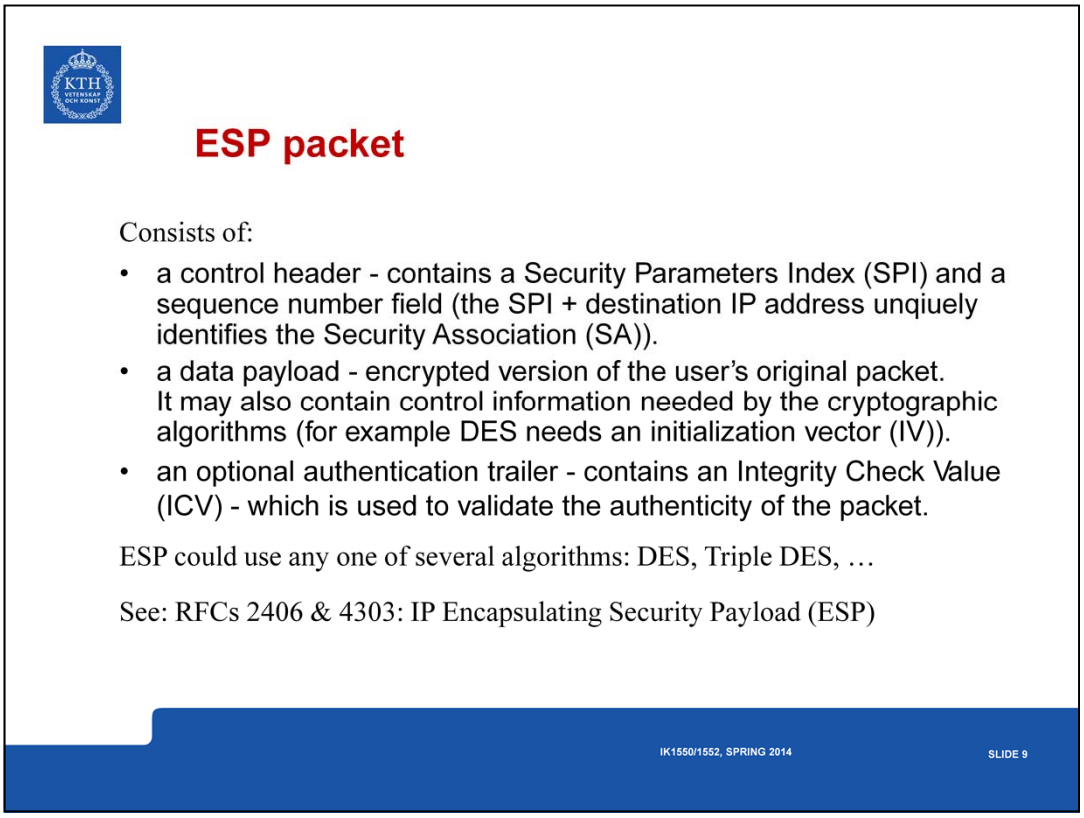
SLIDE 8



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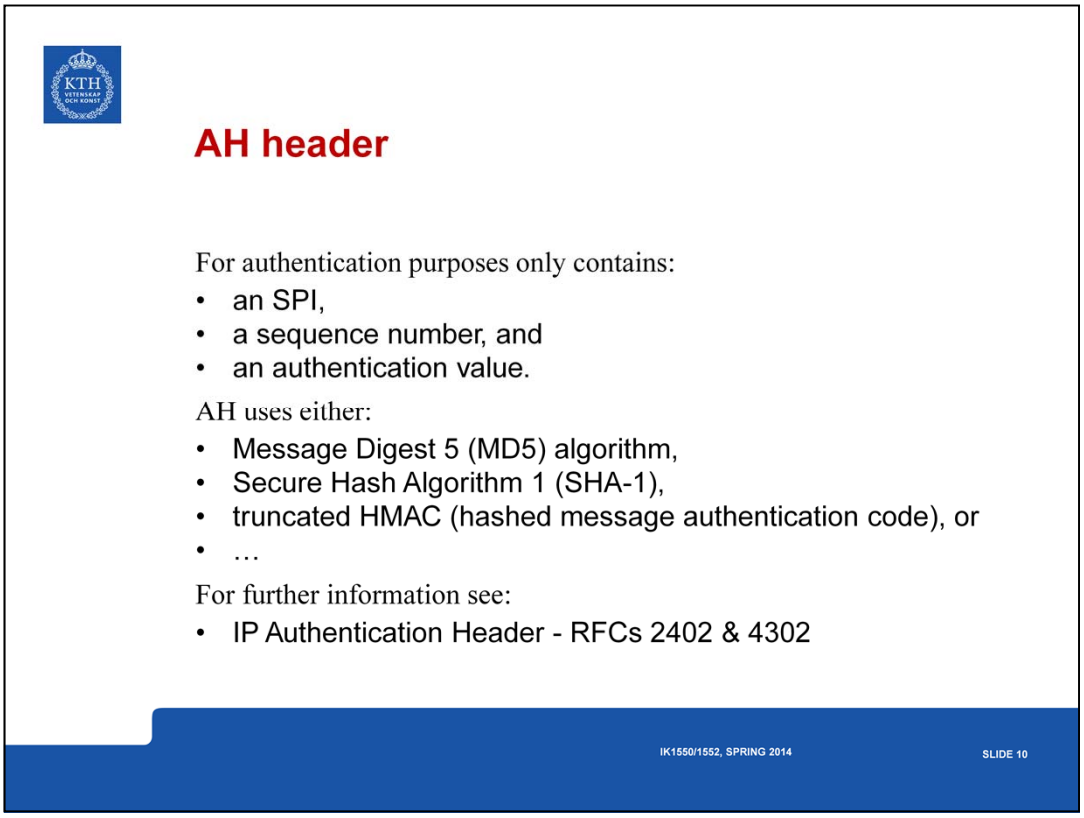

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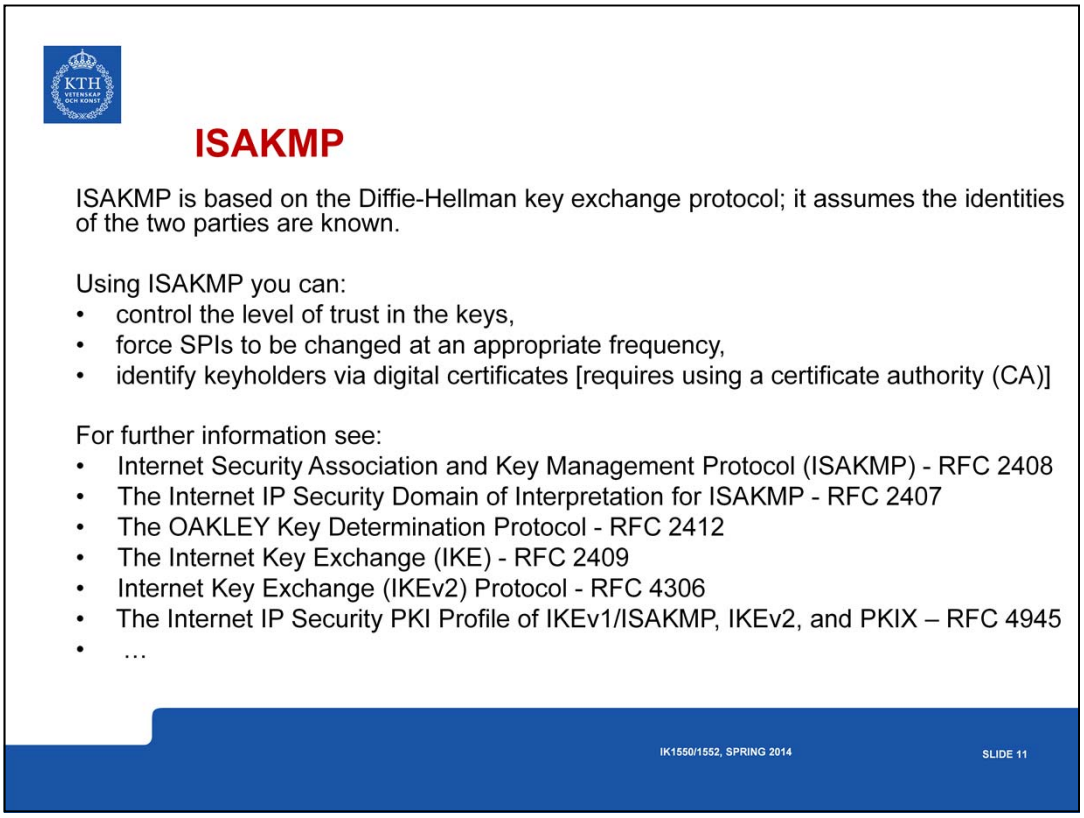

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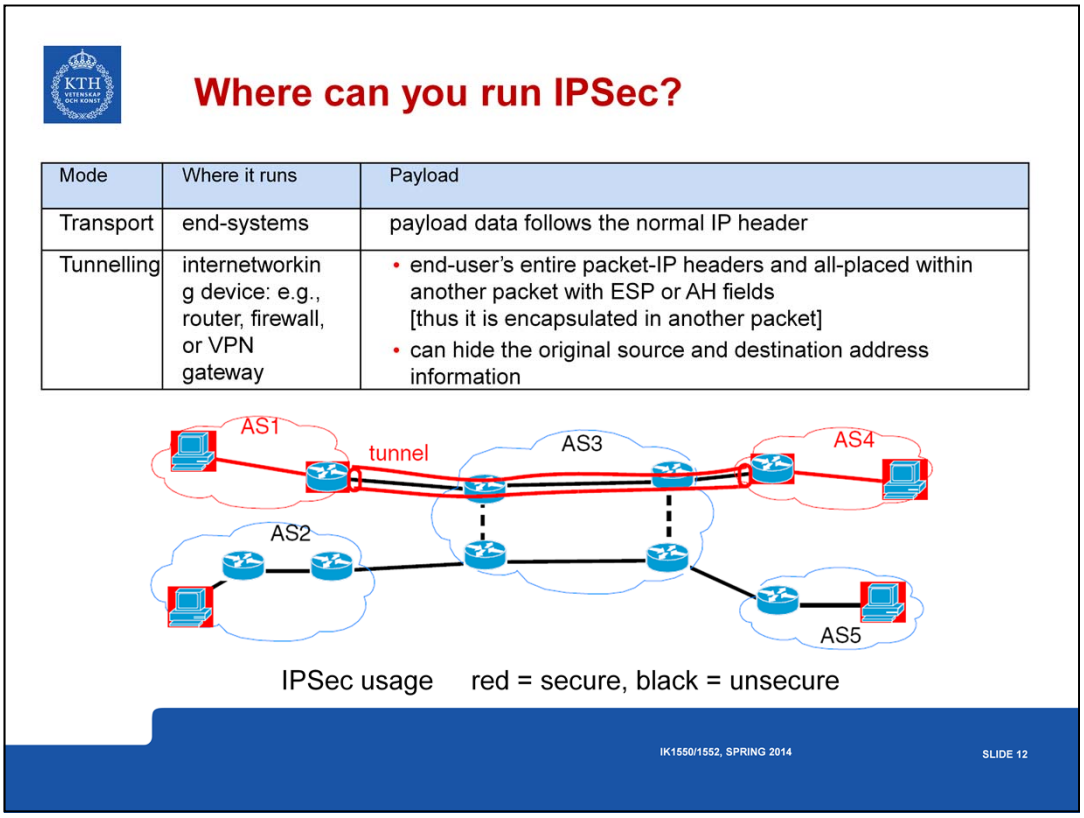
Where can you run IPSec?
Mode
Where it runs
Payload
Transport
end-systems
payload data follows the normal IP header
Tunnelling
internetworking device: e.g., router, firewall, or VPN gateway
• end-user's entire packet-IP headers and all-placed within another packet with ESP or AH fields [thus it is encapsulated in another packet]
• can hide the original source and destination address information
AS1
tunnel
AS3
AS4
AS2
AS5
IPSec usage red = secure, black = unsecure
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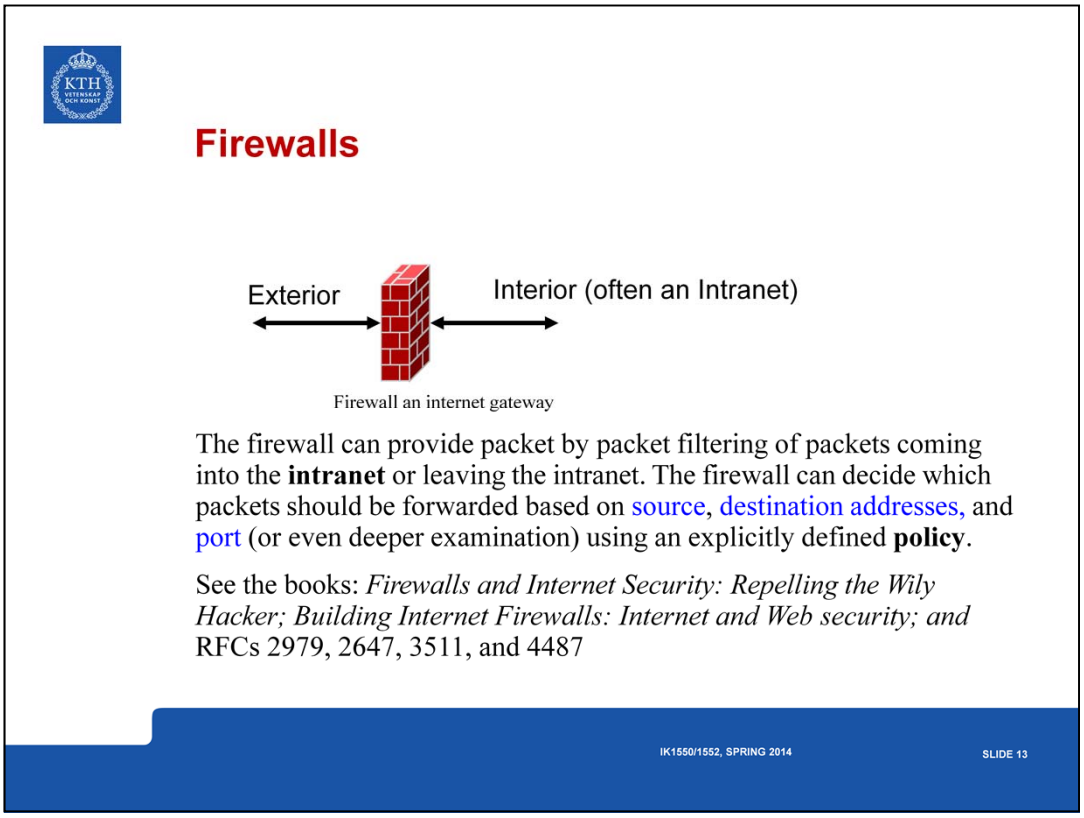
SLIDE 12



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W. R. Cheswick, S. M. Bellovin, and A. D. Rubin, Firewalls and Internet security: repelling the wily hacker, 2nd ed. Boston: Addison-Wesley, 2003, ISBN-10: 020163466X, ISBN-13: 978-0201634662.

http://www.amazon.com/Firewalls-Internet-Security-Repelling-Edition/dp/020163466X

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E. D. Zwicky, S. Cooper, and D. B. Chapman, *Building Internet Firewalls: Internet and Web security*, 2nd ed. Beijing ; Cambridge, Mass: O'Reilly, 2000.

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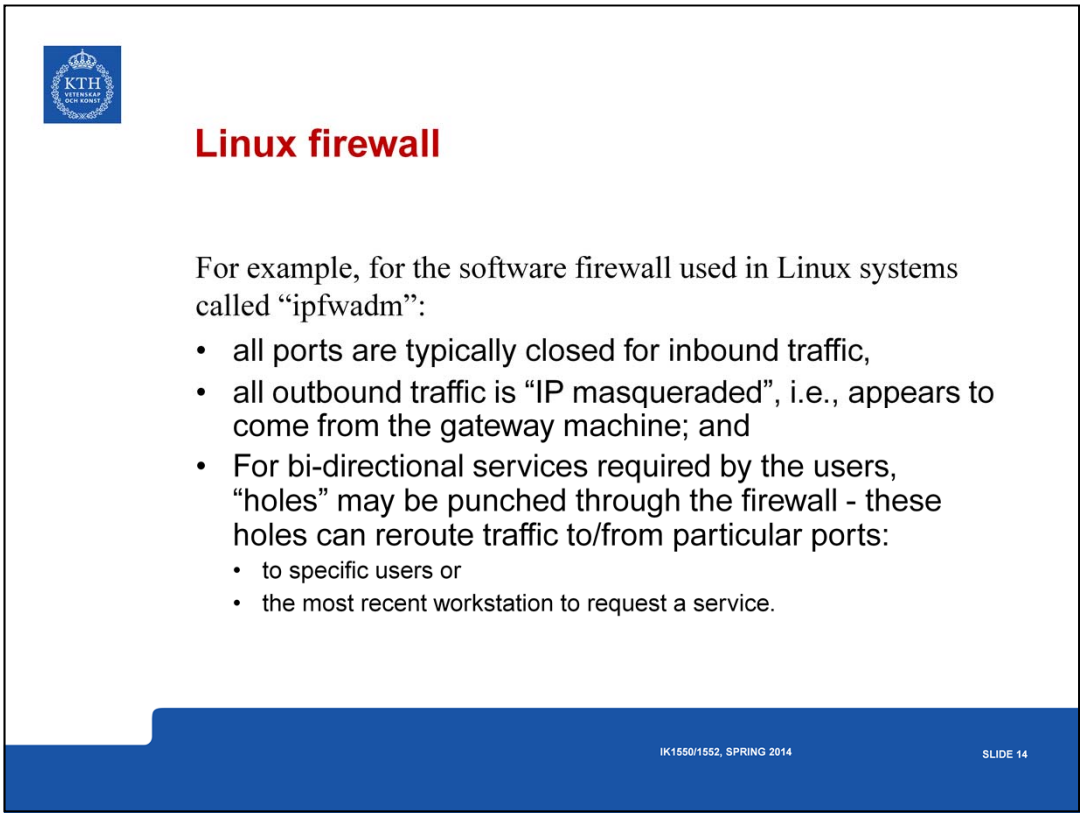
Linux firewall
For example, for the software firewall used in Linux systems called “ipfwadm”:
• all ports are typically closed for inbound traffic,
• all outbound traffic is “IP masqueraded”, i.e., appears to come from the gateway machine; and
• For bi-directional services required by the users, “holes” may be punched through the firewall - these holes can reroute traffic to/from particular ports:
• to specific users or
• the most recent workstation to request a service.
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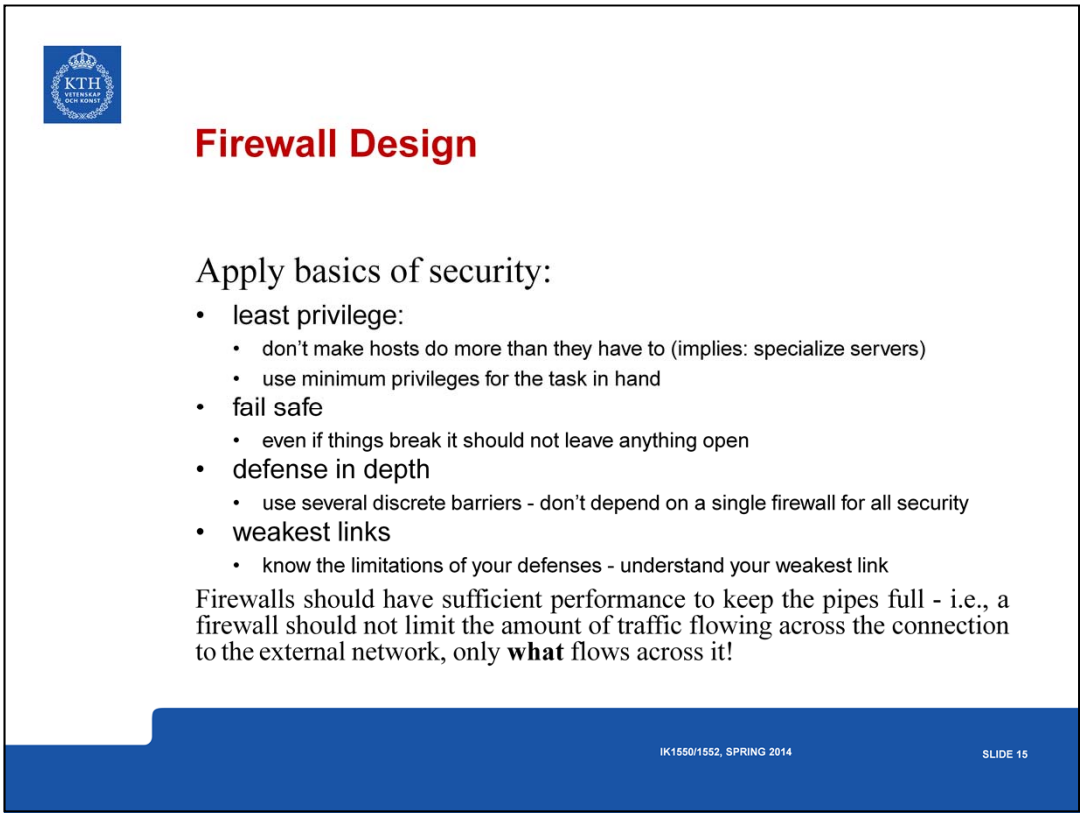
SLIDE 14


Firewall Design
Apply basics of security:
• least privilege:
• don't make hosts do more than they have to (implies: specialize servers)
• use minimum privileges for the task in hand
• fail safe
• even if things break it should not leave anything open
• defense in depth
• use several discrete barriers - don't depend on a single firewall for all security
• weakest links
• know the limitations of your defenses - understand your weakest link
Firewalls should have sufficient performance to keep the pipes full - i.e., a firewall should not limit the amount of traffic flowing across the connection to the external network, only what flows across it!
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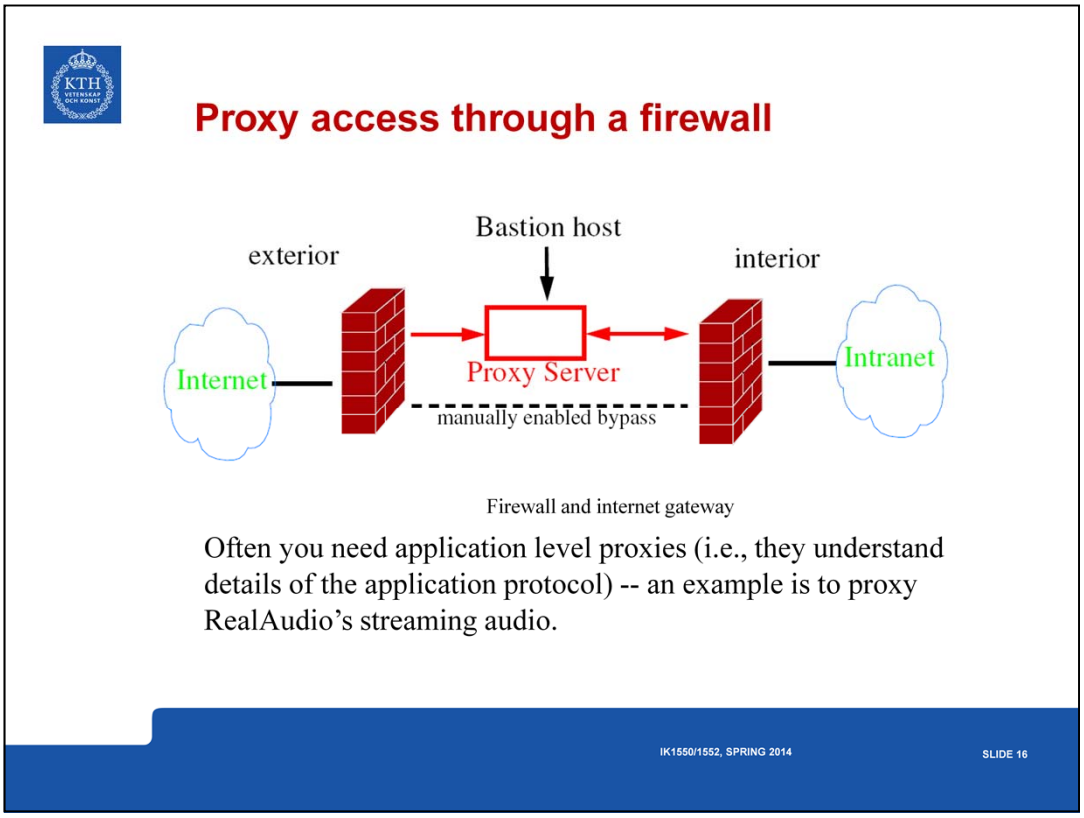
SLIDE 15


Proxy access through a firewall
Bastion host
exterior
interior
Internet
Proxy Server
manually enabled bypass
Intranet
Firewall and internet gateway
Often you need application level proxies (i.e., they understand details of the application protocol) -- an example is to proxy RealAudio's streaming audio.
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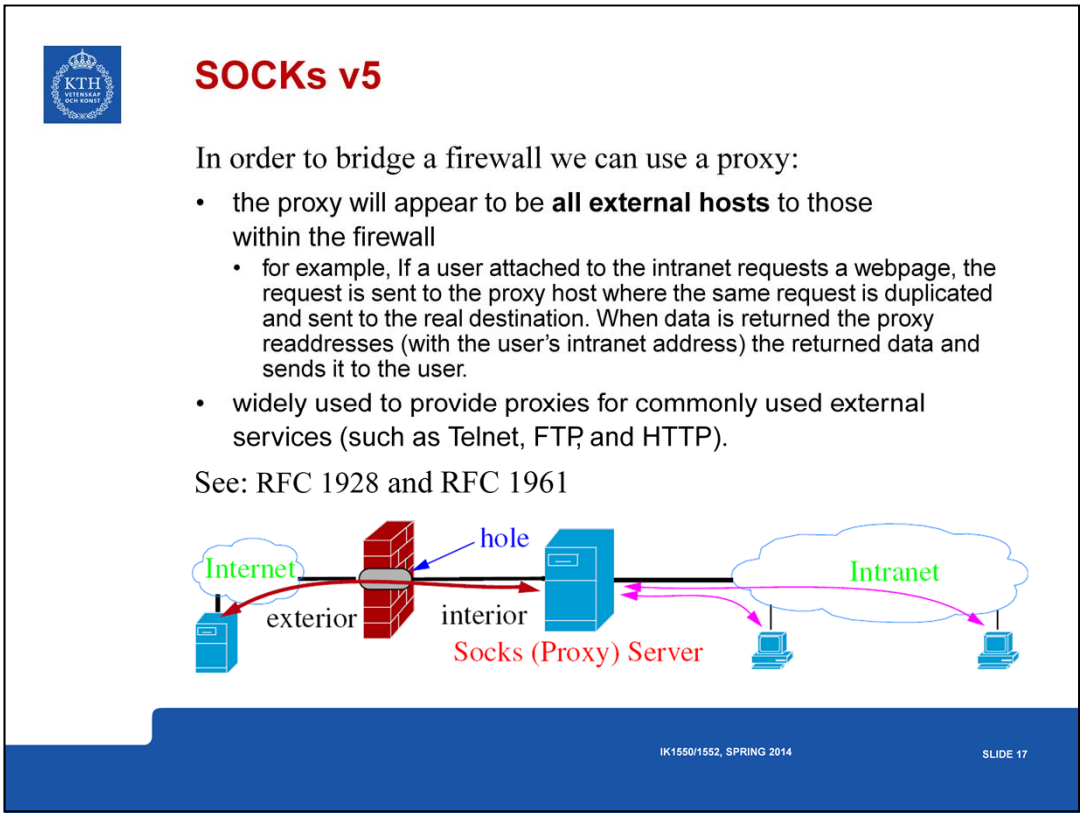
SLIDE 16



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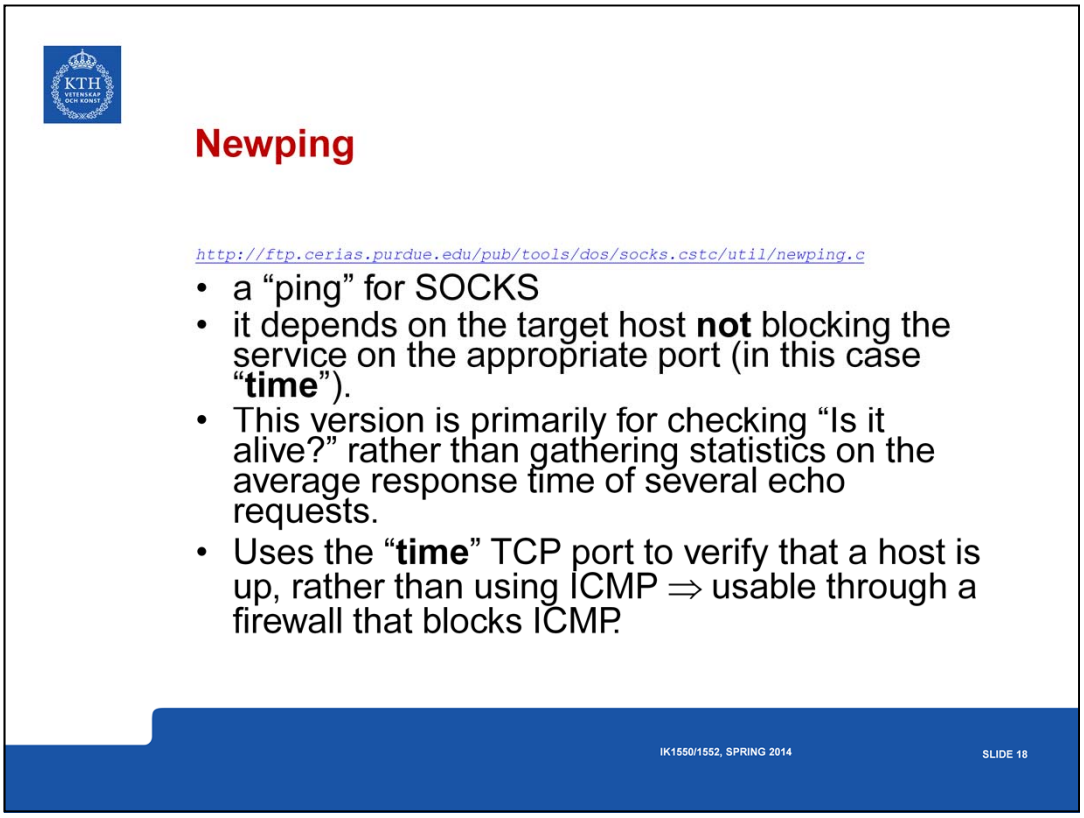
Newping
http://ftp.cerias.purdue.edu/pub/tools/dos/socks.cstc/util/newping.c
• a “ping” for SOCKS
• it depends on the target host **not** blocking the service on the appropriate port (in this case “**time**”).
• This version is primarily for checking “Is it alive?” rather than gathering statistics on the average response time of several echo requests.
• Uses the “**time**” TCP port to verify that a host is up, rather than using ICMP ⇒ usable through a firewall that blocks ICMP.
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SLIDE 18

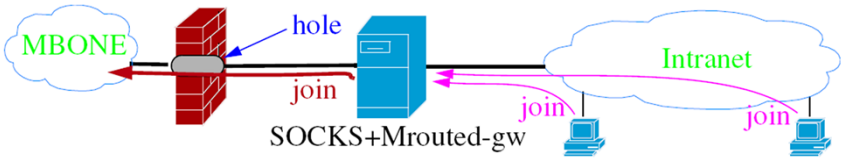
MBONE through firewalls

http://www.cs.virginia.edu/~mngroup/projects/firewalls/

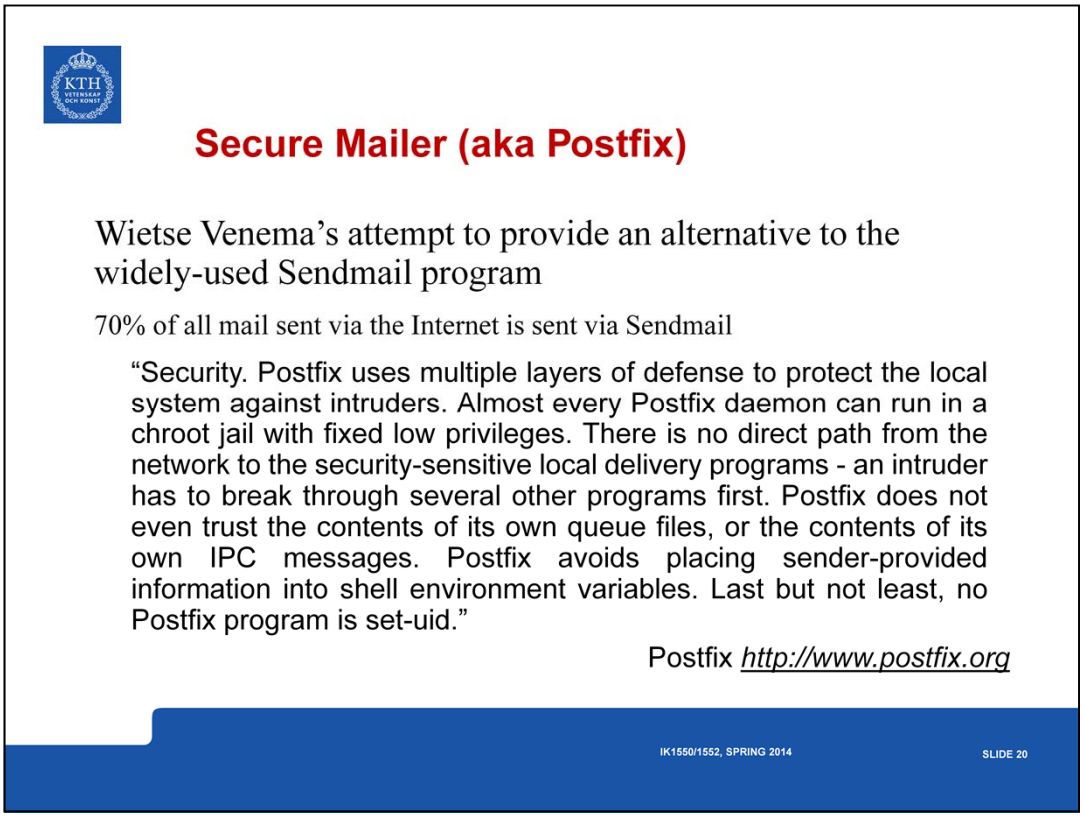
Their firewall features:

- Source host checking (allowing only certain hosts to transmit through the firewall, or denying specific hosts)
- Destination port checking
- Packet contents (unwrapping encapsulated IP)
- Regulating bandwidth allocated to a specific multicast group's traffic

Their Mbone gateway is based on a modified multicast routing daemon.



Firewall and internet gateway


Secure Mailer (aka Postfix)
Wietse Venema's attempt to provide an alternative to the widely-used Sendmail program
70% of all mail sent via the Internet is sent via Sendmail
"Security. Postfix uses multiple layers of defense to protect the local system against intruders. Almost every Postfix daemon can run in a chroot jail with fixed low privileges. There is no direct path from the network to the security-sensitive local delivery programs - an intruder has to break through several other programs first. Postfix does not even trust the contents of its own queue files, or the contents of its own IPC messages. Postfix avoids placing sender-provided information into shell environment variables. Last but not least, no Postfix program is set-uid."
Postfix http://www.postfix.org
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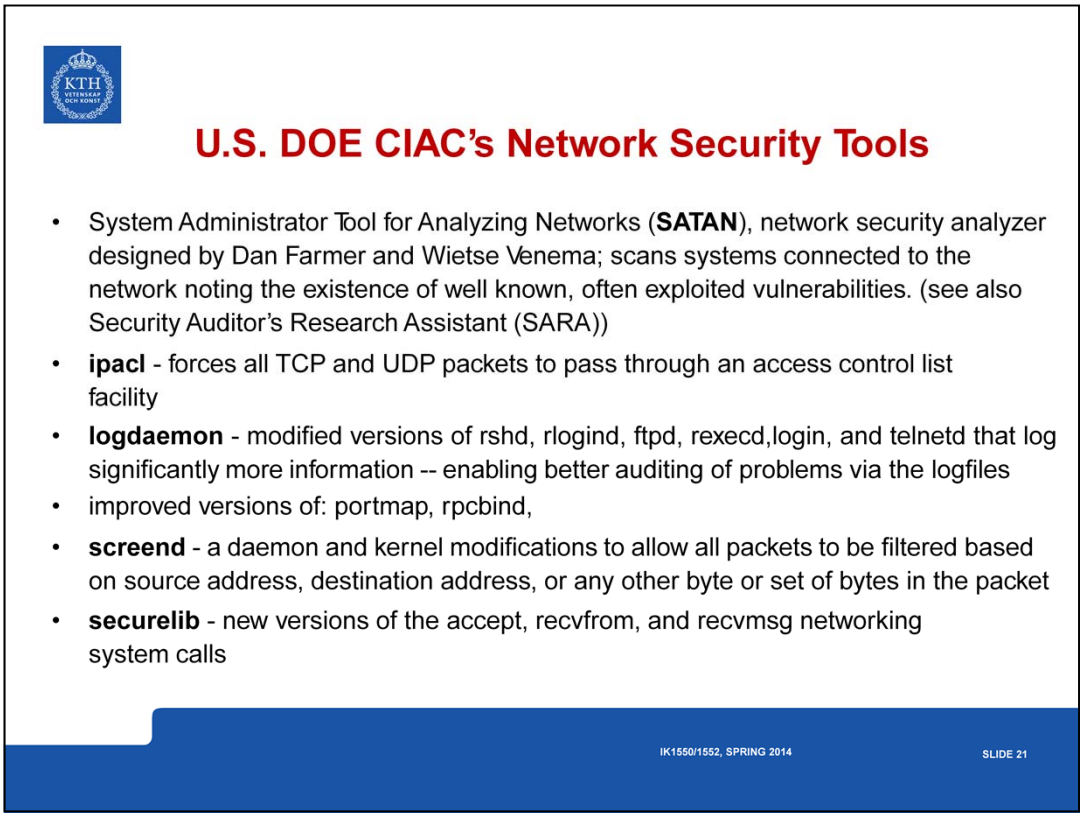
SLIDE 20



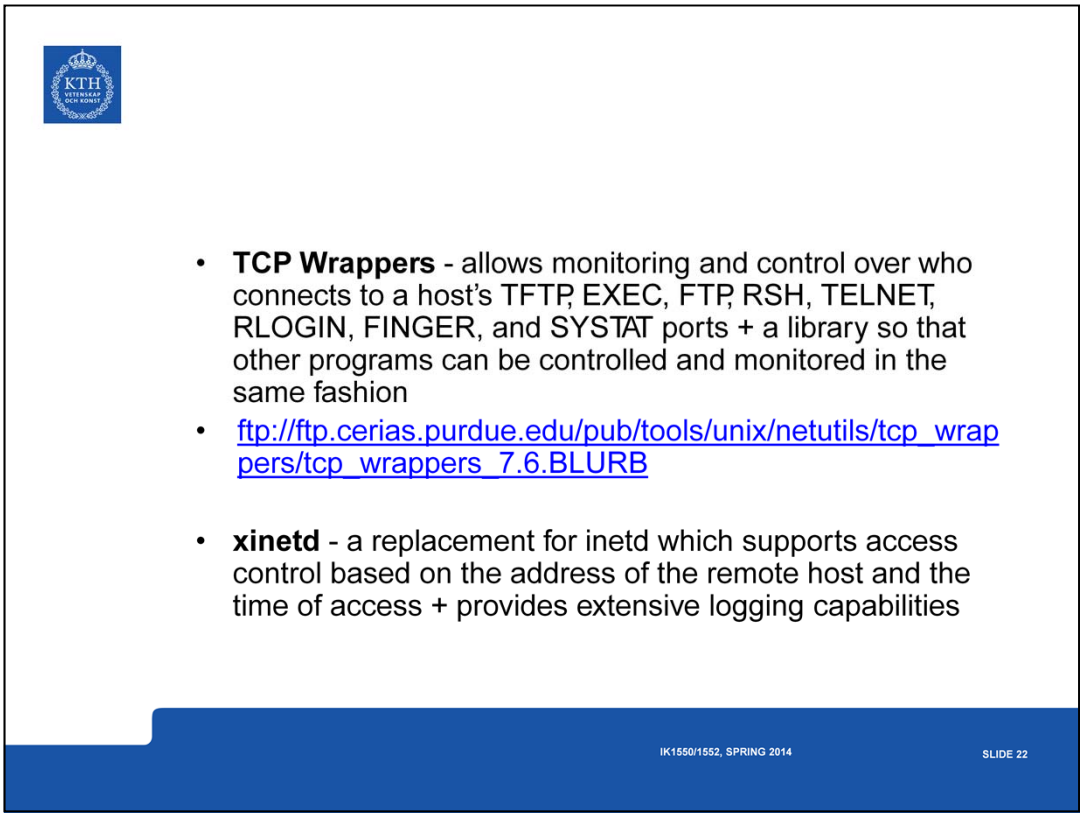
U.S. DOE's Computer Incident Advisory Capability (formerly at *http://ciac.llnl.gov/ciac/ToolsUnixNetSec.html)*

Lawrence Livermore's COMPUTER SECURITY TECHNOLOGY CENTER (CSTC), Making Information Safe, Science and Technology Review, January/February 1998

https://www.llnl.gov/str/Mansur.html

UNIX Public Tools, US Department of Energy, Accessed on 2014.04.22

http://energy.gov/cio/unix-public-tools


• TCP Wrappers - allows monitoring and control over who connects to a host's TFTP, EXEC, FTP, RSH, TELNET, RLOGIN, FINGER, and SYSTAT ports + a library so that other programs can be controlled and monitored in the same fashion
• ftp://ftp.cerias.purdue.edu/pub/tools/unix/netutils/tcp_wrappers/tcp_wrappers_7.6.BLURB
• xinetd - a replacement for inetd which supports access control based on the address of the remote host and the time of access + provides extensive logging capabilities
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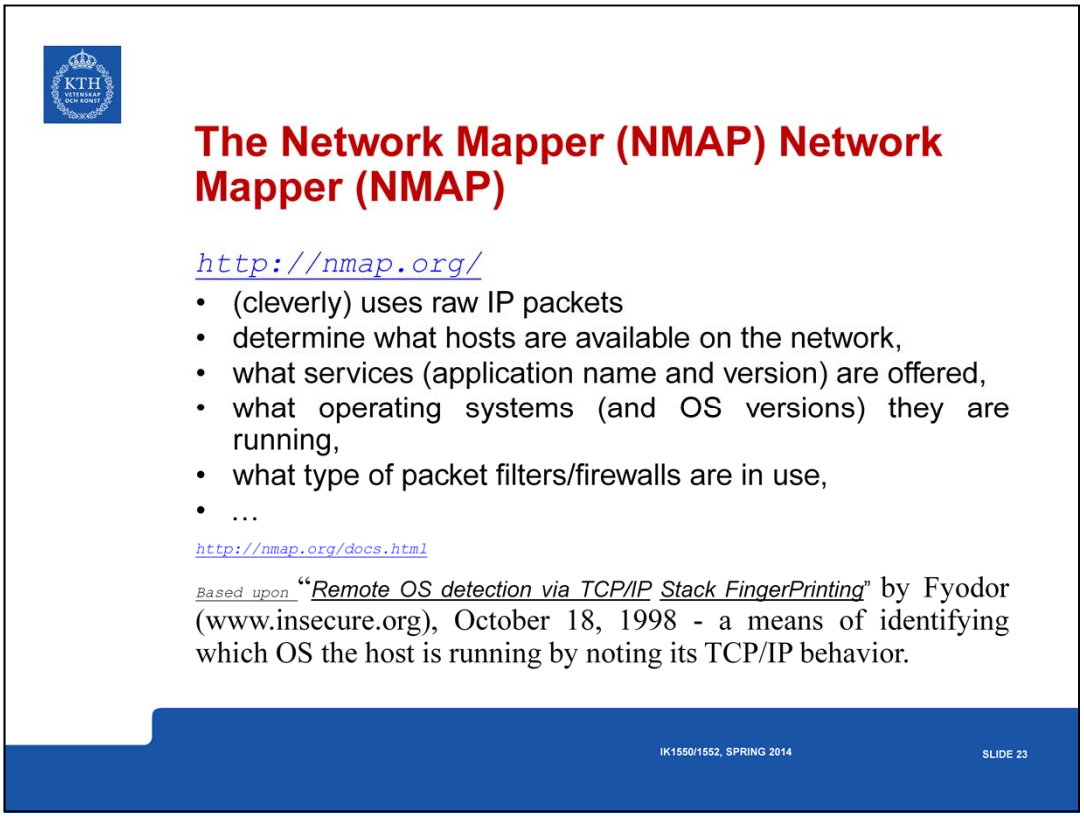
SLIDE 22


The Network Mapper (NMAP) Network Mapper (NMAP)
http://nmap.org/
• (cleverly) uses raw IP packets
• determine what hosts are available on the network,
• what services (application name and version) are offered,
• what operating systems (and OS versions) they are running,
• what type of packet filters/firewalls are in use,
• …
http://nmap.org/docs.html
Based upon "Remote OS detection via TCP/IP Stack FingerPrinting" by Fyodor (www.insecure.org), October 18, 1998 - a means of identifying which OS the host is running by noting its TCP/IP behavior.
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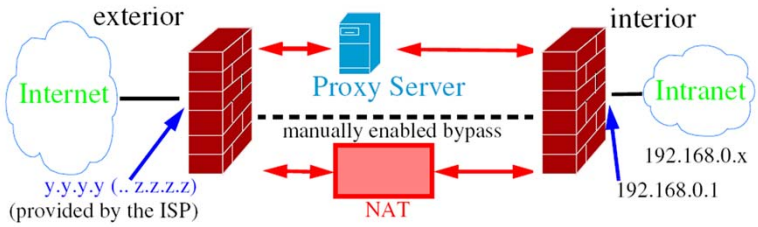
SLIDE 23

Network Address Translation



Example of a Firewall with NAT

NAT maps IP addresses on the inside to one or more addresses on the outside and vice versa. See RFC 3022 and RFC2766. See also RFC 4966 – which describes why RFC 2766 should be historic.

Advantages	Disadvantage
✔ save IPv4 addresses ✔hides internal node structure from outside nodes ✔the intranet does not have to be renumbered when you connect to another ISP	✘ Unfortunately this breaks many services because they use an IP address inside the their data.

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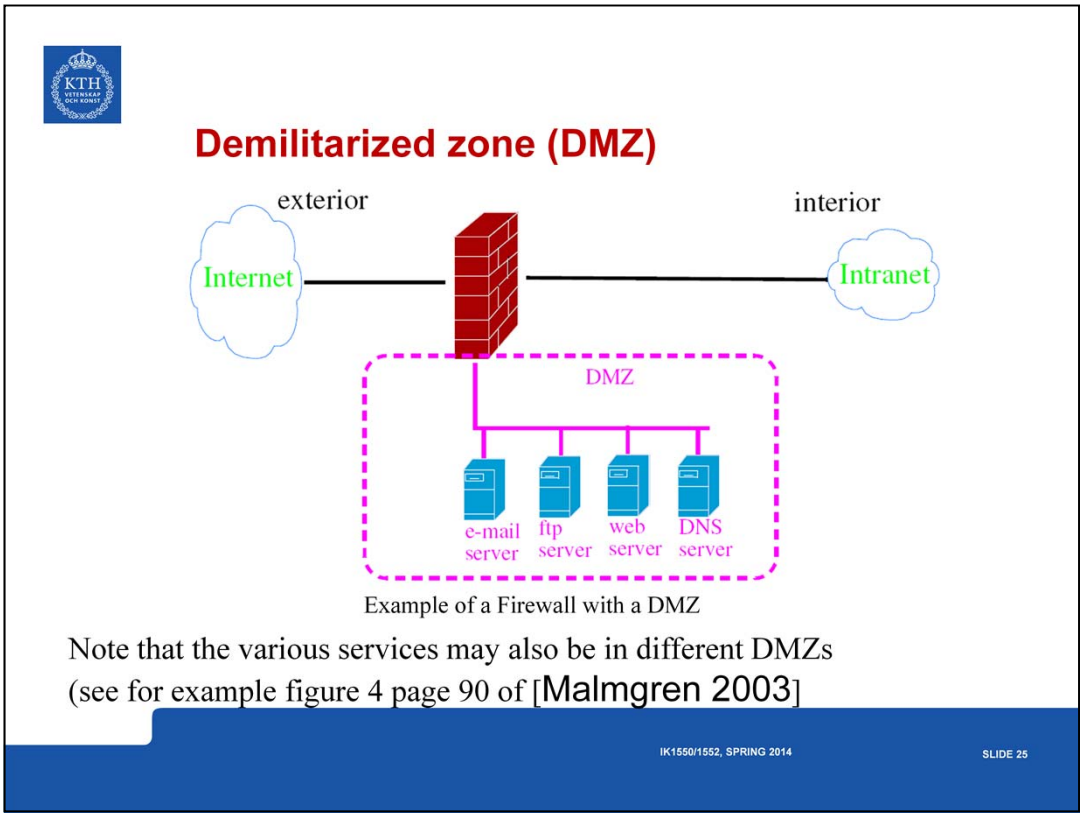

Robert Malmgren, *Praktisk nätsäkerhet*, Internet Academy Press, Stockholm, Sweden, 2003, ISBN 91-85035-02-5

Will Schmied, Victor Chang, Damiano Imperatore, Drew Simonis, Thomas W. Shindler, and Robert J. Shimonski (Technical Editor), Building DMZs For Enterprise Networks. Syngress, 2003, ISBN 1931836884, 978-1931836883.

Computer Emergency Response Team *http://www.cert.org/*

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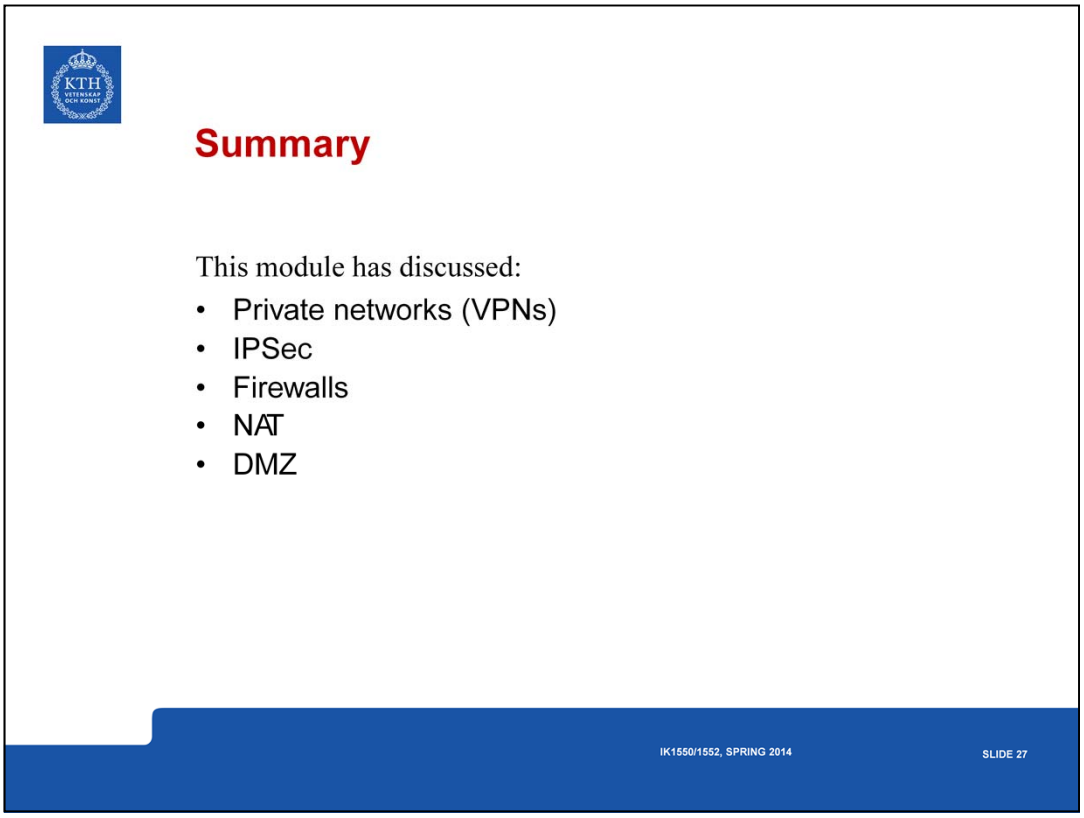
Forum of Incident Response and Security Teams *http://www.first.org/*

U. S. National Institute of Standards and Technology (NIST), Computer Security Division, Computer Security Resource Center *http://csrc.nist.gov/*

Swedish Defense Material Administration *http://www.fmv.se/*

Centre d'Expertise Gouvernemental de Réponse et de Traitement des Attaques informatiques (CERTA) *http://www.cert.ssi.gouv.fr/*


Summary
This module has discussed:
• Private networks (VPNs)
• IPSec
• Firewalls
• NAT
• DMZ
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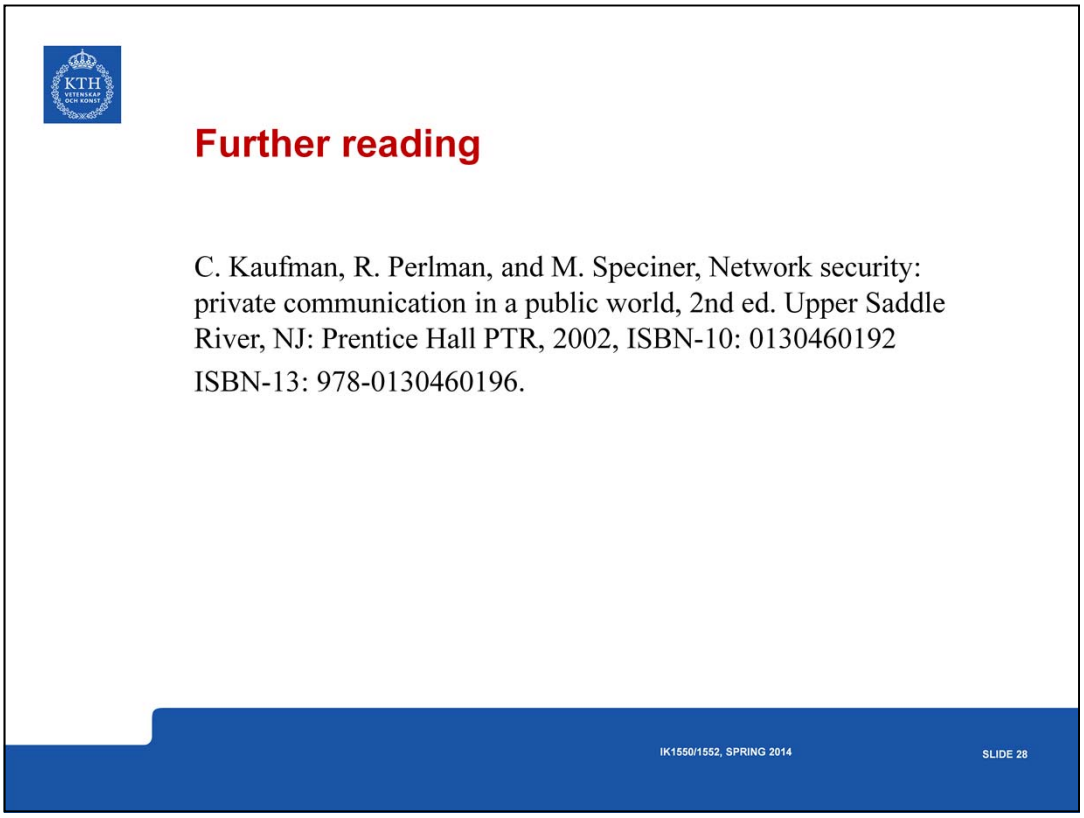
SLIDE 27


Further reading
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IK1550/1552, SPRING 2014
SLIDE 28


¿Questions?
IK1550/1552, SPRING 2014
SLIDE 29