# TCP/IP for VSE: Native SSL for VSE

Connectivity Systems

Product Development

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# Agenda

- The Need
  - Secure communications with applications on VSE
- The Solution
  - The SSL protocol
- The Tools
  - Standard cryptographic algorithms
- The Implementation
  - Installing SSL on VSE
- The Benefits
  - Creating secure applications for VSE

# The Need

- E-Business
- E-Commerce
- Secret web sites and ports
- Viruses
- Hackers
- Denial of Service attacks
- Authentication
- Confidentiality
- Data Integrity

# The Need: IP problems

- IP packets have no inherent security
  - Relatively easy to forge the addresses
  - Modify the contents
  - Replay old packets
  - Contents easy to inspect
- No guarantee that IP packets are:
  - From the claimed sender
  - Contain the original data set by sender
  - Not inspected by a third party

# The Need: TCP problems

- TCP provides a reliable connection
  - Lost packets are retransmitted
  - But no:
    - Authentication
    - Confidentiality
    - Integrity
    - Repudiation

# Application Message Integrity

- Messages
  - contain sensitive data
  - travel a complex path
  - must be authenticated
  - must be kept confidential
  - must not be altered
- Why not AMI for VSE ???

# Why not just front end VSE ?

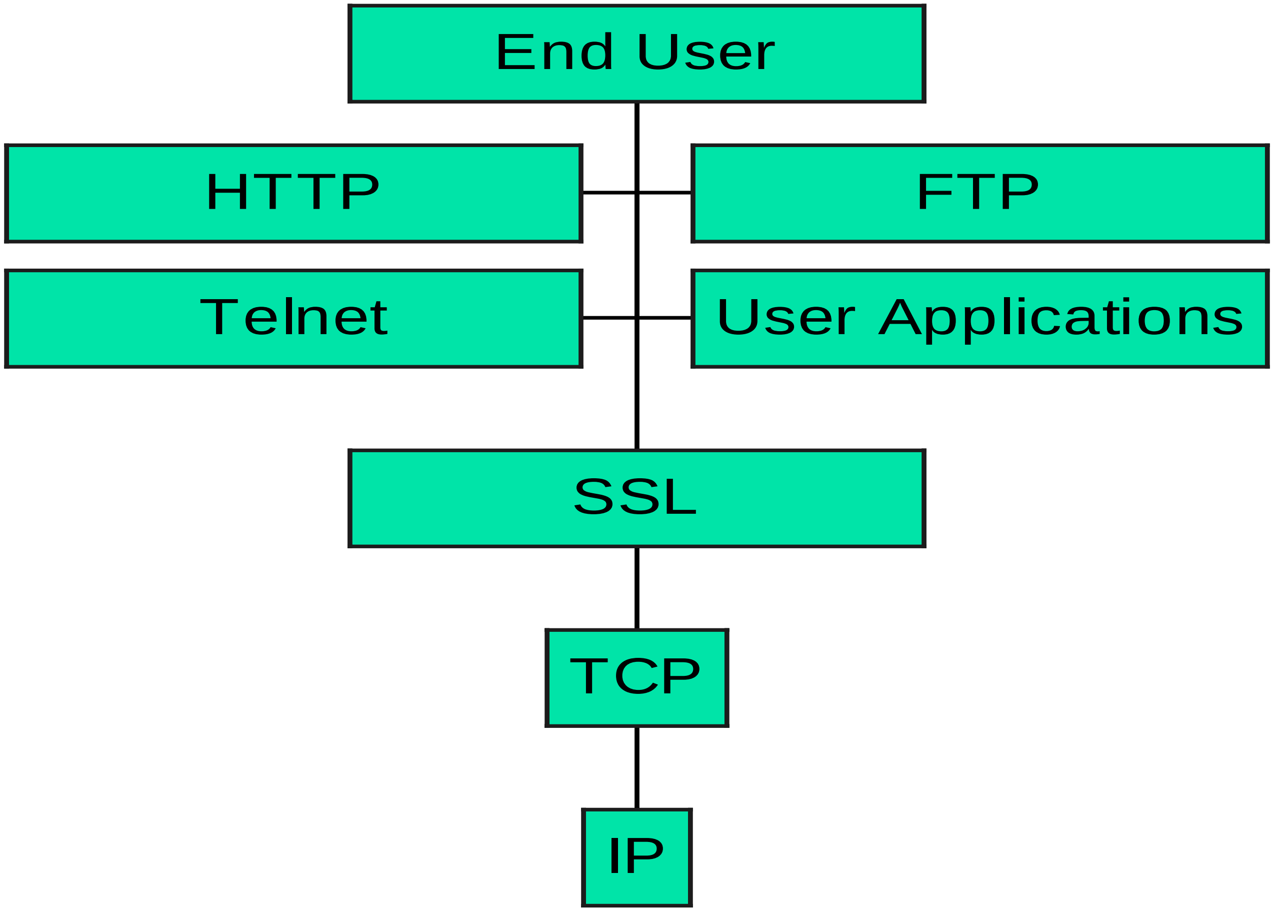
- Native solution is:
  - More secure
  - Efficient
  - Cheaper
  - Easy to maintain
  - Less complicated
- VSE can now do it all too…
- So, why not have secure messaging applications on VSE ?

# The Solution: SSL for VSE

- SSL provides secure messaging for TCP/IP applications on VSE by using:
  - Public Key Infrastructure for server and client authentication
  - Data Encryption for confidentiality
  - One-way keyed hash functions for message integrity
  - Digital Signatures for proof of authorship

# The Solution: TCP with SSL Protocol

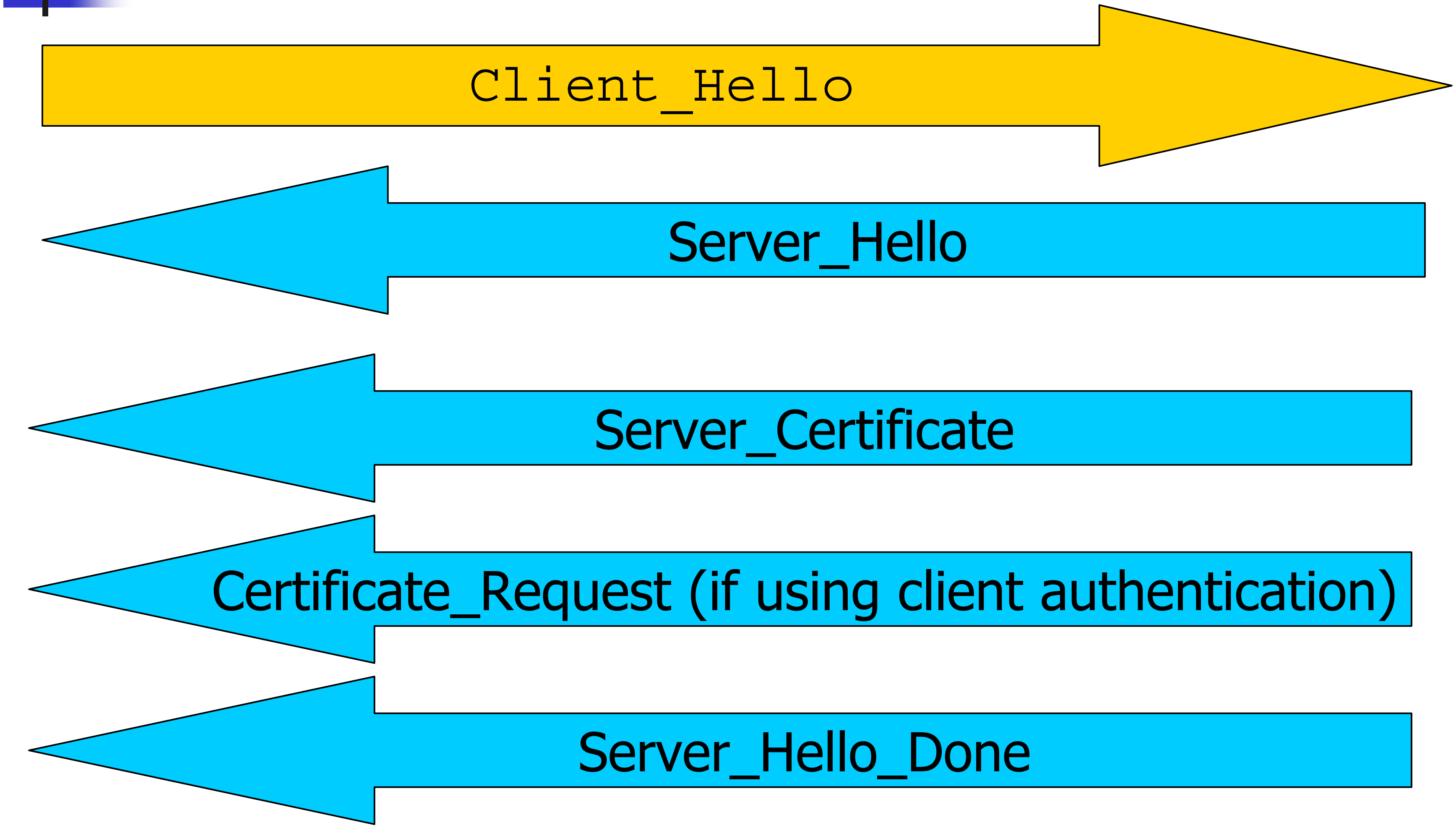
Secure



# SSL Overview

- Two sockets connected
  - One must be a Server the other a Client
- Server always authenticated
- Client authentication optional
- Client and Server must:
  - Agree on cipher algorithms
  - Establish crypto keys

# SSL Handshake Hello's



Client_Hello

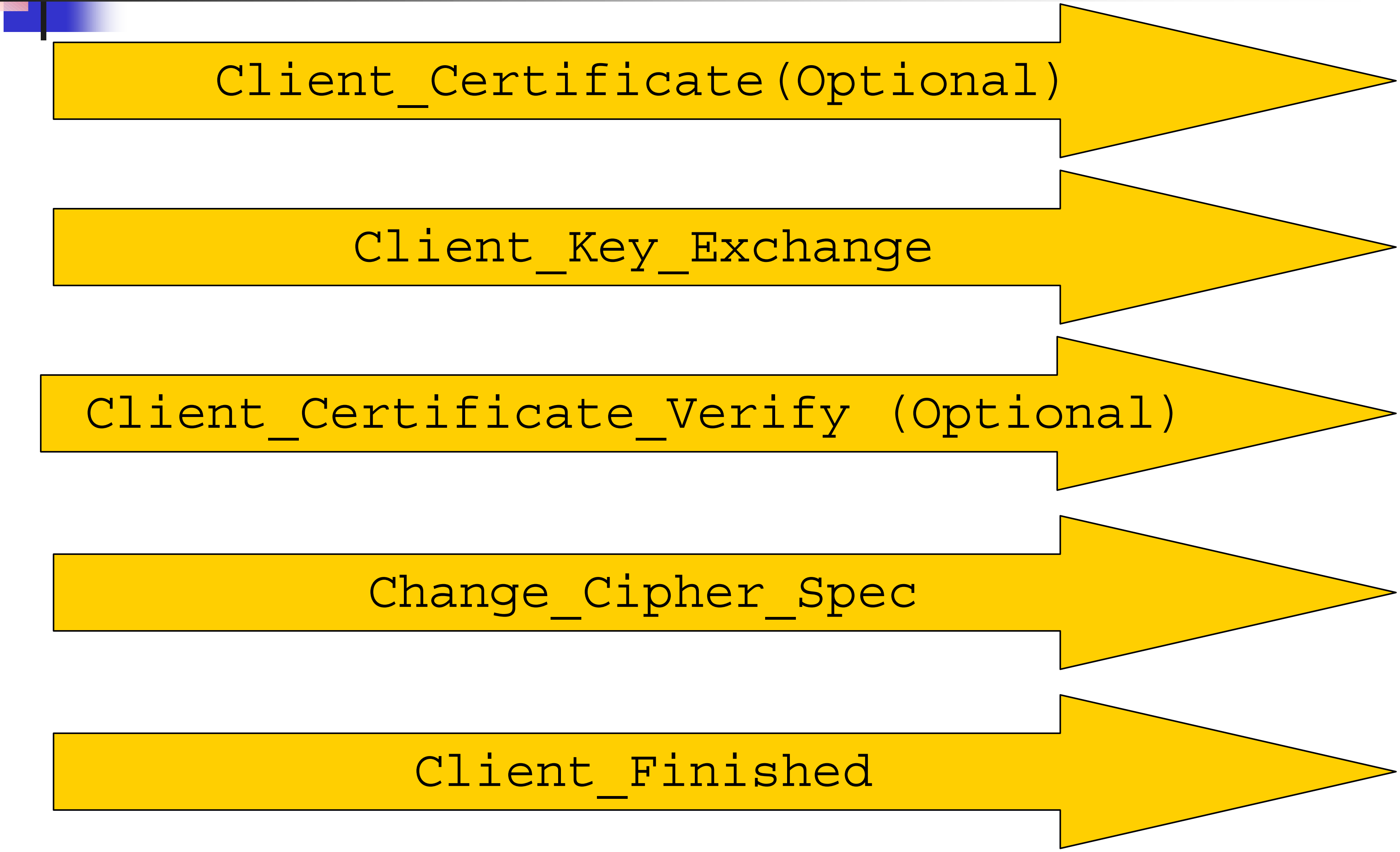
Server_Hello

Server_Certificate

Certificate_Request (if using client authentication)

Server_Hello_Done

# SSL Handshake Client Messages



Client_Certificate(Optional)

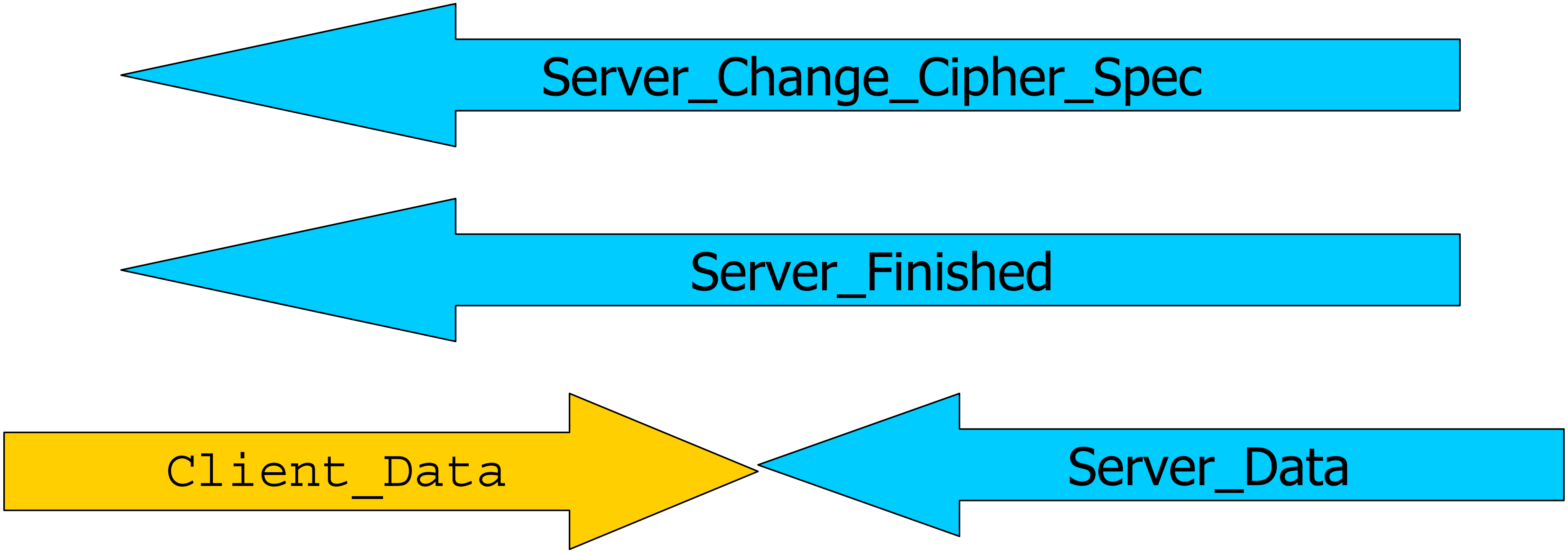
Client_Key_Exchange

Client_Certificate_Verify (Optional)

Change_Cipher_Spec

Client_Finished

# SSL Handshake Server Messages



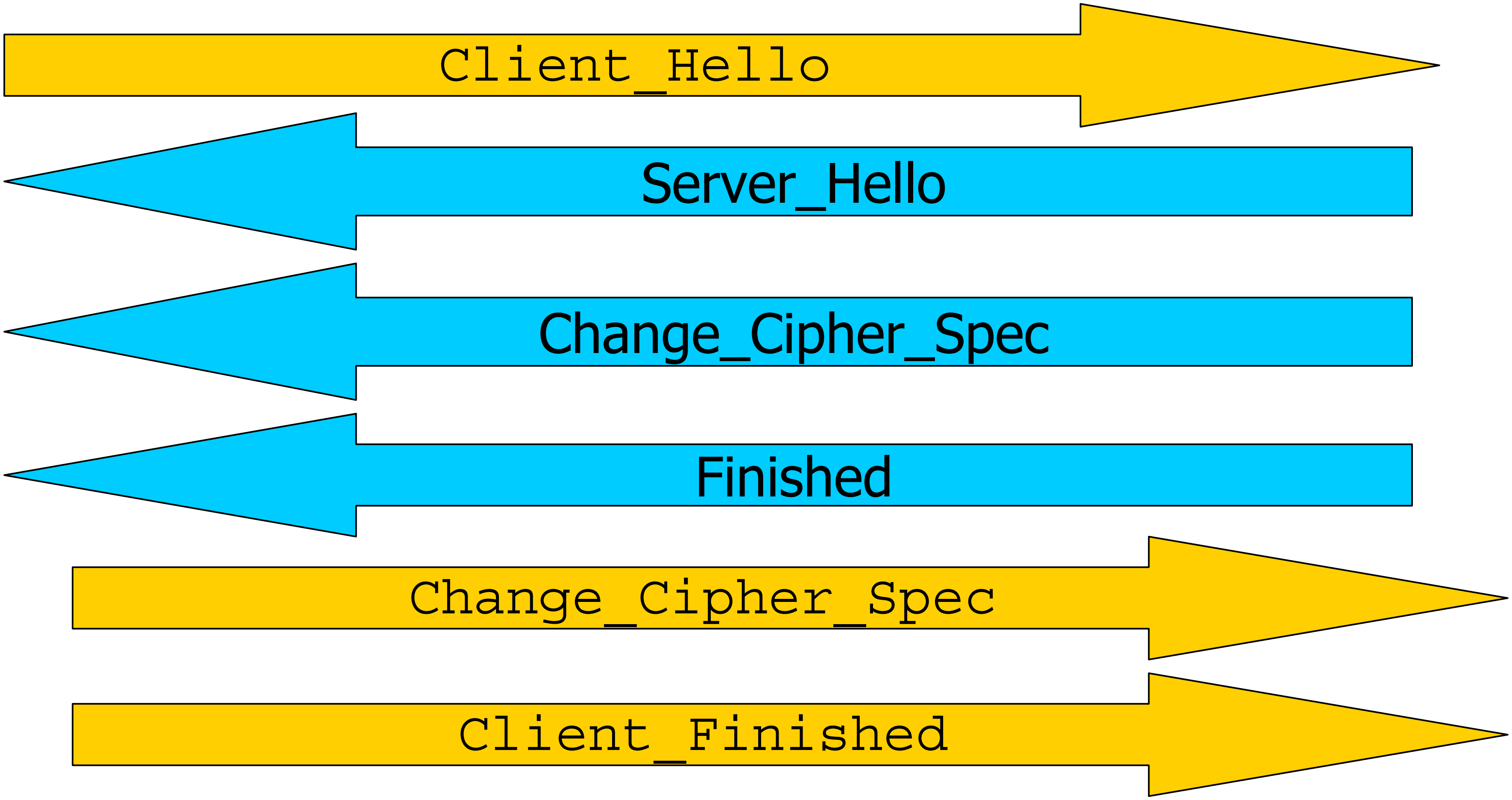
Server_Change_Cipher_Spec

Server_Finished

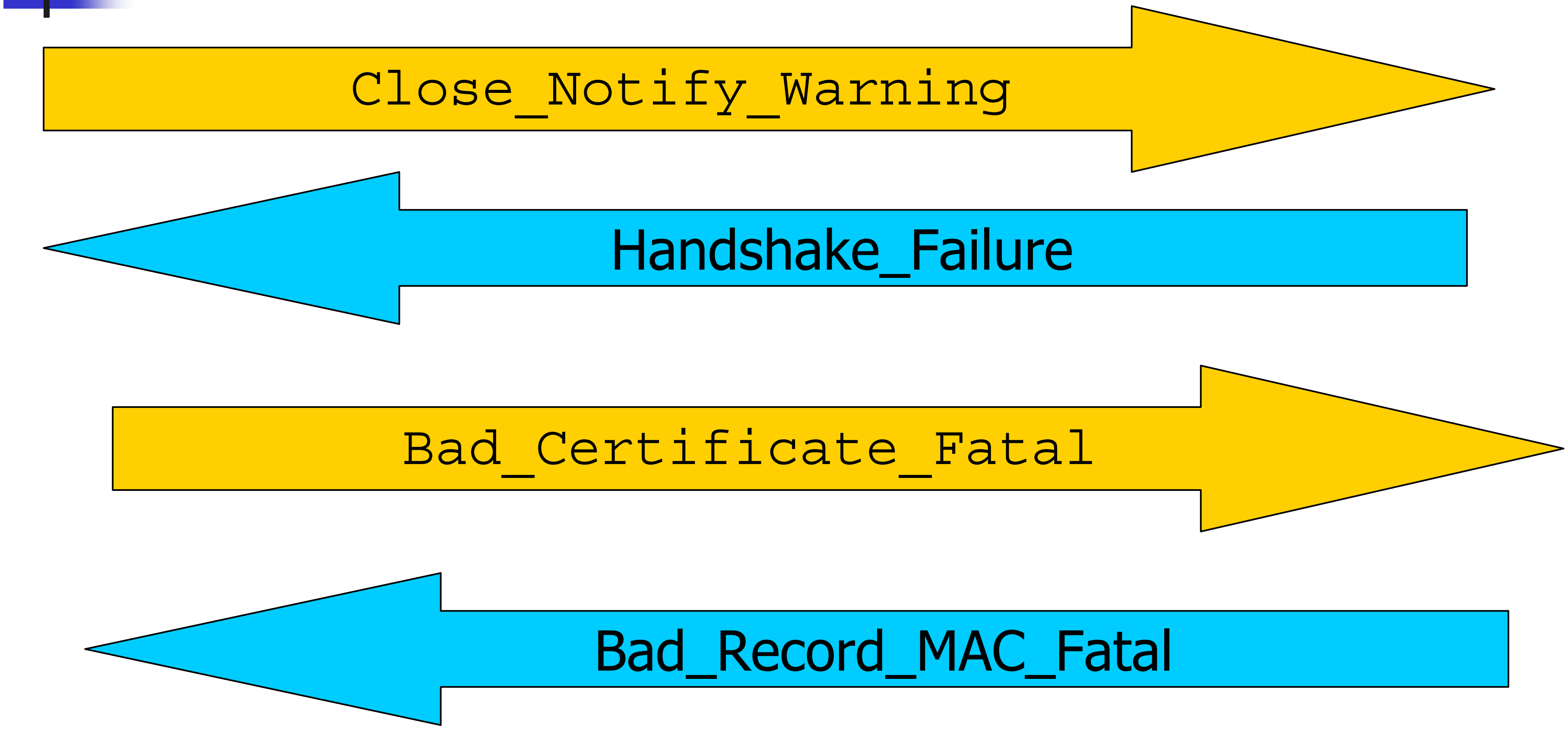
Client_Data

Server_Data

# SSL Handshake Resuming a Previous Session



# SSL Alerts



Close_Notify_Warning

Handshake_Failure

Bad_Certificate_Fatal

Bad_Record_MAC_Fatal

# SSL Enabled Server on VSE

- Server allocates a socket  binds to a port, listens, and issues a accept.
- Client  connects to the VSE server and sends a “client hello”.
- Server passes control to the SSL4VSE secure socket initialization routine which performs the actual SSL handshake.
- Server responds to the “client hello” by choosing the cipher algorithms that will be used during the session and sending the clients its x.509v3 PKI certificate.

# SSL Enabled Server on VSE

- Key material is generated that will be used for encryption, decryption, and message authentication.
- Once the handshake is completed a secure connection is ready, and the server and client can then use secure socket read and write functions of the SSL4VSE API.

# The Tools: Cryptography Algorithms

- SSL requires cryptography functions
  - X509v3 PKI certificates for identification
  - RSA for key exchange
  - DES for data encryption
  - MD5 and SHA-1 for message hashing
  - HMAC for message authentication

# Crypto Toolkit for VSE

- API for cryptography standards
  - Message Digest algorithms
    - MD5 RFC1321
    - SHA-1 FIPS Pub 180-1
  - Bulk Data encryption
    - DES FIPS Pub 46-3
    - Triple DES Ansi x9.52 Triple DES
  - Message authentication
    - HMAC RFC2104
  - Digital Signatures
    - RSA PKCS#1

# RSA Public Key encryption

- Used by SSL for initial key exchange and digital signatures
- Separate keys used for encrypt and decrypt
- Public key shared with others in signed certificate
- Private key used to decrypt and for creating digital signatures
- RSA patent expired in September, 2000

# Installing SSL on VSE

- Install a SSL enabled client
  - MS-IE, QWS3270 Secure, Zephyr Passport, etc
- Create a RSA private key file
- Submit a CSR request to a Certificate Authority.
  - It will contain your public key and is digitally signed with your private key

# Installing SSL on VSE

- Install the CA signed certificate
- Install the CA root certificate
- Configure the SSL daemon on VSE

# Example SSL enabled client

- Microsoft Internet Explorer
  - Must be version 5 or higher
  - Under the the "Tools - Internet Options - Advanced - Security‟ the "Use SSL/TLS‟ checkbox must be checked
  - Under the the "Tools - Internet Options – Content - Certificates the CA root certificate must be installed

# Creating a RSA Key file

- Based on RSA PKCS#1

```
// EXEC CIALSRVR
SETPORT 5622
/*
* *  RSA private key created on PC and sent to VSE
/&
```

# Creating a CSR Request

- Based on RFC2314

```
// EXEC CIALCREQ
Webmaster: dstoever@tcpip4vse.com
Phone: xxx-xxx-xxxx
Server: TCP/IP for VSE 1.4
Common-name: www.dstoever.com
Organization Unit: Development
Organization: Connectivity Systems
Locality: Columbus
State: Ohio
Country: US
/*
```

# Install Certificate Authority Root Certificate

```
// EXEC CIALROOT
-----BEGIN CERTIFICATE-----
MIICpDCCAg2gAwIBAgIDPltCMA0GCSqGSIb3DQEBBAUAMIGHMQswCQYDVQQGEwJa
QTEiMCAGA1UECBMZRk9SIFRFU1RJTkcgUFVSUE9TRVMgT05MWTEdMBsGA1UEChMU
VGhhd3RlIENlcnRpZmljYXRpb24xFzAVBgNVBAsTDlRFU1QgVEVTVCBURVNUMRww
…
IyqW1vNOcNo=
-----END CERTIFICATE-----
/*
```

# Install CA Signed certificate

```
// EXEC CIALCERT
-----BEGIN CERTIFICATE-----
MIICpDCCAg2gAwIBAgIDPltCMA0GCSqGSIb3DQEBBAUAMIGHMQswCQYDVQQGEwJa
QTEiMCAGA1UECBMZRk9SIFRFU1RJTkcgUFVSUE9TRVMgT05MWTEdMBsGA1UEChMU
VGhhd3RlIENlcnRpZmljYXRpb24xFzAVBgNVBAsTDlRFU1QgVEVTVCBURVNUMRww
…
IyqW1vNOcNo=
-----END CERTIFICATE-----
/*
```

# IETF Standards Implemented

http://www.ietf.org/html.charters/tls-charter.html

- RFC2246 The TLS Protocol
  - Handshake requires server certificate from VSE
  - RSA used for generating key material
  - DES used for application data encryption
  - HMAC-SHA1 used for message authentication

# IETF Standards Implemented

- RFC1321 The MD5 Message-Digest Algorithm
- RFC2104 HMAC: Keyed hashing for message authentication
- RFC2202 Test Cases for HMAC-MD5 and HMAC-SHA-1
- RFC1113 Universal Printable Character encoding
- RFC2459 Internet x509v3 PKI certificates
- Internet draft HTTP over TLS

# FIPS Standards

- PUB 46-3 Data Encryption Standard (DES)
- PUB 81 DES Modes of Operation
- Cipher Block Chaining mode
- PUB 180-1 Secure Hash Standard (SHA-1)
- http://www-08.nist.gov/cryptval/des.htm
- http://csrc.nist.gov/pki/nist_crypto/welcome.html

# SSL Implementation on VSE

- Using the SSL Pass-Through server
  - Defining the SSL pass-through daemon on VSE
- Using the SSL API on VSE
  - Client Server application without SSL
  - Client Server application with SSL
- Using Cryptography APIs on VSE
  - Using DES to encrypt data
  - Using SHA-1 to create a message fingerprint
  - Using RSA to create a digital signature
  - Using BASE64 encoding to transmit binary data

# Using the SSL Pass-Through Server

- Allows quick and easy implementation of SSL
- No application modifications
- SSLD on VSE performs handshake with SSL enabled client
  - Encrypts outbound data to SSL client
  - Decrypts inbound data from SSL client
- Currently used by TelnetD

# Defining the SSL daemon on VSE

- DEFINE TLSD,

| | |
|---|---|
| ID=TLSD01, | Identifier |
| PORT=443, | We listen here |
| PASSPORT=23 | Pass to real daemon |
| CIPHER=0A096208 | Allowed ciphers |
| CERTLIB=KEYLIB | Library name |
| CERTSUB=SSLKEYS | Sublibrary name |
| CERTMEM=SSL4VSE | Member name |
| TYPE=1 | Server application |
| MINVERS=0300 | Protocol version |

# Implementing SSL into Applications on VSE

- Two sockets connected
  - One must be a Server the other a Client
- Server always authenticated
- Client authentication optional
- Client and Server must:
  - Agree on cipher algorithms
  - Establish crypto keys

# SSL for VSE API

- Based on IBM OS/390 SSL Programming Guide and Reference, manual number SC24-5877
  - Easy porting for OS/390 SSL applications
  - Callable from either C or BAL

# Client Server without SSL

- Client
  - Allocate socket
  - Connect to server
  - Read/Write socket
  - Close socket

- Server
  - Allocate socket
  - Bind socket to a port
  - Listen on port
  - Accept client connection
  - Read/Write socket
  - Close socket

# Client Server with SSL

- Client
  - SSL setup environment
  - Allocate socket
  - Connect to server
  - SSL socket initialization
  - SSL read/write socket
  - SSL Close socket
  - Close socket

- Server
  - SSL setup environment
  - Allocate socket
  - Bind socket to a port
  - Listen on port
  - Accept client connection
  - SSL socket initialization
  - SSL read/write socket
  - SSL Close socket
  - Close socket

# SSL for VSE API

- Based on IBM OS/390 SSL Programming Guide and Reference, manual number SC24-5877
  - Easy porting for OS/390 SSL applications
  - Callable from either C or BAL

# Setup SSL environment

- C function = gsk_initialize()
  - C header file = SSLVSE.H
- BAL vcon  = IPCRINIT
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Setup SSL environment

- Minimum acceptable protocol version
- Identify lib.sublib containing the private key and certificates
- Session timeout value for fast client reconnect
- Specifies the method for verifying client certificates

# Initialize SSL socket

- C function = gsk_secure_soc_init()
  - C header file = SSLVSE.H
- BAL vcon  = IPCRSINI
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Initialize SSL socket

- Type of handshake
  - Server/Client without client authentication
  - Server/Client with client authentication
- List of acceptable cipher suites
  - RSA512-Null-MD5, RSA512-Null-SHA
  - RSA512-DES40-SHA
  - RSA1024-DES-SHA
  - RSA1024-TripleDES-SHA

# Initialize SSL socket

- @ of read socket routine
- @ of write socket routine
- Calls back into your code for reading and writing to the actual socket
- Parmlist passed contains:
  - Fullword handle for use by application
  - @ of data receive/send area
  - Length of data receive/send area

# Using cryptography APIs on VSE

- SSL requires cryptography functions
  - X509v3 PKI certificates for identification
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# CryptoVSE API algorithms

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    - DES FIPS Pub 46-3
    - Triple DES Ansi x9.52 Triple DES
  - Message authentication
    - HMAC RFC2104
  - Digital Signatures
    - RSA PKCS#1

# Using DES to encrypt data

- C function = cry_des_encrypt()
  - C header file = SSLVSE.H
- BAL vcon  = CRYDESEC
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Using DES to encrypt data

- Parameters addresses off R1
  - 0(R1) = address of data to encrypt
  - 4(R1) = length of data to encrypt
  - 8(R1) = address of key
  - 12(R1) = length of key
  - 16(R1) = address of work area
  - 20(R1) = length of work area

# Using SHA-1 to create a message fingerprint

- C function = cry_sha_hash()
  - C header file = SSLVSE.H
- BAL vcon  = CRYSHAHA
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Using SHA-1 to create a message fingerprint

- Parameters addresses off R1
  - 0(R1) = address of input data for hash
  - 4(R1) = length of input data
  - 8(R1) = not used
  - 12(R1) = not used
  - 16(R1) = address of work area
  - 20(R1) = length of work area
- 20-byte SHA-1 hash will be returned in the supplied work area

# Using RSA to create a digital signature

- C function = cry_rsa_signature_create()
  - C header file = SSLVSE.H
- BAL vcon  = CRYRSASI
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Using RSA to create a digital signature

- Parameters addresses off R1
  - 0(R1) = address of input data
  - 4(R1) = length of input data
  - 8(R1) = address of RSA private key
  - 12(R1) = length of RSA private key
  - 16(R1) = address of work area
  - 20(R1) = length of work area
- 64 or 128 byte RSA PKCS#1 digital signature will be returned in the supplied work area

# Using BASE64 encoding to transmit binary data

- C function = cry_universal_print_encode()
  - C header file = SSLVSE.H
- BAL vcon  = CRYUPENC
  - BAL macro = SSLVSE.A
- Standard linkage
  - R13 = save area
  - R14 = return address
  - R15 = entry point
  - R1 = parameter list
- On return R15 = return code
  - Negative = failed, R1=@reason

# Using BASE64 encoding to transmit binary data

- Parameters addresses off R1
  - 0(R1) = address of input data
  - 4(R1) = length of input data (48)
  - 8(R1) = not used
  - 12(R1) = not used
  - 16(R1) = address of work area
  - 20(R1) = length of work area
- 64 bytes of universally printable characters will be returned in the supplied work area

# Questions ?

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