CSS322 – Quiz 11

Security and Cryptography, Semester 2, 2012

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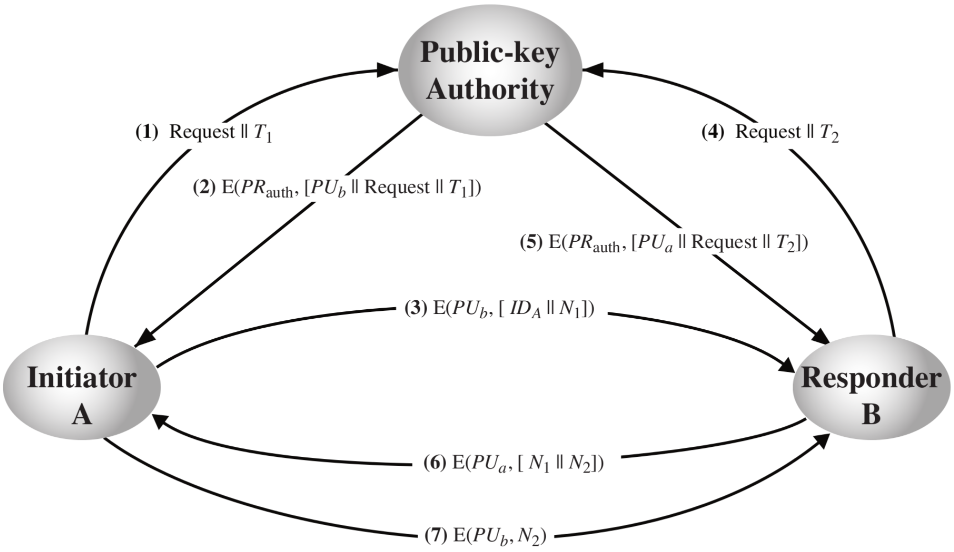
CSS322Y12S2Q11, Steve/Courses/2012/s2/css322/assessment/quiz11.tex, r2675

Question 1 [2 marks]

Consider the scheme in the figure below.


Public-key Authority
Initiator A
Responder B
(1) Request ∥ T_1
(2) E(PR_{auth}, [PU_b ∥ Request ∥ T_1])
(3) E(PU_b, [ID_A ∥ N_1])
(4) Request ∥ T_2
(5) E(PR_{auth}, [PU_a ∥ Request ∥ T_2])
(6) E(PU_a, [N_1 ∥ N_2])
(7) E(PU_b, N_2)

(a) List all keys assumed to be known by [A | the authority | B | the authority] before the scheme starts (i.e. before message (1) is sent). [1 mark]

Answer. *Each user should know its own Public/Private key pair, and the Public key of the authority. The authority knows its own Public/Private key pair and the Public keys of the users:*

- *A:* PU_a, PR_a, PU_{auth}
- *B:* PU_b, PR_b, PU_{auth}
- *Authority:* $PU_{auth}, PR_{auth}, PU_a, PU_b$

(b) List all keys known by [the authority | B | the authority | A] after the scheme is finished (i.e. after message (7) is sent). [1 mark]

Answer. *Each user learns the Public key of the other user. The authority does not learn any new keys.*

- *A:* $PU_a, PR_a, PU_{auth}, PU_b$
- *B:* $PU_b, PR_b, PU_{auth}, PU_a$
- *Authority:* $PU_{auth}, PR_{auth}, PU_a, PU_b$

Question 2 [5 marks]

Consider the X.509 certificate in Listing 1.

Listing 1: X.509 Certificate

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number: 3 (0x3)
        Signature Algorithm: sha1WithRSAEncryption
        Issuer: C=TH, ST=Pathumthani, O=[ ABC | TrustUs | DigiCert | Malicous ], OU=[ Security | Crypto | Secure
| Department ],
                CN=[ ABC Security | TrustUsCrypto | DigitCertSecure | Malicious Department ]
        Validity
            Not Before: Jan 25 02:25:10 2011 GMT
            Not After : Jan 25 02:25:10 2012 GMT
        Subject: C=TH, ST=Pathumthani, O=[ TrustUs | Malicious | ABC | DigiCert ], OU=[ Crypto | Department |
Security | Secure ],
                 CN=[ TrustUsCrypto | Malicious Department | ABCSecurity | DigiCertSecure ]
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (1024 bit)
                Modulus (1024 bit):
                    00:aa:1f:cf:01:2f:d3:2e:80:63:98:1b:0f:16:5d:
                    dd:af:e2:38:de:78:88:56:b6:14:2b:61:79:92:0b:
                    f3:7f:b6:89:7b:d0:fc:59:5a:1a:be:24:61:39:d5:
                    4d:80:3a:40:2b:7c:89:ef:5e:50:a5:3b:44:68:a9:
                    7f:97:d9:c4:9a:bf:b6:97:eb:4c:87:0d:00:96:b4:
                    f9:ea:8c:6a:cb:e0:bd:f8:a8:1f:82:d3:2b:23:3c:
                    b6:54:85:37:5b:13:1a:2e:be:0d:20:52:c5:98:b6:
                    4c:97:67:6e:b2:43:04:3f:01:41:8e:e0:2f:38:1f:
                    e1:cc:cf:0d:c2:5f:0a:04:[ a3 | 49 | ga | ae ]
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Basic Constraints:
                CA:FALSE
            Netscape Comment:
                OpenSSL Generated Certificate
            X509v3 Subject Key Identifier:
                EA:1C:DC:C5:16:F2:9D:BC:61:5E:A8:D2:67:2A:06:13:C5:64:8A:[ AE | A3 | GA | 49 ]
            X509v3 Authority Key Identifier:
                keyid:61:52:40:EA:7F:E0:EC:77:41:F6:4F:6F:7C:49:EB:05:C1:56:6D:[ 49 | GA | A3 | AE ]

    Signature Algorithm: sha1WithRSAEncryption
        a5:7a:36:91:ef:11:46:58:74:37:87:81:7a:99:ff:b6:40:4a:
        80:6a:07:69:e3:3c:33:9a:fd:31:50:e9:9f:bf:ff:36:a4:34:
        21:50:49:70:e0:88:b3:01:c9:51:26:8b:1e:8b:34:ca:4c:3c:
        a2:ab:0a:a3:b3:39:c0:fb:88:72:98:69:c9:af:42:b2:48:1b:
        4e:4a:76:e8:b4:c7:d4:f8:15:d2:5e:f8:69:fc:53:0c:ca:85:
        84:ea:e5:36:17:20:65:fc:d0:3e:d1:33:17:f7:d1:40:f8:3d:
        2a:87:f8:3c:66:8e:43:62:ea:02:ef:7a:d4:a7:55:e9:d9:2d:
        38:[ 1a | 1a | 1a | 1a ]
-----BEGIN CERTIFICATE-----
MIIC5zCCAlCgAwIBAgIBAzANBgkqhkiG9w0BAQUFADCBnzELMAkGA1UEBhMCVEgx
GDASBgNVBAgTC1BhdGh1bXRoYW5pMREwDwYDVQQHEwhCYW5na2FkaTENMAsGA1UE
ChMEU0lJVDEMMAoGA1UECxMDSUNUMR4wHAYDVQQDExVDZXJ0aWZpY2F0ZSBBdXRo
b3JpdHkxKjAoBgkqhkiG9w0BCQEWG2NzczMyMi1jYUBpY3Quc2lpdC50dS5hYy50
aDAeFw0xMTAxMjUwMjI1MTBaFw0xMjAxMjUwMjI1MTBaMFYxCzAJBgNVBAYTAlRI
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gYkCgYEAqh/PAS/TLoBjmBsPFl3dr+I43niIVrYUK2F5kgvzf7aJe9D8WVoaviRh
OdVNgDpAK3yJ715QpTtEaKl/l9nEmr+2l+tMhw0AlrT56oxqy+C9+KgfgtMrIzy2
VIU3WxMaLr4NIFLFmLZMl2duskMEPwFBjuAvOB/hzM8Nwl8KBKMCAwEAAaN7MHkw
CQYDVR0TBAIwADAsBglghkgBhvhCAQ0EHxYdT3BlblNTTCBHZW5lcmF0ZWQgQ2Vy
dGlmaWNhdGUwHQYDVR0OBBYEFOoc3MUW8p28YV6o0mcqBhPFZIquMB8GA1UdIwQY
MBaAFGFSQOp/4Ox3QfZPb3xJ6wXBVm1JMA0GCSqGSIb3DQEBBQUAA4GBAKV6NpHv
EUZYdDeHgXqZ/7ZASoBqB2njPDOa/TFQ6Z+//zakNCFQSXDgiLMByVEmix6LNMpM
PKKrCqOzOcD7iHKYacmvQrJIG05Kdui0x9T4FdJe+Gn8UwzKhYTq5TYXIGX80D7R
Mxf30UD4PSqH+DxmjkNi6gLvetSnVenZLT[ ga | ae | 49 | a3 ]
-----END CERTIFICATE-----
```

(a) Whose certificate is this? [1 mark]

Answer. *The user is shown in the subject field.* TrustUsCrypto*,* Malicious Department*,* ABCSecurity*,* DigiCertSecure

(b) Whose RSA key is included in the certificate? [1 mark]

Answer. *The users/subjects key is included. The answer is the same as part (a).*

(c) The RSA algorithm is: $C = M^e \bmod n$. What are the last two hexadecimal digits of n in the users RSA key? [1 mark]

Answer. *The modulus, n, is given in hex and ends with either: a3, 49, ga, ae (depending on the quiz variant you had).*

In general, an X.509 certificate for user A can be expressed as:

$$C_A = Data||S$$

where $Data$ is the concatenation of the fields: Version, SerialNumber, SignatureAlgorithm, Issuer, Validity, Subject, SubjectPublicKeyInfo and X509v3extensions.

(d) Write an equation for how S is calculated in the certificate in Listing 1? You must use the names of algorithms used in the above certificate (i.e. you cannot use E()), as well as clearly identify which user each key belongs to. You may use the variable $Data$ in your equation to represent the concatenation of various fields. [2 marks]

Answer. *If the issuer/authority in the certificate is ABC Security, then*

$$S = RSA(PR_{ABCSecurity}, SHA1(Data))$$

Question 3 [3 marks]

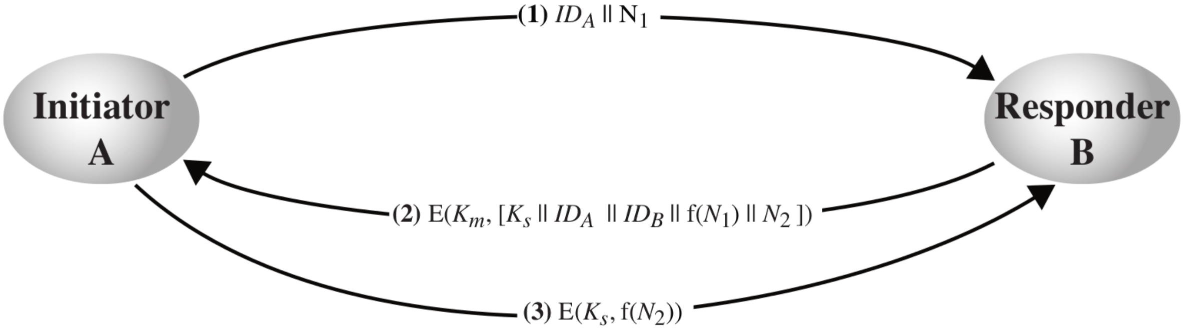
Considered the scheme below (top of next page).

(a) For this scheme to work, what keys are known by A and B before the 3 steps are taken? [1 mark]

Answer. *A and B both must know K_m.*

(b) Assume a network has [15 | 11 | 12 | 20] users, all using the above scheme. How many keys in total must be manually distributed prior the scheme being used? [2 marks]

Answer. *Each pair of users must manually exchange a master key. With n users there are $n(n-1)/2$ pairs, and therefore $n(n-1)/2$ keys manually exchanged.*


Initiator A
Responder B
(1) $ID_A \| N_1$
(2) $E(K_m, [K_s \| ID_A \| ID_B \| f(N_1) \| N_2])$
(3) $E(K_s, f(N_2))$