

Co:Z® Co-Processing Toolkit for z/OS

Co:Z Launcher - User's Guide

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Table of Contents

1. Introduction	1
1.1. Co:Z Launcher Features	1
2. Co:Z Launcher Installation	2
2.1. Co:Z Launcher environment requirements	2
2.2. Co:Z Launcher Quick Start	2
3. Co:Z Launcher Configuration	4
3.1. Co:Z Launcher Properties	4
Required Property	4
Optional Properties	4
3.2. Configuration Best Practices	7
When tunneling	7
When not tunneling	8
3.3. Console communication	8
Commands directed to the CoZAgent process	8
4. Running the Co:Z Launcher	10
4.1. Running with SSH_ASKPASS Authentication	10
4.2. Running with an OpenSSH keypair	10
4.3. Running with a RACF Digital Certificate	11
5. Co:Z Launcher Examples	12
5.1. Execute commands on a target server	12
5.2. Launch remote shell that reads a PDS member	13
5.3. Offload PGP encryption of MVS Datasets	13
5.4. Use a Linux server as a secure gateway to information on the Internet	15
A. Client Authentication Mechanisms	17
A.1. Interactive password authentication	17
A.2. OpenSSH keypair authentication	17
A.3. OpenSSH SSH_ASKPASS authentication	19
A.4. RACF Digital Certificate authentication	19
Renewing RACF self-signed certificates	22
B. Problem Determination	23
B.1. Common Configuration Issues	23
B.2. Common Logging/Tracing Options	25
B.3. Enabling Component Logging	26
Set the default logging threshold for the batch launcher job	26
Set the default logging threshold for the target system components	26
Enabling ssh diagnostic messages	26
B.4. Co:Z Toolkit Component Overview	28
C. Co:Z Launcher Return Codes	30
D. Co:Z Environment Variables	31
E. License	33
F. References	39
F.1. z/OS OpenSSH	39
F.2. Using the z/OS Unix Shell	39
F.3. The z/OS C library fopen() routine	39

F.4. The z/OS BPXWDYN dynamic allocation service 40
F.5. The z/OS Unicode Translation Services 40

1. Introduction

The Co:Z Launcher is a batch utility which remotely launches a process on a distributed system, redirecting input and output from that process to traditional z/OS datasets or spool files. Remote processes are securely launched using proven SSH (Secure Shell) technology to the target platform, which may be Linux, AIX, or other Unix/POSIX environments.

1.1 Co:Z Launcher Features

- Securely launch and control remote processes (programs, scripts, etc.) from a z/OS batch job step or started task.
- Redirect input and output of remote process to DDs in the launching job step.
- Target process exit code is captured as job step condition code.
- Co:Z Launcher job step acts as a server for z/OS dataset I/O.
- z/OS console commands can be used to monitor, control, and send input to remote process.
- Existing z/OS scheduling and automation facilities can be used to schedule, monitor, and control processes on all servers on the network.
- Dataset Pipes client commands may be used in the target process to reach back and access datasets in the launching jobstep. These commands provide flexible conversion of z/OS datasets to streams for use in target applications. Options allow for control of line rules, translation, padding/truncation, dataset allocation and DCB processing.
- SAF/RACF Digital Certificates may be used for client authentication.

2. Co:Z Launcher Installation

In order to use the Co:Z Launcher to enable z/OS batch jobs to remotely launch a process on a distributed system, installation is required for the *Co:Z Toolkit for z/OS*. Additionally, the *Co:Z Target System Toolkit* must be installed on the remote systems that you have identified.

2.1 Co:Z Launcher environment requirements

- **z/OS requirements**
 - Co:Z Toolkit for z/OS
 - Batch job userid allowed to listen on local port; OMVS segment required
- **Target System requirements:**
 - Co:Z Target System Toolkit
 - OpenSSH sshd
 - sshd_config AllowTcpForwarding=yes for target userid

2.2 Co:Z Launcher Quick Start

After completing the installation of the Co:Z Toolkit for z/OS and the Co:Z Target System Toolkit on the remote system, the following are the minimum steps to get started using Co:Z Launcher. For more detailed information, see the remaining chapters in this guide.

On z/OS:

1. Edit //COZUSER.COZ.SAMPJCL(COZCFGD), updating the server-path variable with your installation directory.
2. Edit //COZUSER.COZ.SAMPJCL(COZPROC), updating the LIBRARY and COZCFGD arguments with your installation datasets.
3. Verify that /etc/ssh/sshd_config has AllowTcpForwarding=yes. If not set, update the sshd configuration. Restart SSHD with the following:

```
kill -HUP $(cat /var/run/sshd.pid)
```

4. Test that the z/OS user running Co:Z Launcher jobs can SSH to the target system without an interactive password.

```
ssh user@linux1.myco.com
```

See *OpenSSH keypair authentication* for additional information, if needed.

5. Create and test JCL similar to the example provided here: [*Running with an OpenSSH keypair*](#). This JCL is also included in `//COZUSER.COZ.SAMPJCL(RUNLNCH)`.
6. Once this test job runs successfully, experiment by trying [*Co:Z Launcher Examples*](#). See [*General Dataset Pipes Examples*](#) for some Dataset Pipes commands to add to your JCL.

3. Co:Z Launcher Configuration

The Co:Z Launcher is initiated in batch via JCL job steps that execute the COZLNCH load module. The z/OS installation package includes a sample stored procedure for invoking the launcher COZPROC. The launcher is configured through a set of customizable properties, which are described below (default values are shown in braces).

3.1 Co:Z Launcher Properties

Some server properties (`server-ports`, `server-ip-stack` and `server-host`) may be optionally suffixed with a z/OS sysid. In this case, these properties will apply only to a specific z/OS system. This allows for a single COZCFG member to be used for all of the candidate z/OS systems in an installation.

The PDS member COZCFGD can be customized for each installation to provide system level defaults for many of these properties.



Note

If duplicate property names are supplied, only the final value is used. To specify multi-line values for a property, place a backslash (\) continuation character on the line(s) to be continued.

Required Property

Each installation is required to customize the following property:

`server-path { <COZ_INST>/bin/cozserver }`

The absolute path on z/OS of the `cozserver` executable, where `<COZ_INST>` is the directory where Co:Z Toolkit for z/OS is installed.

Optional Properties

The following properties may be overridden in COZCFGD or by individual job step

`server-ports[-sysid] { none }`

The range of ports reserved for communication between CoZServer and the target system. **This option should only be used when option `ssh-forward-dynamic-port` is required to be `false`.** If specified, each invocation of a Co:Z Launcher batch job will find one available port in this range and establish a socket listener.

If `ssh-tunnel=true` (the default), an available port in this range will be bound to the z/OS loopback adapter (127.0.0.1), and the target program on the target server will connect to this port via the tunnel established by `ssh`.

If `ssh-tunnel=false`, an available port in this range will be bound to any stack on z/OS (this can be changed using the `server-ip-stack` property), and the target program on the target server will connect to this port directly over the network.

Installations must reserve a port range on z/OS large enough for each concurrent Co:Z Launcher batch job. If `ssh-tunnel=true`, then the target servers must also ensure that these port are available (unless `ssh-forward-dynamic-port=true`). If multiple z/OS systems share the same target machines, each z/OS system

should reserve its own port range.

The following example sets up a 20 port pool for use by any Co:Z Launcher instance.

```
server-ports=8040-8059
```

The following example sets up separate 20 port pools for three z/OS systems running in an installation (and sharing the same COZCFGD member). If `ssh-tunnel=true` (the default), then each target system must make 8040-8099 available.

```
server-ports-SYSA=8040-8059
server-ports-SYSB=8060-8079
server-ports-SYSC=8080-8099
```

`ssh-le-options {none}`

Custom Language Environment (LE) options to set for the ssh client process created by the Launcher. No options are set by default, but see the COZCFGD sample for the recommended options to work around a problem that causes out-of-memory conditions in z/OS OpenSSH. See IBM APAR OA34819.

`ssh-options {none}`

Additional options to be supplied to z/OS ssh command.

`ssh-path {/bin/ssh}`

Specifies the location of the z/OS ssh client executable.

`ssh-tunnel {true}`

If true, target program IO requests (via `fromdsn` and `todsn`) are tunnelled over ssh via remote port forwarding. If false, direct socket connections are made to the server.

`ssh-tunnel-loopback {legacy}`

Specifies which loopback adapter (IPv4 or IPv6) to use over ssh via remote forwarding (when `ssh-tunnel=true`). The following values may be set:

- `first --` will cause CoZ to match OpenSSH. This will generally result in the desired behavior, and is recommended.
- `4 | 6 --` will force the tunnelled connection to be on either IPv4 or IPv6 respectively. Requires remote version of OpenSSH 6.7 or later.
- `legacy --` retains original behavior, which will specify IPv4 only. If the remote OpenSSH picks IPv6, the connection will fail.

`ssh-forward-dynamic-port {true}`

If true, allows the target ssh server to dynamically assign the target port. In order to enable this option:

- The `ssh-tunnel` option must be set to true
- The target ssh server must support dynamic reverse port forwarding (e.g. OpenSSH version 5.3 or later)

If false, the target port is set matching the selected server-port. Setting the target port to the server-port value can cause collisions when multiple Co:Z Launcher jobs from different LPARS are running concurrently to the same target host. Enabling the ssh-forward-dynamic-port option prevents these collisions.

ssh-forward-dynamic-port-wait { 30 }

The number of seconds the Launcher will wait for the target system to report its dynamic port.

saf-cert { none }

Specifies that the user's RACF Digital Certificate should be used for client authentication. The value supplied for this property is in the form KEYRING[:LABEL]. If LABEL is omitted, the keyring's default label will be used. Examples:

```
saf-cert=MY-RING
saf-cert=MY-RING:MY-CERT
```

agent-path { /opt/dovetail/coz/bin/cozagent }

The absolute path on the target system of the cozagent executable. Note that the Co:Z Target System Toolkit source distributions will by default install the Co:Z executables in directory /opt/dovetail/coz/bin. This property need only be set if you install in a different directory

agent-options { none }

Command line options to CoZAgent. These include:

- -c -- allow the operator to communicate with the agent to control the target program. See [Section 3.3, "Console communication"](#) for a list of available commands.
- -n -- run the target-command without a shell.

agent-output-wto { false }

If true, messages written by the CoZAgent are written to the operator console. If false, they are written to the launcher's stdout (DD://SYSPRINT)

server-host[-sysid] { gethostname() }

The external hostname (or address) of the CoZServer running on z/OS. If ssh-tunnel=false, the target program will connect to CoZServer on z/OS at this address. If ssh-tunnel=true, this value is ignored.

server-ip-stack[-sysid] { 0.0.0.0 (all addresses) }

The IP address on z/OS that the CoZServer will accept connections on. If ssh-tunnel=true, this value is ignored.

server-env-MY_VAR { none }

Customized server environment variables that will be set prior to launching the CoZServer on z/OS. MY_VAR should be replaced by the name of the environment variable to be set. These environment variables will also be adopted by the Launcher itself. See [Appendix Co:Z Environment Variables](#) for a list of environment variables.

target-env-MY_VAR { none }

Customized target environment variables that will be set prior to launching the target program on the remote system. MY_VAR should be replaced by the name of the environment variable to be set.

target-command {none}

The target program to be run by CoZAgent on the remote system. If not supplied, the target user's default shell will be executed.

target-host {none}

The hostname or IP address of the target machine. This value may alternatively be supplied in the form `user@host:port` on the COZPROC ARGS= parameter.

target-port {none}

The port of the target machine. This value may alternatively be supplied in the form `user@host:port` on the COZPROC ARGS= parameter.

target-user {none}

The userid that the target program runs under on the target machine. This value may alternatively be supplied in the form `user@host:port` on the COZPROC ARGS= parameter.

properties-exit {none}

Specifies the executable Unix command and arguments that are used to run a Unix program or shell script that may write additional configuration properties to its **stdout**. Output lines from this program will be used as additional configuration properties as if they were specified at the end of the **DD:COZCFG** file. A practical use for this feature might be to dynamically determine the **target-host** property from a list of candidate servers.

The command string specified is run using `/bin/sh -c "command args"`. Note that the Co:Z Launcher batch utility does not run a "login" shell, so that the PATH environment variable will only contain /bin and other variables as determined by the installations `/etc/init.options` file. Therefore, a fully qualified command path name is often required, and a shell script may wish to "dot in" `/etc/profile` and `~/profile` if appropriate.

3.2 Configuration Best Practices

Data transferred between z/OS and the target remote system can be configured in one of two ways:

- tunnelled (and encrypted) over ssh via reverse port forwarding
- direct socket connection (better throughput with lower overhead, but unencrypted)

When tunneling

When using tunneling, the preferred configuration is to use dynamic port forwarding if supported. For a tunneled configuration, use the following settings:

```
ssh-tunnel=true
ssh-forward-dynamic-port=true
```

If dynamic port forwarding is not supported on the target system, override the defaults in a job specific COZCFG:

```
ssh-tunnel=true
ssh-forward-dynamic-port=false
server-ports=8040-8059
```

When not tunneling

When using a direct socket connection and no `server-ports` definition, a server ephemeral port will be used which may cause trouble with existing firewall policies. Therefore, it is recommended that a `server-ports` range be defined so that network administration has visibility to the ports being used by Co:Z. The following settings are recommended (note that the `ssh-forward-dynamic-port` option will be ignored, as it only takes effect if `ssh-tunnel=true`):

```
ssh-tunnel=false
server-ports=8040-8059
```

3.3 Console communication

If the CoZAgent is started with the console communication switch (-c), the MVS system console can be used to communicate with the target system. This interaction can occur once the target program has completed its processing of the STDIN DD, if it exists. In this case, the target program will not receive an EOF from stdin until a /QUIESCE command is sent from the console. The available commands are described below.

If the CoZAgent is started *without* the -c switch, no console communication is permitted. When the target program finishes reading STDIN, it will receive an EOF as in normal processing.

Console commands are sent to the remote agent by using the MVS MODIFY (F) and STOP (P) commands. The modify string must be prefixed by keyword APPL=.

If the text supplied on the modify command is surrounded by single quote (') characters, it is passed unmodified to the console. Note that in some cases ISPF panels will force entered text to uppercase. If so, eliminate the single quote characters and the entire command will be folded to lower case by Co:Z, which is generally more compatible with remote Unix systems. In this situation, upper case characters may be specified by prefixing each character with an underscore ('_').

The MVS console suppresses certain characters, such as ` , \ , ~ , ^ , [,] , { , } . These characters should not be specified.



Note

Because of the way z/OS Unix names child processes, your job/task name should consist of 7 characters or less (or use an identifier) if you wish to use console commands. If you use an 8 character jobname, you will see the following message IEE342I MODIFY REJECTED-TASK BUSY (the command will still be processed).

Commands directed to the CoZAgent process

/QUIESCE

Sends an EOF to the target program's stdin. This will allow the target program that waits for interactive stdin commands to perform its normal completion processing.

`/KILL [signal_level] {SIGKILL}`

Issues the specified signal to the target program.

`/CMD <command>`

Issues `command` as a `system()` call. Typical commands include process status commands such as `ps -eaf`. Any resulting stdout data is written either to the MVS console or the STDOUT DD, depending on the value of the `agent-output-wto` property, described above.

Any console command not prefixed with a slash (/) as above is sent directly to the target program for processing.

Examples:

```
F MYJOB,APPL=/CMD PS -E_AF
F MYJOB,APPL=INPUT TO REMOTE PROGRAM
F MYJOB,APPL=/QUIESCE
```

4. Running the Co:Z Launcher

This chapter explains how to run the Co:Z Launcher, based on the user's configured authentication mechanism. Authentication with the remote system must be set up so as not to require any user interaction. There are three ways to do this with OpenSSH:

- Use the `SSH_ASKPASS` environment variable to point to a program that will read a password.
- Use an OpenSSH public/private keypair.
- Use a RACF Digital Certificate.

For details on these three authentication options, see [Appendix A, Client Authentication Mechanisms](#). Note that instructions in this appendix must be followed in order to run the examples described below.

4.1 Running with `SSH_ASKPASS` Authentication

Note: The JCL discussed below is included in the Co:Z toolkit samples as member `RUNLNCHP`

```
//USERP JOB ( ), 'DOVETAIL',MSGCLASS=H,NOTIFY=&SYSUID
//PROCLIB JCLLIB ORDER='USER.COZ.SAMPJCL'
//*
//RUNCOZ EXEC PROC=COZPROC,ARGS='-LI user@linux1.myco.com'
//COZCFG DD *
ssh-options=-oStrictHostKeyChecking=no
server-env-PASSWD_DSN="//HLQ.PASSWD(SITE1) ❶
server-env-SSH_ASKPASS=/usr/local/coz/bin/read_passwd_dsn.sh
server-env-DISPLAY=none
//STDIN DD *
uname -a
//
```

- ❶ The member `//HLQ.PASSWD(SITE1)` contains a single line with the password starting in the first column and *without* line numbers.

4.2 Running with an OpenSSH keypair

Note: The JCL discussed below is included in the Co:Z toolkit samples as member `RUNLNCH`

```
//COZUSERC JOB ( ), 'DOVETAIL',MSGCLASS=H,NOTIFY=&SYSUID,CLASS=A
//PROCLIB JCLLIB ORDER='COZUSER.COZ.SAMPJCL'
//*
//RUNCOZ EXEC PROC=COZPROC,ARGS='cozuser@linux1.myco.com'
//COZCFG DD *
//STDIN DD *
uname -a
//
```

4.3 Running with a RACF Digital Certificate

Note: The JCL discussed below is included in the Co:Z toolkit samples as member RUNLNCHK

```
//COZUSERC JOB ( ), 'DOVETAIL',MSGCLASS=H,NOTIFY=&SYSUID,CLASS=A
//PROCLIB JCLLIB ORDER='COZUSER.COZ.SAMPJCL'
//*
//RUNCOZ EXEC PROC=COZPROC,ARGS='cozuser@linux1.myco.com'
//COZCFG DD *
saf-cert=MY-RING
//STDIN DD *
uname -a
//
```

5. Co:Z Launcher Examples

This chapter contains common examples ("recipes") for using the Co:Z Launcher. These examples assume that you have installed and configured the Co:Z toolkit on your z/OS and target systems. Additionally, these examples rely on Dataset Pipes commands. See the *Co:Z Dataset Pipes User's Guide* for the command reference.

5.1 Execute commands on a target server

This is a simple example of how to use the Co:Z Launcher to run commands on a remote Linux server.

```
//COZCB1 JOB ( ), 'COZ'  
//STEP1 EXEC PROC=COZPROC,  
//      ARGS='myuid@linux1.myco.com'  
//STDIN DD *  
# This is input to the remote shell  
echo "We are running on: " `uname`  
//
```

- The userid and hostname (myuid@linux1.myco.com) are given as a parameter to the COZPROC stored procedure, but all other configuration options are taken from the installation defaults.
- The Co:Z Launcher will start an SSH connection to the remote server as user "myuid".
- Since SSH is unable in a batch job to prompt for a password, it will use a private key associated with the current z/OS user to login to the target server.
- The default program to launch on the target server is the user's "default shell", which happens to be "bash".
- Input to the remote shell is redirected from the job's //STDIN DD.
- Output from the remote shell is redirected to //STDOUT DD and //STDERR DD in the launching jobstep. By default these are defined in COZPROC to go to SYSOUT spool files.
- Output from the remote shell is redirected to //STDOUT DD and //STDERR DD in the launching jobstep. By default these are defined in COZPROC to go to SYSOUT spool files.

In this example, the following output will be written to the //STDOUT DD:

```
We are running on: Linux
```

The exit code from the remote program (bash) will be adopted as the return code for the batch job step; in this case: "0". Log messages from the Co:Z Toolkit are written to //SYSOUT DD:

```

fromdsn(DD:STDIN)[N]: 2 records/160 bytes read; 75 bytes written in 0 milliseconds.
todsn(DD:STDERR)[N]: 0 bytes read; 0 records/0 bytes written in 0.072 seconds (0.000 Bytes)
todsn(DD:STDOUT)[N]: 39 bytes read; 1 records/38 bytes written in 0.074 seconds (527.027 Bytes)
CoZLauncher[N]: myuid@linux1.myco.com target command '<default shell>' ended with RC=0

```

5.2 Launch remote shell that reads a PDS member

In this example we use the Co:Z Launcher to send commands to a target Linux server which reads a PDS member from the launching z/OS system.

```

//COZCB2 JOB ( ), 'COZ'
//STEP1 EXEC PROC=COZPROC,
//      ARGS='myuid@linux1.myco.com'
//STDIN DD *
fromdsn '//sys1.maclib(acb)' | grep BLKSIZE
//

```

- Input to the remote shell is redirected from the job step's //STDIN DD, which in this example has a single line.
- The `fromdsn` command, *running on the target server*, establishes a connection with the launching z/OS job. This connection is used to read a PDS member.
- The single quotes are required so that the Linux shell does not interpret the parentheses as meta characters.
- The `fromdsn` command converts the records in the dataset to a stream of bytes that is written to stdout. By default the data will be converted to a text file using the target platform's codepage and line separator.
- The data is piped (|) by the shell into the Unix `grep` command which writes matching lines to stdout.
- Output from the remote shell is redirected to //STDOUT DD and //STDERR DD in the launching jobstep. By default, these are defined in COZPROC to go to SYSOUT spool files.

In this example, the following output will be written to the //STDOUT DD:

```

&BLKSIZE=0 , &LRECL=0 , &BUFSP=0 , -00001600
BLKSIZE=&BLKSIZE , LRECL=&LRECL , -01700000
BLKSIZE=&BLKSIZE , LRECL=&LRECL , -02406800

```

5.3 Offload PGP encryption of MVS Datasets

In this example we use the Co:Z Launcher to send commands to a Linux server which reads data from an //INPUT DD in the launching job step and writes PGP encrypted output data to //OUTPUT DD.


```

//COZCB3 JOB (),'COZ'
//STEP1 EXEC PROC=COZPROC,
//      ARGS='myuid@linux1.myco.com'
//STDIN DD *
fromdsn -l rdw -k //DD:INPUT \
| gpg -r key-1 --batch --output=- --encrypt=- \
| todsn -b //DD:OUTPUT
/*
//INPUT DD DISP=SHR,DSN=KIRK.CLEARTEXT.DATA
//OUTPUT DD DSN=KIRK.ENCRYPT,DISP=(NEW,PASS),
//          SPACE=(CYL,(1,1),RLSE),
//          DCB=(RECFM=U,BLKSIZE=4096)

```

- Input to the remote shell is redirected from the job step's //STDIN DD, which in this example contain three commands chained together with Unix pipes.
- The fromdsn command, *running on the target server*, establishes a connection with the launching z/OS job. This connection is used to read from the //INPUT DD. The -l rdw option is used so that 4 byte RDWs are used as record separators. This option also disables any default codepage translation. The -k option disables any trimming of trailing pad (space) characters from the end of records. The result is that the fromdsn simply writes RDW-prefixed records, as-is, to stdout.
- The output from fromdsn is piped into the Linux gpg command which PGP-encrypts the data stream. The "--encrypt=-" option causes gpg to read input from stdin (the output pipe from fromdsn).
- The "output=-" option causes gpg to write its encrypted output to stdout, which is piped (|) into a todsn command.
- The todsn command, running on the Linux server, tunnels back into the launching jobstep and writes the encrypted data stream to DD:OUTPUT, which in the example goes to new cataloged MVS dataset. The "-b" option causes fromdsn to write the records in binary, with no record separators, in effect filling each record to its maximum size, which is set by the DD card in this case to be 4096 bytes.
- Output log messages from the Co:Z Launcher, the Co:Z Agent (running on the target server), and the Dataset Pipes utilities fromdsn and todsn are written to //SYSOUT DD.

In this example, the following log message will be written:

```

fromdsn(DD:STDIN)[N]: 3 records/240 bytes read; 106 bytes written in 0 milliseconds.
fromdsn(DD:INPUT)[N]: 78 records/6240 bytes read; 6552 bytes written in 0 milliseconds.
todsn(DD:OUTPUT)[N]: 2034 bytes read; 2 records/2034 bytes written in 0.038 seconds (52.7
todsn(DD:STDOUT)[N]: 0 bytes read; 0 records/0 bytes written in 0.708 seconds (0.000 Byte
todsn(DD:STDERR)[N]: 0 bytes read; 0 records/0 bytes written in 0.706 seconds (0.000 Byte
CoZLauncher[N]: myuid@linux1.myco.com target command '<default shell>' ended with RC=0

```

Note that the data is encrypted during transfer automatically by the SSH tunnel used by Co:Z to communicate between the target server and the launching batch job. Also note that the file is never stored on disk on the target server.

Decrypting is just as easy:

```
fromdsn -b //DD:INPUT \
|  gpg -r key-1 --batch --output=- --decrypt=- \
|  todsn -l rdw //DD:OUTPUT
```

5.4 Use a Linux server as a secure gateway to information on the Internet

In this example the Co:Z Launcher is used to run a script on a server which downloads a tab-delimited file from the Internet and converts selected fields to SQL statements which are written to a temporary MVS dataset. A second step in the job runs the DB2 batch SPUFI utility to load the data to a DB2 table.

```
//COZCB4 JOB (),'COZ'
//*****
/* STEP1: Launch a remote script to ftp download a tab-delimited
/* text file. Use selected columns to generate DB2 INSERT statments
/* which are written to an MVS temporary dataset.
/*
//STEP1 EXEC PROC=COZPROC,ARGS='cozcb4@dmz1.myco.com'
//STDIN DD *
wget -O- ftp://ftp.visi.com/users/juan/ContactingCongress.db.txt |
awk -F "\t" -v sq="" '{
  if (NR == 1) #skip header/empty table
    print "DELETE FROM CONGRESS;"
  else {
    print "INSERT INTO CONGRESS VALUES("
    print sq $1 sq ", "
    print sq $2 sq ", "
    print sq $4 sq ", "
    print sq $5 sq ", "
    print sq $3 sq
    print ");"
  }
}'
//STDOUT DD DSN=&&SPUFIN,DISP=(NEW,PASS),SPACE=(CYL,(2,1)),
// DCB=(RECFM=FB,LRECL=80)
//*****
/* STEP2: Run DB2 "SPUFI" in batch to execute the insert statements
/* to reload a DB2 table
/*
//STEP2 EXEC PGM=IKJEFT01,DYNAMNBR=20,COND=(0,NE)
//SYSTSPRT DD SYSOUT=*
```

```
//SYSPRINT DD SYSOUT=*
//SYSTSIN DD *
DSN SYSTEM(DBS1)
RUN PROGRAM(DSNTEP2) PLAN(DSNTEP71) LIB('DB2V810.RUNLIB.LOAD')
END
//SYSIN DD DSN=&&SPUFIN,DISP=(OLD,DELETE)
//
```

- `//STEP1.STDIN DD` contains command input to the remote shell. The `wget` command is used to download a file from the internet using the ftp protocol, piping the output into the `awk` command.
- The `awk` command script, running on the Linux target server, is used to reformat selected columns from the tab-delimited file into SQL INSERT commands, which are written to `stdout`.
- `//STEP1.STDOUT DD` is overridden to point to a temporary MVS dataset, which is passed to STEP2.
- The second step runs the DB2 batch SPUFI utility to execute the SQL, thereby loading the CONGRESS table.

In environments where the z/OS mainframe is not connected to the Internet, the target server may be deployed in a DMZ which is only accessible in one direction from the z/OS host using SSH. Only the target process started by the Co:Z launcher (and its children) have access to redirected I/O resources in the launching Co:Z job step.

This example also demonstrates how open source Linux tools (`wget`, `awk`) may be used to access and transform data for use within the z/OS environment.

Appendix A. Client Authentication Mechanisms

Running the Co:Z SFTP client and/or the Co:Z Launcher requires that the z/OS ssh client can authenticate with the Target System ssh server. Several authentication choices are available from z/OS; site policies will usually dictate which is best.

One of the following authentication mechanisms should be performed on z/OS from **each** userid that will be used to execute the Co:Z SFTP or Co:Z Launcher jobs.

- Interactive password: *Section A.1, “Interactive password authentication”*. **Note:** this mechanism requires user keyboard interaction, so it will not work in batch. It should only be used for command line invocations of the Co:Z SFTP client.
- OpenSSH ASK_PASS (read a password from a dataset): *Section A.3, “OpenSSH SSH ASKPASS authentication”*.
- Conventional OpenSSH keypairs: *Section A.2, “OpenSSH keypair authentication”*.
- RACF Digital Certificates: *Section A.4, “RACF Digital Certificate authentication”*.

A.1 Interactive password authentication

This is the simplest form of OpenSSH client authentication and requires no additional setup. It can only be used from a terminal (Unix TTY) connected shell where the user can supply the target system password. Due to this requirement, it is not suitable for z/OS batch programs and is therefore not an option for running the Co:Z Launcher or batch Co:Z SFTP. It *is* suitable for interactive shell invocations of Co:Z SFTP.

Note: The IBM z/OS OpenSSH ssh client tools are supported from a TSO OMVS shell session, but do not allow a password to be entered from a 3270 terminal.

A.2 OpenSSH keypair authentication

This is the conventional mechanism for performing OpenSSH client authentication. A public/private key pair is generated on z/OS. The private key is kept (protected) in the user's `~/.ssh` directory. The public key is stored on each target system in the user's `~/.ssh/authorized_keys` file. The following steps describe how to generate and use an OpenSSH keypair:

Note: Proceed with caution if you have more than one userid mapped to the same uid number (an unfortunately common occurrence on z/OS USS). The default key storage home directory is hard to predict.

1. Generate a keypair using `ssh-keygen`:

```
$ mkdir ~/.ssh
$ chmod 700 ~/.ssh
$ ssh-keygen -t rsa -b 2048
Generating public/private rsa key pair.
```

```

Enter file in which to save the key (/home/<userid>/.ssh/id_rsa): <enter>
Enter passphrase (empty for no passphrase): <enter>
Enter same passphrase again: <enter>
Your identification has been saved in /home/<userid>/.ssh/id_rsa.
Your public key has been saved in /home/<userid>/.ssh/id_rsa.pub.
The key fingerprint is:
dd:ff:00:87:43:11:fa:7b:0d:84:3a:19:3b:7f:5d:2e <userid>@<host>
The key's randomart image is:
+--[ RSA 2048]-----+
| oEoo .                |
| o.. + o .             |
| .  ..= o .           |
| .   .o=o.            |
| .    ...o+.          |
| . .   ...            |
|  o     o              |
|  o     o              |
| .                    |
+-----+

```

The private key file `id_rsa` will be generated without a passphrase so that `Co:Z` can run in batch. It is therefore important that this file is protected with file permissions and/or ACLs that only allow the owning `userid` to read the file.

2. Move a copy of the public key to the target system:

```

ZOS$ sftp -oPort=<port> cozuser@linux1.myco.com
Connecting to n.n.n.n...
cozuser@linux1.myco.com's password: *****
sftp> ascii
Sets the file transfer type to ASCII.
sftp> cd .ssh
sftp> put -P id_rsa.pub authorized_keys
Uploading id_rsa.pub to /home/sgoetze/.ssh/authorized_keys
id_rsa.pub                               100% 601      0.6KB/s   00:00
sftp> quit

```

Note: If you are adding more than one public key to `authorized_keys`, then you must log in to the remote system and append the new public key line to `authorized_keys`. Be careful that you don't replace an existing `authorized_keys` file.

Note: The `authorized_keys` file, the `.ssh` directory, and the home directory must not be writable by any user other than the owning `userid`. For details on required file permissions, see the section *OpenSSH files Quick Reference / User-generated files* in *IBM z/OS OpenSSH User's Guide*.

Note: For more information on using SSH key authentication, see our webinar archives: [IBM Ported Tools for z/OS: OpenSSH - Key Authentication](#).

A.3 OpenSSH SSH_ASKPASS authentication

OpenSSH supports the use of the `SSH_ASKPASS` environment variable to point to a program that will read a password, without keyboard interaction.

Using `SSH_ASKPASS` with OpenSSH requires that other ssh settings and environment variables are configured. The `SFTPSAMP` and `RUNSFFTP` sample JCL members illustrate how to do this with Co:Z SFTP; the `RUNLNCHP` sample JCL shows how for Co:Z Launcher. With these samples, a dataset must be created (e.g.) `//HLQ.PASSWD(SITE1)` that contains a single line with the password starting in the first column and *without* line numbers. The dataset should be protected with RACF so that it cannot be read except by the required jobs.

A.4 RACF Digital Certificate authentication

Traditional OpenSSH keypairs and `SSH_ASKPASS` are convenient, but some sites have strict policies about keeping key material in RACF (or another security package), or even ICSF hardware. The z/OS Communications Server FTP command can exploit SAF/RACF Digital Certificates for authentication and encryption. z/OS OpenSSH allows you to use keys that are stored in SAF/RACF certificates.

An existing SAF/RACF key ring and client certificate set up for use with the z/OS FTP client may be used with Co:Z Launcher and the Co:Z SFTP client.

The following steps describe how to create an RSA RACF Digital Certificate, export its public key in OpenSSH compatible format, and transfer the public key to the target system.

1. Create a Key Ring and RSA Digital Certificate:

Note: In order to create RACF Digital Certificates, certain RACF permissions must be held. This step is typically performed by an administrator; the permissions required are *not* required for the user to access the certificate (see below). For details, see the chapter *RACF and Digital Certificates* [z/OS Security Server RACF Security Administrator's Guide](#).

This JCL is located in RACDCERT member of the `COZ.SAMPJCL` PDS. It will create an RSA Digital Certificate labeled `MY-CERT` held in the key ring `MY-RING`.

It is also possible to skip creating a key ring - any certificate automatically belongs to the user's *virtual key ring*, and may be referenced by using the special key ring name `"*"`. For more information on using SAF/RACF key rings with OpenSSH, see our webinar archives: [IBM Ported Tools for z/OS: OpenSSH - Using Key Rings](#).

```
//COZUSERJ JOB ( ), ' ', MSGCLASS=H, NOTIFY=&SYSUID
//*
// EXEC PGM=IKJEFT01
//SYSPRINT DD SYSOUT=*
//SYSOUT DD SYSOUT=*
//SYSTSPRT DD SYSOUT=*
//SYSTSIN DD *

/* Generate a self-signed RSA certificate to use */
/* for SSH client authentication. */
/* A certificate signed by your CA will also work. */
```

```

RACDCERT ID(COZUSER) GENCERT          + ❶
      SUBJECTSDN(                      +
        CN('First Lastname' )         + ❷
        O('My Company' )              + ❷
        OU('Development' )             + ❷
        C('US' )                       + ❷
      )                                  + ❷
      NOTAFTER( DATE(2026-12-31) )      + ❸
      WITHLABEL('MY-CERT' )            +
      ICSF                              ❹

/* Create a KEYRING for the user (skip for virtual keyring) */
RACDCERT ID(COZUSER) ADDRING(MY-RING)  ❶

/* Connect the certificate to the ring (skip for virtual) */
RACDCERT ID(COZUSER) CONNECT (         + ❶
      ID(COZUSER)                      + ❶
      LABEL('MY-CERT' )                +
      RING(MY-RING)                    +
      DEFAULT                           + ❺
      USAGE(PERSONAL) )                +

/* Refresh if RACLISTed */
SETROPTS RACLIST(DIGTCERT, DIGTRING) REFRESH

/* List the user's certs */
RACDCERT ID(COZUSER) LIST              ❶
//

```

- ❶ Change the string COZUSER to the MVS userid that will own and use the certificate.
- ❷ Change the subject DSN fields according to your company's standards.
- ❸ Specifies the expiry date of the certificate, otherwise it defaults to one year.
- ❹ Optional keywords ICSF or PCICC, may be specified. When not specified, the generated certificate is stored in the RACF database as a non-ICSF RSA key. When one of ICSF or PCICC is specified, the certificate generated is stored in the ICSF PKA key data set. The ICSF and PCICC keywords require ICSF to be started as well as CSFKEYS authorities. For more information, see: "z/OS ICSF Administrator's Guide SA22-7251" - "Using RACF to protect Keys and Services".

Note: If using ICSF or PCICC, you will only be able to use the Co:Z saf-ssh-agent, and not the IdentityKeyRingLabel support in z/OS OpenSSH.

- ❺ Makes this certificate the default in the ring. This allows the user to specify just the key ring name in order to access the certificate.

2. Export an OpenSSH version of the certificate's public key:

Note: This and the remaining steps are performed by the user. In order to access the key ring and certificate, the user must have the following SAF/RACF permissions:

- CLASS(FACILITY) IRR.DIGTCERT.LISTRING ACCESS(READ)
- CLASS(CSFSEV) CSFDSEV ACCESS(READ)

- CLASS(CSFSERV) CSFDSV ACCESS(READ)

Public key extraction is performed using IBM z/OS OpenSSH `ssh-keygen`:

```
$ _ZOS_SSH_KEY_RING_LABEL="MY-RING MY-CERT" ssh-keygen -y > cozuser_saf.pub
```

Note: An administrator may export the key of a another user by prefixing the key ring name with USERID/. In order to do this, the administrator must have UPDATE access to the IRR.DIGTCERT.LISTRING SAF permission above.

Note: READ access to the CLASS(FACILITY) IRR.DIGTCERT.LISTRING resource allows the user to use any key ring the he or she owns. It is also possible to use ring-specific authorization, using CLASS(RDATALIB). See the section *"Managing key rings and restricting access to them"* in *IBM z/OS OpenSSH User's Guide* for more information.

3. Move a copy of the public key to the target system:

```
ZOS$ sftp -oPort=<port> cozuser@linux1.myco.com
Connecting to n.n.n.n...
cozuser@linux1.myco.com's password: *****
sftp> ascii
Sets the file transfer type to ASCII.
sftp> cd .ssh
sftp> put -p cozuser_saf.pub authorized_keys
Uploading cozuser_saf.pub to /home/cozuser/.ssh/authorized_keys
cozuser_saf.pub          100% 601    0.6KB/s   00:00
sftp> quit
```

Note: If you are adding more than one public key to `authorized_keys`, then you must log in to the remote system and append the new public key line to `authorized_keys`. Be careful that you don't replace an existing `authorized_keys` file.

Note: The `authorized_keys` file, the `.ssh` directory, and the home directory must not be writable by any user other than the owning userid. For details on required file permissions, see the section *"OpenSSH files Quick Reference / User-generated files"* in *IBM z/OS OpenSSH User's Guide*

4. Using a SAF/RACF certificate for SSH authentication:

- with Co:Z SFTP client:

```
ZOS$ cozsftp -k MY-RING:MY-CERT cozuser@linux1.myco.com
```

(see also the SFTPSAMP or RUNSFTPK sample JCL)

- with Co:Z Launcher:

```
//COZCFG DD *
saf-cert=MY-RING:MY-CERT
```

(see also the RUNLNCHK sample JCL)

Renewing RACF self-signed certificates

You may wish to renew/extend a certificate used with OpenSSH, using the same self-signed key. Note that certificates must be renewed prior to expiration, or a new keypair will be generated, which will require that the new public key be stored on the remote system in the user's `authorized_keys` file. The following commands can be executed by the owning user before the certificate expires. The owning user must have FACILITY authorities. Refer to "z/OS Security Server RACF Command Language Reference" for additional information.

```
DELETE 'SYSADM.CERT.REQ'

RADCERT GENREQ(LABEL('MY-CERT'))           +
          ID(COZUSER)                       +
          DSN('SYSADM.CERT.REQ')           +

RADCERT GENCERT('SYSADM.CERT.REQ')         +
          ID(COZUSER)                       +
          WITHLABEL('MY-CERT')             +
          NOTAFTER( DATE(2016-12-31) )     +
          SIGNWITH(LABEL('MY-CERT'))
```

Appendix B. Problem Determination

This part of the Co:Z User's Guide contains information to help you diagnose problems with the Co:Z Launcher.

B.1 Common Configuration Issues

The following sections describe the symptoms of several common Co:Z configuration problems.

EDC8127I Connection timed out

If you receive a "EDC8127I Connection timed out" trying to ssh to your Target system, ensure that the ssh daemon (sshd) is started on the target machine. Confirm that you can connect by starting a local ssh session: `ssh -p <port> userid@localhost`. If you can connect locally, ensure that your firewall is not blocking access to your designated ssh port.

cozagent: command not found

Make sure that the Co:Z target toolkit has been downloaded and installed on the target system as described in the installation instructions. By default, the executables, including `cozagent` are installed in the directory `/opt/dovetail/coz/bin`. If the executables are installed in a different directory, set the `agent-path` property in your JCL to point explicitly to that alternate path.

/usr/bin/cozagent: Permission denied

This is likely due to not having the execute bit set on the Co:Z target executables. Locate the directory where they are installed and execute the following: `chmod +x cozagent cozclient fromdsn todsn`

Host key verification failed

Ensure that you have added the target system's host key to `known_hosts` of the `userid` running the Co:Z Launcher. This is discussed in the installation instructions, but a simple way to do this is to establish an ssh session with the target system from a USS command line and answer "yes" when prompted to add the host:

```
ZOS$ ssh user@68.255.253.94
The authenticity of host '68.255.253.94 (68.255.253.94)' can't be established.
RSA key fingerprint is 09:2c:46:23:56:4e:8f:15:ee:26:5a:12:ec:8d:3a:99.
Are you sure you want to continue connecting (yes/no)? yes
```

Permission denied (publickey,keyboard-interactive).

Usually due to an attempt to connect to a target server with a userid that doesn't have a keypair set up with the calling z/OS system. See the "Configure and test sshd" section in the *Co:Z Target System Toolkits* installation steps.

command not found for fromdsn or todsn on //STDERR DD

The z/OS Co:Z Launcher uses ssh to first launch the CoZAgent executable at the default path: /opt/dovetail/coz/bin/cozagent. CoZAgent then adds its own directory to the PATH before invoking the target program or shell.

This is sufficient on most Unix/Linux distributions, but some distributions such as SUSE have default login profiles that reconstruct the PATH variable from scratch, and lose this information when a new login shell is started. In these cases, you will need to update the login profile to include the /opt/dovetail/coz/bin directory

Assuming that your default shell is **bash**, here is an example that verifies that an existing PATH variable is not lost by a new login shell:

```
linux$ export PATH=foo:$PATH
linux$ bash --login
(a new shell)
linux$ echo $PATH
(check for the presence of "foo")
linux$ exit
```

If you find that your target distribution has this problem, you will need to update the /etc/profile file (or equivalent) to explicitly add the Co:Z binaries directory to the PATH.

B.2 Common Logging/Tracing Options

Several aspects control the logging of messages and trace information in the Co:Z toolkit:

The logging level

A threshold level: **Error**, **Warning**, **Notice**, **Info** (default), **Debug**, and **Trace**. **Fine**. Each message has a level and will only be logged if that level is at or below the current logging threshold.

The component's logger object

Each major component in the system will typically have its own logger, which can have its own threshold level set, or can use the default threshold.

The common logging destination

All logger messages eventually go to the same logging logging destination, which defaults to **stderr**, but a specific file, a user-written routine, or the SYSLOG facility may also be used.

Logging options are set using either the **-L** command-line switch or by by setting the COZ_LOG environment variable. In either case, the value of the setting is a list of one or more of the following values:

E|W|N|I|D|T|F

The default logging threshold: Error, Warning, Notice, Info (default), Debug, Trace, Fine.

t

Prefix log messages with a system timestamp.

e

Include consumed cpu time in log messages.

f=filepath

Messages are logged to the given filepath instead of stderr.

s

Messages are logged to SYSLOG facility instead of stderr.

logname=E|W|N|I|D|T|F

Set a specific log name to the given threshold

B.3 Enabling Component Logging

The following examples demonstrate how to enable logging for various Co:Z toolkit components:

Set the default logging threshold for the batch launcher job

The following example uses the **-LT** command switch to set the default logging level to "Trace" for all components in the batch launcher job (but not the target system components). The **t** option is also used to prefix all messages with a timestamp.

```
//COZLG1 JOB (),'COZ'
//STEP1 EXEC PROC=COZPROC,
//      ARGS='-LT,t myuid@linux1.myco.com'
//COZCFG DD *
server-env-COZ_LOG=T,t
//STDIN DD *
# This is input to the remote shell
echo "We are running on: " `uname -sr`
//
```

Set the default logging threshold for the target system components

The following example uses the **agent-options** property to set the **-L** command line switch to configure CoZAgent logging.

The example also sets the target system environment variable **COZ_LOG** to set logging options for all other target components. Environment variables for the target system can be set using the **target-env-** property prefix in the Co:Z Launcher configuration properties DD (COZCFGD).

```
//COZLG1 JOB (),'COZ'
//STEP1 EXEC PROC=COZPROC,
//      ARGS='myuid@linux1.myco.com'
//COZCFG DD *
agent-options=-LT,t
target-env-COZ_LOG=T,t
//STDIN DD *
# This is input to the remote shell
echo "We are running on: " `uname -sr`
//
```

Enabling ssh diagnostic messages

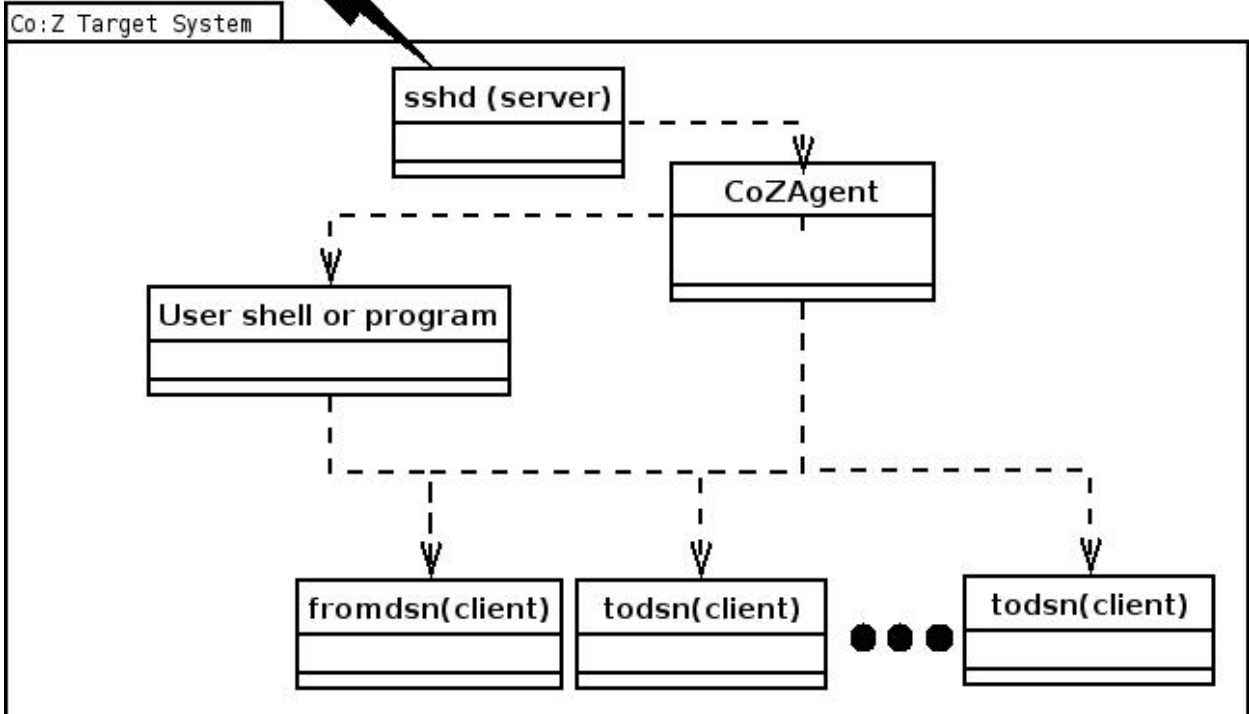
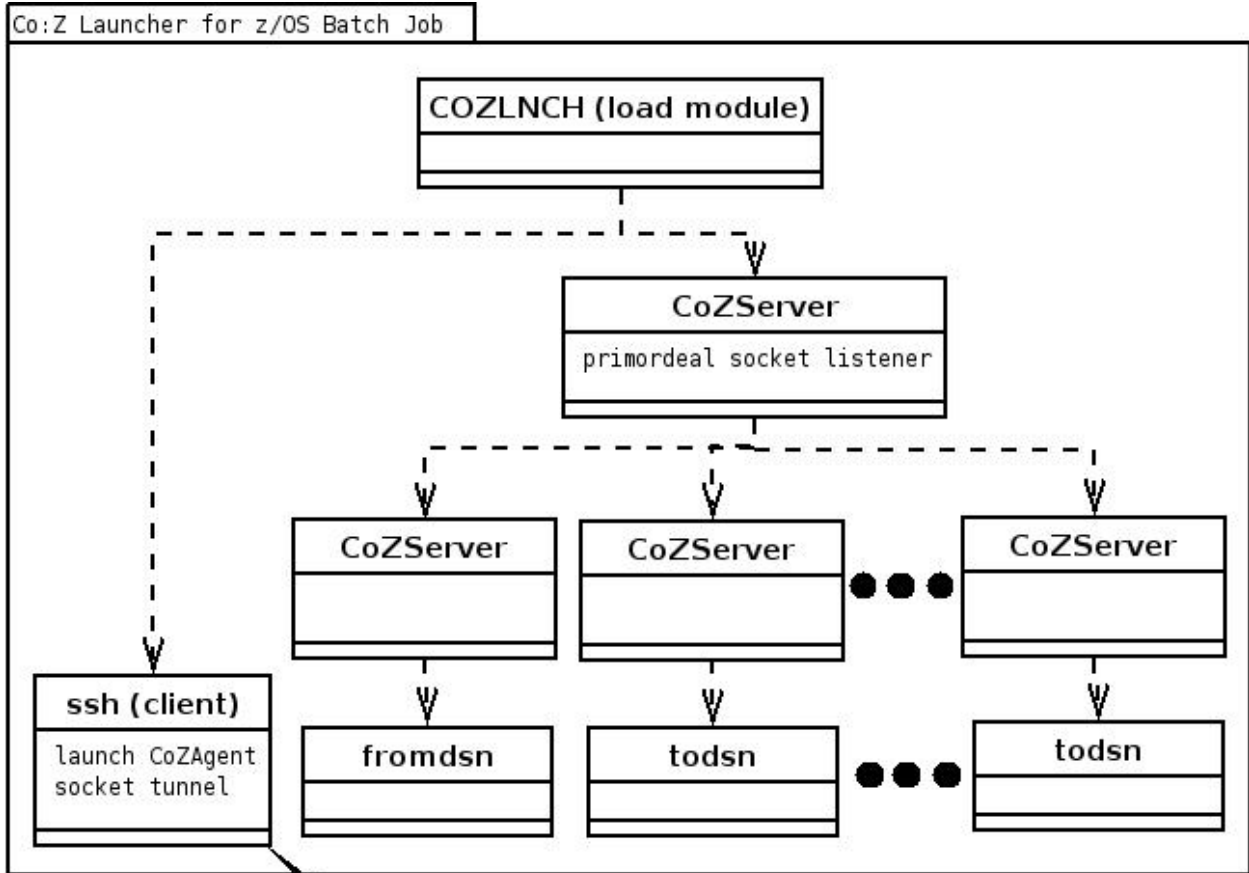
It is sometimes useful to increase the verbosity of ssh itself to determine a problem source. To do this for the ssh client (used by the Co:Z Launcher process), add one or more **v** switches to **ssh-options** property in COZCFG:

```
//COZCFG DD *  
ssh-options=-vv  
//
```

More v's increase the debug level. Note that ssh can produce lots of output.

B.4 Co:Z Toolkit Component Overview

The following diagram illustrates the processes that occur (on z/OS and the target system) when running the Co:Z Launcher:



Appendix C. Co:Z Launcher Return Codes

The following table defines the Co:Z Launcher return codes:

Table C.1. Return codes

Return Code	Description
101	user input or config error
102	system api error other than I/O
103	file or network I/O error
104	translation error
105	a program was killed
106	bad authentication token
107	failed starting CoZAgent on target
108	child process failed for unknown reason

Appendix D. Co:Z Environment Variables

The following table describes the environment variables defined by the Co:Z Toolkit. These variables can be set to override default behavior.

Table D.1. Environment variables

Variable	Context	Description
COZ_SERVER_KEEPALIVE	Co:Z Launcher	Interval in seconds Co:Z Server sends a NOOP packet. This option sends out actual data packets at the application level for situations where TCP_KEEPALIVE does not work due to firewall configuration. By default, this feature is not enabled.
COZ_SERVER_TCP_KEEPALIVE	Co:Z Launcher	Interval in seconds Co:Z Server sets the TCP_KEEPALIVE socket option. Note that this setting must be lower than the time that any firewall(s) may time out the connection. By default, this feature is not enabled.
COZ_SSH_CMD	Remote Dataset Pipes (Co:Z Target System Toolkit)	Specifies an alternate executable for the SSH client used to connect to z/OS. By default, this is <code>ssh</code> . For example, to use the PuTTY command line client <code>plink</code> instead of <code>ssh</code> set <code>COZ_SSH_CMD=/path/to/plink</code> .
COZ_SSH_OPTS	Remote Dataset Pipes (Co:Z Target System Toolkit)	Convenience setting for supplying SSH options, including <code>userid</code> and <code>host</code> when making remote dataset pipes calls. For example, the command <code>fromdsn -ssh user@host //mydsn</code> can be simplified to <code>fromdsn //mydsn</code> if <code>COZ_SSH_OPTS</code> is set to <code>user@host</code> . This is very handy for repeated use of the remote dataset pipes commands.
COZ_SSH_SUBSYS	Remote Dataset Pipes (Co:Z Target System Toolkit)	Specifies an alternate SSH server subsystem name for Dataset Pipes. By default, this is <code>dspipes</code> .
COZ_CLIENT_CODEPAGE	Remote Dataset Pipes (Co:Z Target System Toolkit)	Changes the default client code page, which is used for codepage translation in text mode data transfers (i.e. if the <code>-t</code> is not supplied). By default, the default client code page is set the result of the POSIX system call <code>nl_langinfo(CODESET)</code> .
COZ_DEFAULT_LOGSTREAM	Co:Z Log (all)	Changes the default stream that the Co:Z Log facility

Variable	Context	Description
	contexts)	writes its messages to. By default, this is the <code>stderr</code> stream.
COZ_LOG	Co:Z Log (all contexts)	Sets default logging options for the Co:Z Log facility.
COZ_STRICT_CERT_CHECK	Co:Z Launcher, Co:Z SFTP	Affects the level of RACF digital certificate checking performed when authenticating. If set to true (the default), strict checking (e.g. certificate expiration date) is performed.
SFTP_LOGFILE	Co:Z SFTP	Pathname of file to where Co:Z SFTP log/debug messages are written. The default is <code>/tmp/sftp-server.<userid>.<...>.log</code>
SFTP_LOGDIR	Co:Z SFTP	Directory name (without trailing slash) where Co:Z SFTP log files are created, rather than <code>/tmp</code> or <code>\$TMPDIR</code> . This variable is ignored if <code>SFTP_LOGFILE</code> is set.
SFTP_ZOS_OPTIONS	Co:Z SFTP	Used to set a default Co:Z SFTP options string for the user. There is no default. Example: <code>SFTP_ZOS_OPTIONS=mode=text,l=crlf</code> . To set Co:Z SFTP Server options, this variable is exported in the user's <code>sftp-server.rc</code> file. To set Co:Z SFTP client options, export this environment variable prior to running cozsftp

Appendix E. License

The Co:Z Co-Processing Toolkit for z/OS, comprised of Co:Z Launcher, Co:Z Dataset Pipes, Co:Z SFTP, Co:Z Batch, Co:Z Utilities and Co:Z Target System Toolkit (in object code form only) is distributed under the Co:Z Community License Agreement (see below). *Note:* This community license is superseded for Co:Z Toolkit Enterprise License and Support customers. All components are distributed in binary form.

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12. MISCELLANEOUS Governing Law. This Agreement shall be governed and interpreted for all purposes by the laws of the State of Missouri, U.S.A., without reference to any conflict of laws principles that would require the application of the laws of a different jurisdiction. The United Nations Convention on Contracts for the International Sale of Goods and the Uniform Computer Information Transactions Act (as enacted in any jurisdiction) do not and shall not apply to this Agreement, and are hereby specifically excluded.

Jurisdiction; Venue. Any dispute, action or proceeding arising out of or related to this Agreement shall be commenced in the state courts of St. Louis County, Missouri or, where proper subject matter jurisdiction exists, the United States District Court for the Eastern District of Missouri. Each party irrevocably submits to the personal jurisdiction and exclusive venue of such courts, and waives any objections thereto, including based on forum non conveniens.

Notices. All notices under this Agreement shall be in writing, and shall be delivered personally, by electronic, mail, or by postage prepaid certified mail or express courier service, return receipt requested. Notices to You may be delivered to the most current address on file. Notices to Dovetail shall be directed to the following address, unless Dovetail has provided an alternative notice address:

Dovetailed Technologies, LLC
305 Willowpointe Drive
St. Charles, MO 63304

Email: legal@coztoolkit.com

Assignments. You may not assign or transfer this Agreement, or any rights or duties hereunder, in whole or in part, whether by operation of law or otherwise, without the prior written consent of Dovetail. Any attempted assignment or transfer in violation of the foregoing shall be null and void from the beginning and without effect. Dovetail may freely assign or transfer this Agreement, including to a successor upon Dovetail's merger, acquisition, corporate reorganization, or sale or other transfer of all or substantially all of its business or assets to which this Agreement relates.

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Questionnaires; Audits. You agree to complete and promptly return to Dovetail any Software usage questionnaires issued by Dovetail from time to time, and to promptly provide Dovetail or its designated auditor with reasonable access to Your facilities, systems, personnel, books and records for the purpose of verifying Your compliance with the license terms and restrictions of this Agreement. All audits shall be conducted in a reasonable manner designed to minimize disruption to Your normal business operations. Dovetail agrees to initiate an audit no more than once during any twelve (12) month period; provided, however, if Dovetail reasonably suspects, or any audit reveals, non-compliance with this Agreement, Dovetail shall have the right to conduct additional audits until compliance is achieved.

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Amendment; Waiver. This Agreement may be amended only by a written instrument signed by an authorized representative of Dovetail. No rights shall be waived by any act, omission, or knowledge of a party, except by an instrument in writing expressly waiving such rights and signed by an authorized representative of the waiving party. Any waiver on one occasion shall not constitute a waiver on subsequent occasions.

Severability; Construction. If any provision of this Agreement is determined to be invalid or unenforceable under applicable law, such provision shall be amended by a court of competent jurisdiction to accomplish the objectives of such provision to the greatest extent possible, or severed from this Agreement if such amendment is not possible, and the remaining provisions of this Agreement shall continue in full force and effect. The captions and section headings in this Agreement are for reference purposes only and shall not affect the meaning or interpretation of this Agreement. The term "including" as used herein means "including without limitation." The terms "herein," "hereto," "hereof," and similar variations refer to this Agreement as a whole, rather than to any particular section.

Entire Agreement. This Agreement sets forth the entire agreement of the parties and supersedes all prior agreements and understandings, whether written or oral, with regard to the subject matter hereof. Any additional or conflicting terms proposed by You in any purchase order, request for proposal, acknowledgement, or other writing shall not be binding, and are hereby objected to and expressly rejected.

Appendix F. References

F.1 z/OS OpenSSH

Using remote `todsn` and `fromdsn` clients requires that *IBM z/OS OpenSSH* be configured on z/OS. z/OS V2R2 and later includes OpenSSH. We provide a *Quick Install Guide* to help systems programmers quickly configure IBM z/OS OpenSSH.

F.2 Using the z/OS Unix Shell

The Dataset Pipes `todsn` and `fromdsn` commands may be used from any of the following z/OS Unix shell environments:

- The TSO "OMVS" command
- The **BPXBATCH** utility, running under MVS batch or TSO

*Note:*The BPXBATCH enhancement **OA11699** significantly improves its usability.

- The z/OS Unix Shell under a telnet or ssh console.

For more information on z/OS Unix, see:

- *z/OS Unix System Services publications*
- *z/OS Unix System Services User's Guide*

F.3 The z/OS C library `fopen()` routine

The Dataset Pipes utilities open MVS datasets in "record mode" using the z/OS C library `fopen()` routine. For example:

```
fopen( name, mode );
```

where:

name

either `///'fully.qualified.dsn'` or `///dd:ddname` depending on whether **BPXWDYN** allocation keywords were used (*Section F.4, "The z/OS BPXWDYN dynamic allocation service"*).

mode

- `"rb,type=record,noseek"` - if reading (`fromdsn`)
- `"wb,type=record,noseek"` - if writing (`todsn`)
- `"ab,type=record,noseek"` - if appending (`todsn -a`)

Additional open mode options may be specified by using the `-o` option.

The Dataset Pipes utilities read and write records using the z/OS C library `fread()` and `fwrite()` routines. For more information on the capabilities of record-mode dataset processing with the z/OS C library, see:

- *z/OS XL C/C++ publications*
- *z/OS XL C/C++ Runtime Library Reference*
- *z/OS XL C/C++ Programming Guide*. See Ch. 10 "Performing OS I/O operations."

F.4 The z/OS BPXWDYN dynamic allocation service

The Dataset Pipes utilities allow for flexible allocation of MVS Datasets through use of the **BPXWDYN** text-based allocation service. If you specify allocation keywords, either with the `-x` option, or by using the `allocKeywords` option, then a new system-assigned DDNAME will be allocated with BPXWDYN and that DDNAME will be opened with [Section F.3, "The z/OS C library `fopen\(\)` routine"](#) `fopen()`.

You may use any allocation keywords defined by BPXWDYN, except the following:

- `DA()`, `DSN()`, `FI()`, `DD()`, `MSG()`, or `REUSE()` (automatically supplied)
- `PATH()`, `PATHDISP()`, `PATHMODE()`, `PATHOPTS()`, `PATHPERM()`
- `RTDDN`, `RTDSN`, `RTVOL` (only works if called from REXX)
- `SYNTAX`

For more information on using BPXWDYN allocation keywords, see:

- *z/OS Using REXX and z/OS UNIX System Services*

F.5 The z/OS Unicode Translation Services

The Dataset Pipes utilities rely on the *z/OS Unicode Conversion Service* when possible, for codepage/character set translation.

This subsystem provides hardware-assisted high-performance codepage conversions services. This is the same service used by later versions of z/OS DB2, so many shops already have it configured in their environments. For z/OS 1.6 and later, the service is configured by default, with a starter set of codepage (CCSID) mappings.

For more information on configuring and customizing this subsystem:

- *z/OS Unicode Services User's Guide and Reference*

When Unicode Conversion Services are not available, Dataset Pipes falls back to **iconv** for codepage translation