4.8 Concurrent Servers

The server in Figure 4.11 is an *iterative server*. For something as simple as a daytime server, this is fine. But when a client request can take longer to service, we do not want to tie up a single server with one client; we want to handle multiple clients at the same time. The simplest way to write a *concurrent server* under Unix is to `fork` a child process to handle each client. Figure 4.13 shows the outline for a typical concurrent server.

Figure 4.13 Outline for typical concurrent server.

```
pid_t pid;
int   listenfd,  connfd;

listenfd = Socket( ... );

    /* fill in sockaddr_in{} with server's well-known port */
Bind(listenfd, ... );
Listen(listenfd, LISTENQ);

for ( ; ; ) {
    connfd = Accept (listenfd, ... );    /* probably blocks */

    if( (pid = Fork()) == 0) {
       Close(listenfd);    /* child closes listening socket */
       doit(connfd);       /* process the request */
       Close(connfd);      /* done with this client */
       exit(0);            /* child terminates */
    }

    Close(connfd);         /* parent closes connected socket */
}
```

When a connection is established, `accept` returns, the server calls `fork`, and the child process services the client (on `connfd`, the connected socket) and the parent process waits for another connection (on `listenfd`, the listening socket). The parent closes the connected socket since the child handles the new client.

In Figure 4.13, we assume that the function `doit` does whatever is required to service the client. When this function returns, we explicitly `close` the connected socket in the child. This is not required since the next statement calls `exit`, and part of process termination is to close all open descriptors by the kernel. Whether to include this explicit call to `close` or not is a matter of personal programming taste.

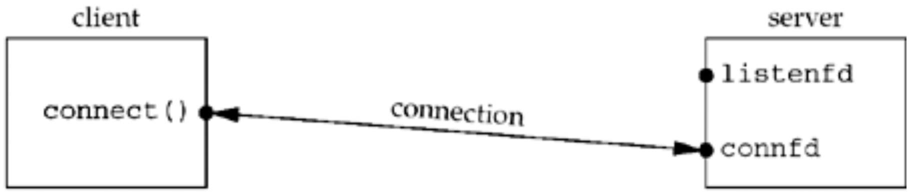
We said in Section 2.6 that calling `close` on a TCP socket causes a FIN to be sent, followed by the normal TCP connection termination sequence. Why doesn't the `close` of `connfd` in Figure 4.13 by the parent terminate its connection with the client? To understand what's happening, we must understand that every file or socket has a reference count. The reference count is maintained in the file table entry (pp. 57–60 of APUE). This is a count of the number of descriptors that are currently open that refer to this file or socket. In Figure 4.13, after `socket` returns, the file table entry associated with `listenfd` has a reference count of 1. After `accept` returns, the file table entry associated with `connfd` has a reference count of 1. But, after `fork` returns, both descriptors are shared (i.e., duplicated) between the parent and child, so the file table entries associated with both sockets now have a reference count of 2. Therefore, when the parent closes `connfd`, it just decrements the reference count from 2 to 1 and that is all. The actual cleanup and de-allocation of the socket does not happen until the reference count reaches 0. This will occur at some time later when the child closes `connfd`.

We can also visualize the sockets and connection that occur in Figure 4.13 as follows. First, Figure 4.14 shows the status of the client and server while the server is blocked in the call to `accept` and the connection request arrives from the client.

Figure 4.14. Status of client/server before call to `accept` returns.

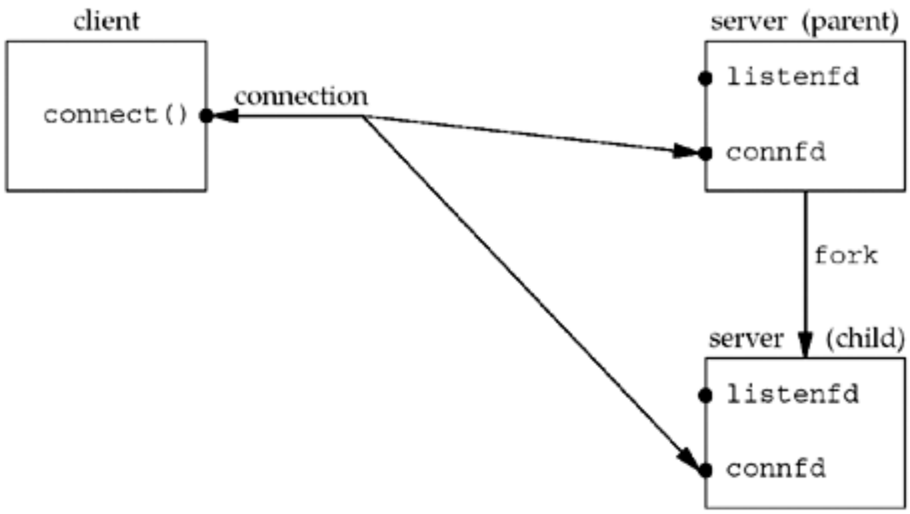
Immediately after `accept` returns, we have the scenario shown in Figure 4.15. The connection is accepted by the kernel and a new socket, `connfd`, is created. This is a connected socket and data can now be read and written across the connection.

Figure 4.15. Status of client/server after return from `accept`.



The next step in the concurrent server is to call `fork`. Figure 4.16 shows the status after `fork` returns.

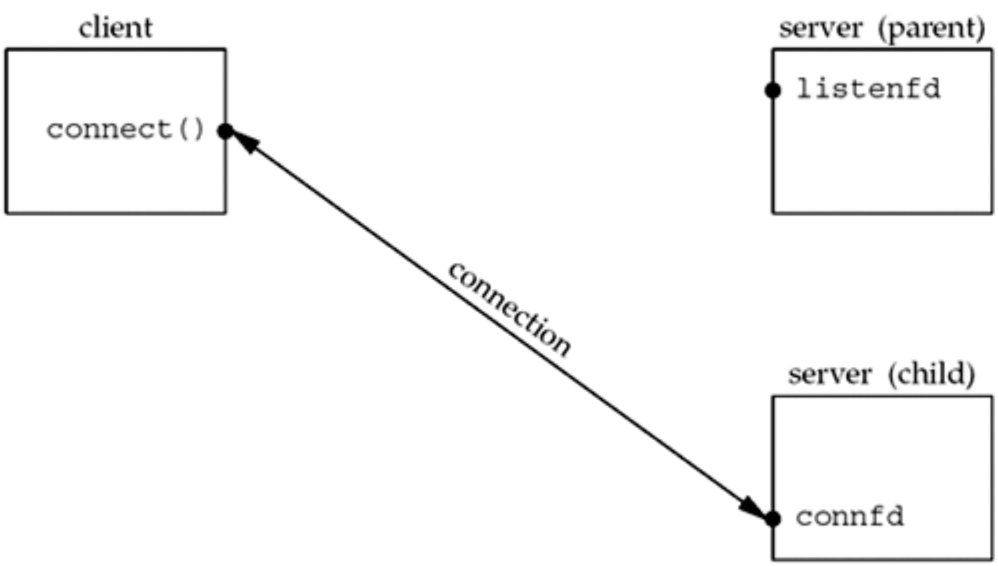
Figure 4.16. Status of client/server after `fork` returns.



Notice that both descriptors, `listenfd` and `connfd`, are shared (duplicated) between the parent and child.

The next step is for the parent to close the connected socket and the child to close the listening socket. This is shown in Figure 4.17.

Figure 4.17. Status of client/server after parent and child close appropriate sockets.



This is the desired final state of the sockets. The child is handling the connection with the client and the parent can call `accept` again on the listening socket, to handle the next client connection.

[Team LiB] PREVIOUS NEXT