Algebraic Formal Modelling for FTP

Study on FTP Active Mode and Passive Mode

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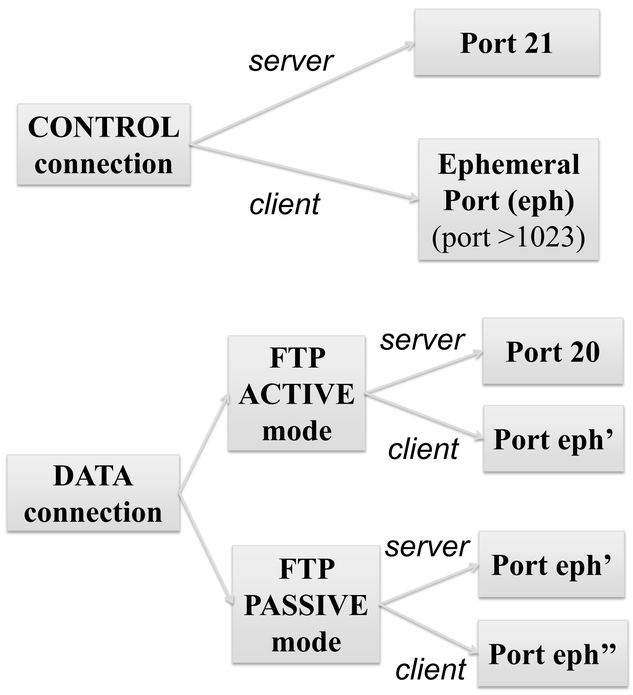
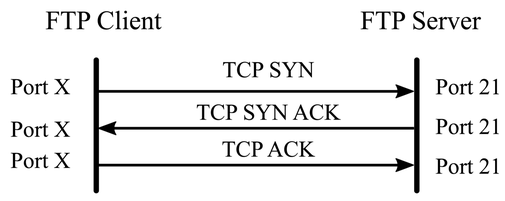
FTP behaviour



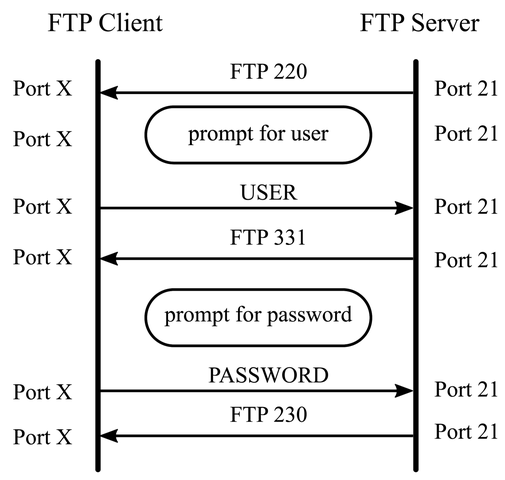
FTP SESSION: Sequence of Events

1.- Establishing initial control connection



FTP SESSION: Sequence of Events

2.- Requiring login credentials



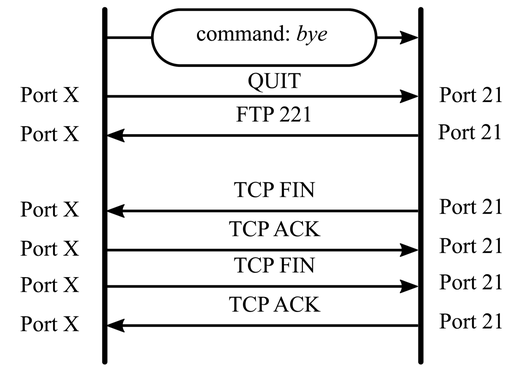
FTP SESSION: Sequence of Events

3.- Establishing and tearing down a new data connection for each command run

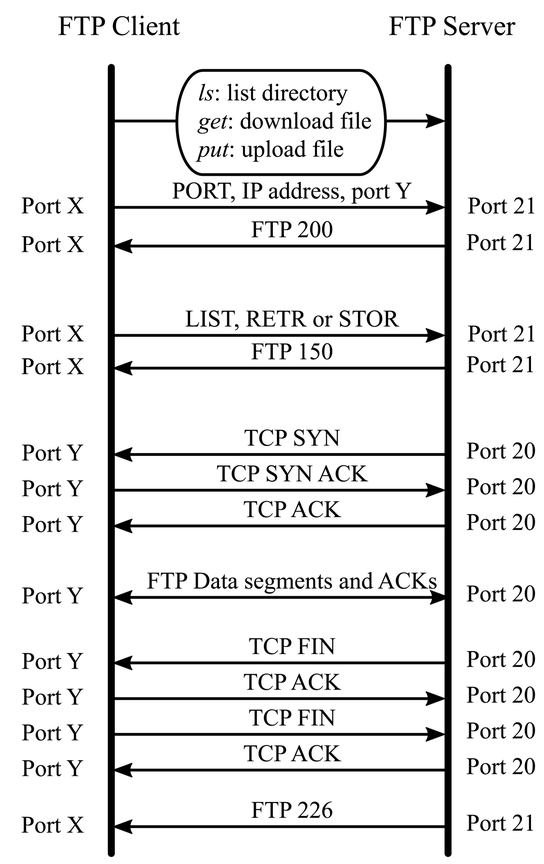
➢FTP Active and Passive mode do it different

FTP SESSION: Sequence of Events

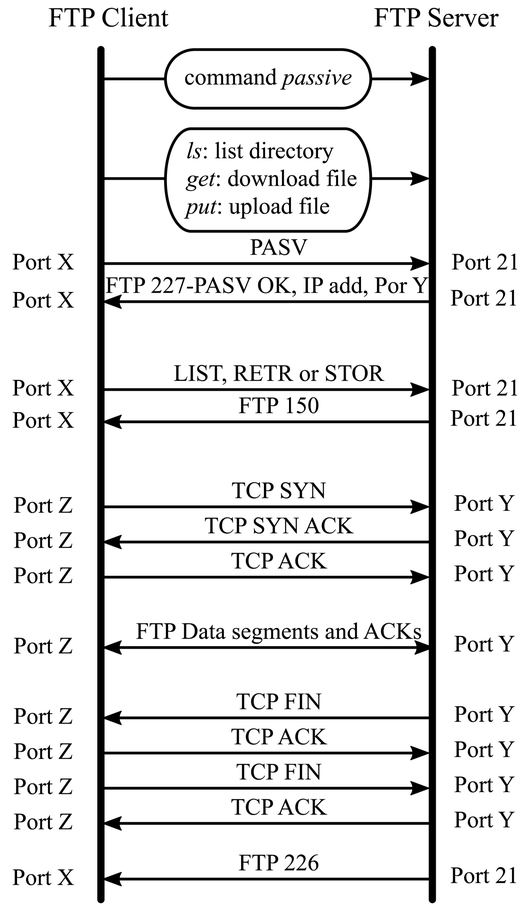
4.- Tearing down the control connection



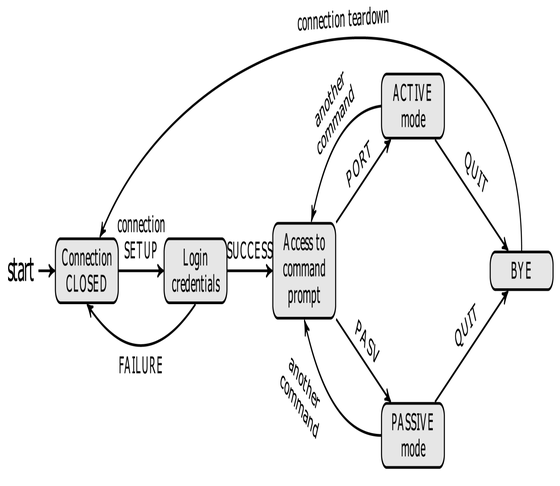
Executing a command in FTP Active Mode



Executing a command in FTP Passive Mode



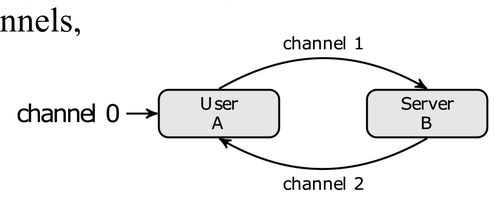
State diagram for FTP



Structure of communication messages

Each entity may send (s_x) or receive (r_x) a message through one of the channels, carrying 3 arguments:

- source port
- destination port
- payload information



Control communication setup modelling

User:

$A_0 = r_0\ (start) \cdot A_a$

$A_a = s_1\ (eph,21,SYN) \cdot A_b$

$A_b = r_2\ (21,eph,SYN\text{-}ACK) \cdot A_c$

$A_c = s_1\ (eph,21,ACK) \cdot A_d$

Server:

$B_0 = B_a$

$B_a = r_1(eph,21,SYN) \cdot B_b$

$B_b = s_2(21,eph,SYN\text{-}ACK) \cdot B_c$

$B_c = r_1(eph,21,ACK) \cdot B_d$

Non-Deterministic Interaction

$\partial_H(A_0||B_0) = r_0\ (start) \cdot (A_a||B_a)$

$\partial_H(A_a||B_a) = c_1\ (eph,21,SYN) \cdot (A_b||B_b)$

$\partial_H(A_b||B_b) = c_2\ (21,eph,SYN\text{-}ACK) \cdot (A_c||B_c)$

$\partial_H(A_c||B_c) = c_1\ (eph,21,ACK) \cdot (A_d||B_d)$

External Behaviour

$\tau_I\ (\partial_H(A_0||B_0)) = N/A$

This action does not make any difference neither on the server nor the client side

ls command in FTP Active Mode

Non-Deterministic Interaction:

$\partial_H(A_i||B_i) = c_1\ (eph,21,PORT,x1,x2,x3,x4,x5,x6) \cdot (A_j||B_j)$

$\partial_H(A_j||B_j) = c_2\ (21,eph,200) \cdot (A_k||B_k)$

$\partial_H(A_k||B_k) = c_1\ (eph,21,LIST) \cdot (A_l||B_l)$

$\partial_H(A_l||B_l) = c_2\ (21,eph,150) \cdot (A_m||B_m) + c2\ (21,eph,550) \cdot (A_i||B_i)$

$\partial_H(A_m||B_m) = c_2\ (20,eph',SYN) \cdot (A_n||B_n) + c2\ (20,eph',425) \cdot (A_i||B_i)$

$\partial_H(A_n||B_n) = c_1\ (eph',20,SYN\text{-}ACK) \cdot (A_o||B_o)$

$\partial_H(A_o||B_o) = c_2\ (20,eph',ACK) \cdot (A_p||B_p)$

$\partial_H(A_p||B_p) = c_2\ (20,eph',FTPDATA) \cdot (A_q||B_q)$

$\partial_H(A_q||B_q) = c_1\ (eph',20,FTPACK) \cdot (A_r||B_r) +$

$+ c_1\ (eph',20,426) \cdot (A_i||B_i)$

$\partial_H(A_r||B_r) = c_2\ (20,eph',FTPDATA\text{-}FIN) \cdot (A_s||B_s)$

$\partial_H(A_s||B_s) = c_2\ (20,eph',\ FIN) \cdot (A_t||B_t)$

$\partial_H(A_t||B_t) = c_1\ (eph',20,ACK) \cdot (A_u||B_u)$

$\partial_H(A_u||B_u) = c_1\ (eph',20,FIN) \cdot (A_v||B_v)$

$\partial_H(A_v||B_v) = c_2\ (20,eph',ACK) \cdot (A_w||B_w)$

$\partial_H(A_w||B_w) = c_2\ (21,eph,226) \cdot (A_i||B_i) + c2\ (21,eph,451) \cdot (A_i||B_i)$

ls command in FTP Passive Mode

Non-Deterministic Interaction:

$\partial_H(A_i||B_i) = c_1\ (eph,21,PASV) \cdot (A_j||B_j)$

$\partial_H(A_j||B_j) = c_2\ (21,eph,227,x1,x2,x3,x4,x5,x6) \cdot (A_k||B_k)$

$\partial_H(A_k||B_k) = c_1\ (eph,21,LIST) \cdot (A_l||B_l)$

$\partial_H(A_l||B_l) = c_2\ (21,eph,150) \cdot (A_m||B_m) + c2\ (21,eph,550) \cdot (A_i||B_i)$

$\partial_H(A_m||B_m) = c_1\ (eph'',eph',SYN) \cdot (A_n||B_n) +$

$+ c_1\ (eph'',eph',425) \cdot (A_i||B_i)$

$\partial_H(A_n||B_n) = c_2\ (eph',eph'',SYN\text{-}ACK) \cdot (A_o||B_o)$

$\partial_H(A_o||B_o) = c_1\ (eph'',eph',ACK) \cdot (A_p||B_p)$

$\partial_H(A_p||B_p) = c_2\ (eph',eph'',FTPDATA) \cdot (A_q||B_q)$

$\partial_H(A_q||B_q) = c_1\ (eph'',eph',FTPACK) \cdot (A_r||B_r) +$

$+ c_1\ (eph'',eph',426) \cdot (A_i||B_i)$

$\partial_H(A_r||B_r) = c_2\ (eph',eph'',FTPDATA\text{-}FIN) \cdot (A_s||B_s)$

$\partial_H(A_s||B_s) = c_2\ (eph',eph'',\ FIN) \cdot (A_t||B_t)$

$\partial_H(A_t||B_t) = c_1\ (eph'',eph',ACK) \cdot (A_u||B_u)$

$\partial_H(A_u||B_u) = c_1\ (eph'',eph',FIN) \cdot (A_v||B_v)$

$\partial_H(A_v||B_v) = c_2\ (eph',eph'',ACK) \cdot (A_w||B_w)$

$\partial_H(A_w||B_w) = c_2\ (21,eph,226) \cdot (A_i||B_i) + c2\ (21,eph,451) \cdot (A_i||B_i)$

Conclusions

FTP commands have been studied by applying ACP rules, syntax and semantics, proving that the model proposed meet the expected behaviour for both active and passive FTP working modes.