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AIM: Implement Bully Election Algorithm

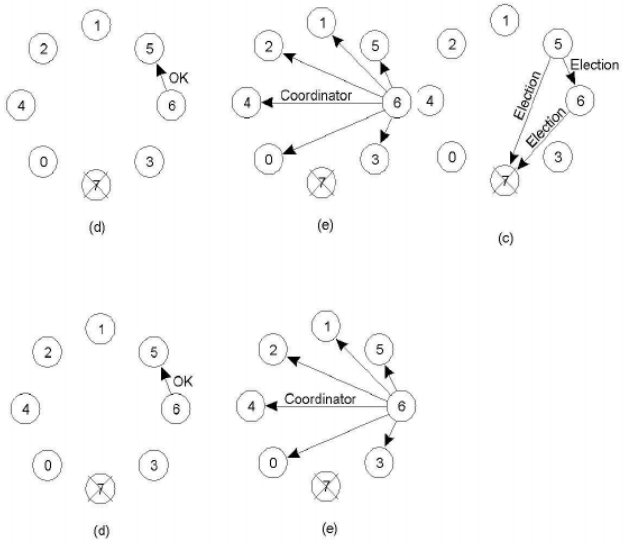
Introduction and Theory

Election Algorithms

Election algorithms choose a process from group of processors to act as a coordinator. If the coordinator process crashes due to some reasons, then a new coordinator is elected on other processor. Election algorithm basically determines where a new copy of coordinator should be restarted. Election algorithm assumes that every active process in the system has a unique priority number. The process with highest priority will be chosen as a new coordinator. Hence, when a coordinator fails, this algorithm elects that active process which has highest priority number. Then, this number is sent to every active process in the distributed system.

The Bully Election Process

1. P sends a message to the coordinator.
2. If coordinator does not respond to it within a time interval T, then it is assumed that coordinator has failed.
3. Now process P sends election message to every process with high priority number.
4. It waits for responses, if no one responds for time interval T then process P elects itself as a coordinator.
5. Then it sends a message to all lower priority number processes that it is elected as their new coordinator.
6. However, if an answer is received within time T from any other process Q,
   (I) Process P again waits for time interval T' to receive another message from Q that it has been elected as coordinator.
   (II) If Q doesn't respond within time interval T' then it is assumed to have failed and algorithm is restarted.



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- Disadvantages
  - A large number of messages are sent, this can overload the system.
  - There may be cases in very large systems that multiple coordinators get elected.

Code

Node

```c
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>
#include <sys/types.h>
#include <time.h>
#define MSG_CONFIRM 0
#define TRUE 1
#define FALSE 0
#define ML 1024
#define MPROC 32
/*
        Function to create a new connection to port 'connect_to'
        1. Creates the socket.
        2. Binds to port.
        3. Returns socket id
*/
int connect_to_port(int connect_to)
{
        int sock_id;
        int opt = 1;
        struct sockaddr_in server;
        if ((sock_id = socket(AF_INET, SOCK_DGRAM, 0)) < 0)
        {
                perror("unable to create a socket");
                exit(EXIT_FAILURE);
        }
        setsockopt(sock_id, SOL_SOCKET, SO_REUSEADDR, (const void
*)&opt, sizeof(int));
        memset(&server, 0, sizeof(server));
        server.sin_family = AF_INET;
        server.sin_addr.s_addr = INADDR_ANY;
        server.sin_port = htons(connect_to);

        if (bind(sock_id, (const struct sockaddr *)&server,
sizeof(server)) < 0)
        {
                perror("unable to bind to port");
                exit(EXIT_FAILURE);
        }
        return sock_id;
}
/*
        sends a message to port id to
*/
```

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```
50  void send_to_id(int to, int id, char message[ML])
51  {
52          struct sockaddr_in cl;
53          memset(&cl, 0, sizeof(cl));
54
55          cl.sin_family = AF_INET;
56          cl.sin_addr.s_addr = INADDR_ANY;
57          cl.sin_port = htons(to);
58
59          sendto(id, \
60                    (const char *)message, \
61                     strlen(message), \
62                     MSG_CONFIRM, \
63                     (const struct sockaddr *)&cl, \
64                     sizeof(cl));
65  }
66  /*
67          starts the election, returns 1 if it wins the round
68  */
69  int election(int id, int *procs, int num_procs, int self)
70  {
71          int itr;
72          char message[ML];
73          strcpy(message, "ELECTION");
74          int is_new_coord = 1; // assume you are the winner until you
75  lose
76          for (itr = 0; itr < num_procs; itr += 1)
77          {
78                  if (procs[itr] > self)
79                  {
80                          printf("sending election to: %d\n",
81  procs[itr]);
82                          send_to_id(procs[itr], id, message);
83                          is_new_coord = 0; // a proc with id > self
84  exists thus cannot be coord
85                  }
86          }
87          return is_new_coord;
88  }
89  /*
90          announces completion by sending coord messages
91  */
92  void announce_completion(int id, int *procs, int num_procs, int
93  self)
94  {
95          int itr;
96          char message[ML];
97          strcpy(message, "COORDINATOR");
98
99          for (itr = 0; itr < num_procs; itr += 1)
100                 if (procs[itr] != self)
101                         send_to_id(procs[itr], id, message);
102 }
103
104 int main(int argc, char* argv[])
105 {
106         // 0. Initialize variables
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```
107     int self = atoi(argv[1]);
108         int n_proc = atoi(argv[2]);
109         int procs[MPROC];
110         int sock_id, bully_id;
111         int itr, len, n, start_at;
112         char buff[ML], message[ML];
113         struct sockaddr_in from;
114 
115         for (itr = 0; itr < n_proc; itr += 1)
116                 procs[itr] = atoi(argv[3 + itr]);
117 
118         start_at = atoi(argv[3 + n_proc]) == 1? TRUE : FALSE;
119 
120         // 1. Create socket
121         printf("creating a node at %d %d \n", self, start_at);
122         sock_id = connect_to_port(self);
123         // getchar();
124         // 2. check is process is initiator
125 
126         if (start_at == TRUE)
127         {
128                 election(sock_id, procs, n_proc, self);
129         }
130 
131         // 3. if not the initiator wait for someone else
132 
133         while(TRUE)
134         {
135                 memset(&from, 0, sizeof(from));
136                 n = recvfrom(sock_id, (char *)buff, ML, MSG_WAITALL,
137 (struct sockaddr *)&from, &len);
138                 buff[n] = '\0';
139                 printf("Recieved messed: %s\n", buff);
140 
141                 if (!strcmp(buff, "ELECTION"))
142                 {
143                         strcpy(message, "E-ACK"); // send election
144 ack
145                         sendto(sock_id,
146                                 (const char *)message,
147                                 strlen(message),
148                                 MSG_CONFIRM,
149                                 (const struct sockaddr *)&from,
150                                 sizeof(from));
151 
152                         if (election(sock_id, procs, n_proc, self))
153                         {
154                                 announce_completion(sock_id, procs,
155 n_proc, self);
156                                 printf("ANNOUNCING SELF AS NEW
157 COORD\n");
158                         }
159                 }
160                 else if (!strcmp(buff, "E-ACK"))
161                         continue; // nothing do, your job is done
162                 else if (!strcmp(buff, "COORDINATOR"))
163                         bully_id = from.sin_port;
```

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```
        }
}


```

Results and Outputs:

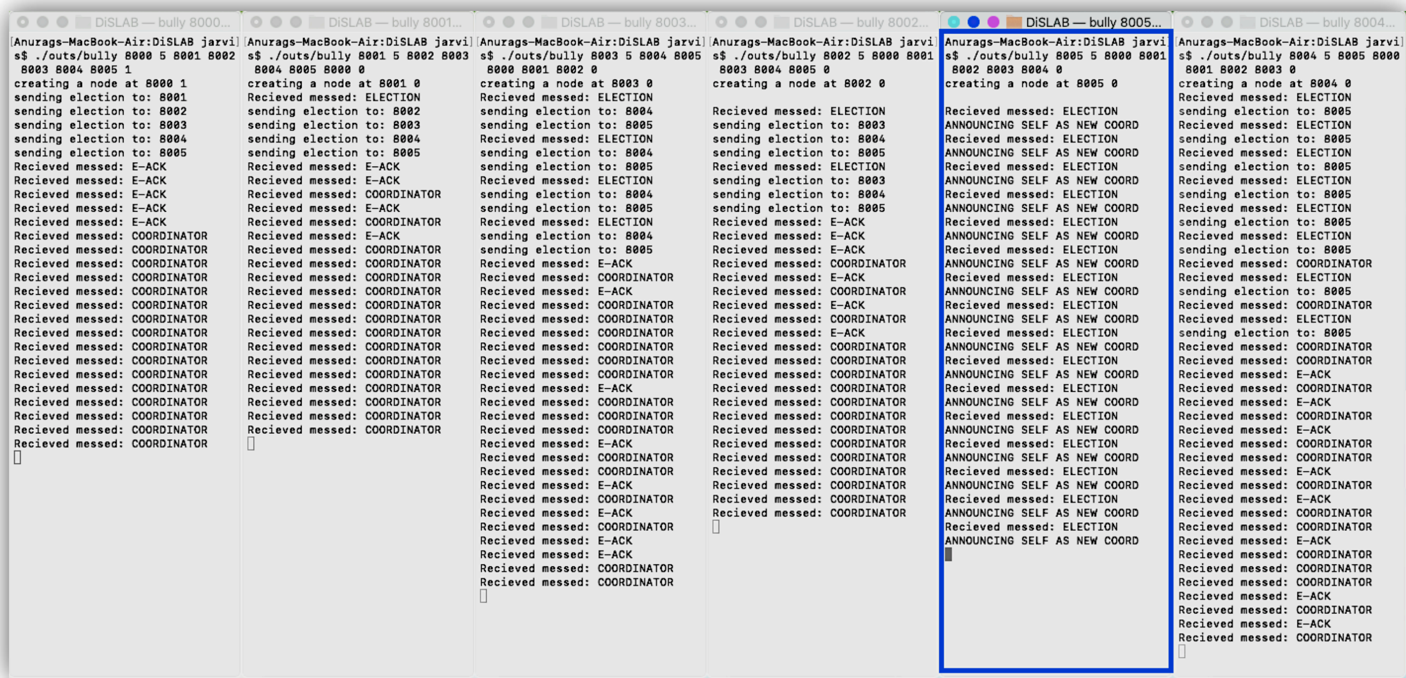

Figure 1 Election result

Findings and Learnings:

1. We successfully implemented Bully-Election Algorithm.