CSE-C3400 Information security
Examination 2017-10-26
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No electronic equipment or reference material is allowed in the examination.

1. Access control terminology

Give an example of each of the following concepts in a civilian (i.e. non-military) information system:

(a) principle of minimum privilege (2p)
(b) covert channel (2p)
(c) role inheritance (2p)

Please answer each item with one sentence.

2. Linux permissions

Kermit is administering a Linux server. He has become completely confused. He asks your help to understand the protection state of his computer. Here is the output of some Linux commands:

```
$ groups fred kermit ted carrie
fred : users frogteam
kermit : users sudo frogteam
ted : users toadteam
carrie : users
$ ls -l
-r--rw---- 1 fred frogteam 29 Oct 25 07:01 croak.txt
-rwxrwxrw- 1 ted  toadteam 29 Oct 25 07:01 plop.sh
-rw-r--rw- 1 fred toadteam 29 Oct 25 07:01 ribbit.txt
-rwsr-x--- 1 fred users    29 Oct 25 07:01 squash.sh
```

Problem:

(a) Show the protection state for the above objects in the form of an access control matrix where the subjects are the individual users. If the matrix cannot accurately express the protection state, write a note explaining why. (4p)
(b) Why are the permissions for `plop.sh` particularly dangerously configured? (1p)
(c) What is the meaning of the character 's' on the last output row? (1p)

Note that these permissions are an artificial example and not realistic in any way.

3. Remote electronic voting

Explain the election process and security mechanisms in the Estonian E-voting system or a similar remote electronic voting system that is based on the double-envelope scheme.

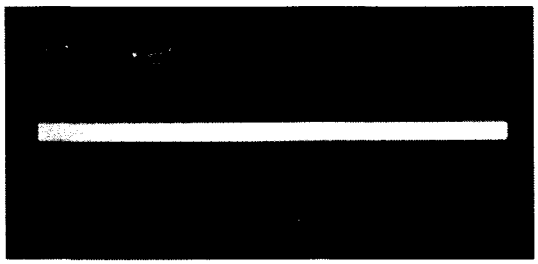
Notes: It is a good idea to draw a diagram of the election process. Describe just one possible process, not many variants. This is not a threat analysis question. Do not write lists of threats, assets etc. Focus on the security mechanism and what they achieve. Even residual threat analysis is not required.

(6p)

Please turn the paper for the remaining parts of the examination.

4. Data encryption

In your role as a penetration tester, you have been asked to infiltrate the Euro Shopper factory and retrieve the secret energy drink formula from a computer in the factory control room. You have taken a job in the factory as cleaner. This allows you to roam the facility with relative freedom in the evenings, after everyone else goes home. So far, you have discovered the location of the computer. It is a desktop PC that runs Windows, and the factory employees power down the computer before leaving work. Next, you sneak into the office in the evening and power up the computer. The following text appears on the screen: "BitLocker – Enter the PIN to unlock this drive".



Problem: What different ways are there for you to get access to the secret files, preferably without getting caught?

You may also get some points for explaining why certain methods do not work.

(6p)

5. Network security

In appendix 1, there is a pretty-printed certificate chain. Explain in detail, how a web browser would use this chain to authenticate a web site.

Notes: You do not need to explain the details of the TLS handshake protocol. "rsaEncryption" in this context means the RSA algorithm for any purpose, which may be encryption or signature.

(6p)

Appendix 1

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            0c:e7:e0:e5:17:d8:46:fe:8f:e5:60:fc:1b:f0:30:39
    Signature Algorithm: sha1WithRSAEncryption
        Issuer: C=US, O=DigiCert Inc, OU=www.digicert.com, CN=DigiCert Assured ID Root CA
        Validity
            Not Before: Nov 10 00:00:00 2006 GMT
            Not After : Nov 10 00:00:00 2031 GMT
        Subject: C=US, O=DigiCert Inc, OU=www.digicert.com, CN=DigiCert Assured ID Root CA
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
                    00:ad:0e:15:ce:e4:43:80:5c:b1:87:f3:b7:60:f9:
                    71:12:a5:ae:dc:26:94:88:aa:f4:ce:f5:20:39:28:
                    58:60:0c:f8:80:da:a9:15:95:32:61:3c:b5:b1:28:
                    84:8a:8a:dc:9f:0a:0c:83:17:7a:8f:90:ac:8a:e7:
                    79:53:5c:31:84:2a:f6:0f:98:32:36:76:cc:de:dd:
                    3c:a8:a2:ef:6a:fb:21:f2:52:61:df:9f:20:d7:1f:
                    e2:b1:d9:fe:18:64:d2:12:5b:5f:f9:58:18:35:bc:
                    47:cd:a1:36:f9:6b:7f:d4:b0:38:3e:c1:1b:c3:8c:
                    33:d9:d8:2f:18:fe:28:0f:b3:a7:83:d6:c3:6e:44:
                    c0:61:35:96:16:fe:59:9c:8b:76:6d:d7:f1:a2:4b:
                    0d:2b:ff:0b:72:da:9e:60:d0:8e:90:35:c6:78:55:
                    87:20:a1:cf:e5:6d:0a:c8:49:7c:31:98:33:6c:22:
                    e9:87:d0:32:5a:a2:ba:13:82:11:ed:39:17:9d:99:
                    3a:72:a1:e6:fa:a4:d9:d5:17:31:75:ae:85:7d:22:
                    ae:3f:01:46:86:f6:28:79:c8:b1:da:e4:57:17:c4:
                    7e:1c:0e:b0:b4:92:a6:56:b3:bd:b2:97:ed:aa:a7:
                    f0:b7:c5:a8:3f:95:16:d0:ff:a1:96:eb:08:5f:18:
                    77:4f
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Key Usage: critical
                Digital Signature, Certificate Sign, CRL Sign
            X509v3 Basic Constraints: critical
                CA:TRUE
            X509v3 Subject Key Identifier:
                45:EB:A2:AF:F4:92:CB:82:31:2D:51:8B:A7:A7:21:9D:F3:6D:C8:0F
            X509v3 Authority Key Identifier:
                keyid:45:EB:A2:AF:F4:92:CB:82:31:2D:51:8B:A7:A7:21:9D:F3:6D:C8:0F
    Signature Algorithm: sha1WithRSAEncryption
         a2:0e:bc:df:e2:ed:f0:e3:72:73:7a:64:94:bf:f7:72:66:d8:
         32:e4:42:75:62:ae:87:eb:f2:d5:d9:de:56:b3:9f:cc:ce:14:
         28:b9:0d:97:60:5c:12:4c:58:e4:d3:3d:83:49:45:58:97:35:
         69:1a:a8:47:ea:56:c6:79:ab:12:d8:67:81:84:df:7f:09:3c:
         94:e6:b8:26:2c:20:bd:3d:b3:28:89:f7:5f:ff:22:e2:97:84:
         1f:e9:65:ef:87:e0:df:c1:67:49:b3:5d:eb:b2:09:2a:eb:26:
         ed:78:be:7d:3f:2b:f3:b7:26:35:6d:5f:89:01:b6:49:5b:9f:
         01:05:9b:ab:3d:25:c1:cc:b6:7f:c2:f1:6f:86:c6:fa:64:68:
         eb:81:2d:94:eb:42:b7:fa:8c:1e:dd:62:f1:be:50:67:b7:6c:
         bd:f3:f1:1f:6b:0c:36:07:16:7f:37:7c:a9:5b:6d:7a:f1:12:
         46:60:93:d7:27:04:be:4b:ce:97:be:c3:67:2a:68:11:df:80:
         e7:0c:33:66:bf:13:0d:14:6e:f3:7f:1f:63:10:1e:fa:8d:1b:
         25:6d:6c:8f:a5:b7:61:01:b1:d2:a3:26:a1:10:71:9d:ad:e2:
         c3:f9:c3:99:51:b7:2b:07:08:ce:2e:e6:50:b2:a7:fa:0a:45:
         2f:a2:f0:f2

Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            08:70:bc:c5:af:3f:db:95:9a:91:cb:6a:ee:ef:e4:65
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: C=US, O=DigiCert Inc, OU=www.digicert.com, CN=DigiCert Assured ID Root CA
        Validity
            Not Before: Nov 18 12:00:00 2014 GMT
            Not After : Nov 18 12:00:00 2024 GMT
        Subject: C=NL, ST=Noord-Holland, L=Amsterdam, O=TERENA, CN=TERENA SSL CA 3
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
                    00:c5:76:0f:0f:d9:43:29:3b:6c:6d:d1:47:ad:de:
                    10:bf:23:c2:78:a8:4a:77:35:f1:23:5b:e0:4c:1e:
                    41:e7:c2:31:00:bd:88:37:45:75:dd:b9:02:10:80:
                    1e:8f:ed:64:23:04:45:a7:a0:39:3b:81:4d:cf:63:
                    3f:c2:49:ff:22:9e:88:b0:d2:96:b9:5c:8a:74:1f:
                    92:2a:2a:f2:12:c8:b7:68:54:b5:58:41:81:40:68:
                    06:1a:4f:85:29:fb:b5:4d:3c:0f:4f:3f:40:96:1b:
                    ce:a8:cc:5e:35:ff:64:98:f5:75:dd:74:54:05:a0:
                    36:11:04:12:24:55:63:ef:94:77:2e:77:f1:15:76:
                    ee:d3:a4:59:45:21:9f:a8:be:d1:27:ed:0a:e8:ab:
                    38:ca:3f:87:d1:da:f1:8f:b9:0b:1f:44:e7:e0:ad:
                    f3:95:c2:16:4d:ec:84:a3:3a:92:d4:cf:c6:7d:e6:
                    bd:cb:1a:40:4f:b3:54:b1:f3:8f:6f:0d:1e:e3:be:
                    49:a3:56:e4:07:bc:8d:a7:ce:1d:b0:5b:57:56:d1:
                    c4:1c:fc:98:65:d1:cd:46:2f:91:94:bf:45:85:49:
                    f8:6d:52:87:1c:02:56:01:27:16:ab:72:2e:f4:71:
                    e4:61:b5:20:a0:fa:26:69:6a:0a:f1:ab:9f:6d:b7:
                    cf:25
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Basic Constraints: critical
                CA:TRUE, pathlen:0
            X509v3 Key Usage: critical
                Digital Signature, Certificate Sign, CRL Sign
            Authority Information Access:
                OCSP - URI:http://ocsp.digicert.com
                CA Issuers - URI:http://cacerts.digicert.com/DigiCertAssuredIDRootCA.crt
            X509v3 CRL Distribution Points:
                Full Name:
```

```
                URI:http://crl3.digicert.com/DigiCertAssuredIDRootCA.crl
                Full Name:
                  URI:http://crl4.digicert.com/DigiCertAssuredIDRootCA.crl
            X509v3 Certificate Policies:
                Policy: X509v3 Any Policy
                  CPS: https://www.digicert.com/CPS
            X509v3 Subject Key Identifier:
                67:FD:88:20:14:27:98:C7:09:D2:25:19:BB:E9:51:11:63:75:50:62
            X509v3 Authority Key Identifier:
                keyid:45:EB:A2:AF:F4:92:CB:82:31:2D:51:8B:A7:A7:21:9D:F3:6D:C8:0F
    Signature Algorithm: sha256WithRSAEncryption
         a9:28:35:7a:c4:7b:d6:da:27:1e:ac:98:cf:27:36:4f:11:32:
         74:74:e6:40:dd:1d:cd:f2:68:77:35:af:b3:8c:5d:c6:04:bf:
         15:f4:23:67:8b:b9:6f:97:04:eb:46:9d:c2:cd:c9:d1:a4:ae:
         81:2e:c9:ba:b1:e8:80:d0:1c:c9:39:c1:56:76:59:6c:9c:7d:
         e3:a9:f0:d3:d1:34:d8:3c:49:59:8b:1a:98:ce:bf:c6:f2:d8:
         30:35:ff:e9:6f:5d:a0:af:3a:ee:66:53:ae:aa:8c:69:c8:be:
         9a:a7:a0:7b:d8:82:4b:33:13:c8:07:f3:77:d7:f3:64:cd:9e:
         63:f9:42:27:53:ae:10:33:89:72:37:15:f1:be:f7:1e:35:a2:
         ce:c3:2d:f2:d7:b2:e6:0b:c7:69:c0:e5:1f:5f:7c:69:9b:7e:
         ce:26:1a:33:44:c3:ba:77:05:3b:ba:5d:3f:41:89:fa:16:3b:
         ee:04:6e:5b:ac:56:4b:ef:8c:70:f2:4a:7b:57:bd:19:6e:8b:
         36:07:54:26:2d:86:09:94:1f:5f:37:ab:f0:23:3f:8f:2c:5f:
         96:9e:47:71:a8:44:de:a9:b9:85:2f:b5:34:60:a5:5f:09:a0:
         9a:43:1d:d4:bf:2d:44:d6:8d:da:fd:75:cb:5f:16:a0:0e:61:
         c2:70:3d:36

Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            02:72:71:c2:fe:ca:5c:4e:3b:1c:cc:a8:67:97:c4:1e
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: C=NL, ST=Noord-Holland, L=Amsterdam, O=TERENA, CN=TERENA SSL CA 3
        Validity
            Not Before: Jan 15 00:00:00 2016 GMT
            Not After : Jan 23 12:00:00 2019 GMT
        Subject: C=FI, ST=Uusimaa, L=Espoo, O=Aalto University Foundation, OU=Department of
Computer Science, CN=www.cs.hut.fi
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
                    00:ce:7a:5c:cd:45:da:fb:51:db:8f:13:fb:ea:39:
                    cd:3f:db:e6:18:45:8d:75:12:b6:3b:8a:be:df:4f:
                    5c:c0:42:2c:1a:7a:d4:ca:d5:35:ff:e3:f3:a5:7f:
                    a9:71:df:2e:95:c8:3e:cb:9e:b9:e1:22:b8:70:7c:
                    7f:f4:9c:67:61:da:a6:01:56:8a:f4:e5:97:01:9f:
                    dc:dc:4a:2b:36:f7:91:0e:fe:a9:e3:91:c3:cf:0b:
                    22:94:bf:55:ea:de:d4:cb:8c:7f:c4:5f:4e:3c:e7:
                    16:30:d6:5a:c3:fe:ab:71:39:a0:d9:2b:f7:6e:54:
                    7a:8c:c3:e6:c5:59:37:3d:51:40:66:36:38:2c:4d:
                    7d:a6:c2:5f:f8:e7:a1:d9:07:1f:c6:2e:01:ba:b3:
                    a8:52:a5:8e:b8:da:48:3a:2d:e7:3a:d4:ee:e7:d5:
                    fe:d6:06:f5:9e:50:bd:d3:99:2a:65:7e:09:74:0f:
                    40:d7:87:e3:bc:0f:39:90:69:7f:8c:1a:af:1e:8b:
                    88:e9:4f:99:29:f4:4b:14:36:f3:ee:46:32:91:ca:
                    37:ea:21:37:ef:13:f2:99:42:ad:f3:93:2c:97:1f:
                    26:84:7c:73:00:27:ad:cf:fe:bb:10:6e:e9:b3:29:
                    c4:dd:f4:f1:56:21:95:e1:2f:96:8a:76:bf:89:6e:
                    52:3b
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Authority Key Identifier:
                keyid:67:FD:88:20:14:27:98:C7:09:D2:25:19:BB:E9:51:11:63:75:50:62
            X509v3 Subject Key Identifier:
                DD:21:81:30:50:E5:D6:D2:E7:1F:8C:BB:C5:0C:31:C7:60:50:C4:91
            X509v3 Subject Alternative Name:
                DNS:www.cs.hut.fi, DNS:www.cse.tkk.fi
            X509v3 Key Usage: critical
                Digital Signature, Key Encipherment
            X509v3 Extended Key Usage:
                TLS Web Server Authentication, TLS Web Client Authentication
            X509v3 CRL Distribution Points:
                Full Name:
                  URI:http://crl3.digicert.com/TERENASSLCA3.crl
                Full Name:
                  URI:http://crl4.digicert.com/TERENASSLCA3.crl
            X509v3 Certificate Policies:
                Policy: 2.16.840.1.114412.1.1
                  CPS: https://www.digicert.com/CPS
                Policy: 2.23.140.1.2.2
            Authority Information Access:
                OCSP - URI:http://ocsp.digicert.com
                CA Issuers - URI:http://cacerts.digicert.com/TERENASSLCA3.crt
            X509v3 Basic Constraints: critical
                CA:FALSE
    Signature Algorithm: sha256WithRSAEncryption
         88:25:ff:0c:a6:6d:55:01:b3:fc:64:35:16:c5:56:c4:e1:bb:
         0e:94:83:85:07:7a:6e:96:2e:50:6a:8a:b9:8c:00:a9:c8:f9:
         ba:cc:6e:ec:da:ab:0a:e3:77:c0:d8:f6:91:d2:b2:8e:7a:5b:
         4c:1c:e5:82:d1:49:a0:95:e3:c8:d4:d8:ce:62:59:43:b3:db:
         d6:e6:c9:ad:e3:63:d2:24:d7:d6:49:a8:20:92:df:01:79:03:
         d2:54:93:98:06:e0:cd:13:79:29:ea:a6:9c:63:83:37:06:3f:
         36:71:ed:a4:62:54:ec:b4:61:40:41:f1:66:3f:32:3c:f0:33:
         98:4b:84:43:d0:0c:ec:08:71:51:8e:32:66:64:4f:cf:41:d7:
         e0:ac:53:fe:b5:cd:f2:5a:43:19:69:b7:f4:7a:c8:b2:fb:57:
         54:1b:ab:04:ce:18:e6:54:1c:52:d0:a6:7a:ad:db:43:ac:82:
         ad:37:71:d3:be:4e:97:26:0e:9a:8e:3f:c6:0e:52:bc:fa:b7:
         f7:91:01:d9:cf:36:e5:72:58:29:6f:fb:29:6b:78:87:98:49:
         85:42:3a:ea:57:09:2a:92:52:2a:c2:18:11:1a:ef:62:29:65:
         de:5a:47:7b:49:41:d0:ee:c5:a6:73:0a:9f:f2:14:ed:95:1b:
         b0:b6:7f:8b
```