CSGE602055 Operating Systems
CSF2600505 Sistem Operasi
Week 08: Scheduling

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REV117 08-FEB-2018

Operating Systems 2018-1 (Room 3114 Tue/Thu)
Class: A (10:00-12:00) | B (13:00-15:00) | C (16:00-18:00)

Week	Schedule	Topic	OSC9
Week 00	06 Feb - 12 Feb 2018	Intro & Review1	Ch. 1, 16
Week 01	13 Feb - 19 Feb 2018	Review2 & Scripting	Ch. 1, 2
Week 02	20 Feb - 26 Feb 2018	Protection, Security, Privacy, & C-language	Ch. 14, 15
Week 03	27 Feb - 05 Mar 2018	I/O, BIOS, Loader, & Systemd	Ch. 13
Week 04	06 Mar - 12 Mar 2018	Addressing, Shared Lib, & Pointer	Ch. 8
Week 05	13 Mar - 19 Mar 2018	Virtual Memory	Ch. 9
Reserved	20 Mar - 24 Mar 2018		
Mid-Term	26 Mar - 03 Apr 2018	(UTS)	
Week 06	05 Apr - 11 Apr 2018	Concurency: Processes & Threads	Ch. 3, 4
Week 07	12 Apr - 18 Apr 2018	Synchronization	Ch. 5, 7
Week 08	19 Apr - 25 Apr 2018	Scheduling	Ch. 6
Week 09	26 Apr - 05 May 2018	File System & Persistent Storage	Ch. 10, 11, 12
Week 10	07 May - 16 May 2018	I/O Programming & Network Sockets Programming	
Reserved	17 May - 22 May 2018		
Final	23 May - 26 May 2018	(UAS)	
Deadline	07 Jun 2018 16:00	Extra assignment **deadline**	

Agenda

Week 08: Scheduling

- Reference: (OSC9-ch06 demo-w08)
- Scheduling
  - Basic Concepts
    - **WARNING:** It's just a BURST
    - IO Burst
    - CPU Burst
    - CPU Burst vs. Freq (OLD)
  - Utilization, throughput, {turnaround, waiting, response} time.
  - (Burst) Algorithm
    - FCFS, SJF, RR, Priority, Multilevel Queue.
  - Preemptive / Non-preemptive Scheduling
  - I/O Bound / CPU Bound Processes
- Standard Linux Scheduling
  - Completely Fair Scheduler (CFS).
  - Real Time Scheduling.

Thread Scheduling

- Thread Scheduling
  - User-level thread scheduling
  - Kernel-level thread scheduling
- Multi-threading Models:
  - Many to One Model
  - One to One Model
  - Many to Many Model
- Pthread Contention Scope
  - Process-Contention Scope (PCS): many to many (eg. Linux).
  - System-Contention Scope (SCS): one to one.
- MultiCore/ MultiProcessor/ MultiThread
  - affinity
  - load balancing
- Soft / Hard Real Time
- Big O Notation
  - O(1)
  - O(log N)
  - O(N)

Scheduling Model

- Two State Model: CPU State – I/O State – CPU State – ...
  - n: processes in memory.
  - p: I/O time fraction.
  - p^n: probability n processes waiting for I/O.
  - $1 - p^n$: CPU utilization of n processes.
  - $\left[\frac{(1-p^n)}{n}\right]$: CPU utilization of ONE processes.
- Example: $p = 60\% \Rightarrow$ **CPU Utilization Per Process**: $\left[\frac{1-(60\%)^n}{n}\right]$

CPU Utilization	**Multiprogramming (%)**				
N	**1**	**2**	**3**	**4**	**5**
Per Process	40	32	26	21	18

  - For 5 concurrent processes:
    If total time is 100 seconds, each CPU time will be 18 seconds.

Sockets

- Sockets
  - `atoi()`
  - `accept()`
  - `bind()`
  - `connect()`
  - `exit()`
  - `fprintf()`
  - `getenv()`
  - `gethostbyname()`
  - `htons()`
  - `listen()`
  - `memcpy()`
  - `memset()`

Sockets

- Sockets
  - `perror()`
  - `sizeof()`
  - `socket()`
  - `snprintf()`
  - `strchr()`
  - `strcmp()`
  - `strncpy()`
  - `strlen()`
  - `read()`
  - `write()`

00-server

```
/*
 * (c) 2007-2016 Rahmat M. Samik-Ibrahim -- This is free software
 * This program was copased from the net and hacked until it works.
 * Feel free to copy and/or modify and/or distribute it,
 * provided this notice, and the copyright notice, are preserved.
 * REV00 Tue Nov  8 11:45:35 WIB 2016
 * START Xxx Xxx XX XX:XX:XX UTC 2007
 */

char pesan[]="[FROM SERVER] ACK MESSAGE...\n";
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>
#include <netdb.h>
#include <sys/socket.h>
#include <arpa/inet.h>
typedef struct sockaddr    sockad;
typedef struct sockaddr_in sockadin;
typedef struct hostent     shostent;

void error(char *msg){
   perror(msg);
   exit(0);
}
```

00-server (2)

```
int main(int argc, char *argv[]) {
   char     buffer[256];
   int      clilen, newsockfd, nn, portno, sockfd;
   sockadin serv_addr, cli_addr;
   if (argc < 2) {
      fprintf(stderr, "ERROR, no port provided\n");
      exit(1);
   }
   sockfd = socket(AF_INET, SOCK_STREAM, 0);
   if (sockfd < 0)
      error("ERROR opening socket");
   memset(&serv_addr, 0, sizeof(serv_addr));
   portno = atoi(argv[1]);
   serv_addr.sin_family      = AF_INET;
   serv_addr.sin_addr.s_addr = INADDR_ANY;
   serv_addr.sin_port        = htons(portno);
   if (bind(sockfd, (sockad*) &serv_addr, sizeof(serv_addr))< 0)
      error("ERROR on binding");
   listen(sockfd, 5);
   clilen = sizeof(cli_addr);
   newsockfd=accept(sockfd,(sockad*)&cli_addr,(socklen_t*)&clilen);
   if (newsockfd < 0)
      error("ERROR on accept");
   memset(buffer, 0, 256);
   nn = read(newsockfd,buffer,255);
   if (nn < 0)
      error("ERROR reading from socket");
   printf("[FROM CLIENT]:\n %s\n",buffer);
   nn = write(newsockfd, pesan, sizeof(pesan));
   if (nn < 0)
      error("ERROR writing to socket");
   return 0;
}
```

01-client

```
/*
 * (c) 2007-2016 Rahmat M. Samik-Ibrahim -- This is free software
 * This program was copased from the net and hacked until it works.
 * Feel free to copy and/or modify and/or distribute it,
 * provided this notice, and the copyright notice, are preserved.
 * REV00 Tue Nov  8 11:45:52 WIB 2016
 * START Xxx Xxx XX XX:XX:XX UTC 2007
 */

char pesan[]="[FROM SERVER] ACK MESSAGE...\n";
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>
#include <netdb.h>
#include <sys/socket.h>
#include <arpa/inet.h>
typedef struct sockaddr    sockad;
typedef struct sockaddr_in sockadin;
typedef struct hostent     shostent;

void error(char *msg){
   perror(msg);
   exit(0);
}

int main(int argc, char *argv[]) {
   char      buffer[256];
   int       nn, portno, sockfd;
   sockadin  serv_addr;
   shostent* server;
```

01-client (2)

```
   if (argc < 3) {
      fprintf(stderr, "usage %s hostname port\n", argv[0]);
      exit(0);
   }
   portno = atoi(argv[2]);
   sockfd = socket(AF_INET,SOCK_STREAM,0);
   if (sockfd < 0)
      error("ERROR opening socket");
   server = gethostbyname(argv[1]);
   if (server == NULL) {
     fprintf(stderr, "ERROR, no such host\n");
     exit(0);
   }
   memset(&serv_addr,0,sizeof(serv_addr));
   serv_addr.sin_family = AF_INET;
   memmove( &serv_addr.sin_addr.s_addr, server->h_addr, server->h_length);
   serv_addr.sin_port   = htons(portno);
   if(connect(sockfd,(const struct sockaddr*) &serv_addr, sizeof(serv_addr))<0)
       error("ERROR connecting");
   printf("Enter the message: ");
   memset(buffer,   0, 256);
   fgets (buffer, 255, stdin);
   nn = write(sockfd,buffer,strlen(buffer));
   if (nn < 0)
      error("ERROR writing to socket");
   memset(buffer, 0, 256);
   nn = read(sockfd,buffer,255);
   if (nn < 0)
      error("ERROR reading from socket");
   printf("%s\n",buffer);
   return 0;
}
```

OUTPUT: 00-server – 01-client

```
>>>>> $ PS1="SERVER >> "
SERVER >> 00-server 4444
[FROM CLIENT]:
 This is from client via port 4444.

SERVER >>


>>>>> $ PS1="CLIENT >> "
CLIENT >> 01-client localhost 4444
Enter the message: This is from client via port 4444.
[FROM SERVER] ACK MESSAGE...

CLIENT >>
```

02-clisvr

```
/*
 * (c) 2007 Tadeus Prastowo and Rahmat M. Samik-Ibrahim.
 * (c) 2017 Rahmat M. Samik-Ibrahim.
 * This is free software.  It was copased from the net and hacked until
 * it works.  Feel free to copy and/or modify and/or distribute it,
 * provided this notice, and the copyright notice, are preserved.
 * REV01 Wed Nov  8 20:00:02 WIB 2017
 * START 2007
 *
 * This program serves as both a client and a server. Three modes of
 * operation are available:
 *  - initiating mode
 *  - bridging mode
 *  - terminating mode
 *
 * The following are how to run thisprogram for each mode:
 *  - Initiating mode:  client_server null ANOTHER_HOST ANOTHER_PORT
 *  - Bridging mode:    client_server CURRENT_PORT ANOTHER_HOST ANOTHER_PORT
 *  - Terminating mode: client_server CURRENT_PORT null null
 *
 * The program having the initiating mode _MUST_ run last after all other
 * instances of this program with other operational modes has been started.
 *
 * In initiating mode, this program just simply sends a hello message to
 * another instance of this program that operates either as a bridge or
 * as a terminator that this program points to as specified in
 * ANOTHER_HOST and ANOTHER_PORT. After that this program will quit
 * without printing out any message.
 */
```

02-clisvr (2)

```
/*
 * In bridging mode, this program just simply waits for an incoming hello
 * message in CURRENT_PORT. Once it receives a hello message, it prints
 * out the message in a certain format. Next, this program forwards the
 * modified message to another instance of this program that acts either as
 * a bridge or as a terminator that this program points to as specified
 * in ANOTHER_HOST and ANOTHER_PORT. After that this program will quit.
 *
 * In terminating mode, this program just simply waits for an incoming hello
 * message in CURRENT_PORT. Once it receives a hello message, it prints out
 * the message in a certain format, and then quits.
 *
 * The following illustrates the idea above:
 * 192.168.10.18 (alvin)
 * $ ./client_server 8888 localhost 7777
 * 192.168.10.18 (user)$
 * $ ./client_server 7777 null null
 * 192.168.12.17 (eus)$
 * $ ./client_server null 192.168.10.18 8888
 * The print out will be:
 * 192.168.10.18 (alvin):
 *   From eus to alvin: Hello
 * 192.168.10.18 (user):
 *   From eus to alvin to user: Hello
 */
```

02-clisvr (3)

```
char pesan[]="[FROM SERVER] ACK MESSAGE...\n";
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>
#include <netdb.h>
#include <sys/time.h>
#include <sys/socket.h>
#include <arpa/inet.h>

typedef struct sockaddr    sockad;
typedef struct sockaddr_in sockadin;
typedef struct hostent     shostent;

void error(char *msg){
   perror(msg);
   exit(0);
}
```

02-clisvr (4)

```
#define BUFFER_SIZE 4096

int main (int argc, char *argv []) {
   int sockfd, newsockfd, portno, clilen, count, nn, sysup;
   char buffer [BUFFER_SIZE], temp_buffer [BUFFER_SIZE], *colon_pos;
   struct sockaddr_in serv_addr, cli_addr;
   struct hostent *server;
   struct timeval tval;

   if (argc < 4) {
      fprintf (stderr,
          "\nUsage: %s this_port  next_sever next_server_port\n\n"
          "Start the chain with ‘this_port’ = ‘null’\n\n"
          "Terminte the chain with ‘next_server’ = ‘next_server_port’"
          " = ‘null’\n\n", argv [0]);
      exit (1);
   }
```

02-clisvr (5)

```
if (strcmp (argv [1], "null") == 0) {
   portno = atoi   (argv [3]);
   sockfd = socket (AF_INET, SOCK_STREAM, 0);
   if (sockfd < 0) {
      error ("ERROR opening socket");
   }
   server = gethostbyname(argv[2]);
   if (server == NULL) {
      fprintf (stderr, "ERROR, no such host\n");
      exit (1);
   }
   memset (&serv_addr, 0, sizeof (serv_addr));
   serv_addr.sin_family = AF_INET;
   memcpy(&serv_addr.sin_addr.s_addr, server->h_addr, server->h_length);
   serv_addr.sin_port = htons(portno);
   if (connect(sockfd,(struct sockaddr *)&serv_addr,sizeof(serv_addr))< 0){
      error ("ERROR connecting");
   }
   /* Begin: action */
   memset (buffer, 0, BUFFER_SIZE);
   gettimeofday(&tval,NULL);
   sysup = 0x0000FFFF & (int) (tval.tv_sec * 1000 + tval.tv_usec / 1000);
   snprintf (buffer, BUFFER_SIZE, "From %s[%d]: Hello", getenv ("USER"), sysup);
   nn = write (sockfd, buffer, strlen (buffer));

   if (nn < 0) {
     error ("ERROR writing to socket");
   }
   /* End: action */
   exit (0);
}
```

02-clisvr (6)

```
sockfd = socket(AF_INET,SOCK_STREAM,0);
if (sockfd < 0) {
   error ("ERROR opening socket");
}
memset(&serv_addr,0,sizeof(serv_addr));
portno = atoi (argv [1]);
serv_addr.sin_family = AF_INET;
serv_addr.sin_addr.s_addr = INADDR_ANY;
serv_addr.sin_port = htons (portno);

if (bind (sockfd,(struct sockaddr *)&serv_addr, sizeof(serv_addr)) < 0) {
   error ("ERROR on binding");
}
listen (sockfd, 5);
clilen    = sizeof (cli_addr);
newsockfd = accept (sockfd, (struct sockaddr *) &cli_addr,
            (socklen_t *) &clilen);
if (newsockfd < 0) {
   error ("ERROR on accept");
}
memset (buffer, 0, BUFFER_SIZE);
nn = read(newsockfd,buffer,BUFFER_SIZE-1);
if (nn < 0) {
   error ("ERROR reading from socket");
}
```

02-clisvr (7)

```
/* Modify buffer's message */
colon_pos = strchr (buffer, ':');
nn        = colon_pos - buffer;
memset (temp_buffer, 0, BUFFER_SIZE);
strncpy (temp_buffer, buffer, nn);
memset (buffer, 0, BUFFER_SIZE);
strncpy (buffer, temp_buffer, nn);
for (long ii=0; ii<5000000L; ii++)
   ; // delay
gettimeofday(&tval,NULL);
sysup = 0x0000FFFF &
    (int) (tval.tv_sec * 1000 + tval.tv_usec / 1000);
snprintf (buffer + nn, BUFFER_SIZE-nn,
    " to %s[%d]: Hello", getenv ("USER"), sysup);
/*End of modifying buffer's message*/
```

02-clisvr (8)

```
   if (strcmp (argv [2], "null") != 0 && strcmp (argv [3], "null") != 0) {
      portno = atoi (argv [3]);
      sockfd=socket(AF_INET,SOCK_STREAM,0);
      if (sockfd < 0) {
         error ("ERROR opening socket");
      }
      server = gethostbyname (argv [2]);
      if (server == NULL) {
         fprintf (stderr, "ERROR, no such host\n");
         exit (1);
      }
      serv_addr.sin_family = AF_INET;
      memcpy (&serv_addr.sin_addr.s_addr, server->h_addr, server->h_length);
      serv_addr.sin_port = htons (portno);
      if (connect (sockfd,(struct sockaddr *)&serv_addr,sizeof (serv_addr))<0){
         error ("ERROR connecting");
      }
      /* Begin: action */
      printf ("%s\n", buffer);
      nn=write(sockfd,buffer,strlen(buffer));
      if (nn < 0) {
        error ("ERROR writing to socket");
      }
      /* End: action */
   } else {
      printf ("%s\n", buffer);
   }
   return 0;
}
```

OUTPUT: 02-clisvr

```
TERMINAL >> PS1="TERMINAL >> "
TERMINAL >> 02-clisvr 4000 localhost null
From demo[23440] to demo[23450] to demo[23461]: Hello
TERMINAL >>


MIDDLE >> PS1="MIDDLE >> "
MIDDLE >> 02-clisvr 4001 localhost 4000
From demo[23440] to demo[23450]: Hello
MIDDLE >>


START >> PS1="START >> "
START >> 02-clisvr null localhost 4001
START >>
```

The End

- ☐ This is the end of the presentation.
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