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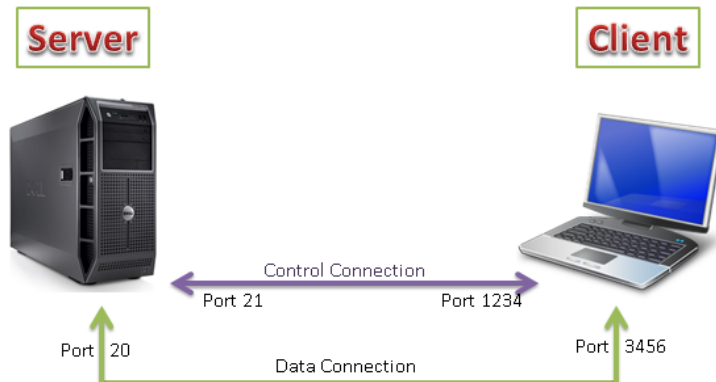
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Saturday, September 1, 2012

## How FTP works

FTP stands for File Transfer Protocol which is used to transfer files from one host to another over TCP. RFC 959 lists all the details of FTP. It is an application layer protocol and is used widely across the world for transferring files.

**FTP connections (what we read and know):-**



FTP consists of 2 connections:-

1. **Control Connection** on port 21 of server (Standard, can be changed)
2. **Data Connection** on port 20 of server (Standard, can be changed)

Control connection is established between port 21 of server and random port of client. Once opened, this connection remains there unless closed by user or idle timeout occurs.

Data connection is established every time client sends a request using control connection to server for data transfer. For every new **Data connection**, port number changes. The new port number is negotiated on the control connection.

**NOTE:-**

**Not all the FTP commands use the Data Connection...**

Here is the list of FTP commands. Commands with (✓) indicates that the command uses data connection and commands with (X) indicates that the command doesn't use data connection.

!	delete	✗ literal	✗ prompt	✗ send	✓
?	debug	✗ ls	✓ put	✓ status	✗
append	✓ dir	✓ mdelete	✗ pwd	✗ trace	✗
ascii	✗ disconnect	✗ mdir	✓ quit	✗ type	✗
bell	✗ get	✓ mget	✓ quote	✗ user	✗
binary	✗ glob	✗ mkdir	✗ recv	✓ verbose	✗
bye	✗ hash	✗ mls	✓ remotehelp	✗	
cd	✗ help	✗ mput	✓ rename	✗	
close	✗ lcd	✗ open	✗ rmdir	✗	

Looking at the above diagram, one could see that of all the commands available for FTP, ratio of commands which use data connection to all commands is very less.

FTP data transfer modes are of 4 types:-

1. Active Mode (Also known as PORT based)
2. Passive Mode (Also known as PASV based)
3. Extended active mode to support NAT (EPRT)
4. Extended passive mode to support NAT (EPSV)

**Active Mode:-**

In this, client tells to the server on which client-port the data connection will be made. So client sends the port number with the command to the server. In PORT commands, port 20 is used by server for Data transfer.

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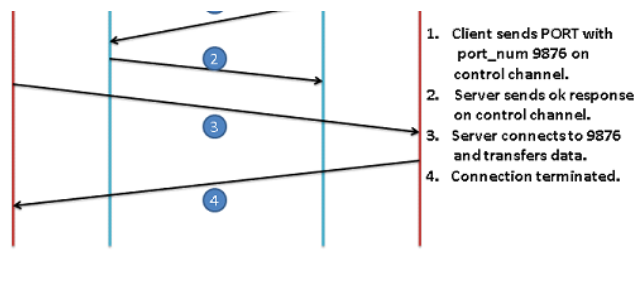
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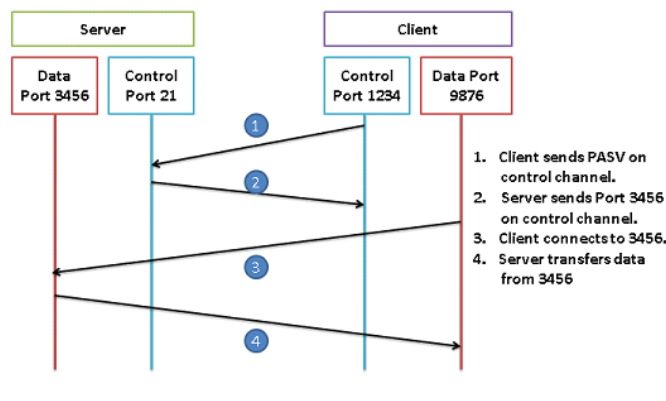
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#### Passive Mode:-

Sometimes client might be behind the firewall. In such cases, server cannot directly connect to the client on the negotiated port. So for that Passive mode is used. In Passive mode, any random port is used by server for Data connection.

In this, Server sends the data connection port no. to client and then client connects to that port number for data connection.



#### EPRT and EPSV modes:-

These modes are to support FTP in case of IPv6 and NATing. More details about them can be found in FTP's RFC document.

#### Traffic flow examples for PORT and PASV modes:-

Now we will try to see what traffic flows in case of FTP connection.

Server's IP: 192.168.10.10

Client's IP: 192.168.10.11

Now let us see what traffic flows when some request is sent by FTP-client to FTP-server which uses data-connection for both Active and passive modes. Thing to note here is that control connection is already established between client and server. We will discuss what happens after that.

#### For Active mode:-

##### ACTIVE MODE

```

192.168.10.11 192.168.10.10 FTP 93 Request: PORT 192,168,10,11,217,55
192.168.10.10 192.168.10.11 FTP 96 Response: 200 PORT command successful.
192.168.10.11 192.168.10.10 TCP 66 34488 > ftp [ACK] Seq=61 Ack=186 win=5856 Len=0
192.168.10.11 192.168.10.10 FTP 72 Request: LIST
192.168.10.10 192.168.10.11 TCP 74 ftp-data > 55607 [SYN] Seq=0 win=5840 Len=0
192.168.10.11 192.168.10.10 TCP 74 55607 > ftp-data [SYN, ACK] Seq=0 Ack=1 win=5840
192.168.10.10 192.168.10.11 TCP 66 ftp-data > 55607 [ACK] Seq=1 Ack=1 win=5888
192.168.10.10 192.168.10.11 FTP 121 Response: 150 opening ASCII mode data connection
192.168.10.10 192.168.10.11 FTP-DAT 2962 FTP Data: 2896 bytes
192.168.10.10 192.168.10.11 FTP-DAT 676 FTP Data: 610 bytes
192.168.10.11 192.168.10.10 TCP 66 55607 > ftp-data [ACK] Seq=1 Ack=1449 win=8192
192.168.10.11 192.168.10.10 TCP 66 55607 > ftp-data [ACK] Seq=1 Ack=2897 win=131072
192.168.10.11 192.168.10.10 TCP 66 55607 > ftp-data [ACK] Seq=1 Ack=3507 win=14336
192.168.10.10 192.168.10.11 TCP 66 ftp-data > 55607 [FIN, ACK] Seq=3507 Ack=1 win=0
192.168.10.11 192.168.10.10 TCP 66 55607 > ftp-data [FIN, ACK] Seq=1 Ack=3508 win=0
192.168.10.10 192.168.10.11 TCP 66 ftp-data > 55607 [ACK] Seq=3508 Ack=2 win=5856
192.168.10.11 192.168.10.10 TCP 66 34488 > ftp [ACK] Seq=67 Ack=241 win=5856 Len=0
192.168.10.10 192.168.10.11 FTP 90 Response: 226 Transfer complete.
192.168.10.11 192.168.10.10 TCP 66 34488 > ftp [ACK] Seq=67 Ack=265 win=5856 Len=0

```

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As seen from the above diagram, client sends request to server and server responds back. Port is successfully negotiated between them.

Next client sends the FTP request on the control channel. Now server performs 3-way handshake with the data port negotiated and then responds back with the output on the data channel. Once the data-transfer is complete, the data-connection is terminated.

192.168.10.11	192.168.10.10	FTP	72 Request: LIST
192.168.10.10	192.168.10.11	TCP	74 ftp-data > 55607 [SYN]
192.168.10.11	192.168.10.10	TCP	74 55607 > ftp-data [SYN,
192.168.10.10	192.168.10.11	TCP	66 ftp-data > 55607 [ACK]
192.168.10.10	192.168.10.11	FTP	121 Response: 150 opening A
192.168.10.10	192.168.10.11	FTP-DAT	2962 FTP Data: 2896 bytes
192.168.10.10	192.168.10.11	FTP-DAT	676 FTP Data: 610 bytes

For each new FTP request, a new data-connection is created.

**For Passive mode:-**

#### PASSIVE MODE

192.168.10.11	192.168.10.10	FTP	72 Request: PASV
192.168.10.10	192.168.10.11	FTP	116 Response: 227 Entering Passive Mo
192.168.10.11	192.168.10.10	TCP	66 55928 > ftp [ACK] Seq=74 Ack=315
192.168.10.11	192.168.10.10	TCP	74 55737 > 46691 [SYN] Seq=0 win=584
192.168.10.10	192.168.10.11	TCP	74 46691 > 55737 [SYN, ACK] Seq=0 Ac
192.168.10.11	192.168.10.10	TCP	66 55737 > 46691 [ACK] Seq=1 Ack=1 w
192.168.10.11	192.168.10.10	FTP	72 Request: LIST
192.168.10.10	192.168.10.11	FTP	121 Response: 150 opening ASCII mode
192.168.10.10	192.168.10.11	FTP-DAT	2962 FTP Data: 2896 bytes
192.168.10.10	192.168.10.11	FTP-DAT	676 FTP Data: 610 bytes
192.168.10.10	192.168.10.11	TCP	66 46691 > 55737 [FIN, ACK] Seq=3507
192.168.10.11	192.168.10.10	TCP	66 55737 > 46691 [ACK] Seq=1 Ack=144
192.168.10.11	192.168.10.10	TCP	66 55737 > 46691 [ACK] Seq=1 Ack=289
192.168.10.11	192.168.10.10	TCP	66 55737 > 46691 [ACK] Seq=1 Ack=350
192.168.10.11	192.168.10.10	TCP	66 55737 > 46691 [FIN, ACK] Seq=1 Ac
192.168.10.10	192.168.10.11	TCP	66 46691 > 55737 [ACK] Seq=3508 Ack=
192.168.10.11	192.168.10.10	TCP	66 55928 > ftp [ACK] Seq=80 Ack=370
192.168.10.10	192.168.10.11	FTP	90 Response: 226 Transfer complete.
192.168.10.11	192.168.10.10	TCP	66 55928 > ftp [ACK] Seq=80 Ack=394

In passive mode, the client first informs server that it wants to open a passive mode data-connection with the server. It sends "PASV" command to server on control channel. Server responds back by sending the port to which it will open the data connection.

FTP	72 Request: PASV
FTP	116 Response: 227 Entering Passive Mode (192,168,10,10,182,99)
TCP	66 55928 > ftp [ACK] Seq=74 Ack=315 win=5856 Len=0 TSval=744151

As we can see from the above diagram, server responds back with the IP and port number. 3-way handshake occurs at this time for the data-connection.

Next client sends the FTP request on the control-connection and server sends back the output on the data-connection. Once the data-transfer is complete for that request, the data-connection is terminated.

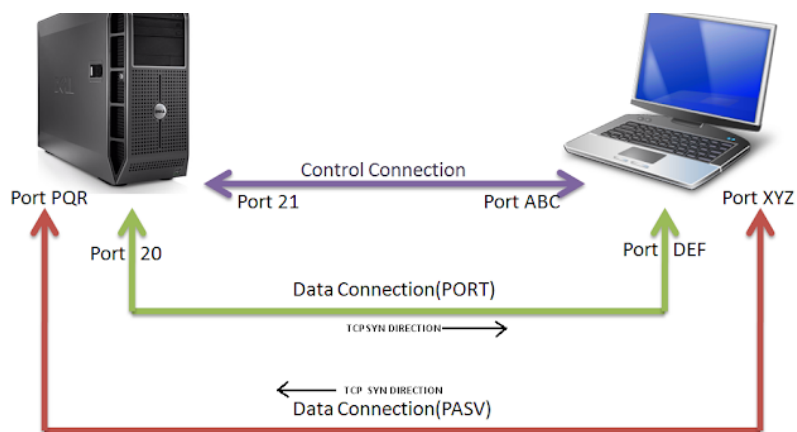
TCP	74 55737 > 46691 [SYN] Seq=0 win=5840 Len=0 MSS=1460 SACK_PERM=
TCP	74 46691 > 55737 [SYN, ACK] Seq=0 Ack=1 win=5792 Len=0 MSS=1460
TCP	66 55737 > 46691 [ACK] Seq=1 Ack=1 win=5856 Len=0 TSval=744151
FTP	72 Request: LIST
FTP	121 Response: 150 opening ASCII mode data connection for '/bin/'
FTP-DAT	2962 FTP Data: 2896 bytes
FTP-DAT	676 FTP Data: 610 bytes
TCP	66 46691 > 55737 [FIN, ACK] Seq=3507 Ack=1 win=5824 Len=0 TSval=
TCP	66 55737 > 46691 [ACK] Seq=1 Ack=1449 win=8736 Len=0 TSval=744
TCP	66 55737 > 46691 [ACK] Seq=1 Ack=2897 win=11648 Len=0 TSval=744
TCP	66 55737 > 46691 [ACK] Seq=1 Ack=3507 win=14528 Len=0 TSval=744
TCP	66 55737 > 46691 [FIN, ACK] Seq=1 Ack=3508 win=14528 Len=0 TSv
TCP	66 46691 > 55737 [ACK] Seq=3508 Ack=2 win=5824 Len=0 TSval=803
TCP	66 55928 > ftp [ACK] Seq=80 Ack=370 win=5856 Len=0 TSval=74415
FTP	90 Response: 226 Transfer complete.
TCP	66 55928 > ftp [ACK] Seq=80 Ack=394 win=5856 Len=0 TSval=74415

**Conclusion:-**

Considering the active and passive modes, we can re-design the basic diagram of FTP to more advanced and appropriate one as follows:-

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This diagram now appropriately lists about the FTP and the various connections in FTP.

Posted by [Rahul Sharma](#) at 2:58 PM



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