



Safe and Secure Transfers with z/OS FTP

SHARE Session 12855

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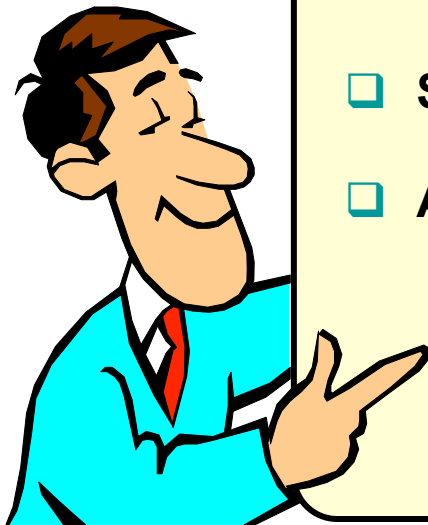
Notes:

- Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.
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Agenda

- 
- ☐ Overview: FTP and Security
 - ☐ Securing the z/OS FTP client and server
 - ☐ Securing the FTP connections
 - ☐ Addressing network traversal challenges



Let's clear up some common confusion from the start...



▪ **FTP (File Transfer Protocol):**

RFC959
FTP

- Also referred to as RFC959 FTP or “normal” FTP
- The FTP protocol we all know and have used for years.
- Has been extended numerous times since RFC 959 was issued in 1985
- An RFC959 FTP client talks to an RFC959 FTP server - not an sftp server
- What the z/OS CS FTP client and server have supported through many years

▪ **sftp (Secure Shell File Transfer Protocol):**

Secure
Shell
FTP

- A sub-protocol of SSH (Secure Shell)
- Supported on z/OS by "IBM Ported tools for z/OS" and at least two ISV products
- Has nothing to do with RFC959 FTP - incompatible protocols
- An sftp client talks to an sftp server - not an RFC959 FTP server

▪ **FTPS (File Transfer Protocol Secure):**

RFC4217
FTP

- Also referred to as FTP – SSL, RFC4217 FTP, FTP AUTH-TLS, FTP AUTH-SSL
- RFC959 FTP but extended with full network security (authentication, data integrity, and data privacy) using a standard security mechanism, such as Kerberos or SSL/TLS
 - SSL/TLS protection specified by RFC4217 "Securing FTP with TLS"
- Both control connection and data connection can be secured
 - No user IDs or password flowing in the clear

Comparison of selected z/OS file transfer technologies from a security perspective

	FTP With no security RFC959	FTPS FTP w. SSL/TLS RFC959 + RFC4217	FTP FTP w. IPSec Any RFC level	SFTP As implemented by IBM Ported Tools
User ID and password protection	No	Yes	Yes	Yes
Data protection (the file being transferred)	No	Yes	Yes	Yes
z/OS UNIX file support	Yes	Yes	Yes	Yes
z/OS MVS data set support	Yes	Yes	Yes	No (but add-on products do exist*)
Use of System z hardware encryption technologies	n/a	Yes	Yes	Yes (for random number generation)
Partner authentication via locally stored copies of public keys	n/a	No	Yes (pre-shared key)	Yes
Partner authentication via X509 certificates	n/a	Yes	Yes	No
Use of SAF key rings and/or ICSF	n/a	Yes	Yes	Yes
FIPS 140-2 mode	n/a	Yes (z/OS V1R11)	Yes (z/OS V1R12)	No
Mutual authentication supported	n/a	Yes	Yes (at an IP address level)	Yes

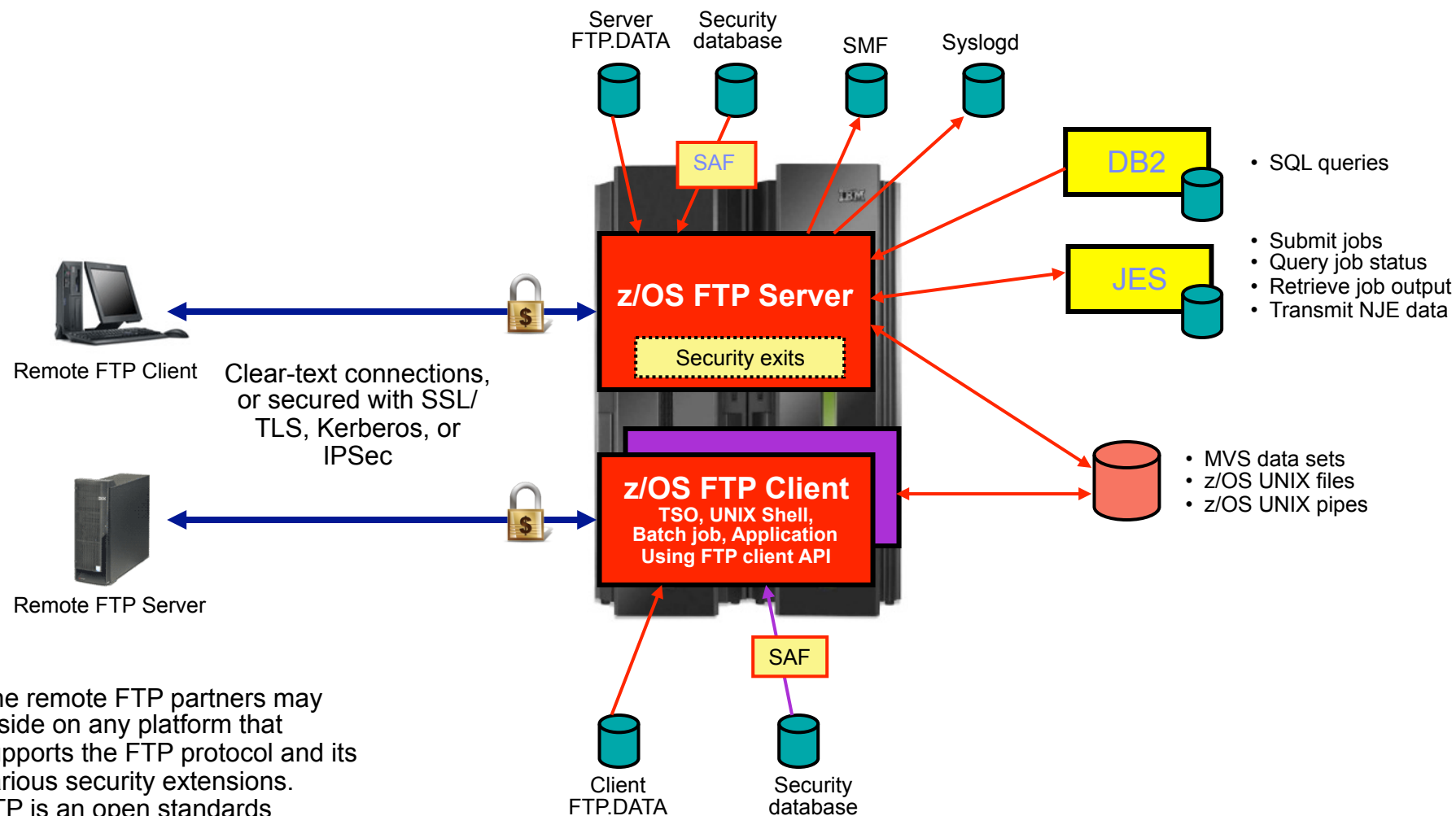
* MVS data set support example: Dovetailed Technologies' Co:Z SFTP

Safe and Secure Transfers with z/OS FTP

Securing the z/OS FTP client and server



z/OS FTP – the big picture



The remote FTP partners may reside on any platform that supports the FTP protocol and its various security extensions. FTP is an open standards protocol.

Securing the local z/OS FTP server

1. Basic platform security setup is a prerequisite

- Users defined with proper MVS data set access protection
- z/OS UNIX files defined with proper owning user and group along with user/group/world access permissions
- ...and so forth

2. FTP server-specific SAF resource definitions

- Via SERVAUTH resource profiles

3. Security-related options in the server's FTP.DATA configuration file

- Controlling various aspects of how the FTP server reacts to selected requests, such as a request for anonymous access

4. Optional security exits in the FTP server

- Can be implemented to provide vary granular levels of controls in the FTP server

Selected SAF resource definitions in the SERVAUTH class

- **EZB.PORTACCESS.sysname.tcpname.port_safname**
 - Controls ability for a started task user ID to establish itself as a server on the matching port number in the TCP/IP Profile port reservation section
- **EZB.FTP.sysname.ftpdname.PORTxxxxx**
 - Controls ability to log into an FTP server (control port number) based on the SAF user ID that is being used to log in
 - Initially used for SSL/TLS connections if SECURE_LOGIN VERIFY_USER was coded in the FTP server's FTP.DATA
 - Can be enforced for all types of connections by coding VERIFYUSER TRUE in the server's FTP.DATA - (This support was added in z/OS V1R10)
- **EZB.FTP.sysname.ftpdname.SITE.DUMP** and **EZB.FTP.sysname.ftpdname.SITE.DEBUG**
 - Provides ability to restrict usage of SITE DUMP and DEBUG commands (commands may generate large amount of output)
- **EZB.FTP.sysname.ftpdname.ACCESS.HFS**
 - Provides ability to generally restrict FTP user access to the z/OS UNIX file system

Selected security options in the FTP server' s FTP.DATA (1 of 3)

▪ **ANONYMOUS**

- Controls the ability to log into your FTP server as an anonymous user
- If the ANONYMOUS option is not included in the server' s FTP.DATA, anonymous access is disabled
- Disabled by default – keep it that way, unless you have specific need for it.
 - If you do enable ANONYMOUS, make sure to change the default value of 1 on the ANONYMOUSLEVEL option to 3
 - Also, verify the settings of all the options that start with “ANONYMOUS” – there are a total of 8 including the ANONYMOUS option itself
 - Use the supplied shell script to build a specific z/OS UNIX file system directory structure for anonymous access
 - EMAILADDRCHECK is a syntax check only of the entered email address

▪ **DEBUGONSITE and DUMPONSITE**

- Controls the ability to enable dump and debug SITE command options
- If you set these to TRUE, make sure you define the corresponding SERVAUTH profiles so only authorized users can issue these two SITE command options

▪ **PORTCOMMAND, PORTCOMMANDPORT, PORTCOMMANDIPADDR, and PASSIVEDATACONN**

- Control the ability of your FTP server to participate in three-way proxy mode.

Selected security options in the FTP server's FTP.DATA (2 of 3)

▪ **REPLYSECURITYLEVEL**

- Controls how much identification information is sent on the initial 220 greeting message from the FTP server, and also how much detail is returned when MVS data set contention occurs.
- Default is no restrictions (level 0).
- If your auditors request you to send as little information as possible, use a setting of 1 on this option
 - Level 0: 220-FTPABC1 IBM FTP CS V1R11 at MVS098, 16:42:51 on 2009-05-24.
 - Level 1: 220-IBM FTP, 16:45:57 on 2009-05-24.

▪ **ACCESSERRMSG**

- To prevent details of failed log in attempts to be returned to the FTP client user, set this option to FALSE (which is the default).
- You may change it to TRUE in an internal-only shop if you want your users to receive details about their failed log in attempt.

▪ **SECURE_...**

- There are a number of options that start with SECURE_ - they are all used to control the ability of the FTP server to accept secure connections (SSL/TLS or Kerberos)

Selected security options in the FTP server's FTP.DATA (3 of 3)

▪ VERIFYUSER

- Discussed earlier – extends SAF check of all users' ability to connect to the server's control port number
 - EZB.FTP.sysname.ftpd daemonname.PORTxxxxx

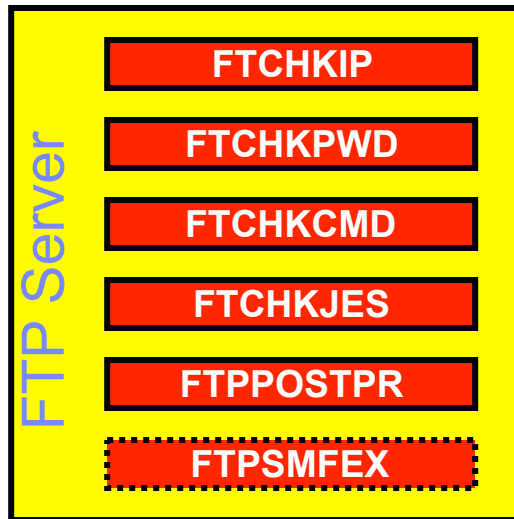
▪ PASSIVEDATAPORTS

- Controls which range of port numbers the server may use for passive mode data connections
- Can be very useful if there are filtering firewalls in-between the FTP client and the FTP server

If you created your server's FTP.DATA data set years ago, we recommend recreating it based on the FTPSDATA member in hlq.SEZAINST. Many new options have been added over the last releases and all are included in this sample member for documentation purposes.



FTP server security exit points – extending FTP server security



Accept/reject connections based on client and server IP address and port information

Accept/reject login based on client user ID and/or password

Accept/reject/modify individual FTP commands and their arguments

Accept/reject submission of a job based on analyzing records of job to be submitted

Initiate file transfer post processing based on result of file transfer

Accept/reject writing of old SMF118 records (no longer recommended)

- If these exits routines are present they will be loaded and called at the defined exit points
- The FTCHKIP exit is called by the FTP daemon, while the others are called by the FTP server (after the new address space has been created)
- The command check routine is the most widely used. It has information about the current command from the client, what the current working directory is, what file-type we are using, etc. It may reject the command or it may modify the command options, such as the file or data set name on a STOR or RETR command. If it does reject the command, it can also return the text that will be returned to the client in the 500 reply
- The FTCHKCMD exit executes under the logged in user's user ID. Installation-defined SAF resource definitions can be checked in that routine if needed
- The exits are normally coded in assembler, but we have seen examples where they were coded in C.

FTP server security exit details

Exit point	Called by	Called when	Main input	Possible actions
FTCHKIP	Daemon address space	When control connection is being accepted by the FTP daemon	Client and server IP addresses and ports	Accept or reject connection setup
FTCHKPWD	Server address space	When the client user sends the PASS command	IP addresses and ports, client user ID and password	Accept or reject login request
FTCHKCMD	Server address space	For every command received over the control connection	IP addresses and ports, client user ID, directory type, file type, current directory, and the FTP command and arguments	Accept, reject, or modify the FTP command
FTCHKJES	Server address space	For every record in a job that is being submitted to JES	IP addresses and ports, the full JES input record	Accept or reject the job submission
FTPOSTPR	Server address space	For every completed file transfer operation	IP addresses and ports, plus details about the completed file transfer	Initiate post processing

Samples for all in hlq.SEZAINST

Securing the local z/OS FTP client

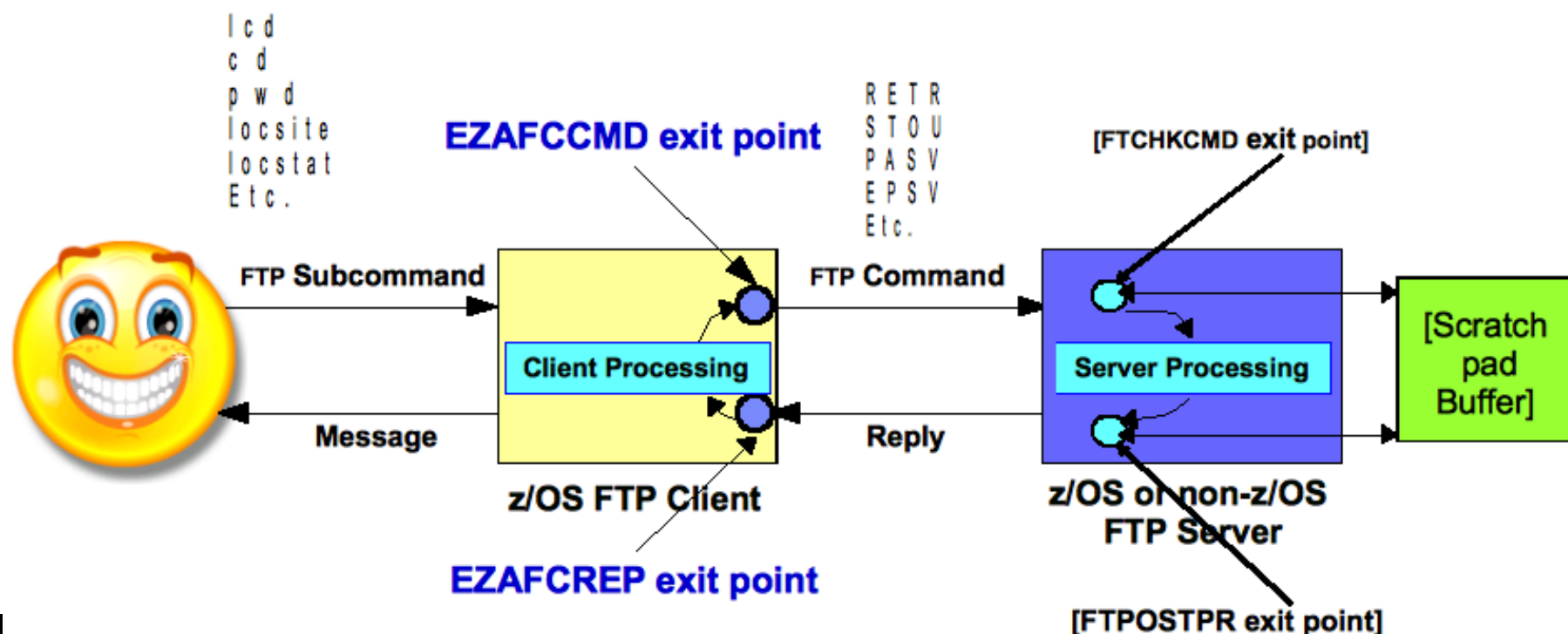
- Basic platform security setup is a pre-requisite
 - Users defined with proper MVS data set access protection
 - z/OS UNIX files defined with proper user/group/world access permissions
 - Etc.
- FTP server-specific SAF resource definitions
 - None for the FTP client
- Security-related options in the client's FTP.DATA
 - Not really any
- Optional security exits
 - No exit points in the z/OS FTP client prior to V2R1

FTP client security user exits in V2R1

- You can use FTP server user exits to limit access to an FTP server, but...
- Currently, a system administrator has no way of controlling FTP client commands or other aspects of the processing done in the z/OS FTP client. Examples of tasks that a system administrator might desire:
 - Preventing a dataset (that the user should have at least limited access to) from being moved from the z/OS host
 - The ability to inspect or modify the dataset names specified by FTP client users for inbound and outbound file transfers
 - The ability to cancel an FTP client address space if that client is in the process of sending an “unauthorized” FTP command
- To address this, V2R1 will provide two FTP client user exit points:
 - FTP command user exit – EZAFCCMD
 - Receives control just before an FTP command is being sent
 - Enables the exit to inspect the command, optionally modify the command arguments, reject the command, or request the FTP client session be terminated
 - FTP reply user exit – EZAFCREP
 - Receives control when an FTP server reply arrives
 - Allows the exit to analyze the results of commands sent to the server, and request the FTP client session be terminated

FTP client security user exits in V2R1 ...

- The EZAFCMD user exit will be called whenever the FTP client is about to send an FTP command to the server.
 - The call of this user exit is done before the command is converted to ASCII
- The EZAFCREP user exit will be called whenever the FTP client receives a reply line over the control connection
 - The call of this exit is done after the reply has been converted to EBCDIC

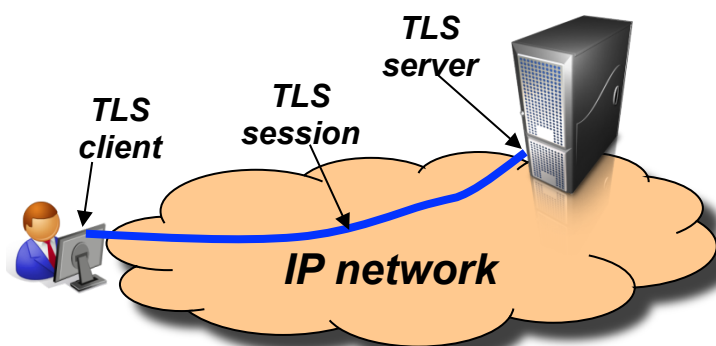


Securing FTP with TLS on z/OS



Transport Layer Security (TLS/SSL) overview

- Transport Layer Security (TLS) is defined by the IETF **
 - Based on Secure Sockets Layer (SSL)
 - TLS defines SSL as a version of TLS for compatibility
- Provides secure connectivity two TLS security session endpoints
 - TLS session
- Full application payload encryption and data authentication / integrity
- TLS security session endpoint plays either a client or server role
- Session endpoint authentication typically via X.509 certificates
 - Server authentication required
 - Client authentication optional (mutual authentication)



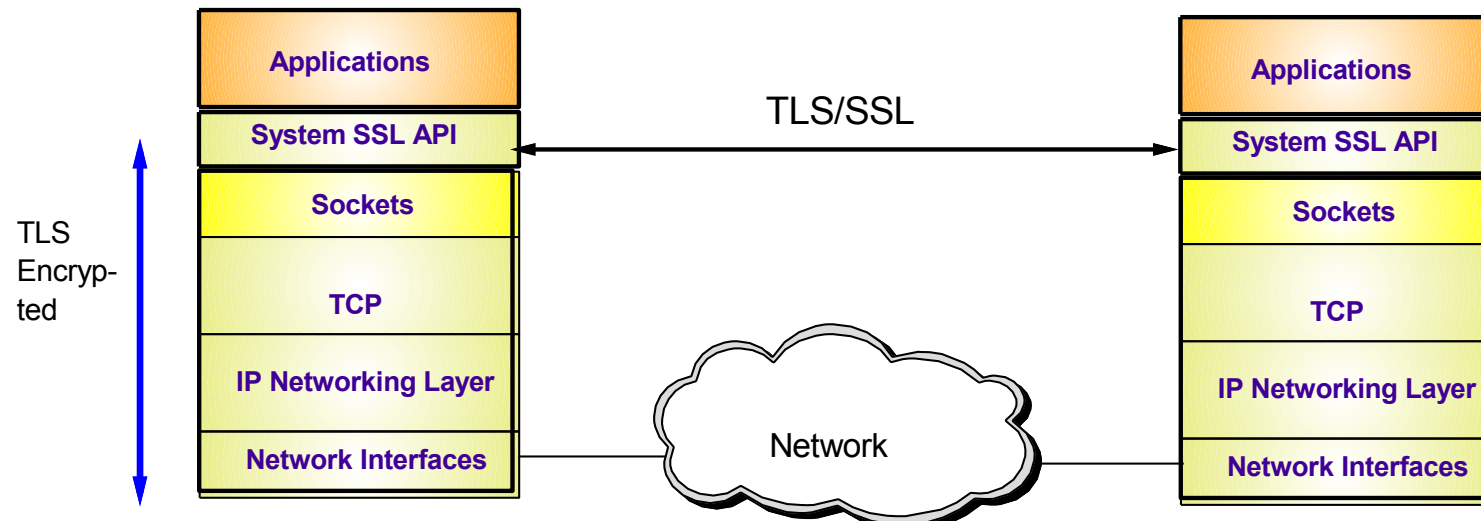
Full application payload encryption

**TLS/SSL
encryption:**

SrcIP	DestIP	SrcPort	DestPort	Data
192.168.100.1	192.168.1.1	50002	443	@%\$#*&&^^!:"J)*GVM><

**** For our purposes, SSL and TLS are equivalent and one term implies the other**

Transport Layer Security enablement



- TLS traditionally provides security services as a socket layer service
 - TLS requires reliable transport layer,
 - Typically TCP (but architecturally doesn't have to be TCP)
 - UDP applications cannot be enabled with traditional TLS
 - There is now a TLS variant called Datagram Transport Layer Security (DTLS) which is defined by the IETF for unreliable transports
- On z/OS, System SSL (a component of z/OS Cryptographic Services) provides an API library for TLS-enabling your C and C++ applications
- Java Secure Sockets Extension (JSSE) provides libraries to enable TLS support for Java applications
 - However, there is an easier way...

z/OS Application Transparent TLS overview

▪ Stack-based TLS

- TLS process performed in TCP layer (via System SSL) without requiring any application change (transparent)
- AT-TLS policy specifies which TCP traffic is to be TLS protected based on a variety of criteria
 - Local address, port
 - Remote address, port
 - Connection direction
 - z/OS userid, jobname
 - Time, day, week, month

▪ Application transparency

- Can be fully transparent to application
- An optional API allows applications to inspect or control certain aspects of AT-TLS processing – “application-aware” and “application-controlled” AT-TLS, respectively

▪ Available to TCP applications

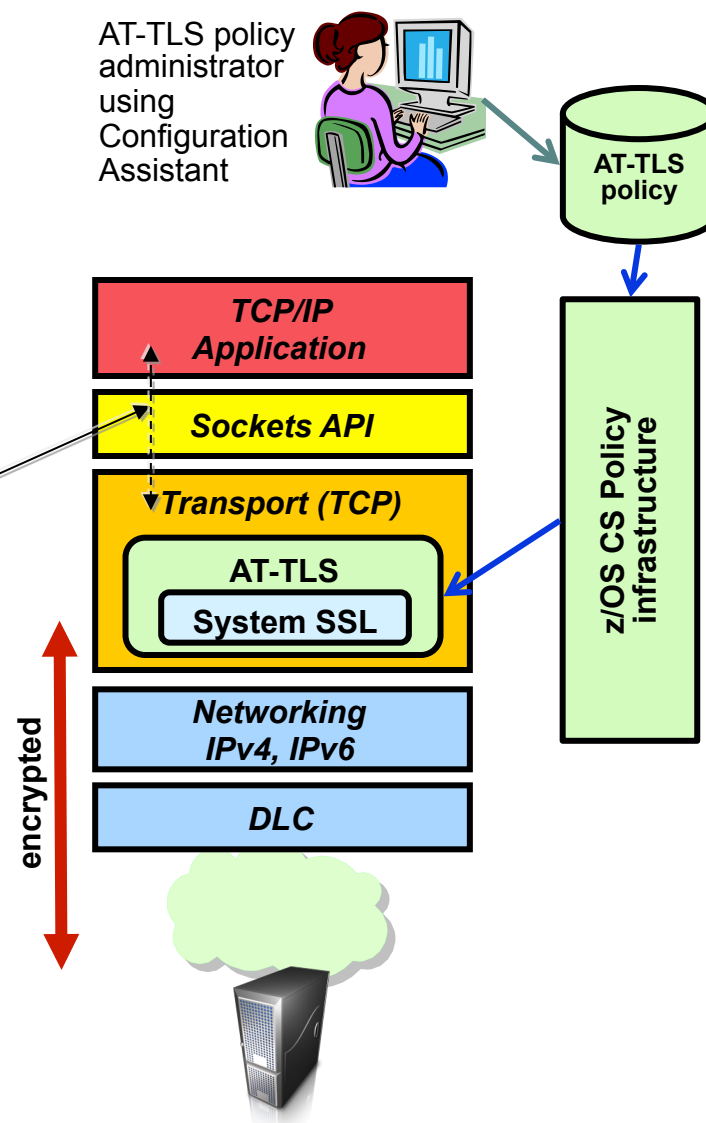
- Includes CICS Sockets
- Supports all programming languages except PASCAL

▪ Supports standard configurations

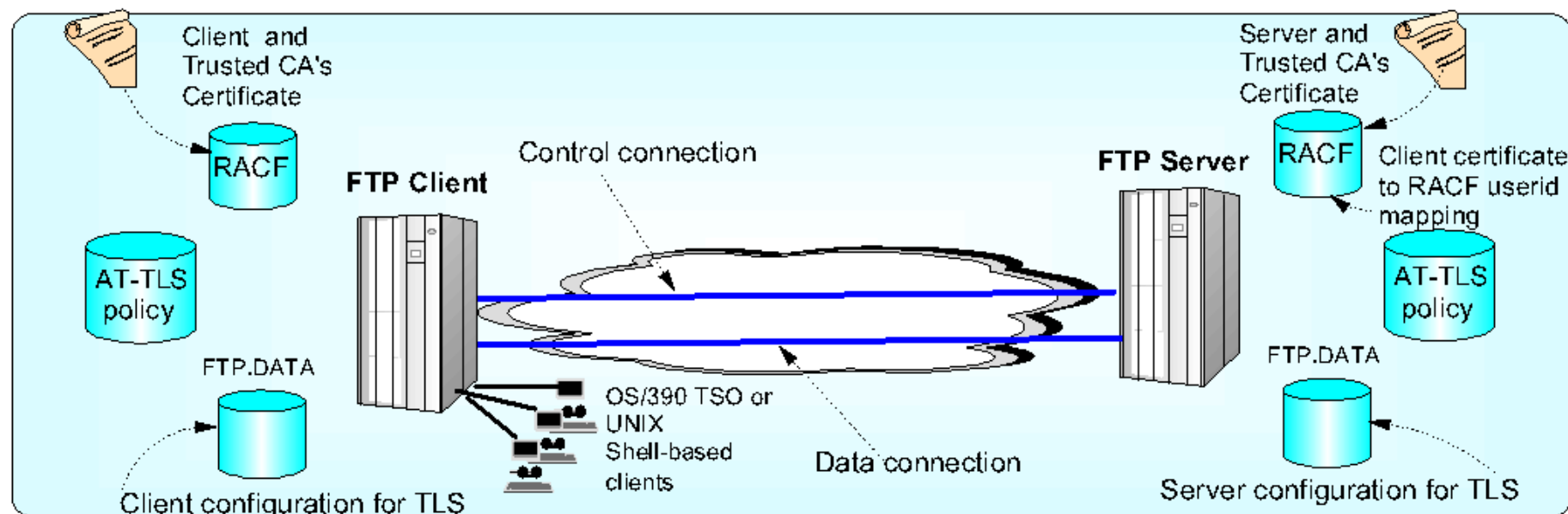
- z/OS as a client or as a server
- Server authentication (server identifies self to client)
- Client authentication (both ends identify selves to other)

▪ Uses System SSL for TLS protocol processing

- Remote endpoint sees an RFC-compliant implementation
- interoperates with other compliant implementations



AT-TLS enabled FTP overview



- **TLS protects control and data connection OR control connection alone**
 - Data connection cannot be protected without control connection
- **Authentication of end users :**
 - Basic - userid/password over encrypted control connection
 - Several options based on TLS session authenticated client certificate
- **Three main areas of FTP TLS configuration**
 - RACF keyrings for certificates and private keys
 - AT-TLS policy defines which FTP traffic to protect and how to protect it (TLS security attributes)
 - FTP.DATA configuration (server and client) controls FTP protocol-specific security policy for TLS session

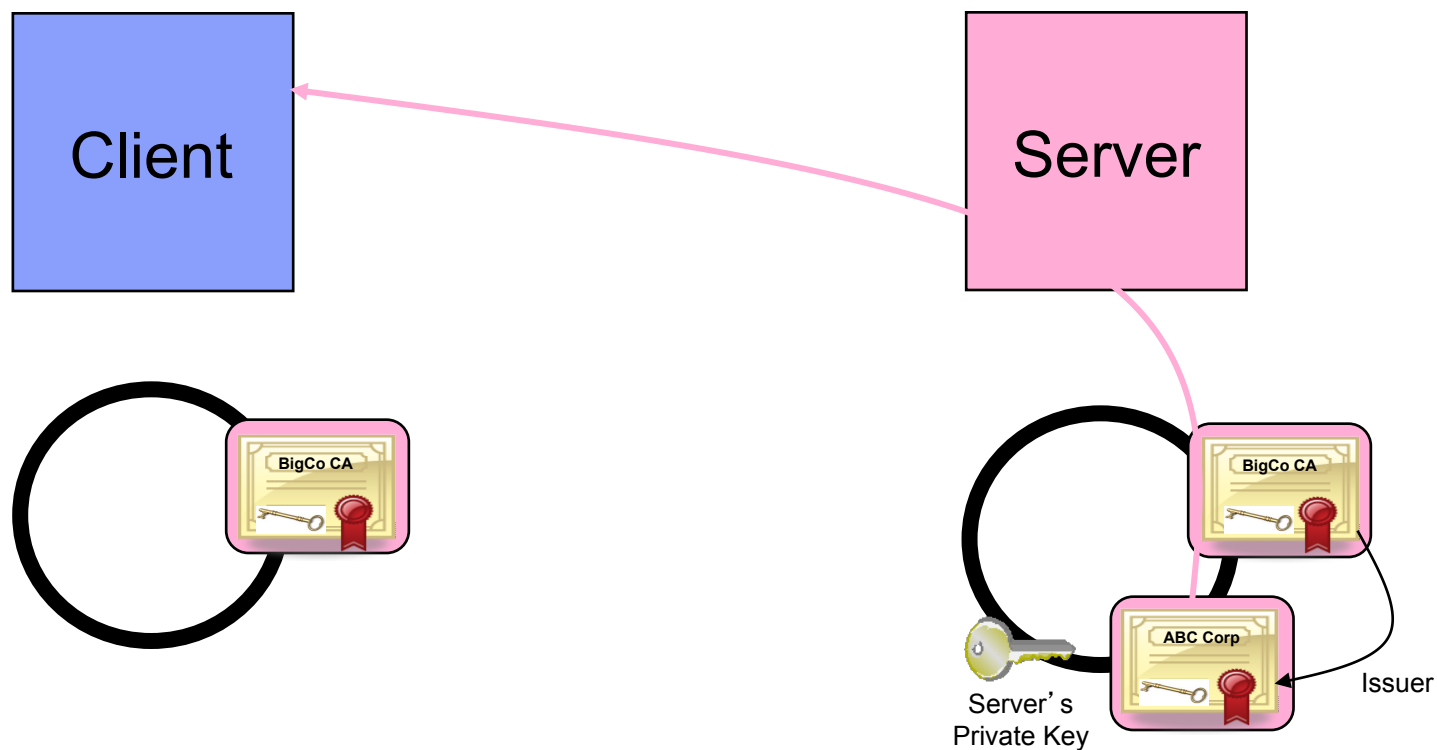
How TLS is requested for FTP

- TLS Modes:
 - ▶ Unconditional TLS
 - Uses separate protected ports for TLS (port 989 and 990)
 - ✓ TLS for client and server assumed
 - ✓ Not included in RFC 4217
 - ▶ Negotiable TLS
 - Both TLS and non-TLS traffic share standard ports (20 and 21)
 - ✓ Negotiation based on subset of the FTP security negotiation functions documented in RFC 2228 and further clarified in RFC 4217
- Negotiable mode TLS requested with client FTP command
 - ▶ AUTH TLS
- Configuration for negotiable mode at the server (FTP.DATA)
 - ▶ Specify that the AUTH comand with TLS is supported
 - EXTENSIONS statement with Auth_TLS
 - ▶ Specify that TLS required or optional on the standard FTP ports
 - SECURE_FTP statement with REQUIRED | ALLOWED

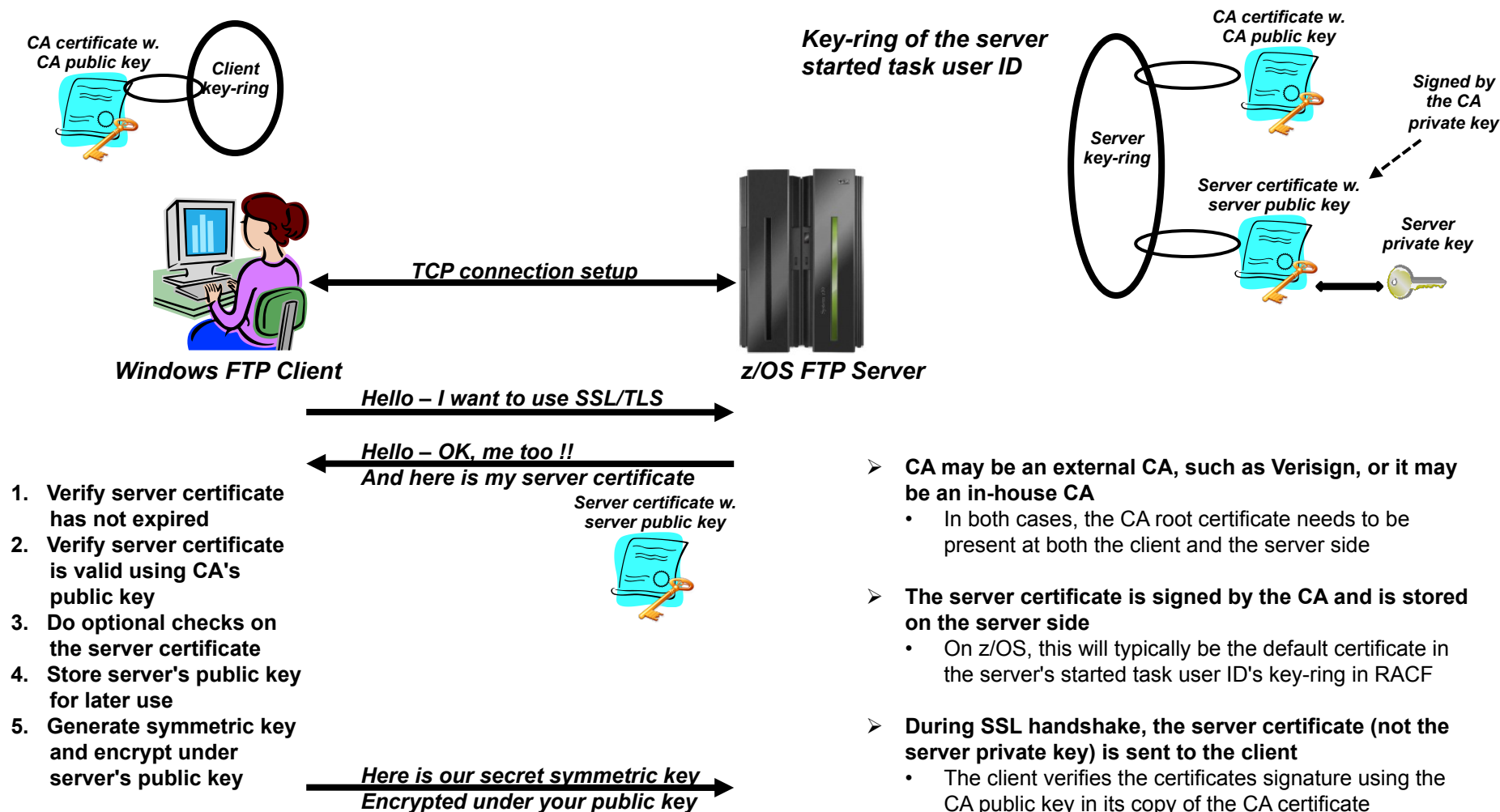
Securing FTP by Connection Type

- FTP has both a control and data connection. Possible combinations of TLS protection are:
 - ▶ Control connection security only
 - ▶ Both control connection and data connection security
 - **Data connection security only not supported**
- Data connection protection levels requested by client FTP command
 - ▶ PROTECT private
 - TLS always uses data authentication and integrity / encryption is optional
 - Protection is based on ciphersuite negotiations
 - TLS session is negotiated for each data connection
 - ▶ PROTECT clear
 - No TLS for the data connection
- FTP server can be configured to specify security requirements for the data connection. Options are:
 - ▶ SECURE_DATACONN
 - NEVER - Not allowed
 - CLEAR - Allowed, Let client decide
 - PRIVATE - Required

Certificates in action: SSL server authentication

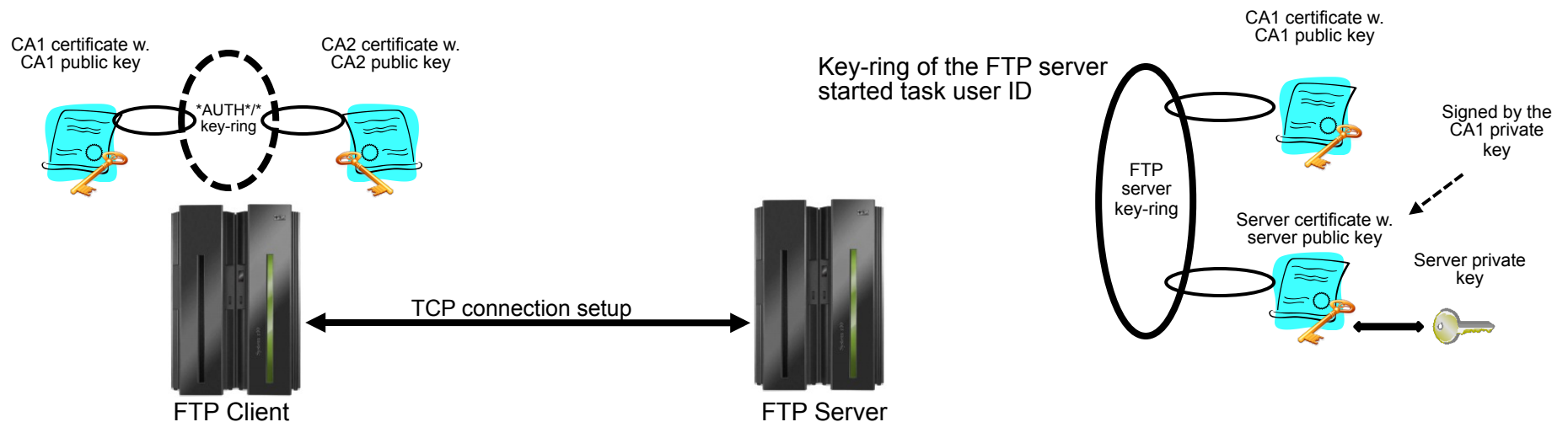


What is needed for z/OS Server authentication only (which is sufficient for encrypted data exchange)



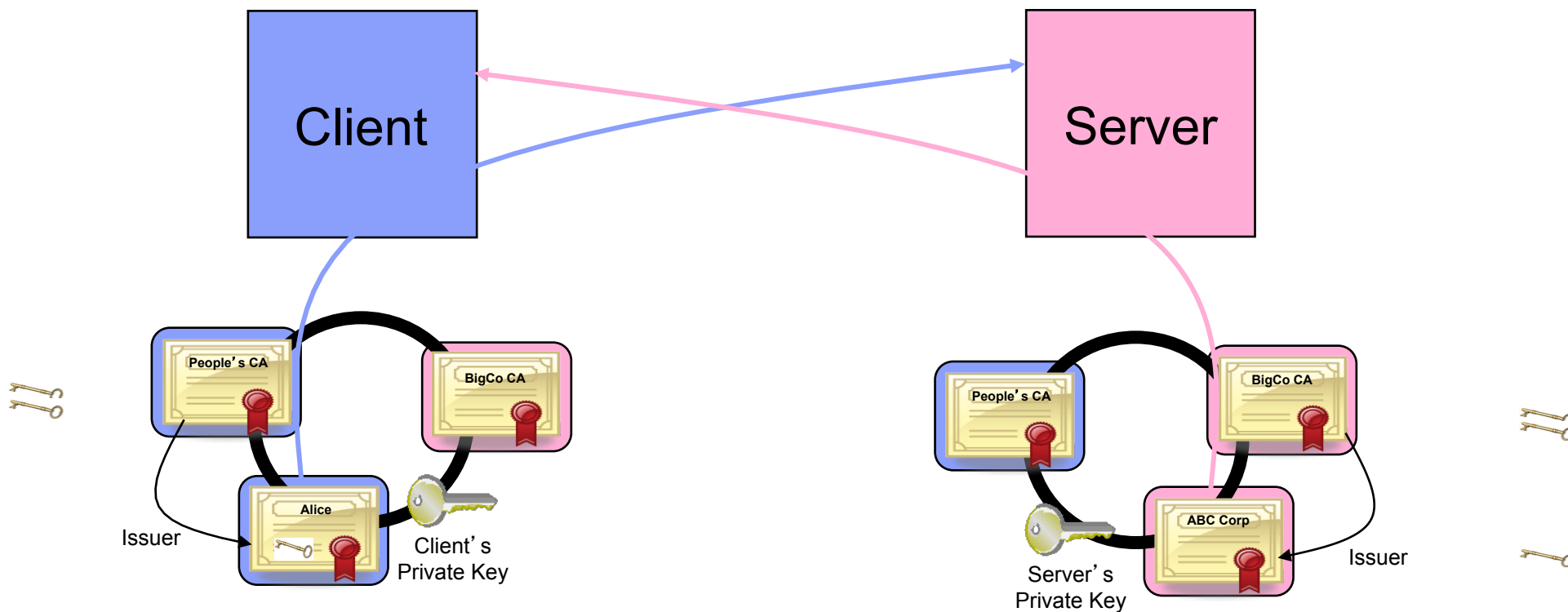
Virtual key-rings are useful when z/OS is the FTP client

- If z/OS is the FTP client, does every FTP user on z/OS have to have a key-ring with a copy of the CA certificate?
 - Originally, the answer was yes
 - What we call an "administratively heavy process"
 - z/OS V1R8 added support for something known as a virtual key-ring
- To have System SSL check all CERTAUTH certificates in RACF when verifying a certificate that was received during the SSL handshake, specify a key-ring in AT-TLS policy as:
 - KEYRING *AUTH*/*
- If client authentication is required, the z/OS FTP user still needs his/her own key-ring

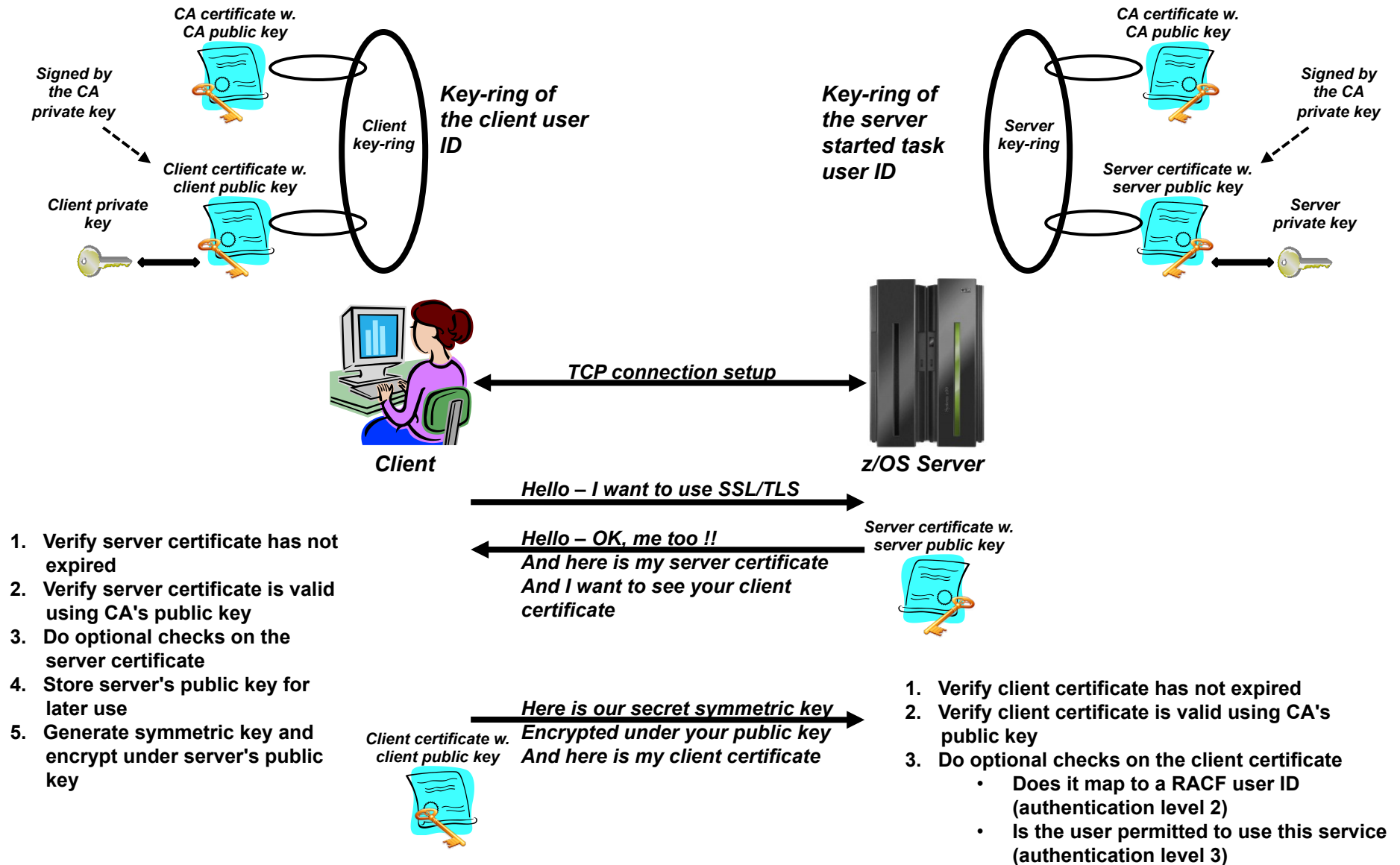


Certificates in action: SSL client authentication

(implies server authentication as well)



What is needed for z/OS Server and client authentication?



z/OS FTP server options for authenticating an FTP client using client certificates and AT-TLS

Authentication level	FTP server SECURE_LOGIN option	Description
Level 1	REQUIRED	The authenticity and validity of the client certificate is verified against the trusted roots in the FTP server's key-ring.
Level 2	VERIFY_USER	Same as level 1 PLUS a verification that the client certificate is registered by RACF and mapped to a known RACF user ID.
Level 3	VERIFY_USER	Same as level 2 PLUS a verification that the user ID has permission to a <u>SERVAUTH</u> profile that represents this specific FTP server: EZB.FTP.sysname.ftpdamonname.PORTnnnnn

Configuring AT-TLS policy: Server traffic descriptor and keyring using IBM Configuration Assistant for z/OS Communications Server

Modify Rule

AT-TLS rule name

Rule name: * ABC_FTP_4021 ☒ Enable rule

Specify settings

Traffic Role Key Ring Data Endpoints Security Level Advanced

Use this panel to specify the traffic settings.

Application name: * ABC_FTP4021_New

Local port

☐ All ports

☐ All ephemeral ports

☒ Ports: * 4021
Separate multiple ports with a co...

Remote port

☐ All ports

☒ All ephemeral ports

☐ Ports: *
Separate multiple po

Indicate the TCP connect direction

☐ Either ☒ Inbound only ☐ Outbound only

Specify jobname and user ID

Jobname: U

OK

Modify Rule

AT-TLS rule name

Rule name: * ABC_FTP_4021 ☒ Enable rule

Specify settings

Traffic Role Key Ring Data Endpoints Security Level Advanced

Use this panel to specify the key ring database and certificate label to use for this rule.

Key ring database

☐ Use the key ring database defined for the z/OS image

☒ Use a Simple name (as in an SAF product or in PKCS #11 Token format):

Key ring: * TLSRING

☐ Use this z/OS UNIX file system key database:

Key database: *

☒ Key database stash file: * or

☐ Key database password: *

Certificate label:

OK Cancel Help ?

Configuring AT-TLS policy: Data endpoints using IBM Configuration Assistant for z/OS Communications Server

Modify Rule

AT-TLS rule name

Rule name: ☒ Enable rule

Specify settings

Traffic | Role | Key Ring | **Data Endpoints** | Security Level | Advanced

Select the address groups of the host endpoints of the traffic you want to protect.

Local data endpoint

☒ Address group

☐ IPv4 or IPv6 address, subnet or range

Examples: x.x.x.x, x.x.x.x/yy, x.x.x.x-y.y.y.y
xxx, xxx/yyy, xxx-yyy

Remote data endpoint

☒ Address group

☐ IPv4 or IPv6 address, subnet or range

Examples: x.x.x.x, x.x.x.x/yy, x.x.x.x-y.y.y.y
xxx, xxx/yyy, xxx-yyy

OK Cancel Help ?

Configuring AT-TLS policy: Security level

using IBM Configuration Assistant for z/OS Communications Server

- **Type:**
 - AT-TLS
- **Encryption:**
 - 0x35 - TLS_RSA_WITH_AES_256_CBC_SHA (first choice)
- **Use TLS Version 1.0:**
 - Yes
- **Use TLS Version 1.1:**
 - Yes
- **Use SSL Version 3:**
 - Yes
- **Use SSL Version 2:**
 - No
- **Client authentication:**
 - None
- **FIPS 140 Support:**
 - Off

Modify Rule

AT-TLS rule name

Rule name: * ABC_FTP_4021 ☒ Enable rule

Specify settings

Traffic Role Key Ring Data Endpoints **Security Level** Advanced

Select the security level that will protect this traffic descriptor

Security levels

Select a security level

Default_Ciphers - IBM supplied: 3DES, AES-256 bit, AES-128 bit encryption

New... Copy... Modify... View Details Show Where Used

OK Cancel Help ?

z/OS FTP server FTP.DATA parameters for AT-TLS

EXTENSIONS	AUTH_TLS	; Enable TLS authentication ; Default is disabled.	
TLSMECHANISM	ATTLS	; Server-specific or ATTLS ; ATTLS - use ATTLS ; FTP - server-specific (D)	Switch between FTP's built-in SSL/TLS support and ATTLS support
SECURE_FTP	ALLOWED	; Authentication indicator ; ALLOWED (D) ; REQUIRED	Must all connections be secure or just those who wish to be?
SECURE_LOGIN	REQUIRED	; Authorization level indicator ; for TLS ; NO_CLIENT_AUTH (D) ; REQUIRED ; VERIFY_USER	Is client authentication required and if so, at what level?
SECURE_PASSWORD	REQUIRED	; REQUIRED (D) - User must enter password ; OPTIONAL - User does not have to enter a password	If client authentication is used at level 3 and a user ID can be matched, is a password still required or not?
SECURE_DATACONN	CLEAR	; Minimum level of security for the data connection ; NEVER ; CLEAR (D) ; PRIVATE	Server's requirement to security of the data connection
TLSRFCLEVEL	RFC4217	; Specify what level of RFC 4217, On Securing FTP with TLS, is supported. ; DRAFT (D) Internet Draft level ; RFC4217 RFC level	Is z/OS FTP server to operate at the old draft RFC level for SSL/TLS or the now existing RFC? The default is to use draft - you may want to change that!

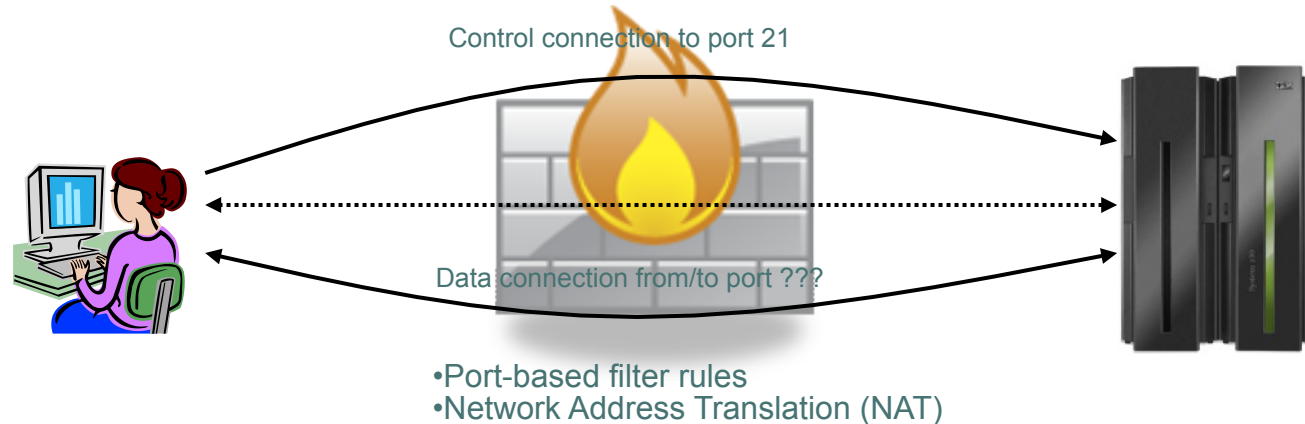
z/OS FTP client FTP.DATA parameters for secure connections

SECURE_MECHANISM	TLS	; Name of the security mechanism ; that the client uses when it ; sends an AUTH command to the ; server. ; GSSAPI = Kerberos support ; TLS = TLS	Set to use TLS when AUTH command used
TLSMECHANISM	ATTLS	; SSL/TLS implementer ; FTP - FTP use of system SSL ; ATTLS - the ATTLS component	Switch between FTP's built-in SSL/TLS support and ATTLS support
SECURE_FTP	ALLOWED	; Authentication indicator ; ALLOWED (D) ; REQUIRED	Must all connections be secure or just those who wish to be?
SECURE_DATACONN	PRIVATE	; Minimum level of security for ; the data connection ; NEVER ; CLEAR (D) ; PRIVATE	Client's requirement to security of the data connection

Addressing Network Traversal Challenges



Firewalls and FTP issues



- **Port-based filter rules – in particular dynamic port rules**
 - FTP control connection is no problem - pre-defined server port number (default 21)
 - Data connection port number (or direction) is not pre-defined, but dynamically negotiated between the FTP client and server
 - The firewall does “deep inspection” (peeks into) the FTP control connection to learn about the negotiated ports and the direction for the data connection
- **NAT**
 - FTP control connection is no problem – only IP headers need translation
 - PORT command and PASV reply refers to local (intranet) IP addresses
 - Firewall needs to do “deep inspection” of the FTP control connection to locate and modify the IP address information in the PORT command and the PASV reply

Deep inspection and data modification is impossible when the data on the FTP control connection is secured through encryption and message integrity checking at the end points.

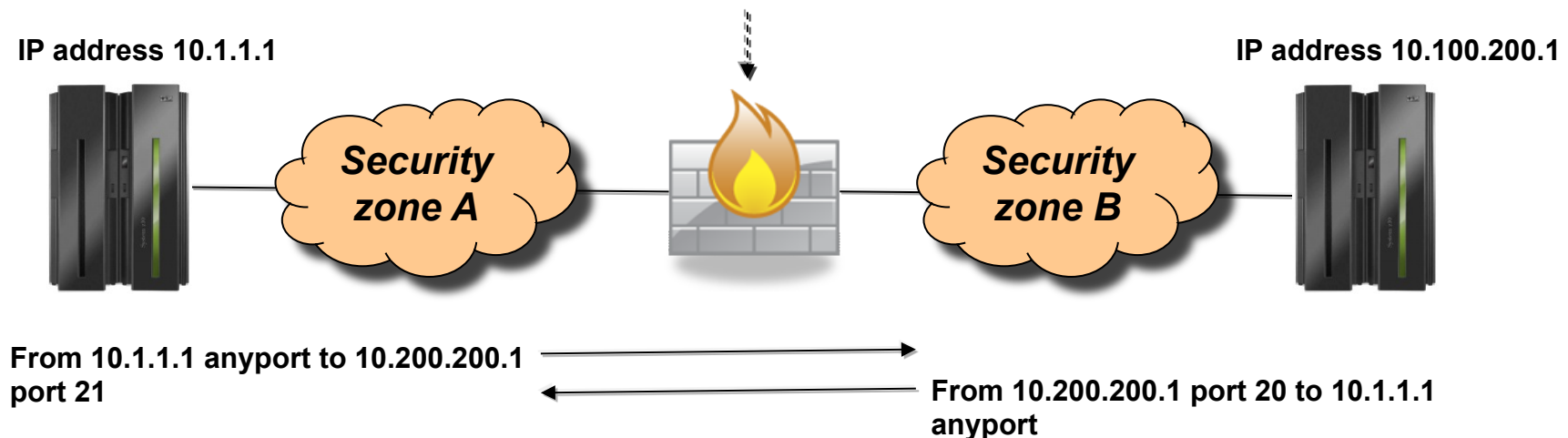


How to deal with static port-based filters in firewalls (active mode)

- If you are able to use active mode FTP, the firewall filters can sometimes be managed:
 - The control connection is permitted inbound to port 21
 - The data connection is permitted outbound from port 20
 - Will work for both standard active mode (PORT) and extended active mode (EPRT)

Static firewall filters

- ▶ Connection setup from 10.1.1.1 any port to port 21 on 10.200.200.1 - permit
- ▶ Connection setup from 10.200.200.1 port 20 to 10.1.1.1 any port - permit

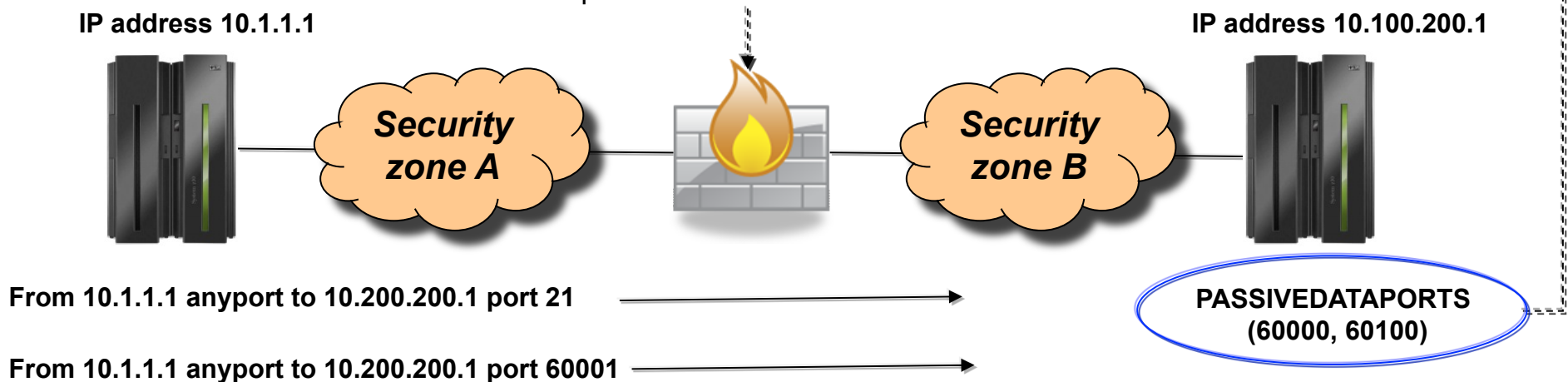


How to deal with static port-based filters in firewalls (passive mode)

- If you use passive mode FTP, and your server is a z/OS FTP server, you can predefine a range of port numbers to be used for passive mode data connections
 - The control connection is permitted inbound to port 21
 - The data connection is permitted inbound to a port in a pre-defined range
 - Will work for both standard passive mode (PASV) and extended passive mode (EPSV)

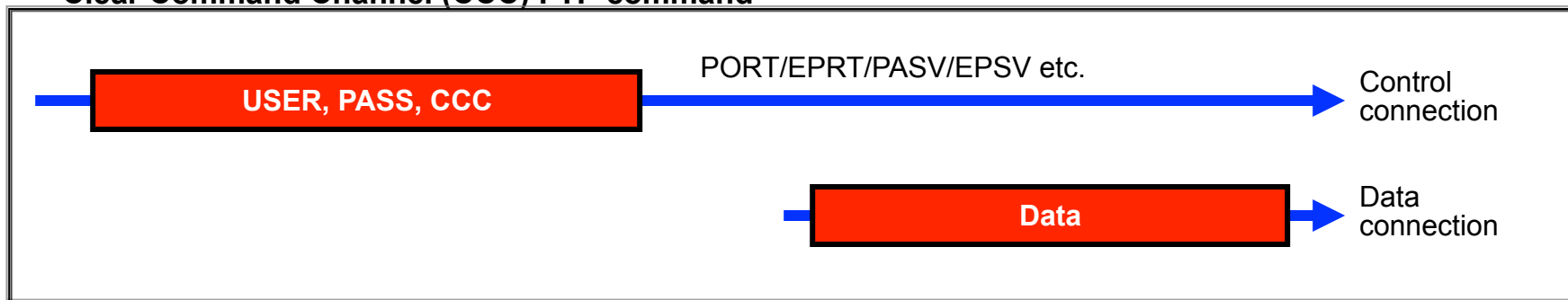
Static firewall filters

- ▶ Connection setup from 10.1.1.1 any port to port 21 on 10.200.200.1 - permit
- ▶ Connection setup from 10.1.1.1 any port to a port in the range from 60000 to 60100 on 10.200.200.1 - permit



How to deal with dynamic port-based filters in firewalls

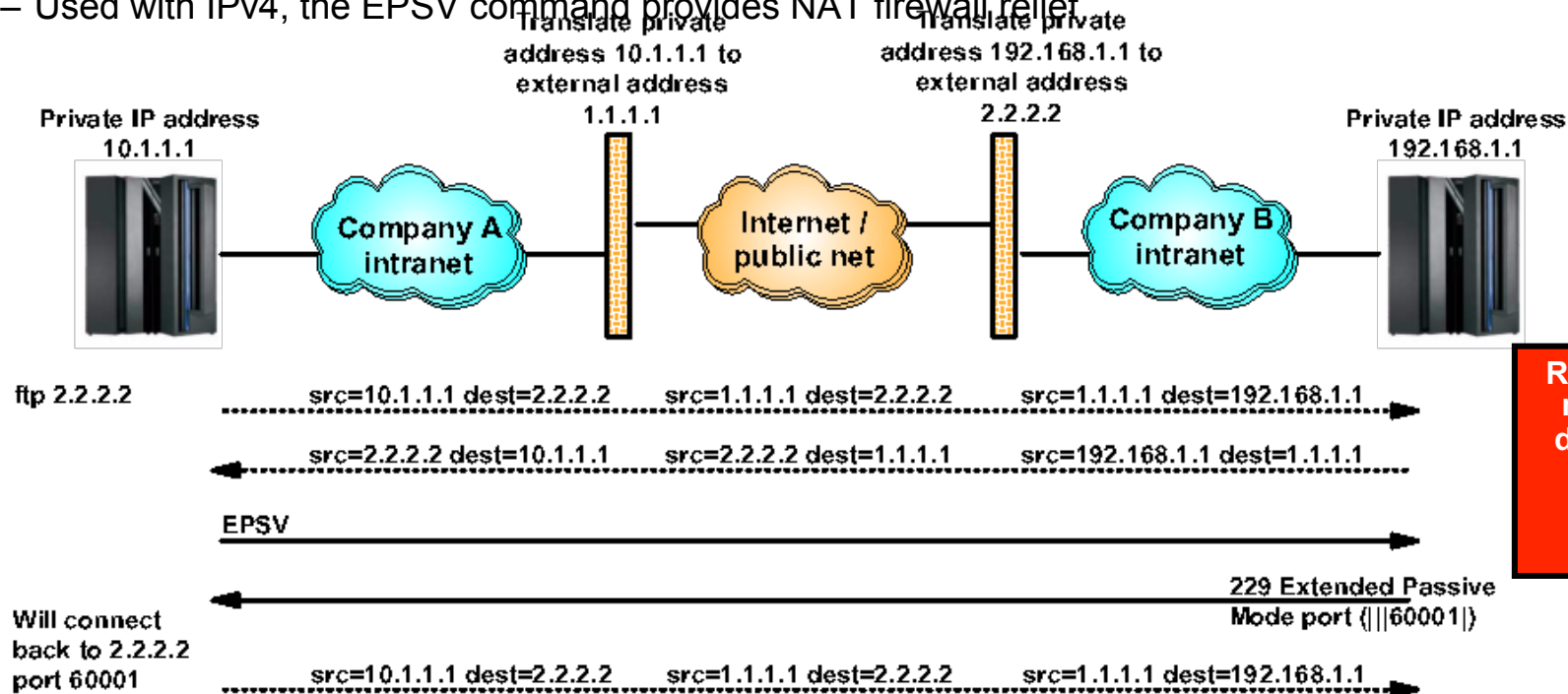
- When using dynamic filters, the firewall enables (permits) ports based on IP address and/or port number information in the PORT/EPRT command or the PASV/EPSV reply
 - The original FTP SSL/TLS draft RFC stated that the FTP control connection always had to be encrypted!
 - The final RFC (RFC 4217 "Securing FTP with TLS") relaxes on this requirement and implements a new **Clear Command Channel (CCC) FTP command**



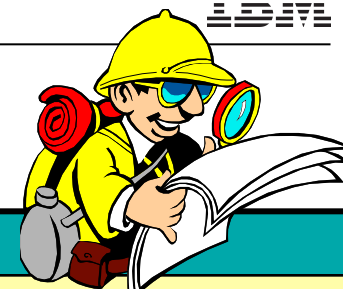
- Both the FTP client and server need to support the CCC command according to RFC 4217
 - Not all FTP clients and servers that support FTP SSL/TLS support the CCC command
 - z/OS added full support for the CCC command in z/OS V1R9 (both z/OS FTP client and server)
 - For those products that claim support, some interoperability issues have been observed !
 - If you have problems getting CCC to work, try to specify `TLSRFCLEVEL CCCNONOTIFY` instead of `TLSRFCLEVEL RFC4217` (applies to both z/OS FTP server and client)
- In general, the CCC command is a solution that solves SSL/TLS-enabled FTP issues with both NAT firewalls and filtering firewalls

RFC 2428: FTP Extensions for IPv6 and NATs



- Extended passive mode (EPSV) will solve NAT problems for secure FTP sessions
 - If using z/OS FTP client to a server that does not support EPSV, code `PASSIVEIGNOREADDR TRUE` in the FTP client's `FTP.DATA`
- The EPSV reply does not include an IP address, but only a port number
 - The FTP client will connect to the same IP address it used for the control connection
- The EPSV and the accompanying extended port command (EPRT) are also used to enable IPv6 support in FTP
 - Used with IPv4, the EPSV command provides NAT firewall relief



RFC 2428 does not help with dynamic port-based filter rules in firewalls!



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