Cryptanalysis of the Tseng-Jan Anonymous Conference Key Distribution System without Using a One-way Hash Function*

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Abstract

This paper mounts a conspiracy attack on the anonymous conference key distribution system without using a one-way hash function proposed by Tseng and Jan. Our attack can reveal the participant's common key shared by the chairperson.

Keywords: Cryptography, conference key distribution system, user anonymity, one-way hash function, discrete logarithm.

1 Introduction

A conference key distribution system (CKDS) [1, 2, 3, 5] guarantee that all and only participants of the conference share a common conference key which can be used to hold a secure conference. In 1999, Tseng and Jan proposed [4] two CKDSs with user anonymity based on the discrete logarithm problem. One of their schemes requires a one-way hash function to hide identify of the participants and to protect each participant's common key shared by the chairperson. The other scheme does not use a one-way hash function, but it can also achieve the same purposes. Tseng and Jan claimed that both schemes were secure against the impersonation attack and the conspiracy attack. However, this note will point out that the claim made in [4], that their scheme without using a one-way hash function is secure against conspiracy attack, is false.

2 Brief Review of Tseng-Jan CKDS

The scheme includes three stages: (1) system set-up stage, (2) conference key distribution stage, and (3) conference key recovery stage. During the system

set-up stage, the system chooses two large primes p and q such that $q \mid (p-1)$ and generates g with order q in $GF(q)$. Then, the system assigns a secret key $x_i \in Z_q^*$ to U_i over a secret channel and publishes the corresponding public key $y_i = g^{xi} \bmod p$.

During the conference key distribution stage, U_c is appointed the chairperson and $A = \{U_1, U_2, \ldots, U_n, n < m\}$ the set of attending members. U_c performs the following steps for distributing a conference key CK shared by the participants in A.

Step 1. Choose a random integer $r \in Z_q^*$ and get a time-sequence T form the system.

Step 2. Compute

$$\begin{aligned} R &= g^r \bmod p, \\ S &= r + H(T \parallel R) \cdot x_c \bmod q. \end{aligned}$$

Here, $H(\cdot)$ denotes a one-way function and $\parallel$ denotes a concatenation.

Step 3. Compute the common secret key shared by each $U_i \in A$ as $k_{ci} = y_i^r \bmod p$.

Step 4. Randomly select a conference key $CK \in Z_q^*$ and construct a polynomial with degree n as

$$\begin{aligned} P(x) &= \prod_{i=1}^{n}(x - k_{ci}) + CK \bmod p, \\ &= x^n + c_{n-1}x^{n-1} + \cdots + c_0 \bmod p. \end{aligned} \tag{1}$$

Step 5. Broadcast $\{R, S, T, c_{n-1}, c_{n-2}, \ldots, c_0\}$.

During the conference key recovery stage, each $U_i \in A$ receives $\{R,\ S,\ T,\ c_{n-1},\ c_{n-2},\ \cdots,\ c_0\}$ and performs the following steps for recovering the conference key CK.

Step 1. Verify T and the following equation

$$g^S = R \cdot y_c^{H(T\|R)} \bmod p.$$

Step 2. Compute the common secret key shared with U_c as $k_{ic} = R^{x_i} \bmod p$.

Step 3. Recover CK by computing

$$\begin{aligned} P(k_{ic}) &= (k_{ic})^n + c_{n-1}(k_{ic})^{n-1} + \cdots + c_1 k_{ic} + c_0 \bmod p, \\ &= CK \bmod p. \end{aligned}$$

3 The Weakness of Tseng-Jan Scheme

Tseng and Jan claimed that their conference key distribution system was secure against the conspiracy attack. However, in this section, we will show that the participant's common secret key shared with the chairperson can be revealed by the conspiracy attack. Any $(n-1)$ attending members in A can conspire to reveal the only other member's common secret key shared with the chairperson.

For example, assume that $(n-1)$ attending members U_i $(i = 1, 2, \ldots, n-1)$ intend to reveal the other member U_n's common secret key k_{cn}. After substituting x to zero in Equation (1), we can obtain the equation $\prod_{i=1}^{n-1}(-k_{ci}) \times (-k_{cn}) = c_0 - CK \bmod p$. With the knowledge of the values c_0, CK and $\prod_{i=1}^{n-1}(-k_{ci})$, the common secret key k_{cn} can be computed. Thus, any $(n-1)$ attending members $U_1, U_2, \ldots, U_{n-1}$ can easily reveal U_n's common secret key k_{cn} shared with the chairperson U_c. Though k_{cn}, shared between U_c and U_n, is different in the next conference, if U_c and U_n use it to communicate with each other in this conference, $U_1, U_2, \ldots, U_{n-1}$ can eavesdrop the confidential message between them.

4 Conclusion

In this paper, we have shown that Tseng and Jan's claim, that their conference key distribution system is secure against the conspiracy attack, is false. Any

$(n-1)$ attending members can conspire to reveal the only other member's common secret key shared with the chairperson.

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BIOGRAPHY

Ting-Yi Chang received the B.S. in Information Management from Chaoyang University of Technology (CYUT), Taichung, Taiwan, Republic of China, in 2001, and his M.S. in Department and Graduate Institute of Computer Science and Information Engineering from CYUT, in 2003. He is currently pursuing his Ph.D. in Computer and Information Science from National Chiao Tung University, Taiwan, Republic of China. His current research interests include

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