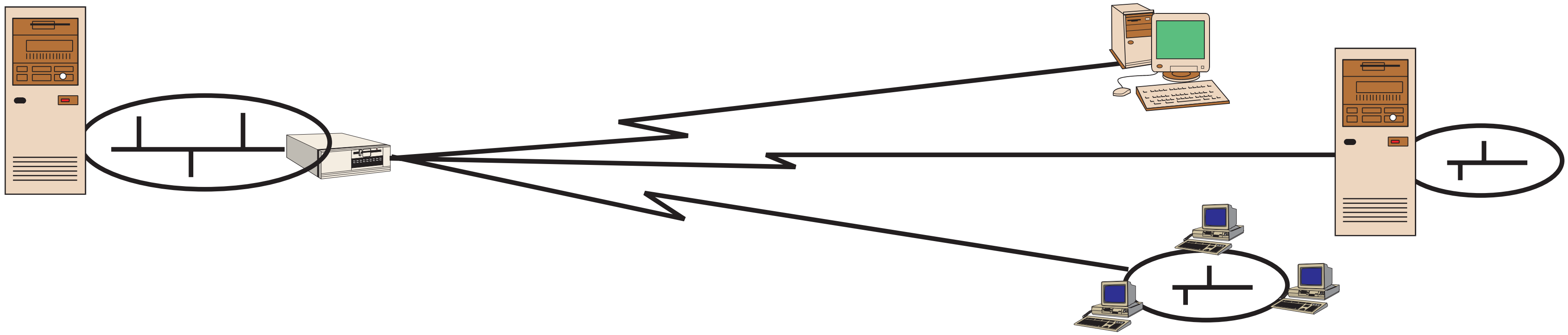
Please Explain VPNs (Virtual Private Networks)

Tom Hadley
Network Consultant
1-919-787-5999
tom@lauraknapp.com

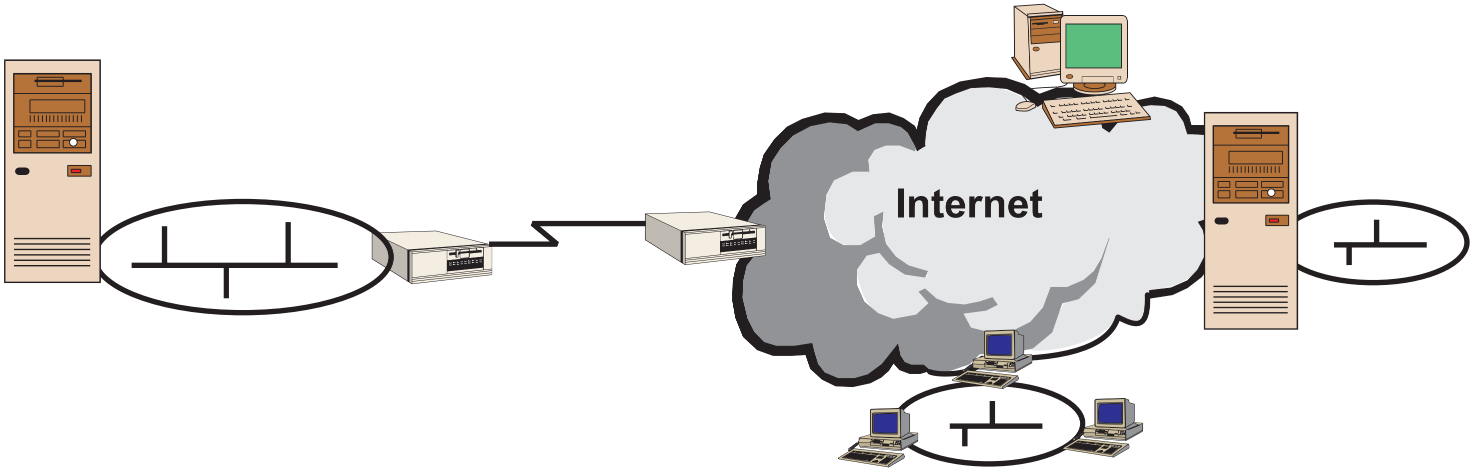
Laura Jeanne Knapp
IBM Technical Evangelist
1-919-224-2205
laura@lauraknapp.com

www.lauraknapp.com

Public Internet Instead of Private Network



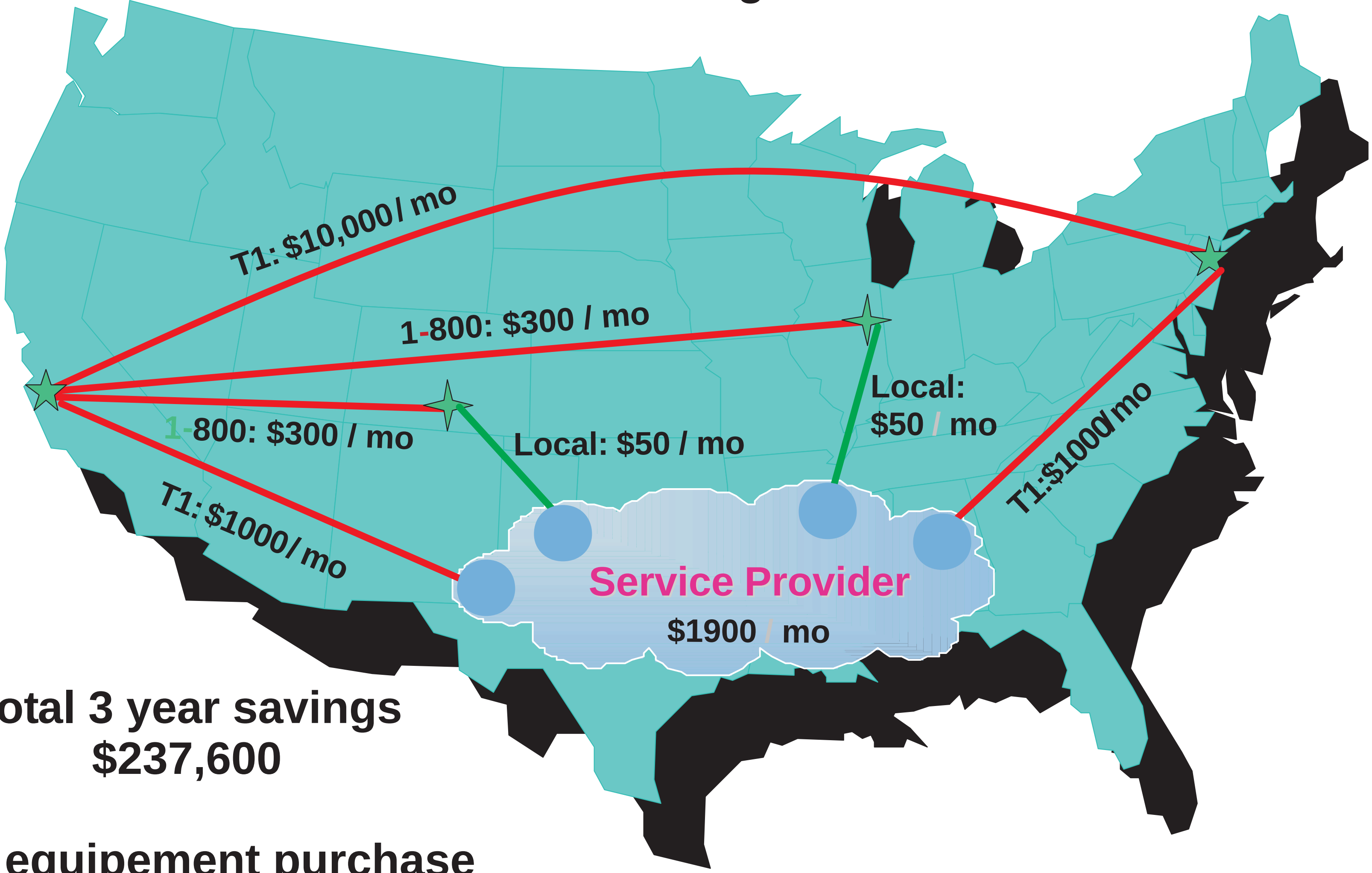
VPNs are a means of moving information between trusted network segments over untrusted network segments like dial, frame relay, leased lines, and customized private networks



A VIRTUAL Private Network replaces all of the above utilizing the public Internet
Performance and availability depend on your ISP and the Internet

VPN Cost Savings

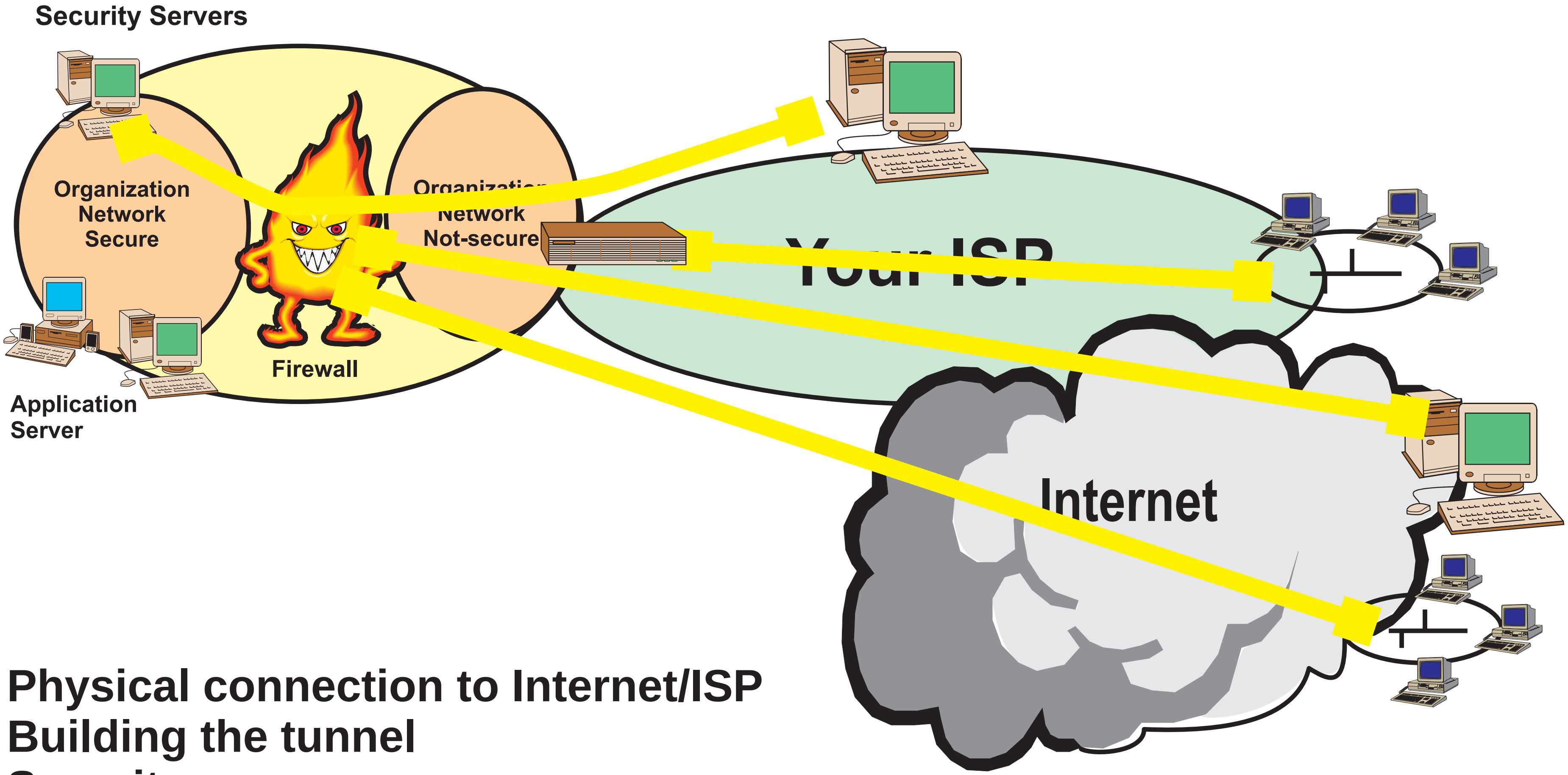
T1 connections between San Francisco and New York City : $10,000/mo
Dial-in access from Denver and Chicago to San Francisco : $600/mo



Total 3 year savings
$237,600

VPN equipement purchase
$7,800

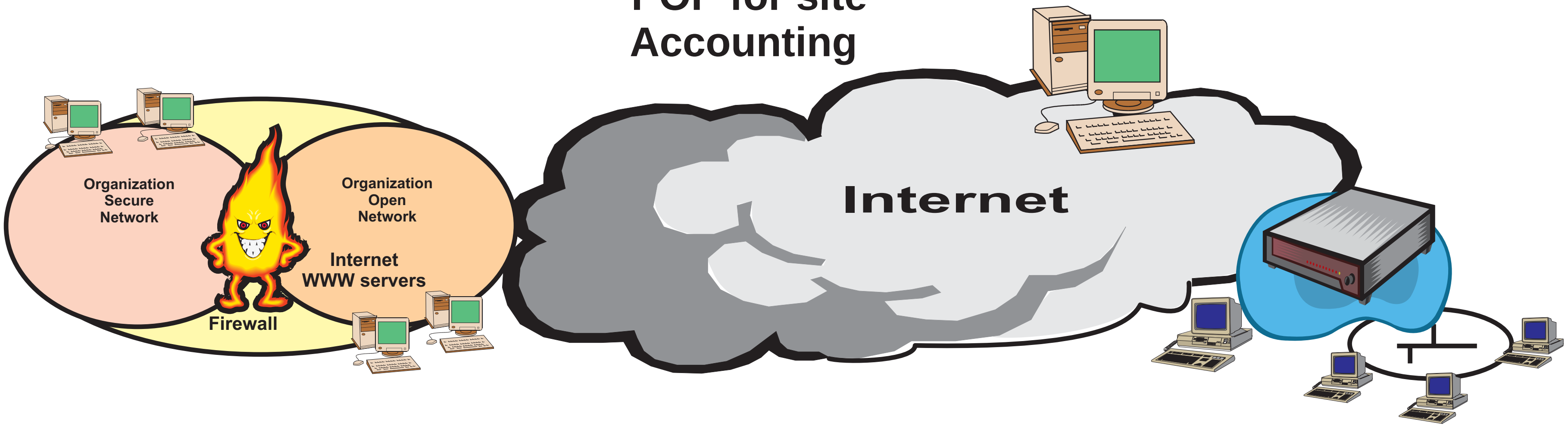
Elements of a Virtual Private Network



Physical connection to Internet/ISP
Building the tunnel
Security servers
Management
Provisioning
Quality of Service (QoS)

VPN - Functional Areas

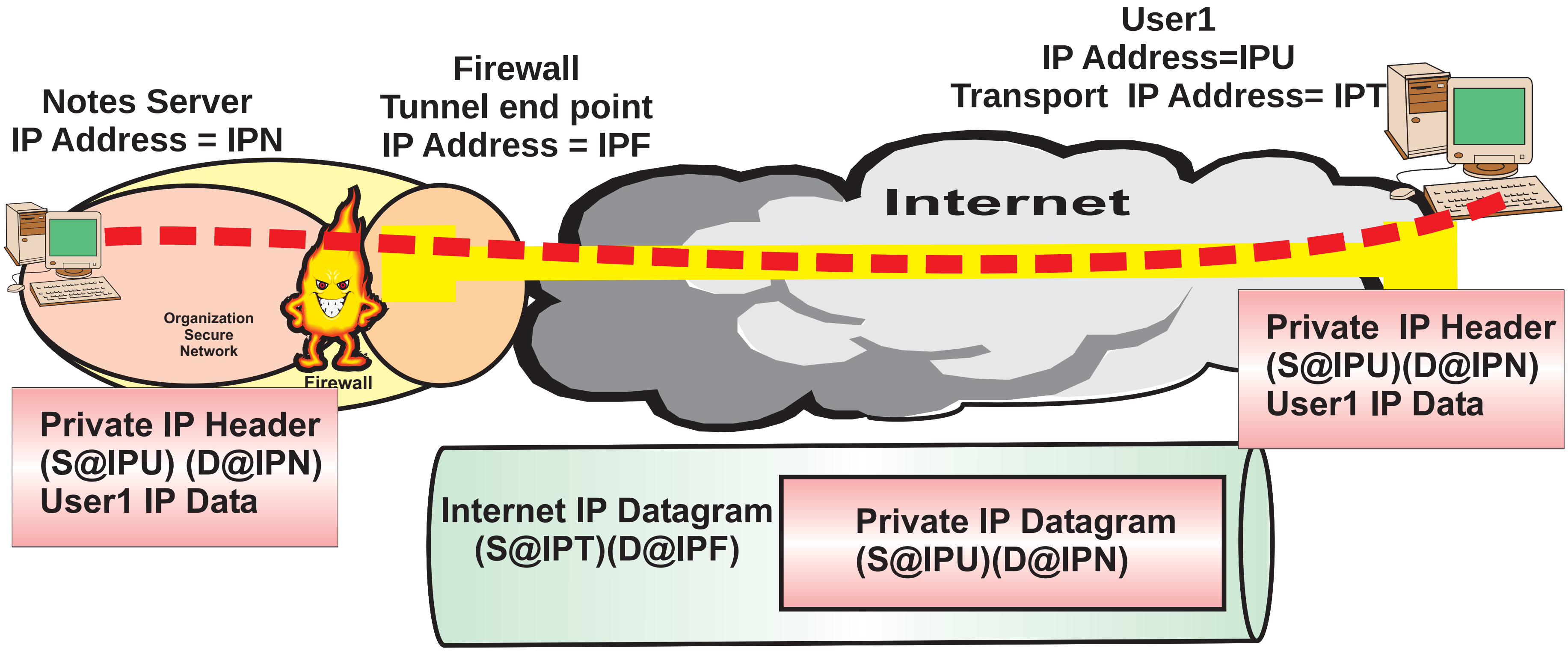
ISP
  POP for site
  Accounting



Organization Network
- Accepts incoming requests
- Terminates tunnel
- Security servers
  - Authenticates user/packet/machine
  - Negotiates encryption
- Policy Servers
  - Enforces routing policy
  - Enforces access rights
- Allocates addresses
- Management

Remote site
- Initiates tunnel
- Negotiates with security servers
  for authentication and encryption
- Requests private IP address assignment
  from home network
- Requests public IP address assignment
  from ISP

VPN - Building the Tunnel - Encapsulation



Notes Server
IP Address = IPN

Firewall
Tunnel end point
IP Address = IPF

User1
IP Address=IPU
Transport IP Address= IPT

Private IP Header
(S@IPU) (D@IPN)
User1 IP Data

Private IP Header
(S@IPU)(D@IPN)
User1 IP Data

Internet IP Datagram
(S@IPT)(D@IPF)

Private IP Datagram
(S@IPU)(D@IPN)

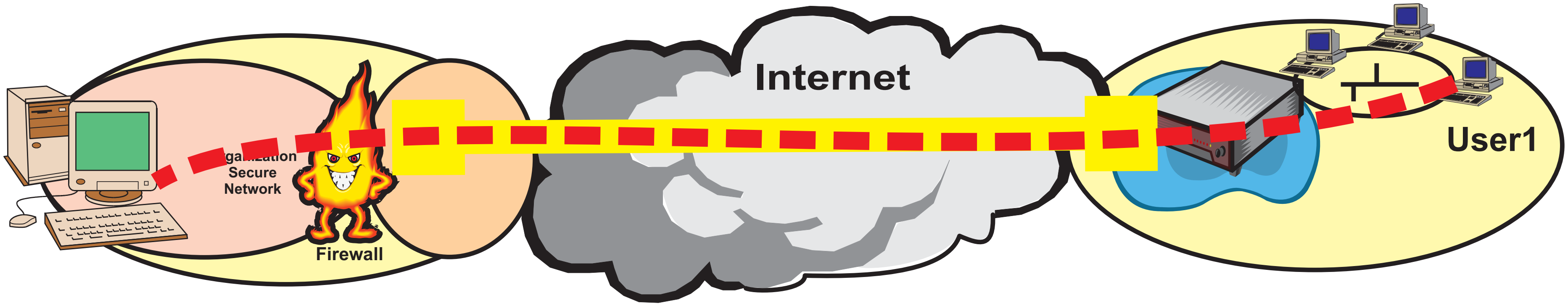
Tunneling includes:
Encapsulation
Transmission
Un-encapsulation

VPN - Technologies

<table>
<tr><th></th><th>Simplicity
Low cost</th><th>Advanced
Security</th></tr>
<tr><td>Application to Application</td><td colspan="2">SSL</td></tr>
<tr><td>End to End</td><td colspan="2">IPSec Transport Mode</td></tr>
<tr><td>Gateway to Gateway</td><td>PPTP</td><td>L2TP/IPSec
IPSec Tunnel Mode</td></tr>
<tr><td>Client to Gateway</td><td>PPTP</td><td>L2TP/IPSec</td></tr>
</table>

PPTP - Point to Point Tunneling Protocol - Layer 2 - Multiprotocol
L2TP/IPSec - Layer 2 Tunneling Protocol - Multiprotocol - Encryption and Authentication
IPSec - IP Security - Layer 3 - IP protocol - Encryption and Authentication
SSL - Secure Sockets Layer - Layer 6/7 - Application - Encryption and Authentication

Building a VPN with IPSec



Builds the tunnel

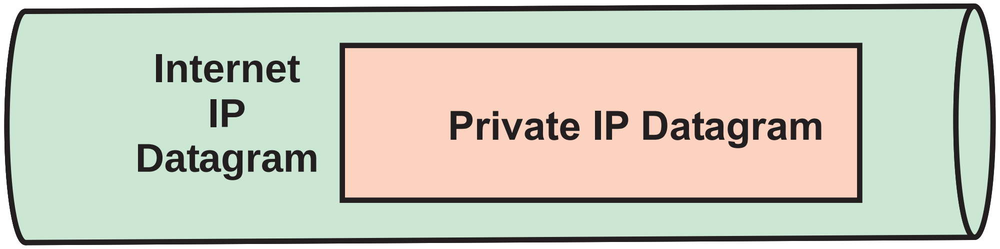
Integrated security technologies

- ESP = Encapsulating Security Payloads - encrypts IP datagram
  - DES and 3DES are most common encryption mechanisms used
  - May provide confidentiality, authentication, integrity, non-repudiation, replay protection, and traffic analysis protection
  - Does everything AH does

- AH = Authentication Header - validates sender and indicates data integrity
  - MD5 and SHA1 are most common authentication mechanisms used
  - Provides integrity and authentication but not confidentiality

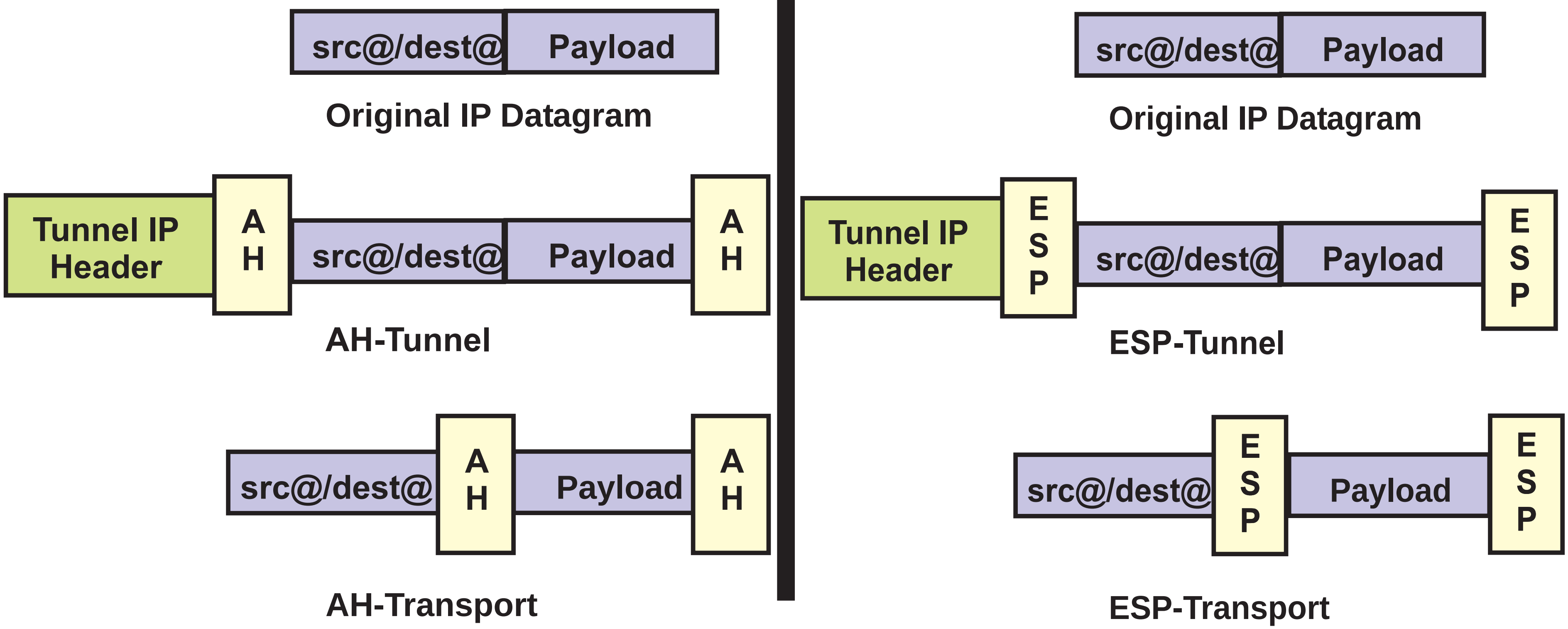
- IKE - Internet Key Exchange (aka:ISAKMP/Oakley) Protocol

IPSec Tunneling and Transport

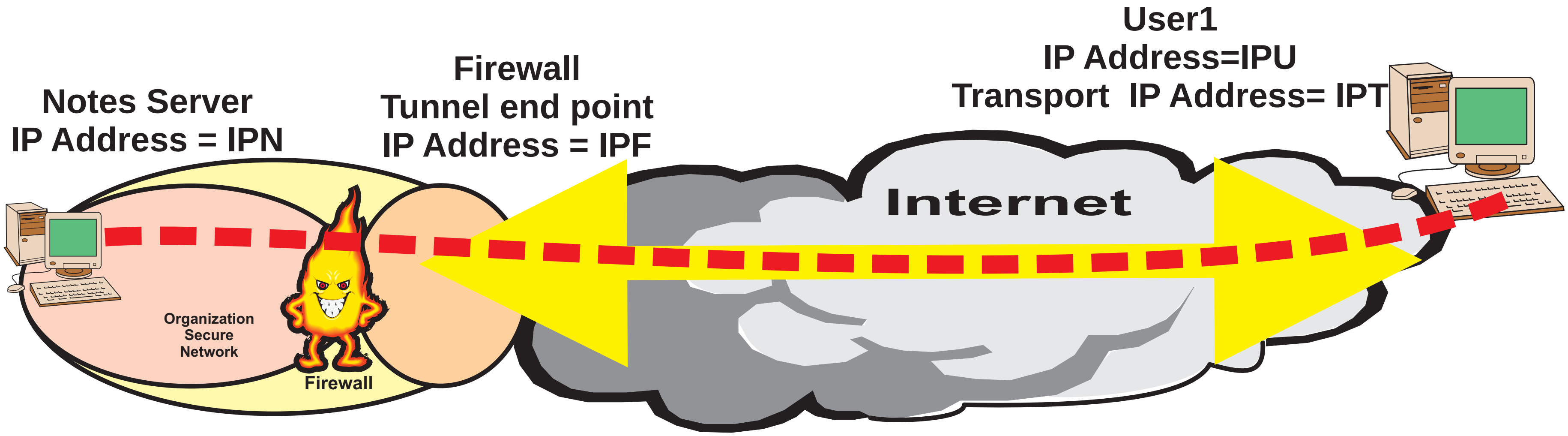


AH-Authentication Header IP Protocol 51

ESP-Encapsulating Security Protocol IP Protocol 50



IPSec VPN
Internet Key Exhange



Agree on parameters
Exchange keys
Use encrypted tunnels

Manual Key Management
- Administrator sets keys at both ends
- Not scalable

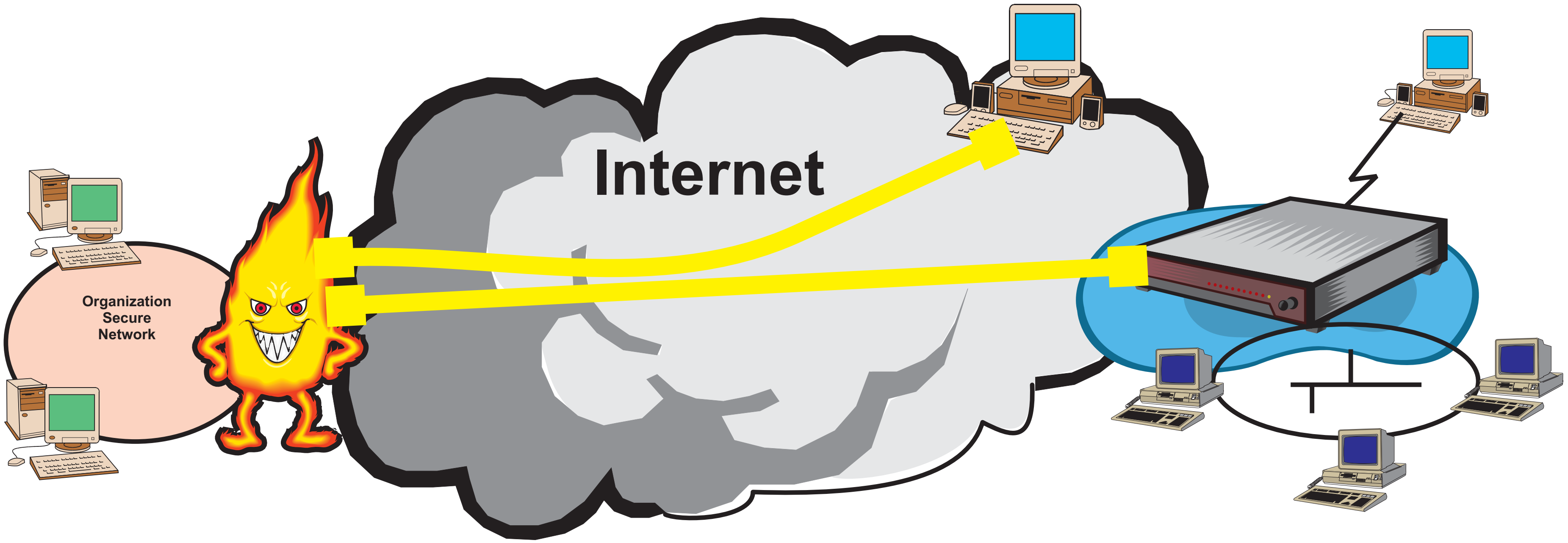
Automated Key Management
- On-demand creation of keys
- Complex to configure
- Scalable

Two parties negotiate
- Encryption algorithm
- Hash digests
- Authentication
- Key strength
- Security association lifetimes

VPN - Tunneling with L2TP and IPSec

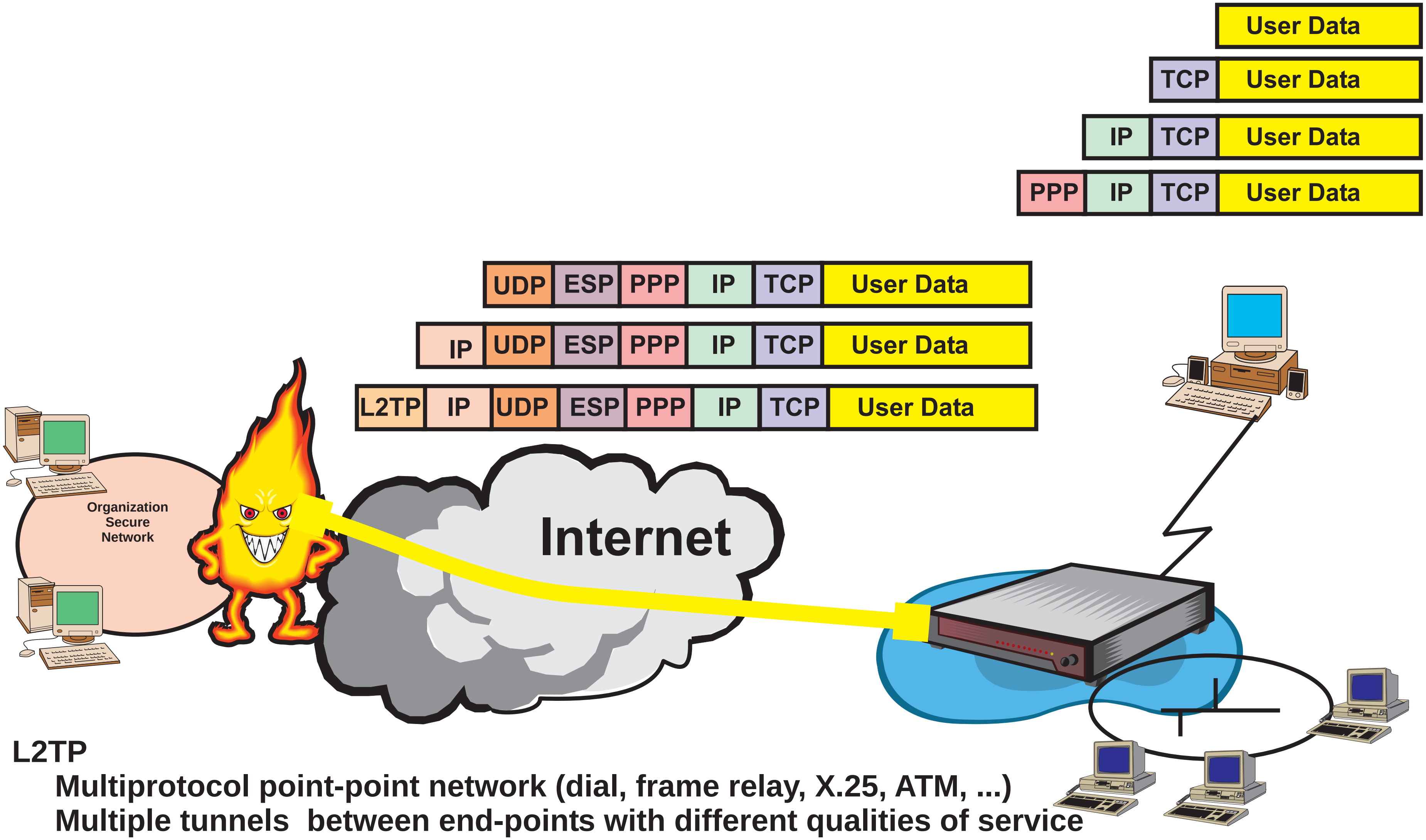
L2TP ↔ L2TP — Domain authentication
(userID/password, smart card, etc)

IPSec ↔ IPSec — Machine authentication
Encryption



IPSec IKE negotiation
Establish IPSec ESP for L2TP UDP port 1701
L2TP tunnel setup, management over IPSec
User authentication to domain

VPN - L2TP Frames



User Data

TCP User Data

IP TCP User Data

PPP IP TCP User Data

UDP ESP PPP IP TCP User Data

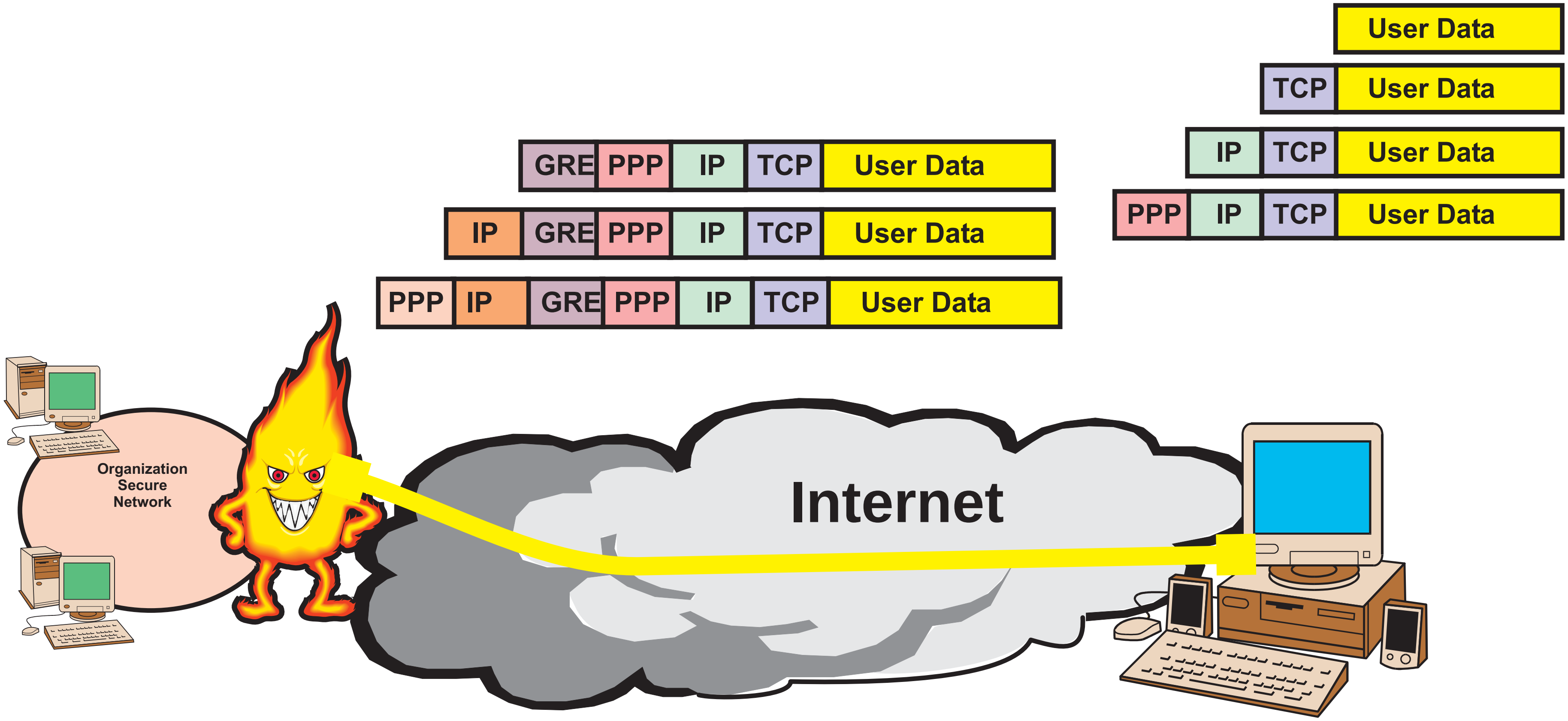
IP UDP ESP PPP IP TCP User Data

L2TP IP UDP ESP PPP IP TCP User Data

L2TP

- Multiprotocol point-point network (dial, frame relay, X.25, ATM, ...)
- Multiple tunnels between end-points with different qualities of service
- 4 bytes of overhead when compression used
- Tunnel authentication
- Can be used with IPSec to provide authentication and encryption

VPN - Tunneling with PPTP and PPoE



User Data

TCP User Data

IP TCP User Data

PPP IP TCP User Data

GRE PPP IP TCP User Data

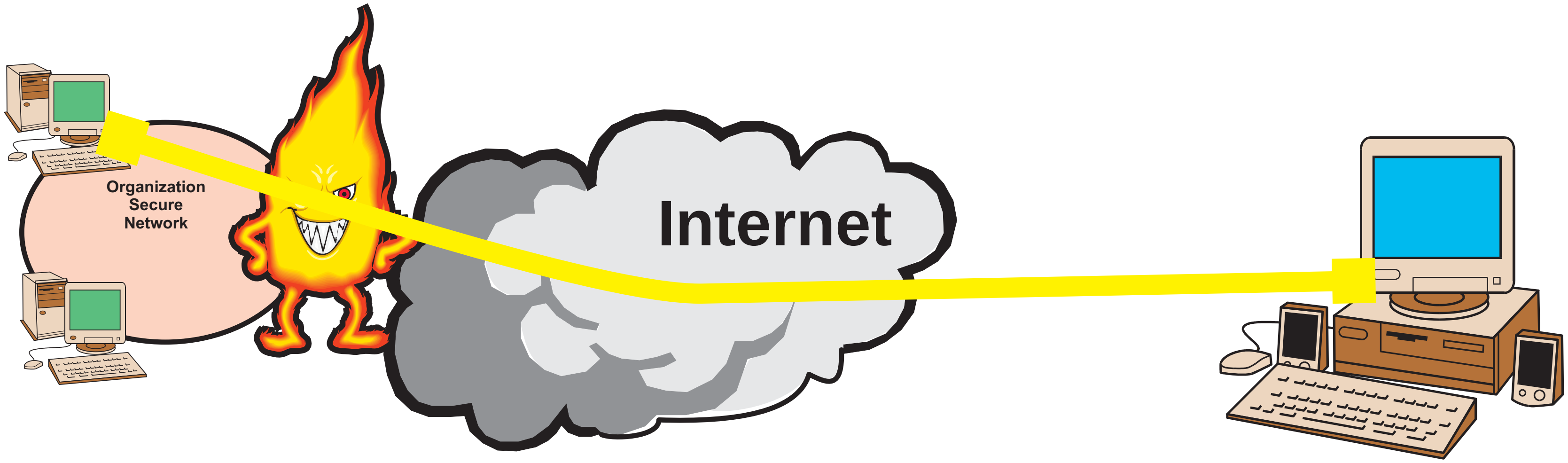
IP GRE PPP IP TCP User Data

PPP IP GRE PPP IP TCP User Data

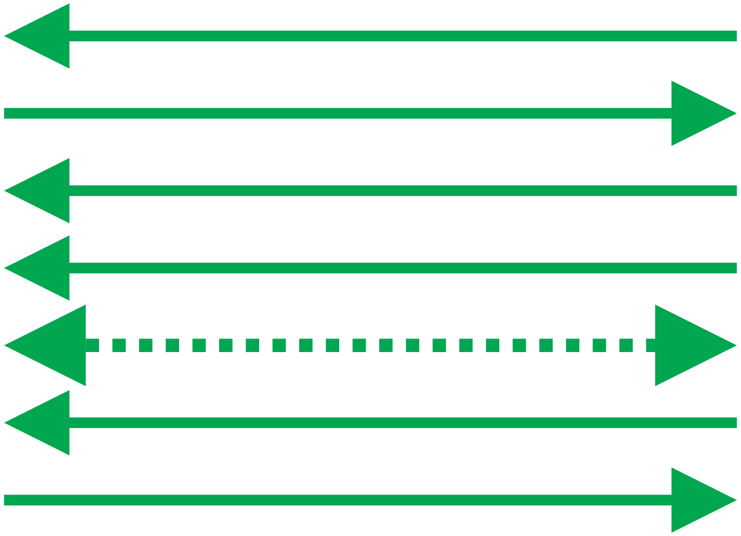
PPTP

PPoE is Point-Point protocol over Ethernet
Single tunnel between end-points : single device support (GRE = generic routing encapsulation)
6 bytes of overhead when compression used
No tunnel authentication
With RADIUS server supports authentication and accounting
CHAP V2 fixes password, masquerading, and encryption weakness
40 or 128 bit RC4 packet encryption

VPN - PPTP Security



CHAP V2 Authentication with 40 or 128 bit RC4 encryption



Connection request

Challenge

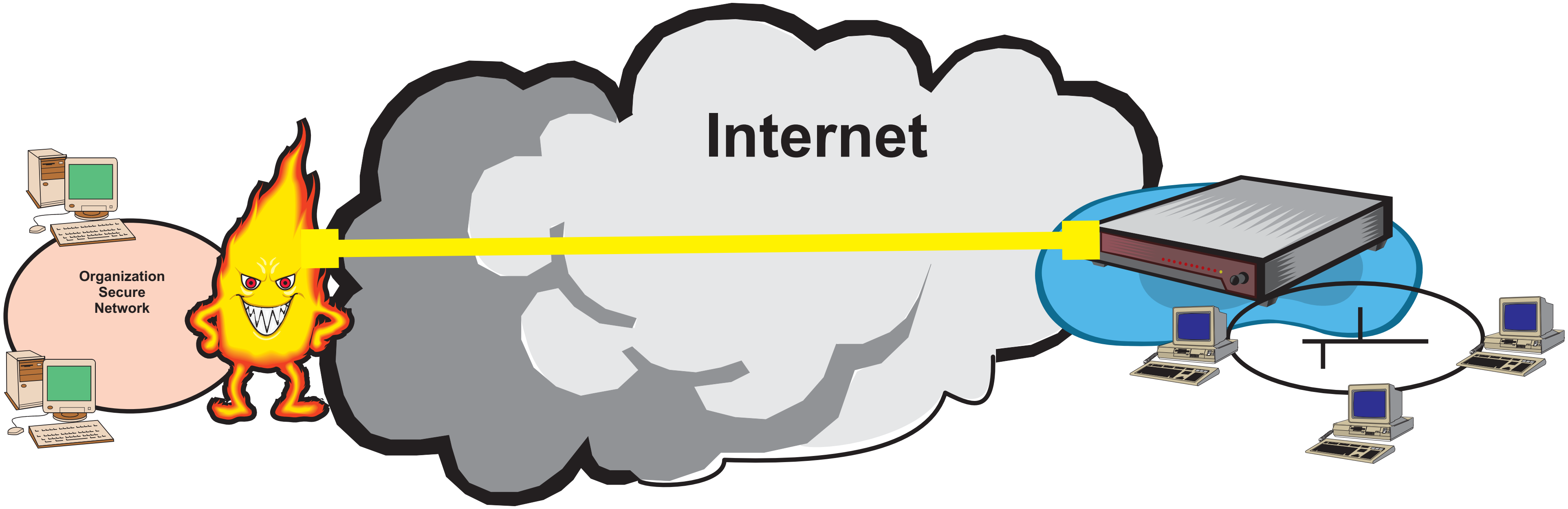
Response
Challenge

Response
New Client Key
New Server Key

New Client Key
New Server Key
Encrypted Packet

Encrypted Packet

VPN - Tunneling with Proprietary Mechanisms



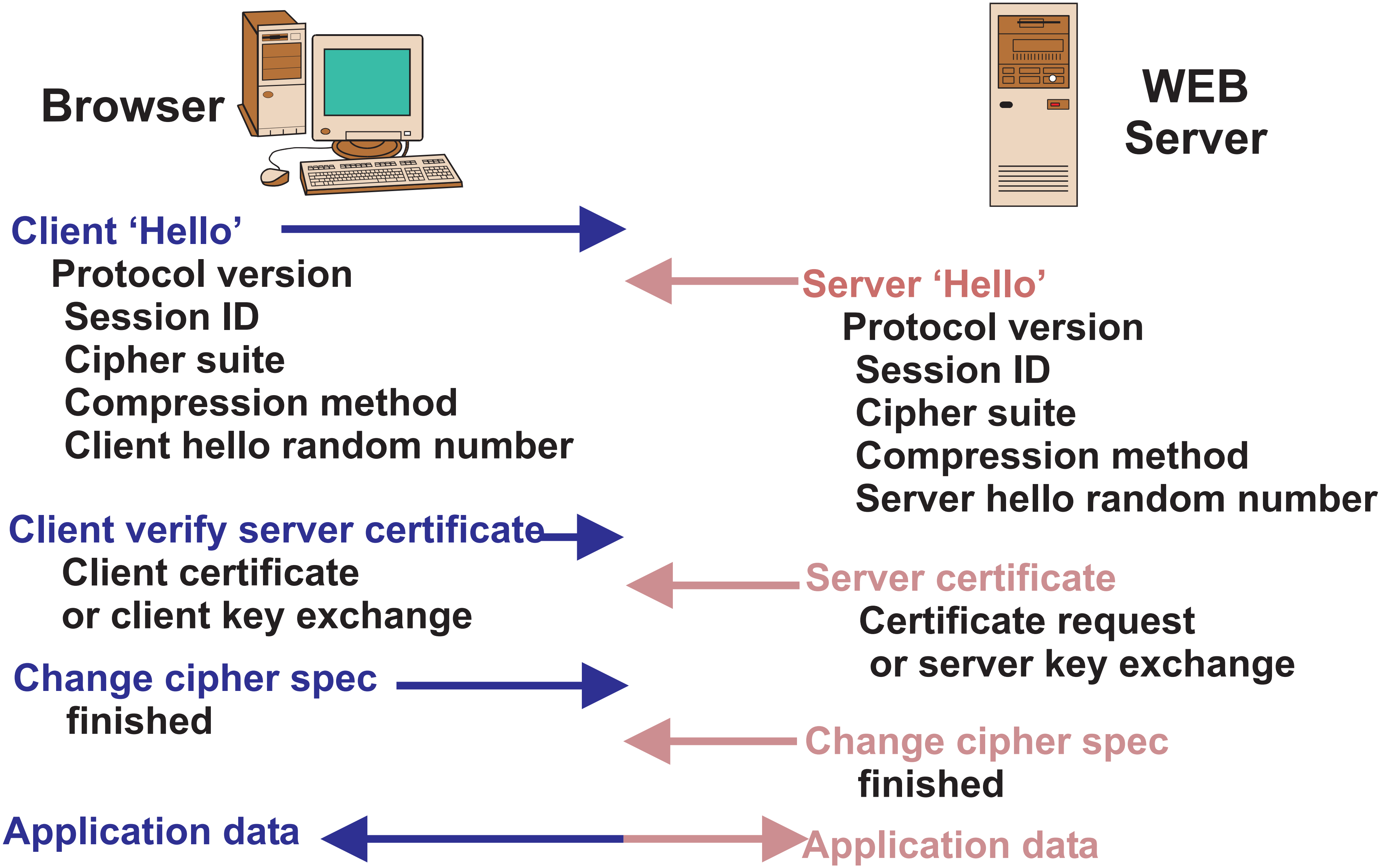
Not as common today as they were

Since ISP owns the entire tunnel, they can use a mixture of standards, emerging standards, and proprietary mechanisms to make the tunnel

End user client code distributed by ISP -- Must use same ISP

These tunnels are dedicated and are not generally taken up and down

VPN - Tunneling with Secure Sockets (SSL)



Browser

WEB
Server

Client ‘Hello’

Protocol version
Session ID
Cipher suite
Compression method
Client hello random number

Server ‘Hello’

Protocol version
Session ID
Cipher suite
Compression method
Server hello random number

Client verify server certificate

Client certificate
or client key exchange

Server certificate

Certificate request
or server key exchange

Change cipher spec

finished

Change cipher spec

finished

Application data

Application data

VPN - Confused about Security

	L2TP	PPTP	IPSec
PAP, CHAP	X	X	
CHAP v2	X	X	
IKE			X
Kerberos			X
Private Key Exchange			X
EAP	X	X	
SmartCard/Token	X	X	
Radius	X	X	
RC4 encryption		X	
DES, 3DES encryption	X		X

VPN - Issues

Pervasiveness of interoperable code

Client code distribution

Use of token/biometric systems

Simultaneous Internet access

Compression and encryption

Key distribution

Key management

Integration into Policy Management System

Vendor interoperability

Administration support

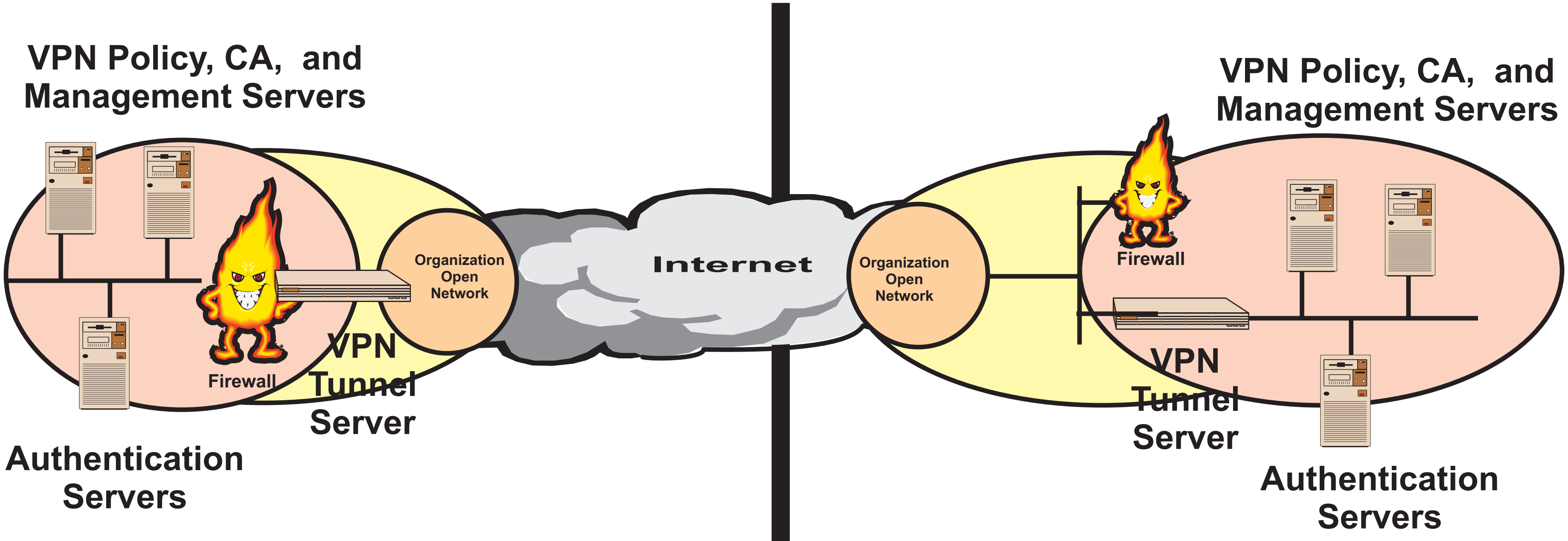
Performance of the Internet or any public shared network

VPN - Tunneling Comparisons

	L2TP/IPSec	IPSec	PPTP	SSL
Mode	Client/server	Host-host	Client/server	Client/server
Layer	2	3	2	7
Protocols	Multiprotocol	IP	Multiprotocol	IP
Security				
User Authentication	PKI		PKI	Log-in
Device Authentication		PKI		
Packet Authentication		X	X	
Packet Encryption	DES, 3DES, PGP	DES, 3DES	X	
Key Management	IKE	IKE	PKI	Private Key

*Provided outside of specification

VPN - Design Options


VPN Policy, CA, and Management Servers
Firewall
Organization Open Network
VPN Tunnel Server
Authentication Servers
Internet
Organization Open Network
VPN Policy, CA, and Management Servers
Firewall
VPN Tunnel Server
Authentication Servers

Tunnel Server in Series with Firewall

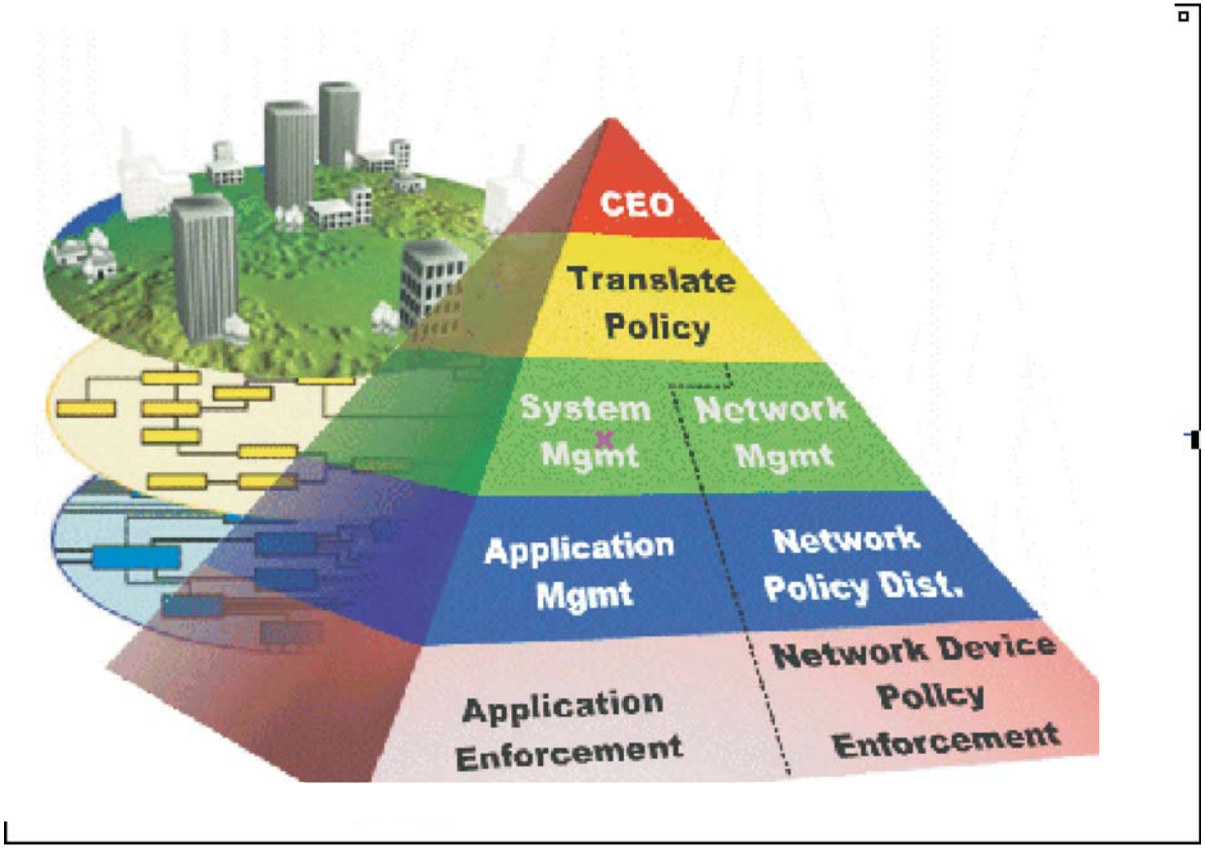
If using intrusion detection systems based on IP address, place VPN tunnel termination before the intrusion detection system

Can the firewall’s performance scale with VPN traffic

Tunnel Server in Parallel with Firewall

Use other authentication mechanism (not IP address) like tokens, time of day, biometrics

Policy Based Networks

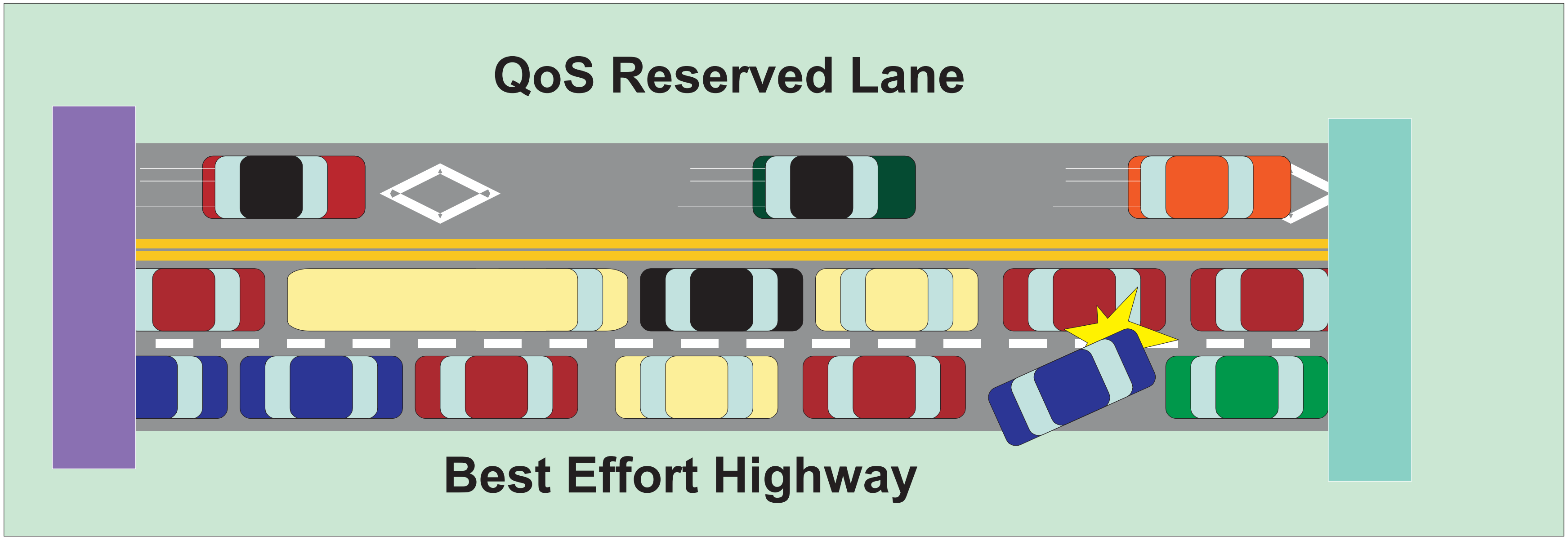


Stores and distributes policy from common directory

Common repository for server, network, client, application information

Globally defined for client, resources, and applications
by individual, group, or role

The Missing Piece of VPNs
QoS - Quality of Service



DiffServ - Differentiated services

MPLS - Multiprotocol Label Swapping

RSVP - Resource Reservation Protocol

Managing VPNs

Verifies Policy

User response time

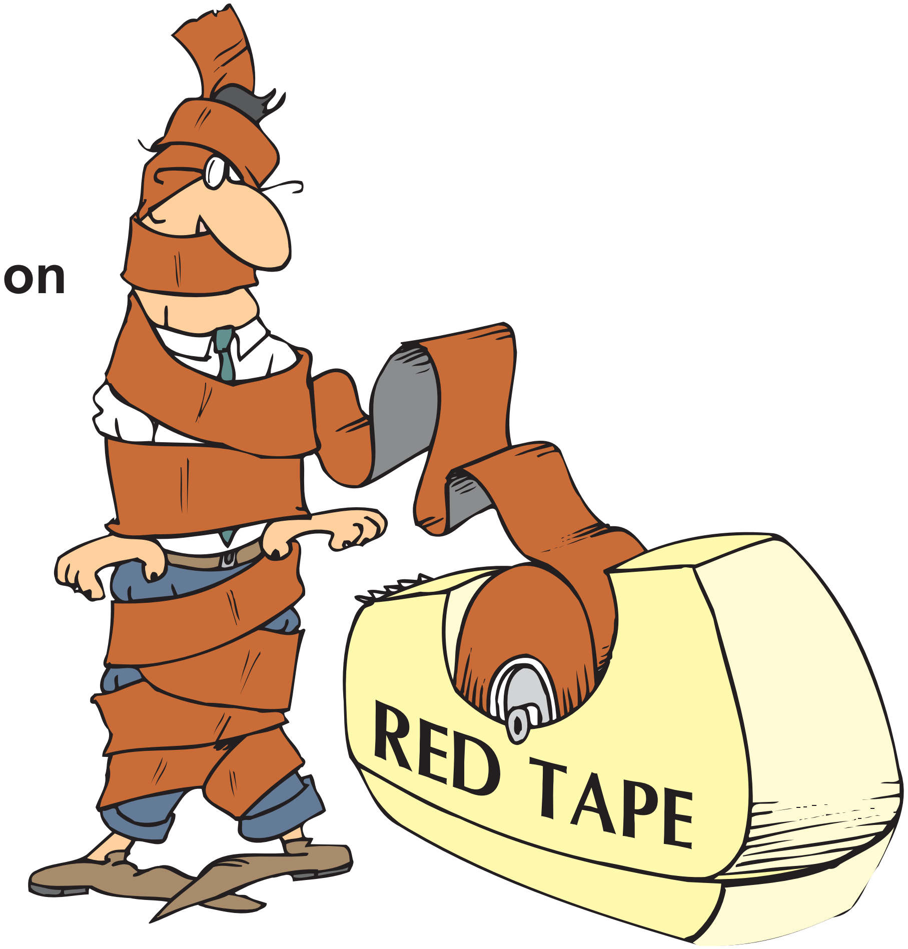
Logging and trapping of authentication
and encryption errors

QoS monitoring

Operational center for VPN tunnels

Key Management
- Key assignment
- Key revocation
- Automatic key exchange
- Ease of canceling key
- International issues

Interface into Policy Management System



VPN Glossary

AH	Authentication Header in IPSec
AIAG	Automotive Industry Action Group
ANS	Automotive Network Exchange
ATM	Asynchronous Transfer Mode
CHAP	Challenge Handshake Authentication Protocol
DES	Data Encryption Standard (64 bit)
3DES	Triple DES (192 bit)
DiffServ	Differentiated Services
EAP	Extensible Authentication Protocol
ESP	Encapsulating Security Payload
GRE	General Routing Encapsulation
ICSA	International Computer Security Association
IETF	Internet Engineering Task Force
IKE	Internet Key Exchange
IP	Internet Protocol
IPSec	IP Security Protocol
ISAKMP	Internet Security Associations /Key Management Protocol
ISP	Internet Service Provider
L2F	Layer 2 Forwarding
L2TP	Layer 2 Tunnel Protocol
MIME	Multipurpose Internet Mail Extensions
MPLS	Multiprotocol Label Swapping
NAS	Network Access Server
NAT	Network Address Translation
PGP	Pretty Good Privacy
PKI	Public Key Infrastructure
POP	Point of Presence
PPP	Point-to-Point Protocol
PPTP	Point-to-Point Tunneling Protocol
QOS	Quality of Service
RADIUS	Remote Authentication Dial-in User Services
RAS	Remote access Server
RSA	Encryption company/standards setter
RSVP	Resource Reservation Protocol
SSL	Secure Sockets Layer
TACACS	Terminal Access Controller Access Control Systems
VPN	Virtual Private Network

VPN Resources

Information from the IETF (Internet Engineering Task Force}:
Active IETF Working Groups: www.ietf.org/html.charters/wg-dir.html
Search for Internet Drafts: search.ietf.org/search/brokers/internet-drafts/query.html
Search for RFCs: www.rfc-editor.org/rfcsearch.html
VPN Mailing List : majordomo@listserv.iegroup.com
Send a message with the text: “subscribe vpn [your e-mail address]”

INFOSYSSEC -- The Security Portal for Information System Security Professionals
http://www.infosyssec.org

VPN info rmation on the Web: http://vpn.shmoo.com

A VPN Glossary: http://www.emory.edu/ITD/RA/vpn/glossary.html

News in the area of encryption: www.eff.org/pub/Crypto/
EFF is the Electronic Frontier Foundation

Computer Security Resource Center: csrc.ncsl.nist.gov
NIST is the US National Institute of Standards and Technology
NCSL is the old name of the Inormation Technology Laboratory

Worldwide encryption mechanisms: http://rechten.uvt.nl/koops/cryptolaw/index.htm
Similar survey of digital signature laws: http://rechten.kub.nl/simone/ds-lawsu.htm
Tilburg University -- Catholic University of Brabant, Netherlands

White Paper on VPNs: www.employees.org/~ferguson/vpn.pdf
Employees.Org is a volunteer group of Cisco employees

US legislation on privacy and cryptography: www.cdt.org/crypto/
CDT is the Center for Democracy and Technology

2003/02

Security Resources

Hacker BBS	www.hackers.com
Internet Security Systems	www.iss.net
JAVA Security FAQ	www.java.sun.com/sfaq/index.html
TruSecure (ICSA Labs)	www.trusecure.com
Network Associates	www.nai.com
Secure Computing	www.sctc.com
RSA Security	www.rsasecurity.com
Computer Security Institute	www.gocsi.com
Computer Emergency Response Team	www.sei.cmu.edu, then search CERT

Network Security: Private Comm. in a Public World, 2nd Ed : Prentice Hall : ISBN:0-13-046019-2

Applied Cryptography, 2nd Ed : Wiley : ISBN:0-471-11709-9

Cryptography and Network Security, Stallings, 3rd Ed : Wiley : ISBN:0-13-091429-0

2003/02