SymQuest GROUP INC

# The Internet, Intranets, Extranets -- and VPNs

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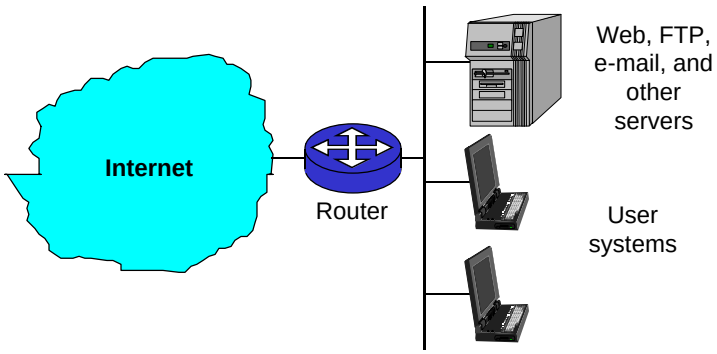
## Overview

- Definition of terms
- Remote access methods
- VPNs
  - » More definitions of more terms
  - » Tunneling and tunneling protocols
    - PPTP, L2F, L2TP, GRE
    - IPsec
- VPN products and services

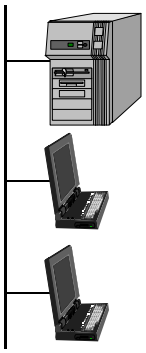
# "Internet"




# Why Use the Internet?

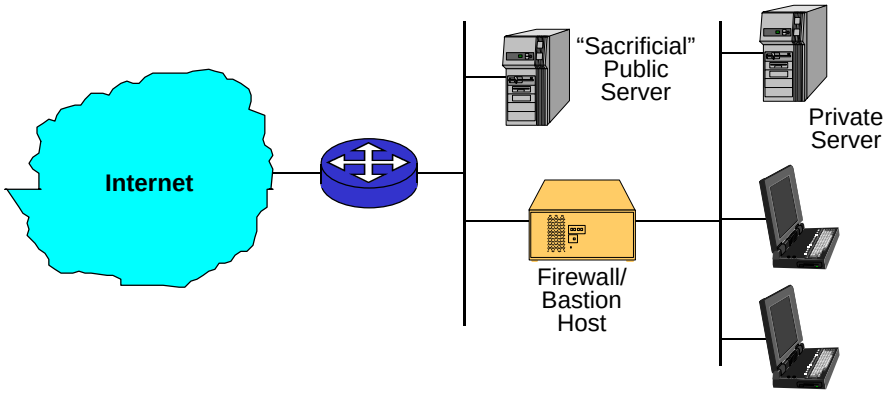
- The Internet is a "network of networks"
- Primary application is to enhance inter-organizational communication
  - » Collaboration
  - » Publishing and research
  - » Sales and commerce
  - » Customer service
  - » Training and education

# “Intranet”



- Applies TCP/IP technology for intra-organizational communication
  - » Internal corporate memos
  - » Customer records
  - » Faster access to employee programs, benefits, etc.
- Results in cost savings, better service

# “Extranet”




**Extranet** = **Internet** + **Intranet**

## What is an Extranet?

- Extranet = Internet + intranet
  - » Intranet servers accessible via the Internet, with password and/or other authentication protection
- Extranets allow *some* users of the public Internet with access to intranet servers, e.g.:
  - » Customer access to sales/product information
  - » Employee access to corporate information, e-mail
  - » Students access to their records, assignments, etc.

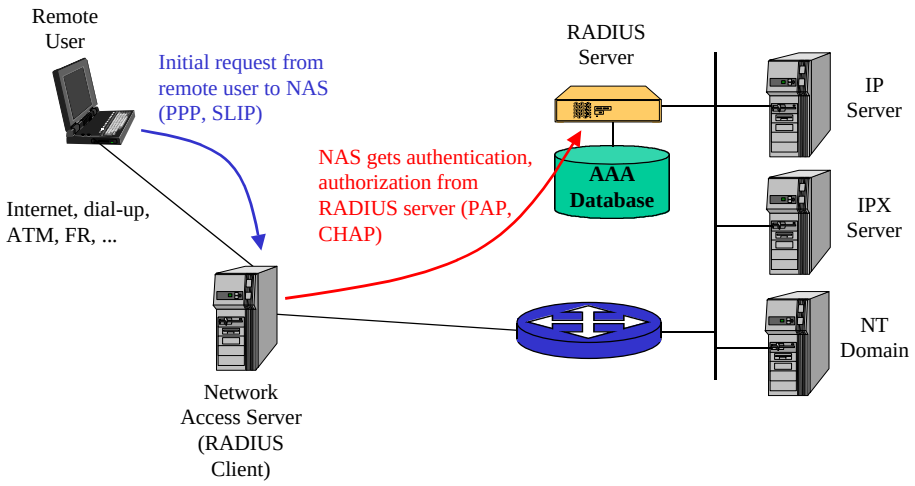
## Remote Access Security

- Major issue for remote access security is the ability to control and monitor access to network resources by users employing many different access technologies
- AAA
  - » Authentication
  - » Authorization
  - » Accounting

# RADIUS

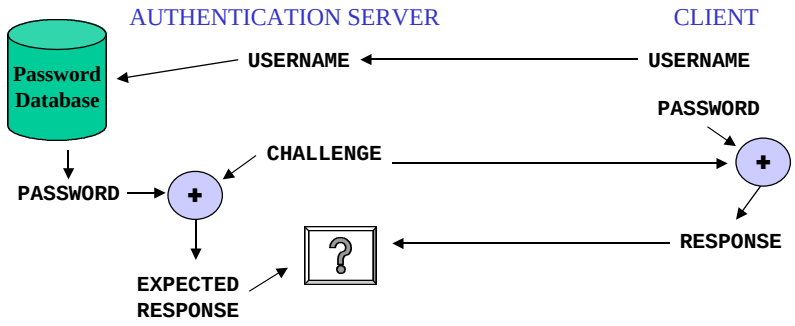
- Remote Authentication Dial In User Service
  - » Provides centralized storage of all AAA information (Accounting optional)
  - » Developed by Livingston (now part of Lucent)
  - » RFC 2138, 2139
  - » Authentication uses PAP or CHAP
  - » Runs over UDP (auth/auth on port 1812, acct on port 1813)
- Widely-used industry de facto standard

# RADIUS (Cont.)



# CHAP

- User identification and authentication *without* sending password over the network (RFC 1994)




# Alternatives to Passwords

- Passwords are "what you know"
- Alternatives include
  - » "What you have"
    - Tokens
    - One-time Passwords
  - » "What you are"
    - Click rate
    - Biometrics: Retina scan, fingerprints, voice prints


## TACACS/TACACS+

- Terminal Access Controller Access Control System
  - » Developed by Cisco to control access to terminal servers
  - » RFC 1492
  - » Runs over TCP (port 49 or other configurable port), sometimes UDP (port 49)

## Virtual Private Networks

- *VPN:* Establishing private connectivity over a public network
- *Internet-based VPN:* Secure transmission over the Internet where the security is implemented at the Network Layer (rather than at the application)

- *virtual* = something you pay for... and don't get!

## VPN Applications

- Cost savings
  - » VPNs (and local ISPs) can replace dial-up servers and toll calls... and even frame relay
- Enhanced connectivity
  - » Can economically provide global access
- Build partner networks/extranets
  - » Uses global, internetwork infrastructure to replace private facilities

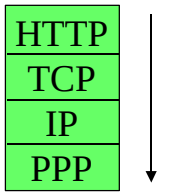
## VPN Applications (cont.)

- Enhanced security
  - » Can use network to authenticate users prior to connecting to servers/applications
- Enhanced protocol support
  - » Internet only carries IP...
  - » ...but IP can tunnel IPX, NetBEUI, DDP, and more!

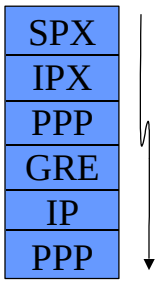
# What Are We Really Worried About?

## *Tunneling* vs. *Encapsulation*

- Both use "enveloping" à la OSI but only encapsulation respects OSI layering

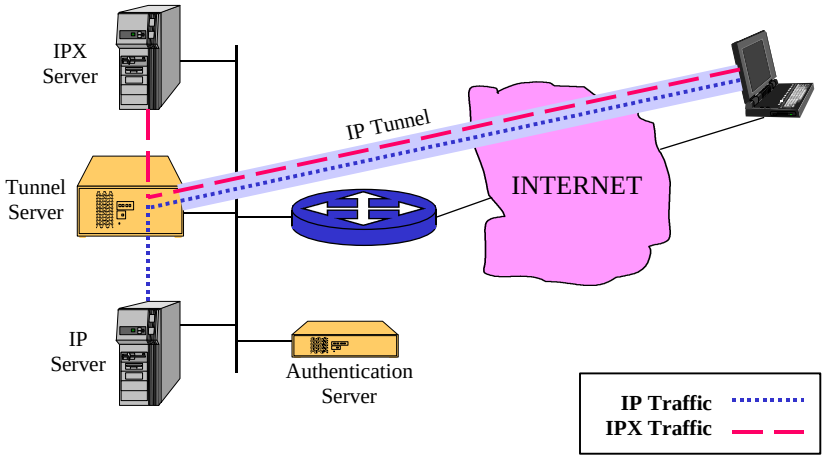



HTTP encapsulated in TCP




SPX/IPX tunneled in IP

# Tunneling Scenario (Host-to-Host)




# Tunneling Scenarios

- Client-initiated
  - » User dials ISP, sets up tunnel to remote tunnel server (e.g., firewall, router, VPN server)
  - » Requires VPN client software
  - » Transparent to network
- NAS-initiated
  - » User dials ISP, ISP's dial-server sets up tunnel
  - » Transparent to client
  - » *No encryption on the dial-up line*

## Some Advantages of Tunneling

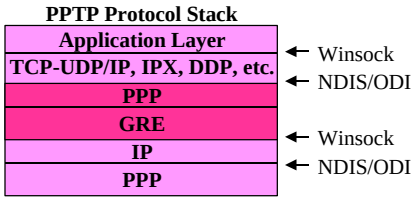
- Uses IP for multiprotocol encapsulation
- Supports additional applications without having to change firewall *(double-edged!)*
- Allows network-based authentication (e.g., WINS, NDS)
- Supports compression for improved thruput

## VPN Protocols

- Lots of protocols to choose from...
  - » Ascend Tunneling Management Protocol (ATMP)
  - » Generic Routing Encapsulation (GRE)
  - » Layer 2 Forwarding (L2F)
  - » Layer 2 Tunneling Protocol (L2TP)
  - » Point-to-Point Tunneling Protocol (PPTP)
  - » Secure Tunnel Establishment Protocol (STEP)

# PPTP

- Developed by PPTP Forum
  - » Ascend, ECI, Microsoft, & 3Com
  - » RFC 2637
- Uses PPP and GRE to route over the Internet




- PPTP offers encapsulation (GRE), authentication (CHAP), encryption (PPP), compression (PPP), and management

# RAS

- Standard feature with Windows NT Server
  - » Supports direct dial-up users and tunneling
  - » Employs MS-PPTP for tunneling
  - » Employs PAP or MS-CHAP for authentication
- Depends upon WINS
  - » Client configuration required
  - » Open many more *vulnerable* ports in the firewall to deal with NetBIOS!

## Sidebar: MS-PPTP Security

- Several security problems with MS-PPTP
  - » Keys are *effectively* less than 128 bits in length
  - » Uses RAS "shared secret" encryption
    - Shared secret is the password hash, which is weak
  - » Poorly designed control channel leaves server open to attack
  - » Encryption can be disabled via the "You Are Now in France" attack

## Sidebar: MS-CHAP

- Server sends 8-byte challenge
- Client creates two 24 byte responses, using LAN Mgr. hash and then WinNT hash each to derive 3 DES keys
- Server uses stored hashes to decrypt response

MS-CHAP has a number of potential vulnerabilities:
- Use of LANMAN hash
- *change password* flaw allowed access to hash

DUN 1.3 introduced MS-CHAPv2

## Sidebar: MS-CHAPv2

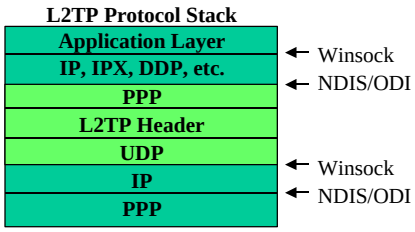
- Available in DUN 1.3
- Improved many weaknesses in PPTP
- MS-CHAPv2
  - » Authenticates both client *and* server
  - » Does not use LANMAN hash
  - » Fixed *change password* flaw
- New MPPE uses different keys in both directions
- Because backward compatibility is retained, a *version rollback* attack may be possible even if MS-CHAPv2 is used

## L2F

- Developed by Cisco
  - » Defined in RFC 2341
- Tunnels data in HDLC, PPP, or SLIP over UDP across the Internet
- Uses PAP or CHAP for authentication

# L2TP

- Developed by IETF
  - » Combines PPTP and L2F
- Uses PPP for encapsulation, authentication, compression, & management
- Uses IPsec for encryption




# GRE

- IETF specification (RFC 1701) for multiprotocol encapsulation
  - » Not a tunneling protocol, per se; offers no authentication, encryption, etc.
  - » Usually deployed in conjunction with additional security mechanisms, such as IPsec
- Firewall friendly!
  - » Runs over IP or UDP

## IPsec

- Mechanism to provide information for data integrity, authentication, privacy, and nonrepudiation to IP
- Defined by the IETF, primarily for IPv6
  - » RFCs 2401-2406
- IP Authentication Header (AH)
  - » Provides integrity and authentication for IP packets using MD5 or SHA-1

## IPsec (cont.)

- IP Encapsulating Security Payload (ESP)
  - » Provides message integrity and privacy using MD5/SHA-1 and DES
  - » Preferred industry direction
- Key management uses ISAKMP/Oakley or IKE
- VPNet Technologies' scheme forms IP Payload Compression Protocol (IPcomp)
- *IP-level security will not make firewalls obsolete*

## Security Association

- An SA is a simplex logical connection between two communicating IP endpoints
  - » SA provides security services to the traffic
  - » Endpoint can be host or security gateway
- An SA is uniquely identified by:
  - » Security Parameter Index (connection i.d.)
  - » IP Destination Address
  - » Security protocol (AH or ESP) i.d.

## IP Authentication Header

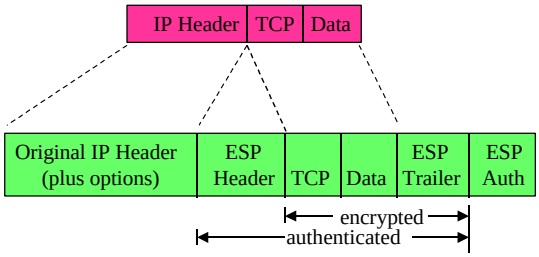
- RFC 2402
- Uses IPv4 PID/IPv6 Next Header = 51
- AH data follows mandatory IPv4/IPv6 header and precedes higher layer (e.g., TCP, UDP) information
- Includes:
  - » Anti-replay mechanism (sequence numbers)
  - » Authentication using HMAC with MD5 (RFC 2403) or HMAC with SHA-1 (RFC 2404)

# IP ESP

- RFC 2406
- Uses IPv4 PID/IPv6 Next Header = 50
- ESP must use HMAC with MD5/SHA-1 authentication (RFCs 2403/2404) and DES-CBC encryption (RFC 2405)

# IPsec ESP Transport Mode

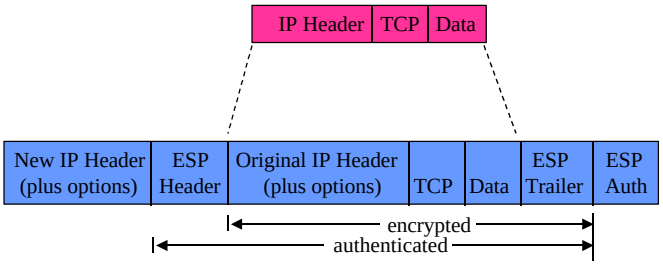
- Encrypts only data portion of tunneled IP packet
- May only be used host-host




Adapted from *RFC 2406*

# IPsec ESP Tunnel Mode

- Encrypts entire IP packet
- Used between hosts and/or security gateways




Adapted from *RFC 2406*

# VPN Protocols Compared

- PPTP
  - » Available from a variety of vendors
  - » Most common version is MS-PPTP, used with RAS and available with all "modern" Windows systems, but has many security problems
- L2TP
  - » Early deployment; part of IETF's security framework
  - » Not yet seen in many products but support expected in Windows 2000

## VPN Protocols Compared (cont.)

- IPsec
  - » Large base of products
    - Axent, BSDI, Check Point, Cisco, Data Fellows, DEC, FTP Software, IBM, Intel, Linux, Lucent, Mentat, Microsoft, Nortel, Novell, Process, Sun, 3Com, TimeStep
  - » Integral portion of IETF's security framework
  - » Robust, flexible, scalable, extendable!!
  - » Long-term direction for mainstream VPNs

## Lucent VPN Gateway (Hardware)

- Lucent VPN Gateway "brick"
  - » Acts as IPsec tunnel endpoint for LAN-to-LAN or client-to-LAN communication
  - » Bridge-like device; no network configuration required
  - » 333 MHz Pentium II, 10/100-BASET

## Lucent VPN Gateway (Software)

- Management Server
  - » Provides Java-based GUI VPN management
  - » Employs SSL, IKE with ISAKMP/Oakley key management
  - » Runs on Windows NT or Sun Solaris, with Netscape Enterprise Server
- Lucent IPsec Client
  - » Enables remote host to set up encrypted link to "brick" over IP
  - » Uses IPsec with DES, 3DES, MD5, and SHA-1, and IKE key management
  - » Runs on Windows 95/98, NT

## VPN Hardware Vendors

- Altiga
- Aventail
- Cisco Systems
- Compatible Systems
- Data Fellows
- Effnet
- Extended Networks
- Indus River
- Lucent (Livingston)
- Nortel Networks
- Radguard
- RedCreek Communications
- 3Com
- TimeStep
- VPNet Technologies
- Xedia

## VPN/Firewall Product Vendors

- Axent Technologies
- Check Point Software
- Cisco Systems
- FreeGate
- Internet Devices
- Lucent
- NetSceen Technologies
- Technologic
- WatchGuard Technologies

## A VPN Can Also Be...

- A public network provider's offering
- Service options vary widely
  - » Remote access services to corporate LAN via dedicated, managed network
  - » Corporate intranet on provider's dedicated facilities, possible employing Internet tunneling
  - » Extranet access via managed service

# UUNET VPN Service

- UUNET
  - » *Extralink Remote:* Remote access network service available in 1000 cities worldwide; client is authenticated and data is encrypted; data transported over a *private* (non-Internet) frame relay network to customer's intranet.
  - » *Extralink:* Managed VPN for multiple corporate sites over private facilities; offers SLAs for network availability and latency

# Bell Atlantic Managed VPN Service

- Managed dial-up
  - » Access control via X.500 directory
  - » DES/3DES encryption
  - » SLA: 97% availability, 99% at 26.4 kbps
- Managed dedicated
  - » IPsec-based, X.509 certificates, DES/3DES encryption
  - » SLA: 99.9% availability of VPN equipment, network connectivity, local loop, and CPE

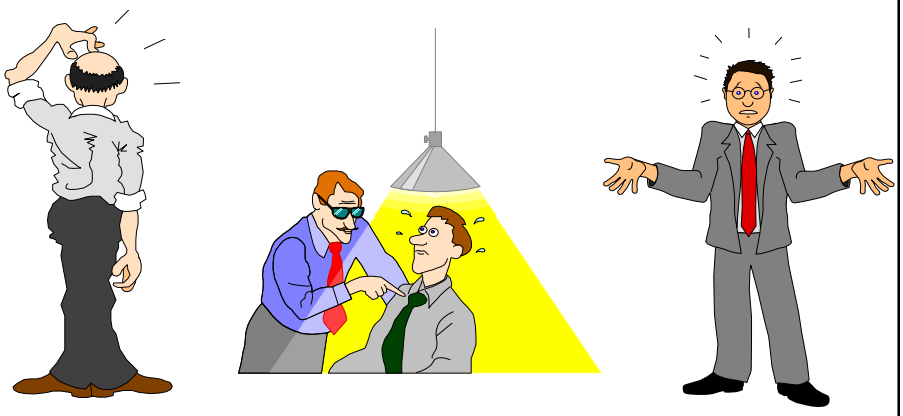
## Other VPN Services

- @Home's @Work Remote
- AT&T's WorldNet VPN Service
- Concentric's Enterprise VPN, RemoteLink VPN, CustomLink VPN
- Frontier VPDN
- GTE's VPN Advantage
- MCI WorldCom Advanced Network Service
- Qwest's Remote Access VPN
- Sprint's Data VPN Service

## Some References

- *Building and Managing Virtual Private Networks*, Kosiur (Wiley)
- Thomas Porter's VPN Web Page
  - » *http://www.dtool.com/vpn.html*
- *Extranet Strategist* (Aventail)
  - » *http://www.extranet-strategist.com*
- *comp.dcom.vpn* Usenet list
- GCK's pointers to VPNs *(www.sover.net/~kessfam/gck/library/commcomp.html#vpn)* and security *(www.sover.net/~kessfam/gck/library/securityurl.html)*

# Questions? Comments? Queries?



# Acronyms and Abbreviations

| | |
|---|---|
| 3DES | Triple DES |
| AAA | Authentication, authorization, accounting |
| AH | Authentication Header (IPsec) |
| ATM | Asynchronous Transfer Mode |
| BIOS | Basic Input/Output Interface |
| CBC | Cipher block chaining mode |
| CHAP | Challenge-Handshake Authentication Protocol |
| CPE | Customer premises (*or* provided) equipment |
| DDP | Datagram Delivery Protocol (Apple) |
| DES | Data Encryption Standard |
| DUN | Dial-Up Networking (MS) |
| ESP | Encapsulating Security Payload (IPsec) |
| FR | Frame relay |
| FTP | File Transfer Protocol (IETF) |
| GRE | Generic Routing Encapsulation (IETF) |
| GUI | Graphical user interface |
| HDLC | High-level Data Link Control |
| HMAC | Hashed message authentication code |
| HTTP | Hypertext Transfer Protocol (IETF) |
| IETF | Internet Engineering Task Force |
| IKE | Internet Key Exchange (IETF) |
| IP | Internet Protocol (IETF) |
| IPcomp | IP Payload Compression Protocol |
| IPsec | IP Security Protocol |
| IPv4/v6 | Internet Protocol version 4/version 6 |
| IPX | Internetwork Packet Exchange (NetWare) |
| ISAKMP | Internet Security Association and Key Management Protocol (IETF) |
| ISP | Internet service provider |
| LAN | Local area network |
| LANMAN | LAN Manager (MS) |
| L2F | Layer 2 Forwarding (Cisco) |
| L2TP | Layer 2 Tunneling Protocol (IETF) |
| MD5 | Message Digest 5 |
| MPPE | Microsoft Point-to-Point Encryption |
| MS | Microsoft |
| NAS | Network access server |
| NDIS | Network Driver Interface Specification (MS/3Com) |
| NDS | NetWare Directory Service (Novell) |
| NetBEUI | NetBIOS Extended User Interface (MS) |
| NetBIOS | Network Basic Input/Output System (MS) |
| ODI | Open Data Link Interface (Novell) |
| OSI | Open Systems Interconnection |
| PAP | Password Authentication Protocol |

# Acronyms and Abbreviations (cont.)

| | |
|---|---|
| PID | Protocol Identifier (IP) |
| PPP | Point-to-Point Protocol (IETF) |
| PPTP | Point-to-Point Tunneling Protocol (MS) |
| RADIUS | Remote Authentication Dial-In User Service |
| RAS | Remote Access Service (MS) |
| RFC | Request for Comments (IETF) |
| SHA | Secure Hash Algorithm (NIST) |
| SLA | Service level agreement |
| SLIP | Serial Line IP (IETF) |
| SPX | Sequenced Packet Exchange (NetWare) |
| SSL | Secure Sockets Layer (Netscape) |
| TACACS+ | Terminal Access Controller Access Control System plus |
| TCP | Transmission Control Protocol (IETF) |
| UDP | User Datagram Protocol (IETF) |
| VPN | Virtual private network |
| WINS | Windows Internet Name Service (MS) |