

# CRYPTANALYSIS OF A MORE EFFICIENT AND SECURE DYNAMIC ID-BASED REMOTE USER AUTHENTICATION SCHEME

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## ABSTRACT

*In 2004, Das, Saxena and Gulati proposed a dynamic ID-based remote user authentication scheme which has many advantage such as no verifier table, user freedom to choose and change password and so on. However the subsequent papers have shown that this scheme is completely insecure and vulnerable to many attacks. Since then many schemes with improvements to Das et al's scheme has been proposed but each has its pros and cons. Recently Yan-yan Wang et al. have proposed a scheme to overcome security weaknesses of Das et al.'s scheme. However this scheme too is vulnerable to various security attacks such as password guessing attack, masquerading attack, denial of service attack.*

## KEYWORDS

*Password, Authentication, Smartcard, Remote User, Masquerade Attack*

## 1. INTRODUCTION

In order to prevent the invasion of privacy and solve security problems, a remote user would need to provide proof to a system that he/she is a legitimate user before he/she logs onto the remote system. There are many methods proposed to verify the legitimacy of a remote user such as password, fingerprint, typing sequence, and so forth. Among them, password based remote user authentication is extensively used and easily implemented to authenticate a legitimate user. In 1981, Lamport [3] proposed a password based authentication scheme that could authenticate remote users over a insecure channel. Since than many schemes [6, 7, 8, 9] have been proposed to improve security, efficiency, and cost.

In 2004, Das, Saxena and Gulati proposed a dynamic ID-based remote user authentication scheme [2] which has many advantage such as no verifier table, user freedom to choose and change password and so on. However the subsequent papers [4,5] have shown that this scheme is completely insecure and vulnerable to many attacks. Since then many schemes[1,4] with improvements to Das et al's scheme has been proposed but each has its pros and cons. Recently Yan-yan Wang et al. [1] have proposed a scheme to overcome security weaknesses of Das et al.'s scheme.

However in this paper we state that this scheme too is vulnerable to few security attacks such as password guessing attack, masquerading attack, denial of service attack.

The rest of the paper is organized as follows. In section 2 we present review of Yan-yan Wang et al.'s scheme. The section 3 describes cryptanalysis of Yan-yan Wang et al.'s scheme. And finally some concluding comments are included in the last section.

## 2. Review OF YAN-YAN WANG ET AL.'S SCHEME

The scheme consists of four phases, the registration phase, the login phase, the verification phase and password change phase. The notations used in the scheme are as follows:

U	The user
PW	The password of U
ID	The identity of U
S	The remote server
h(.)	A one-way hash function
$\oplus$	Bitwise XOR operation
$\rightarrow$	A common channel
$\Rightarrow$	A secure channel
$A \rightarrow B: M$	A sends M to B through common channel
$A \Rightarrow B: M$	A sends M to B through secure channel

### 2.1. Registration Phase

The user  $U_i$  sends the registration request to the remote server S:

- 1)  $U_i$  submits  $ID_i$  to S
- 2) S computes:

$$N_i = h(PW_i) \oplus h(x) \oplus ID_i$$

Where  $x$  is secret of remote server,  $PW_i$  is the password of  $U_i$  chosen by S.

- 3) S personalizes the smartcard with the parameters  $[h(\cdot), N_i, y]$ , where  $y$  is the remote server's secret number stored in each registered user's smartcard.
- 4)  $S \Rightarrow U_i: PW_i$  and smartcard.

### 2.2. Login Phase

When a user wants to login the remote server, he/she inserts the smart card to the terminal and keys the identity  $ID_i$  and the password  $PW_i$ , then the smartcard performs the following steps:

- 1) Computes dynamic ID:

$$CID_i = h(PW_i) \oplus h(N_i \oplus y \oplus T) \oplus ID_i$$

Where  $T$  is the current date and time.

- 2)  $U_i \rightarrow S: ID_i, CID_i, Ni, T$

### 2.3. Verification Phase

When the remote server S receives the request (ID<sub>i</sub>,CID<sub>i</sub>,Ni,T) at time T' , S verifies as:

- 1) checks the validity of time interval, if  $T' - T \leq \Delta T$  holds, S accepts the login request of U<sub>i</sub>, otherwise the login request will be rejected, where  $\Delta T$  is valid time interval.
- 2) S computes:

$$h'(PW_i) = CID_i \oplus h(Ni \oplus y \oplus T) \oplus ID_i$$

- 3) and computes

$$ID_i' = Ni \oplus h'(PW_i) \oplus h(x)$$

and verifies whether it is equal to ID<sub>i</sub> in the login request of U<sub>i</sub>. If it does not hold S rejects the login request of U<sub>i</sub>, otherwise accepts it. Then S computes a' using the result of step 2.

$$a' = h(h'(PW_i) \oplus y \oplus T')$$

- 4) S sends (a',T) to U<sub>i</sub>.

Upon receiving the reply message (a',T) at time T\*, U<sub>i</sub> verifies as:

- 5) U<sub>i</sub> checks whether  $T^* - T' \leq \Delta T$ , if it does then U<sub>i</sub> computes  $a = h(h(PW_i) \oplus y \oplus T')$  , and compares it with the received a' , if it holds, U<sub>i</sub> confirms that S is valid.

### 2.4. Password Change Phase

When the user wants to change the password, he/she inserts the smartcard into the terminal device, keys the password PW<sub>i</sub> and request to change the password to new one PW<sub>new</sub>, then the smartcard computes:

$$Ni^* = Ni \oplus h(PW_i) \oplus h(PW_{new}),$$

and replaces the Ni with the new Ni\*, password gets changed.

## 3. CRYPTANALYSIS OF YAN-YAN WANG ET AL.'S SCHEME

In this section we will show that Yan-yan Wang et al.'s scheme is vulnerable to masquerade attack, password guessing attack, denial of service attack. Although tamper resistant smartcard widely assumed in most of the authentication scheme, but such an assumption is difficult in practice. Many researchers have shown that the secret stored in a smartcard can be breached by analyzing the leaked information or by monitoring the power consumption [10,11]. An attacker can extract secret y stored in the U<sub>i</sub>'s smartcard either by stealing the smartcard or by registering to the server (as each registered user has same value of y stored in their smartcard).

### 3.1. Password guessing attack

Assuming that the attacker has extracted the secret y from U<sub>i</sub>'s smartcard and also he/she has the intercepted parameters, CID<sub>i</sub>, Ni, T and ID<sub>i</sub>. Then the attacker can proceed as follows:

$$h(PW_i) = CID_i \oplus h(Ni \oplus y \oplus T) \oplus ID_i$$

Now attacker can guess different passwords until the hash value of the guessed password matches with  $h(PW_i)$  computed by the attacker.

### 3.2. User Masquerade Attack

In the second step of registration phase S computes:

$$N_i = h(PW_i) \oplus h(x) \oplus ID_i$$

The attacker can now extract  $h(x)$  from  $N_i$  by using  $h(PW_i)$  computed in 'A' :

$$h(x) = h(PW_i) \oplus N_i \oplus ID_i$$

now attacker can calculate new  $N_i^*$  with his/her chosen password  $PW^*$  as follows:

$$N_i^* = h(PW_i^*) \oplus h(x) \oplus ID_i$$

Attacker can now create and send a forged login request to the remote server S, without knowing the original password:

$$CID_i^* = h(PW_i^*) \oplus h(N_i^* \oplus y \oplus T^*) \oplus ID_i$$

where  $T^*$  is fresh time stamp.

Attacker sends to the server S,  $\{CID_i^*, N_i^*, T^*, ID_i\}$ . Upon receiving login request Server S successfully verifies validity of timestamp  $T^*$  and identity  $ID_i$ , hence accepting the request.

### 3.3. Server Masquerade Attack

The attacker can masquerade server by using the  $h(PW_i)$  computed in 'A' and :

$$a^* = h(h(PW_i) \oplus y \oplus T^*)$$

Attacker then sends  $(a^*, T^*)$  to  $U_i$ , which the user successfully verifies.

### 3.4. Denial of Service Attack

The password change phase of Yan-yan Wang et al.'s scheme is same as that of Das et al.'s scheme and it has a serious weakness. The password change phase does not verify whether the input old password matches with the original password. An attacker can use  $U_i$ 's smartcard in his absence and can invoke password change phase by inputting an arbitrary password  $PW'$  in place of original password  $PW_i$  along with a new password  $PW_{new}$ . Then the smartcard updates  $N_i$  without verifying the old password as follows:

$$N_i^* = N_i \oplus h(PW') \oplus h(PW_{new})$$

That will result in some arbitrary value  $N_i^*$ . Now the original user  $U_i$  can not log onto the remote server even by using his correct password as the  $N_i$  has been changed to some arbitrary value.

### 3. CONCLUSION

In this paper, we briefly reviewed Yan-yan Wang et al.'s scheme and shown that this improved scheme too is vulnerable to various security attacks such as password guessing attack, user masquerade attack, server masquerade attack, denial of service attack. In addition to this the password change phase updates smartcard parameter even if wrong password is given as input.

### REFERENCES

- [1] Yan-yan Wang, Jia-yong Liu, Feng-xia Xia, Jing Dan, (2009) "A more efficient and secure dynamic ID-based remote user authentication scheme", *Computer communications*, Vol. 32, pp. 583-585.
- [2] M. L. Das, A. Saxena, V. P. Gulati, (2004) "A dynamic ID-based remote user authentication scheme", *IEEE Trans. Consumer Electron.*, Vol. 50, No. 2, pp. 629-63.
- [3] L. Lamport, (1981), "password authentication with insecure communication", *Communications of the ACM*, Vol. 24, No. 11, pp. 770-772.
- [4] I-En Liao, C. C. Lee and M. S. Hwang, (2005), "Security enhancement for a dynamic ID-based remote user authentication scheme", in *IEEE CS Press, NWeSP'05*, pp. 437-440, Seoul, Korea.
- [5] A. K. Awasthi, S. Lal, (2004), "Security analysis of a dynamic ID based remote user authentication scheme", <http://eprint.iacr.org/2004/238.pdf>.
- [6] H. M. Sun, (2000), "An efficient remote user authentication scheme using smart card", *IEEE Trans. Consumer Elec.*, Vol. 46, no. 1, pp. 28-30.
- [7] W. C. Ku, S. M. Chen, (2004), "weaknesses and improvements of an efficient password based remote user authentication scheme using smartcards", *IEEE Trans. on Consumer Electron.*, Vol. 50, No. 1, pp. 204-206.
- [8] Y. L. Tang, M. S. Hwang, C. C. Lee, (2002), "A simple remote user authentication scheme", *Mathematical and Computer Modeling*, Vol. 36, pp. 103-107.
- [9] C. C. Lee, L. H. Lee, M. S. Hwang, (2002), "A remote user authentication scheme using hash functions", *ACM Operating System Review*, vol. 36, No. 4.
- [10] P. Kocher, J. Jaffe, B. B. Jun, (1999), "Differential power analysis", *Proceedings of Advances in Cryptology (CRYPTO '99)*, pp. 388-397.
- [11] T. S. Messerges, E.A. Dabbish, R.H. Sloan,(2002), "Examining smartcard security under the threat of power analysis attacks", *IEEE Trans. on Computers*, Vol. 51, No. 5, pp. 541-552.

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