

Monitor your system with expect

The previous few *Tclsh Spot* articles described generating IP packets to attack a firewall system being tested. Once the packets can be generated, the next step is to confirm that they are captured and logged correctly.

For someone familiar with the log files, this is a simple exercise. You can `tail -f` the appropriate file and watch for the log messages, or `grep` for the expected pattern.

For someone familiar with the log files, this is also a tedious exercise. Not too bad when you are looking for something tricky, but too much monkey-work if you are generating hundreds of attacks and need to confirm that all are caught correctly.

Automating tedious tasks that would otherwise be done by a skilled (or at least easily bored) human is what the `expect` extension was written for.

The `expect` extension to Tcl was developed by Don Libes of the NIST in 1990, very shortly after John Ousterhout's first Tcl paper was presented at the Usenix technical meeting.

Expect will interact with a text oriented task, looking for patterns, and sending responses as appropriate.

For those with fond memories of UUCP chat scripts, you can think of `expect` as a chat script with much more power.

The `expect` extension can be dynamically loaded into a running Tcl shell with the `package require` command like this:

```
% package require Expect
5.38.0
```

It's more common to use the standalone `expect` shell - invoked as `expect`. When invoked as `expect` a special prompt is provided showing the depth of the evaluation stack, and the number of commands that have been processed.

Defining a simple procedure within the `expect` shell looks like this:

```
$> expect
expect1.1> proc a {a b} {
+> puts "$a"
+> }
expect1.2>
```

The `expect` package is extensive with many commands and options to support the various interactions one might need to perform. There are only three essential commands, however.

`spawn`

Starts a new task for the `expect` script to interact with.

`expect`

Defines a set of patterns and actions to perform when a pattern is matched.

`exp_send`

Sends a stream of data to the child task.

The `spawn` command starts a child process to be controlled by the `expect` script. It starts a new process and connects the process's `stdin` and `stdout` to the `expect` interpreter.

Syntax: `spawn options commandName commandArgs`

options

The `spawn` command supports several options, including

`-noecho`

The `spawn` will echo the command line and arguments unless this option is set.

`-open fileID`

The `-open` option lets you process the input from a file handle (returned by `open`) instead of executing a new program. This allows you to use an `expect` script to evaluate program output from a file as well as directly controlling a program.

commandName

The name of the executable program to start.

commandArgs

The command line arguments for the executable program being spawned.

Opening an `ssh` session would look like this:

```
expect1.1> spawn ssh -l cliff 127.0.0.1
spawn ssh -l cliff 127.0.0.1
1105
expect1.2>
```

Once a new child task has been spawned, your script needs to interact with it. The `expect` command listens to the child task, while the `exp_send` command talks to it.

The `expect` command will scan the input for one of several patterns. When a pattern is recognized the associated action will be evaluated.

Syntax: `expect ?-option? pattern1 action1 ?-option? pattern2 action2 ...`

-option

Options that will control the matching are:

`-exact`

Match the pattern exactly.

`-re`

Use regular expression rules to match this pattern.

`-glob`

Use glob rules to match this pattern.

pattern

A pattern to match in the output from the spawned program.

action

A script to be evaluated when a pattern is matched.

This code snippet will look for the password prompt and report that the prompt was seen:

```
expect1.3> expect {
+> word: {puts "The password: prompt was seen"}
+> }
```

The pattern/action format of the `expect` command resembles the `switch` command. The `switch` command uses the meta-pattern `default` to process unexpected conditions. The `expect` command also supports meta-patterns to process unexpected input.

The `eof` meta-pattern matches when the expect interpreter loses contact with a child task. Usually this happens when a child task dies.

The `timeout` pattern will match if no other pattern has been matched within a given period of time. This script checks for the password prompt, and complains if it doesn't appear:

```
expect {
  word: {puts "The password: prompt was seen"}
  timeout {puts "There was no password prompt!"}
}
```

The default timeout period is 10 seconds. This can be changed by setting a variable named `timeout` to the number of seconds to wait before matching the `timeout` pattern.

Note that the `timeout` value is a maximum value, not a minimum value. The `timeout` is implemented by watching the system's one-second timer. Each time this fires, the `timeout` value is decremented by one. When the value hits zero, the `timeout` pattern is matched, and the associated script is evaluated.

Thus, setting the `timeout` value to 1 will never wait longer than a single second, but could timeout in .0001 seconds.

This code snippet will watch for the password prompt, and complain if either the child task has lost contact with the expect script or there is a timeout.

```
expect {
  word: {puts "The password: prompt was seen"}
  eof {puts "The child task has died!"}
  timeout {puts "There was no password prompt!"}
}
```

The flip-side to listening to a child task is to send strings of data to the child. The `exp_send` sends *string* to the child process.

Syntax: `exp_send string`

string

The string to be transmitted to the slave process. Note that a newline is not appended to this text.

A simple script to look for the password prompt and send a password looks like this:

```
expect {
  word: {exp_send "PASSWORD\n"}
}
```

Notice the `\n` at the end of `PASSWORD`. In order to interact with applications that key off of single keystrokes, the `expect` command sends exactly what you tell it to, and does not add any new characters (like newlines) to the string.

A script to log into a remote system, look for the shell prompt and change to the `/var/log` directory would look like this:

```
spawn ssh 127.0.0.1

expect {
  word: {exp_send "$password\n"}
  timeout {error "Timeout waiting for password"}
  eof {error "Eof waiting for password"}
}

expect {
  "%>" {exp_send "cd /var/log\n"}
  timeout {error "Timeout waiting for prompt"}
  eof {error "Eof waiting for prompt"}
}
```

As with the `switch` statement's default option, you don't need to use the `timeout` and `eof` patterns. But, as with the `switch` (or C case statement), if you ignore catching the exception conditions, you will live to regret it.

This can lead to a lot of repeated code if your application has a lot of simple challenge/response interactions.

One solution to this problem is to create a procedure to maintain the process flow, and provide the customization with the procedure arguments.

The syntax for the `proc` command is:

Syntax: `proc name args body`

The `args` and `body` parameters are generally grouped with braces when you define a procedure within your application.

This procedure generalizes the challenge/response nature of many conversations.

```
#####
# proc challResp {pattern response info}--
#   Hold a single interchange challenge/response interaction.
# Arguments
#   pattern:    the pattern to wait for as a challenge
#   response:   The response to this pattern.
#   info:       Identifying information about this interaction
```

```

#           for use with exception reporting.
#
# Results
#
#
proc challResp {pattern response info} {
  expect {
    $pattern {exp_send "$response\n"}
    timeout  {error "Timeout at $info" "Timeout at $info"}
    eof      {error "Eof at $info" "Eof at $info"}
  }
}

```

Using the challResp procedure, automating this conversation

```

%> ssh -l root 127.0.0.1
root@127.0.0.1's password:
Last login: Thu Jun  5 05:45:02 2003 from localhost
Have a lot of fun...
%> cd /var/log
%> tail -f messages

```

can be done with these four lines of code.

```

spawn ssh -l root 127.0.0.1

challResp "word:" $passWord "password prompt"
challResp "%>" "cd /var/log" "first shell prompt"
challResp "%>" "tail -f messages" "second shell prompt"

```

We can create a generic procedure for watching log files for a given pattern with this procedure.

```

#####
# proc watchFile {host passwd fileName pattern}--
#   Watch a file on a remote system for a given pattern
# Arguments
#   host:      IP Address of the host on which the file resides.
#   passwd:    Password for accessing the host
#   fileName:  Full path to the file to be watched
#   pattern:   A pattern to watch for in the file.
# Results
#   Throws an error if the expected pattern is not seen.
#
proc watchFile {host passwd fileName pattern} {
  global spawn_id

  set stty_init -echo
  spawn ssh -l root 127.0.0.1

  challResp "word:" $passwd "password prompt"
  challResp "%>" "cd /var/log" "first shell prompt"
  challResp "%>" "tail -f messages" "second shell prompt"

  expect {
    "$pattern" {puts "ROOT LOGIN SUCCESSFUL"}
  }
}

```

```
    timeout {error "timeout" "Timeout waiting for \"${pattern}\"}
    eof      {error "eof" "Eof waiting for \"${pattern}\"}
  }
}
```

Note the `global spawn_id` at the beginning of this procedure. When `spawn` creates a new task, it creates a unique identifier for that task and saves that value in the variable `spawn_id` in the current scope. If the new task is spawned in a procedure, `spawn_id` is created in the procedure scope, and it vanishes when the procedure returns. Keeping the `spawn_id` in the global scope is the simplest way to deal with this for applications that only have a single child task.

This discussion of expect barely scratches the surface of what the package can do, but it's enough to automate accessing a remote system and scanning a log file for a pattern.

The next Tclsh Spot article will start looking at ways to coordinate the packet generators described previously with this log file scanner to generate attacks on a test system and confirm that the test system responds to the attacks correctly.