PA193 Secure coding principles and practices

Overview of the subject

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Centre for Research on Cryptography and Security

PA193 Secure coding principles and practices

- Relatively new subject
  - First introduced in September 2013
- Secure coding
  - How to write code in a more secure way
  - So that the program is harder to be attacked/exploited
  - ≠ Programming of security applications
- 2/2/2
  - Lecture: 2 hours weekly
  - Seminar: 2 hours weekly (2 seminar groups)
  - Homework: about 3-6 hours weekly
  - Project: about 20-30 hours

People

- Main contact: Petr Švenda (FI MU)
  - Office hours: Monday 13-14, A406
  - svenda@fi.muni.cz, @rngsec
  - 7 out of 12 lectures
- Other lectures and seminars
  - Zdeněk Říha (EC), Lukáš Němec (FI), Marek Sýs (FI), Kamil Dudka (RedHat), Mirek Jaroš (RedHat), Thenraja Vettivelraj (FI),

Aims of the subject

- To learn how to program in a way that the resulting application is more secure
  - Decrease number of security related bugs
  - Increase difficulty of exploitation
- To understand security consequences of decisions made by programmer
- Many issues are independent on programming language
- Most examples are based on C/C++ and Java

Requirements

- Basic knowledge of (applied) cryptography and IT security
  - symmetric vs. asymmetric cryptography, PKI
  - block vs. stream ciphers and usage modes
  - hash functions
  - random vs. pseudorandom numbers
  - basic cryptographic algorithms (AES, DES, RSA, EC, DH)
  - risk analysis
- Practical experience in programming with C/C++ language
- Basic knowledge in formal languages and compilers
- User-level experience with Windows and Linux OS

Organization

- Lectures + seminars + homework + project + exam
- Homeworks
  - assigned every second week/seminar (+ bonuses)
  - **individual** work of each student
- Project
  - groups of 2-3 students
  - divided into three parts with 2 different deadlines
  - expected workload: 30 hours/project/participant
  1. Write own parser (using Github repo, Travis)
  2. Analyze and attack parser of other group (code review)
  3. Create bugfix(s) for problem(s) found (pull request)

Grading

- Credits
  - 2+2+2 credits, plus 2 for the final exams
- Points
  - Homework (45) – min 3 assignments with >1 points required
  - Project (45)
  - Written exam (60)
- Grading

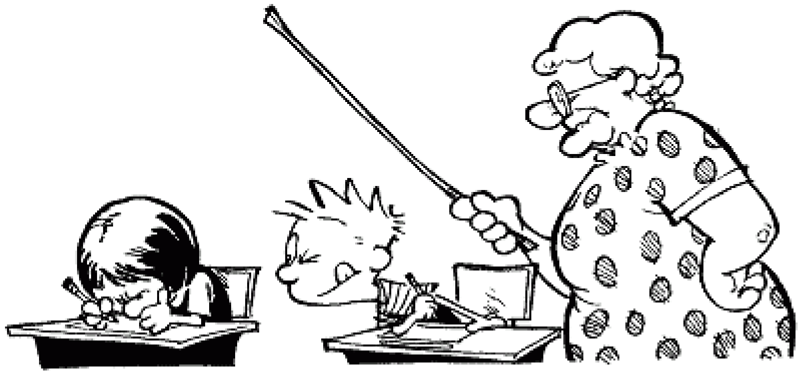
	150+ (max)
– A ≥ 90% of maximum number of points	135
– B ≥ 80% of maximum number of points	120
– C ≥ 70% of maximum number of points	105
– D ≥ 60% of maximum number of points	90
– E ≥ 50% of maximum number of points	75
– F < 50% of maximum number of points	

Attendance

- Lectures
  - Attendance not obligatory, but highly recommended
- Seminars
  - Attendance **obligatory**
  - Absences must be excused at the department of study affairs
  - 2 absences are OK (even without excuse)
- Assignments and projects
  - Done during students free time (e.g. at the dormitory)
  - Access to network lab and CRoCS lab is possible
    - Some assignments indeed require access to the network lab

Discussion forum in Information System

- Discussion forum in Information System (IS)
  - https://is.muni.cz/auth/cd/1433/podzim2016/PA193/
- Mainly for discussion among the students
  - Not observed by stuff all the time!
- What to ask?
  - OK to ask about ambiguities in assignment
  - NOT OK to ask for the solution
  - NOT OK to post your own code and ask what is wrong



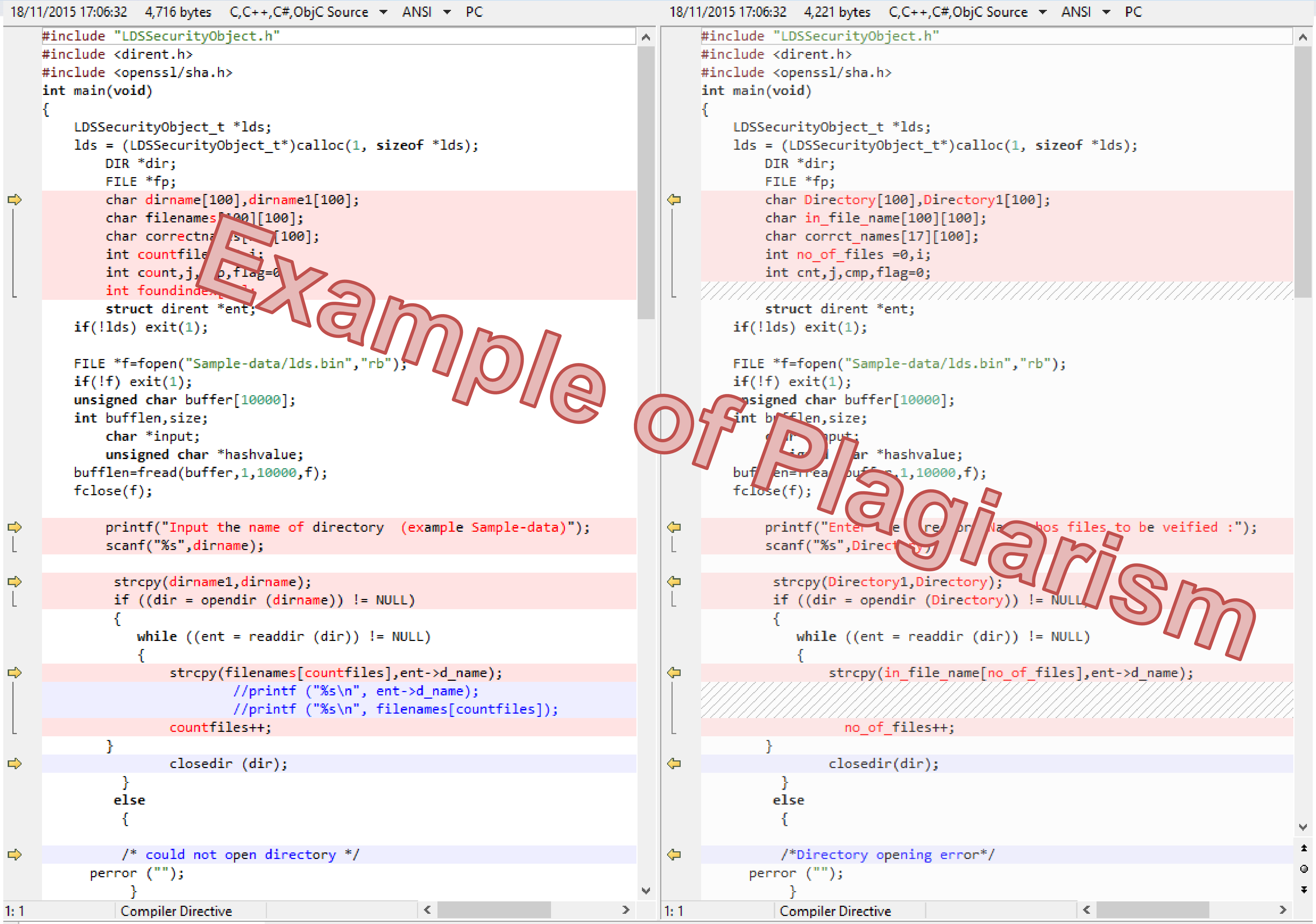
Plagiarism

- Homeworks
  - Must be worked out independently by each student
- Projects
  - Must be worked out by a team of 3 students
  - Every team member must show his/her contribution
- Plagiarism, cut&paste, etc. is not tolerated
  - Plagiarism is use of somebody else words/programs or ideas without proper citation
  - Automatic tools used to recognize plagiarism
  - If plagiarism is detected student is assigned -5 points
  - More serious cases handled by the Disciplinary committee

Reuse of existing code

- Code reuse is generally great thing, but..
- NOT in homework or assignments!
- It is NOTOK:
  - Take any code from web when you should create code completely on your own (project - parser)
  - Share code of your solution with others (homework)

CROCS



Example of Plagiarism

18/11/2015 17:06:32   4,716 bytes   C,C++,C#,ObjC Source   ANSI   PC

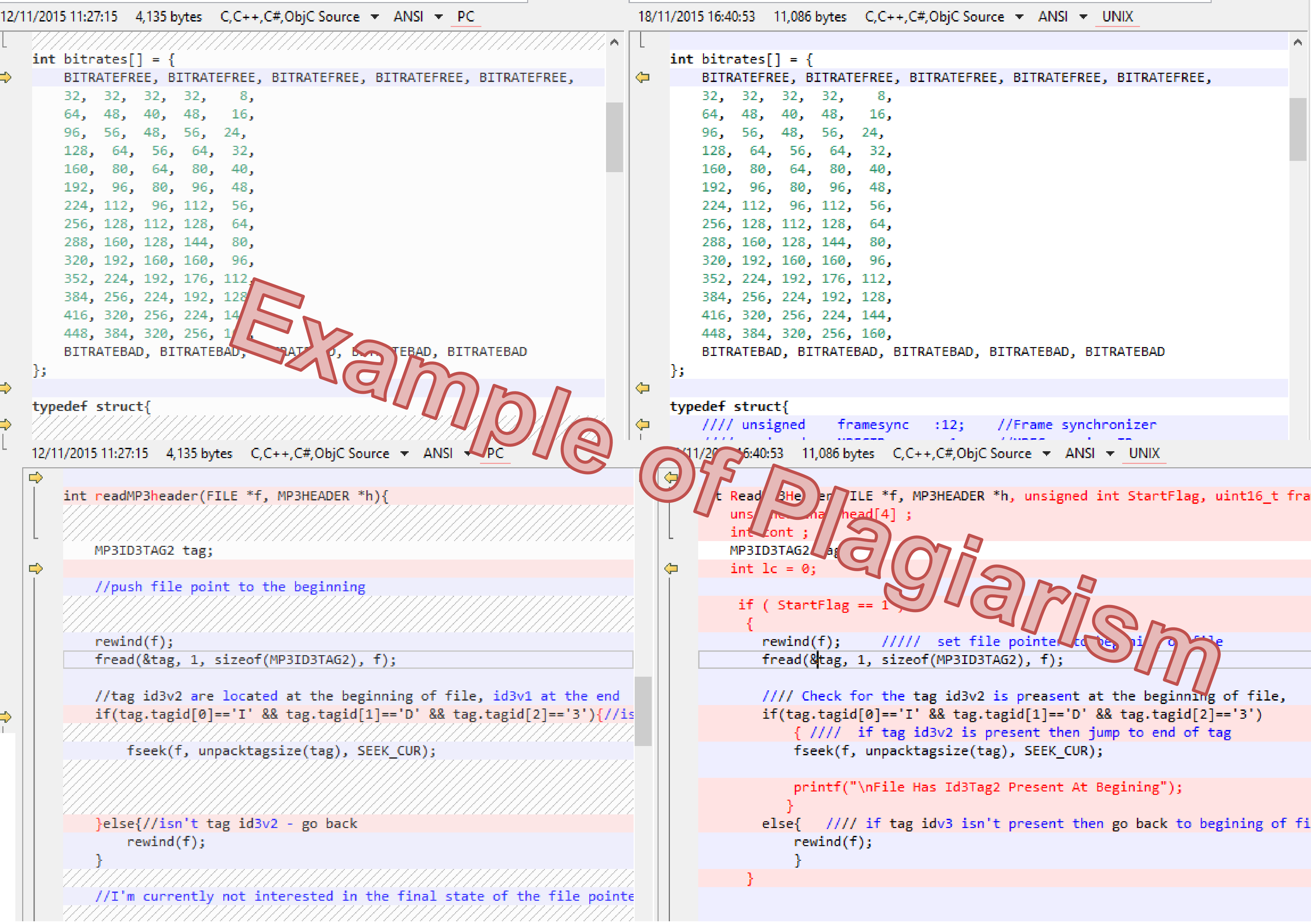
```
#include "LDSSecurityObject.h"
#include <dirent.h>
#include <openssl/sha.h>
int main(void)
{
    LDSSecurityObject_t *lds;
    lds = (LDSSecurityObject_t*)calloc(1, sizeof *lds);
        DIR *dir;
        FILE *fp;
        char dirname[100],dirname1[100];
        char filenames[100][100];
        char correctnames[17][100];
        int countfiles=0,i;
        int count,j,cmp,flag=0;
        int foundindex[
        struct dirent *ent;
    if(!lds) exit(1);

    FILE *f=fopen("Sample-data/lds.bin","rb");
    if(!f) exit(1);
    unsigned char buffer[10000];
    int bufflen,size;
        char *input;
        unsigned char *hashvalue;
    bufflen=fread(buffer,1,10000,f);
    fclose(f);

        printf("Input the name of directory  (example Sample-data)");
        scanf("%s",dirname);

         strcpy(dirname1,dirname);
         if ((dir = opendir (dirname)) != NULL)
         {
            while ((ent = readdir (dir)) != NULL)
            {
                strcpy(filenames[countfiles],ent->d_name);
                        //printf ("%s\n", ent->d_name);
                        //printf ("%s\n", filenames[countfiles]);
                countfiles++;
        }
                closedir (dir);
          }
         else
          {

          /* could not open directory */
        perror ("");
           }
```

1: 1   Compiler Directive

18/11/2015 17:06:32   4,221 bytes   C,C++,C#,ObjC Source   ANSI   PC

```
#include "LDSSecurityObject.h"
#include <dirent.h>
#include <openssl/sha.h>
int main(void)
{
    LDSSecurityObject_t *lds;
    lds = (LDSSecurityObject_t*)calloc(1, sizeof *lds);
        DIR *dir;
        FILE *fp;
        char Directory[100],Directory1[100];
        char in_file_name[100][100];
        char corrct_names[17][100];
        int no_of_files =0,i;
        int cnt,j,cmp,flag=0;

        struct dirent *ent;
    if(!lds) exit(1);

    FILE *f=fopen("Sample-data/lds.bin","rb");
    if(!f) exit(1);
    unsigned char buffer[10000];
    int bufflen,size;
        char *input;
        unsigned char *hashvalue;
    bufflen=fread(buffer,1,10000,f);
    fclose(f);

        printf("Enter the Directory Name whos files to be veified :");
        scanf("%s",Directory);

         strcpy(Directory1,Directory);
         if ((dir = opendir (Directory)) != NULL)
         {
            while ((ent = readdir (dir)) != NULL)
            {
                strcpy(in_file_name[no_of_files],ent->d_name);


                    no_of_files++;
        }
                closedir(dir);
          }
         else
          {

          /*Directory opening error*/
        perror ("");
           }
```

1: 1   Compiler Directive



Example of Plagiarism

```
12/11/2015 11:27:15   4,135 bytes   C,C++,C#,ObjC Source   ANSI   PC

int bitrates[] = {
    BITRATEFREE, BITRATEFREE, BITRATEFREE, BITRATEFREE, BITRATEFREE,
    32,  32,  32,  32,   8,
    64,  48,  40,  48,  16,
    96,  56,  48,  56,  24,
    128,  64,  56,  64,  32,
    160,  80,  64,  80,  40,
    192,  96,  80,  96,  48,
    224, 112,  96, 112,  56,
    256, 128, 112, 128,  64,
    288, 160, 128, 144,  80,
    320, 192, 160, 160,  96,
    352, 224, 192, 176, 112,
    384, 256, 224, 192, 128,
    416, 320, 256, 224, 14
    448, 384, 320, 256, 1
    BITRATEBAD, BITRATEBAD, BITRATEBAD, BITRATEBAD, BITRATEBAD
};

typedef struct{
```

```
18/11/2015 16:40:53   11,086 bytes   C,C++,C#,ObjC Source   ANSI   UNIX

int bitrates[] = {
    BITRATEFREE, BITRATEFREE, BITRATEFREE, BITRATEFREE, BITRATEFREE,
    32,  32,  32,  32,   8,
    64,  48,  40,  48,  16,
    96,  56,  48,  56,  24,
    128,  64,  56,  64,  32,
    160,  80,  64,  80,  40,
    192,  96,  80,  96,  48,
    224, 112,  96, 112,  56,
    256, 128, 112, 128,  64,
    288, 160, 128, 144,  80,
    320, 192, 160, 160,  96,
    352, 224, 192, 176, 112,
    384, 256, 224, 192, 128,
    416, 320, 256, 224, 144,
    448, 384, 320, 256, 160,
    BITRATEBAD, BITRATEBAD, BITRATEBAD, BITRATEBAD, BITRATEBAD
};

typedef struct{
    //// unsigned    framesync    :12;    //Frame synchronizer
```

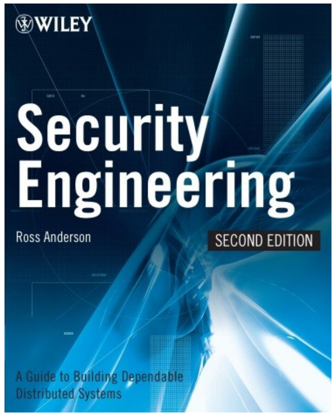
```
12/11/2015 11:27:15   4,135 bytes   C,C++,C#,ObjC Source   ANSI   PC

int readMP3header(FILE *f, MP3HEADER *h){

    MP3ID3TAG2 tag;

    //push file point to the beginning

    rewind(f);
    fread(&tag, 1, sizeof(MP3ID3TAG2), f);

    //tag id3v2 are located at the beginning of file, id3v1 at the end
    if(tag.tagid[0]=='I' && tag.tagid[1]=='D' && tag.tagid[2]=='3'){//is

        fseek(f, unpacktagsize(tag), SEEK_CUR);

    }else{//isn't tag id3v2 - go back
        rewind(f);
    }

    //I'm currently not interested in the final state of the file pointe
```

```
18/11/2015 16:40:53   11,086 bytes   C,C++,C#,ObjC Source   ANSI   UNIX

t ReadMP3Header(FILE *f, MP3HEADER *h, unsigned int StartFlag, uint16_t fra
  unsigned char head[4] ;
  int cont ;
  MP3ID3TAG2 tag;
  int lc = 0;

   if ( StartFlag == 1 )
    {
      rewind(f);     /////  set file pointer to beginning of file
      fread(&tag, 1, sizeof(MP3ID3TAG2), f);

      //// Check for the tag id3v2 is preasent at the beginning of file,
      if(tag.tagid[0]=='I' && tag.tagid[1]=='D' && tag.tagid[2]=='3')
        { ////  if tag id3v2 is present then jump to end of tag
        fseek(f, unpacktagsize(tag), SEEK_CUR);

        printf("\nFile Has Id3Tag2 Present At Begining");
        }
      else{   //// if tag idv3 isn't present then go back to begining of fi
        rewind(f);
        }
    }
```

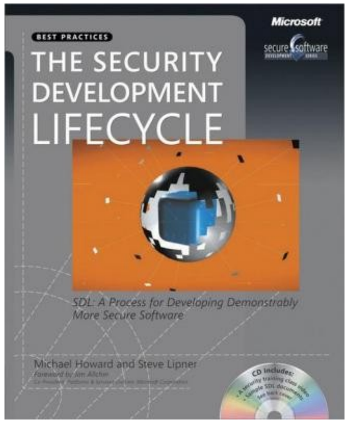
Course resources

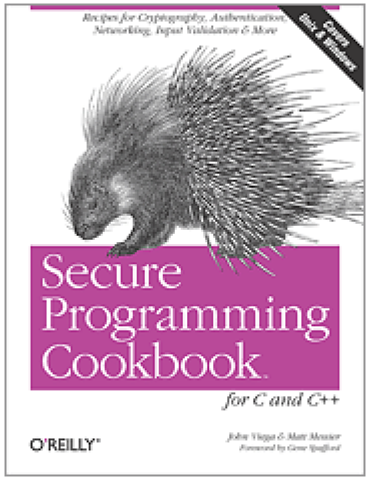
- Lectures (PDF) available in IS
  - IS = Information System of the Masaryk University
  - https://is.muni.cz/auth/el/1433/podzim2016/PA193/
- Homeworks/assignments available in IS
  - Submissions also done via IS (Homework vaults)
- Additional tutorials/papers/materials from time to time will also be provided in IS
  - To better understand the issues discussed
- Recommended literatures
  - To learn more …

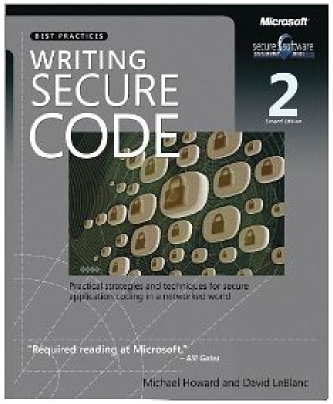
Recommended literature



- Ross Anderson - Security engineering, Wiley
- Michael Howard, Steve Lipner - Secure Development Lifecycle, MS Press
- John Viega, Matt Messier - Secure programming cookbook, O'Reilly
- Michael Howard - Writing secure code, MS Press


BEST PRACTICES
Microsoft
THE SECURITY DEVELOPMENT LIFECYCLE
SDL: A Process for Developing Demonstrably More Secure Software
Michael Howard and Steve Lipner


Recipes for Cryptography, Authentication, Networking, Input Validation & More
Secure Programming Cookbook
for C and C++
O'REILLY
John Viega & Matt Messier


BEST PRACTICES
Microsoft
WRITING SECURE CODE
2
Practical strategies and techniques for secure application coding in a networked world
"Required reading at Microsoft."
Michael Howard and David LeBlanc

Questions