Generating CA-authenticated public keys in ad hoc networks Demo

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1. GOALS OF THE DEMO

The demo is a proof of concept of an entity authentication solution defined in [1] that permits nodes in ad hoc networks to generate, on-demand, public/private key pairs whose validity can be verified based on a unique certificate issued by a Certification Authority (CA) during registration in the fixed network. Registration only occurs once and the certificate issued by the CA does not contain any public key but binds an identity to a hash code. This avoids the need to manage the revocation of the certificate in the ad hoc network. In the demo, the entity authentication solution is used by a buying/selling application defined in [2][3] that permits users, in ad hoc networks, to buy or/and sell digital multimedia resources anytime, anywhere and from anybody. Subsequently, we briefly present the authentication solution and the buying/selling application.

2. Entity authentication solution

The authentication solution comprises the steps of entity registration, public/private key pair generation and public key validation. These steps are further detailed hereafter.

2.1 Registration

In the fixed network, for instance, when a user registers at his network provider, he requests a certificate from a CA as follows. He contacts a CA with his mobile device A in order to obtain a reliable copy of the system parameters: the two one way hash functions *h* and *f* as well as the large prime g , K_{CA} the CA's public key and an integer *L*. Upon registration or whenever connected to a fixed network A's mobile device synchronizes its clock; this is important for reasons that become obvious later.

When A receives these parameters, it chooses a secret s. Note that s is not stored by A; instead, it is generated from a strong passphrase. Then A generates the check value v :

$$v = h(g^{\prod_{j=0}^{m} f^j(s)})$$

Where $f^j(s)$ means that the cryptographic one way hash function f is applied j times on *s*.

A then sends its identity ID_A and the check value v to the CA, in order to obtain a certificate that binds these two values. The CA next verifies that A really owns ID_A and that no certificate has been issued that already contains v . If all the verifications succeed, then CA sends to A the certificate $Cert_A$ which includes the mentioned system parameters but as well ID_A and v . After A has received the certificate, it divides time into interval T_i of equal length *L*. The first time interval T_0 starts at the issue time t_0 of $Cert_A$. The solution works such that for each time interval T_i a new public/private key pair is generated as discussed in the following sections. Obviously, the smaller *L* is the smaller is the risk that an attacker uses a revoked public/private key pair in the ad hoc network that is linked to $Cert_A$.

2.2 Public/private key pair generation

In time interval T_i, $0 \le i < m$, A uses as private key K_{m-1-i} , generated as follows:

$$K_{m-1-i} = \prod_{j=0}^{m-i-1} f^j(s)$$

and as corresponding public key $g^{K_{m-1-i}}$. The key pair expires automatically, when the next time interval T_{i+1} after at most L time units is reached.

2.3 Public key validation

To enable a device B to obtain a verified copy of the public key $g^{K_{m-1-i}}$, A sends to B:

- $g^{K_{m-1-i}}$,
- $f^{m-i}(s)$ and
- $Cert_A$.

B determines *i* from its local time, t_0 and *L* both contained in $Cert_A$. Then B computes:

$$f^j(s) \text{ , for } m\text{-}i<i\le m$$

Then, B computes v^* as follows:

$$\begin{aligned} v^* &= (g^{K_{m-i-1}})^{\prod_{j=m-i}^{m} f^j(s)} \\ &= (g^{\prod_{j=0}^{m-i-1} f^j(s)})^{\prod_{j=m-i}^{m} f^j(s)} \\ &= g^{\prod_{j=0}^{m} f^j(s)} \end{aligned}$$

Then B verifies that $v = h(v^*)$ where v is contained in Cert_A.

If yes, then, B considers $g^{K_{m-1-i}}$ as valid and can use it to verify some digital signatures during T_i or to establish some secure communication channels with A. These details are omitted due to limited space.

3. Buying/Selling multimedia resource in ad hoc networks

In the demo, the CA is emulated. Certificates are generated from public parameters stored on the devices. However, the public/private key pairs used are generated and validated as defined previously

The process that permits B – for buyer— to buy a previously requested multimedia resource to a node S – for seller— in ad hoc networks is represented below in Figure 1.

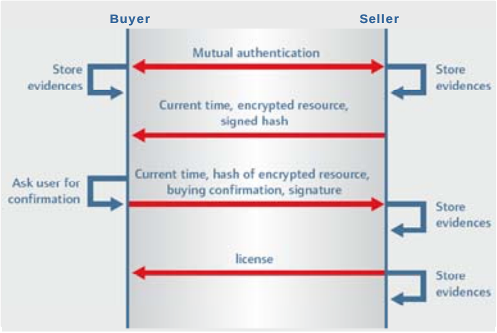
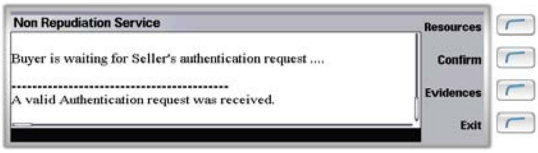

Buyer
Seller
Mutual authentication
Store evidences
Store evidences
Current time, encrypted resource, signed hash
Ask user for confirmation
Current time, hash of encrypted resource, buying confirmation, signature
Store evidences
license
Store evidences

Figure 1 Selling/Buying process

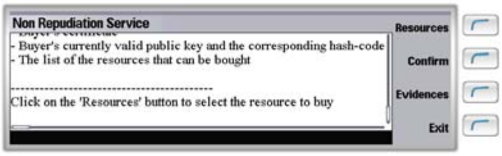
Without implementing DRM features, for example the encryption of the resource, the previous process has been implemented entirely on constrained devices (Nokia Communicator 9300/9500i in Java) and appears in the demonstration as shown in Figures 2 to 6. The implementation confirmed that the authentication solution performs on constrained devices. Performance figures are include in [1] and are shown on the poster that goes with the demonstration.



Buyer is waiting for Seller's authentication request ....

A valid Authentication request was received.

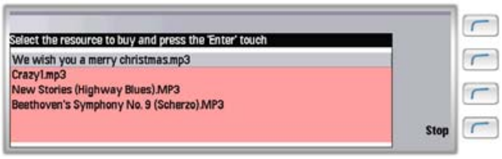
Figure 2 Authentication of the seller



- Buyer's certificate
- Buyer's currently valid public key and the corresponding hash-code
- The list of the resources that can be bought

Click on the 'Resources' button to select the resource to buy

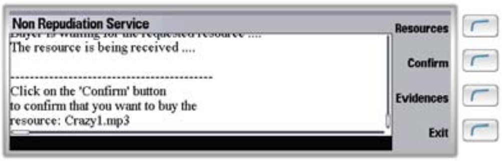
Figure 2 Request to choose the resource to be bought



Select the resource to buy and press the 'Enter' touch

We wish you a merry christmas.mp3
Crazy1.mp3
New Stories (Highway Blues).MP3
Beethoven's Symphony No. 9 (Scherzo).MP3

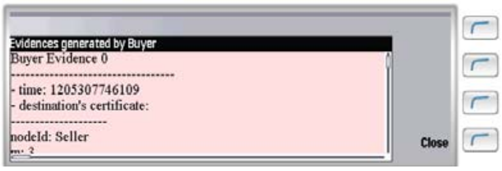
Figure 3 Selection screen permitting to choose the resource that can be bought



Buyer is waiting for the requested resource ....
The resource is being received ....

Click on the 'Confirm' button
to confirm that you want to buy the
resource: Crazy1.mp3

Figure 4 Request to confirm the buying of the previously selected resource



Evidences generated by Buyer
Buyer Evidence 0

- time: 1205307746109
- destination's certificate:

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nodeId: Seller

Figure 5 Screen displaying the evidences permitting to prove to a third party that the transaction took place

4. SETUP TIME AND FACILITIES NEEDED

The demo requires 3 power plugs (220 V) and some space for a A0 poster (59.4cm x 84cm). The set up time for the demo is 30 minutes.

5. EXTRA INFORMATION

Please refer to the “References” section.

6. References

[1] G. Kounga, C. Mitchell, and T. Walter, “Generating CA-authenticated public keys in ad hoc networks,” DoCoMo Euro-Labs Internal report I-ST-021, 2007.

[2] Gina Kounga, Christian Schaefer, "Non-repudiation for service accounting in ad hoc networks", in Proceedings of the 7th International Workshop on Applications and Services in Wireless Network (ASWN2007), May 2007

[3] Gina Kounga, Christian Schaefer, " Selling Multimedia Resources in Ad Hoc Networks", IEEE Communications Magazine, vol. 46, no. 2, February 2008