A Group Key Management Protocol For Multicast Cryptosystems

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ABSTRACT

The security in the multicast communication in the large group is the major obstacles for effectively controlling access to the transmitting data. The IP Multicast itself does not provide any specific mechanisms to control the intruders in the group communication. Group key management mainly addresses upon the trust model developed by Group Key Management Protocol (GKMP). There are several group key management protocols that are proposed, this paper will however elaborate mainly on Group key management which has a sound scalability when compared with other central key management systems. This paper emphases protocol which provides a scope for the dynamic group operations like join the group, leave the group, merge without the need of central mechanisms. An important component for protecting group secrecy is re-keying. With the combination of strong public and private key algorithms this would become a better serve to the multicast security.

I.INTRODUCTION

1.1 Unicast - Broadcast Multicast

The multicast group can be identified with the class D's IP address so that the members can enter or leave the group with the management of Internet group management protocol. The trusted model gives a scope between the entities in a multicast security system. For secure group communication in the multicast network, a group key shared by all group members is required. This group key should be updated when there are membership changes in the group, such as when a new member joins or a current member leaves. Along with these considerations, we take the help relatively prime numbers and their enhancements that play a vital role in the construction of keys that enhances the strength for the security. Multicast cryptosystems are preferably for sending the messages to a specific group of members in the multicast group. Unicast is for one recipient to transfer the message and 'Broadcast' is to send the message to all the members in the network. Multicast applications have a vital role in enlarging and inflating of the Internet.

II.BACKGROUND STUDY

IGMPv2 [Internet Group Management protocol] allows group membership termination to be quickly reported to the routing protocol, which is important for high-bandwidth multicast groups and/or subnets with highly volatile group membership [1]. The specification proposes a protocol to create grouped symmetric keys and distribute them amongst communicating peers. This protocol has the following advantages: 1) virtually invisible to operator, 2) no central key distribution site is needed, 3) only group members have the key, 4) sender or receiver oriented operation, 5) can make use of multicast communications protocols[2].

There are two main areas of concern with respect to key management, which are, initializing the multicast group with a common net key and rekeying the multicast group. A rekey may be necessary upon the compromise of a user or for other reasons (e.g., periodic rekey). In particular,this report identifies a technique which allows for secure compromise recovery, while also being robust against collusion of excluded users. The benefits of this proposed technique are that it minimizes the number of transmissions required to rekey the multicast group and it imposes minimal storage requirements on the multicast group[3].

In new methods for building such cryptosystems with various levels of security are provided (e.g., IND-CPA, IND-CCA2).The results are obtained enabled the construction of a whole class of new multicast schemes with guaranteed security using a broader range of common primitives such as OAEP[4].A novel solution to the scalability problem of group/multicast key management is discussed. Formalize the notion of a secure group as a triple where denotes a set of users, a set of keys held by the users, and a user-key relation. Introduce key graphs to specify secure groups. For a special class of key graphs, present three strategies for securely distributing rekey messages after a join/leave and specify protocols for joining and leaving a secure group. The rekeying strategies and join/leave

protocols are implemented in a prototype key server [5].

A taxonomy of multicast scenarios on the Internet and point out relevant security concerns. Address two major security problems of multicast communication: source authentication, and key revocation. Maintaining authenticity in multicast protocols is a much more complex problem than for unicast; in particular, known solutions are prohibitively inefficient in many cases. We present a solution that is reasonable for a range of scenarios. Approach can be regarded as a 'midpoint' between traditional Message Authentication Codes and digital signatures. An improved solution to the key revocation problem is presented [6].

It is considered one of the best solutions proposed for solving the scalability of multicast security protocols depending on a centralized manager. Instead of using one tree as in KMBFM, the members are divided into a number of subgroup trees[7].In keystone, the authentication of client identify can be offloaded to one or more registars to imrove performance. For efficient and reliable key updates, key updates used UDP/IP multicast delivery with forward error correction to reduce message loss, and an efficient re-synchorinization mechanism for clients o reliably update their keys in case of actual message loss[8].

This paper focuses the use of periodic batch rekeying this can improve efficiency and alleviate the out-of-sync problem. Devise a marking algorithm to process a batch of join and leave requests[9]. This approach is shows that if a group is re-keyed on each membership changed, as the size of the group increases and/or the rate at which members leave and join the group increases, the frequency of rekeying becomes the primary bottle neck for scalable group re-keying[10].

III.ISSUES ON SECURE MULTICAST

The special Characteristics of a secure system includes: Confidentiality, Integrity, Authentication, Access control, Non-repudiation.

3.1 Key Management

The key management for multicast requires quite a lot more traffic compared to the key management for unicast. First, the common group key should be distributed to each group member and all the senders. If the traffic should also be authenticated, each sender has to distribute their authentication key to all of the group members.

Some multicast routing systems don't require that there is a group owner or a group originator (core router), so the key management scheme presented above won't work. A simple solution is to use a semi-permanent group key, which is used to generate temporary group keys used to encrypt traffic or authenticate messages.

3.2 N-Way Cryptosystems

Symmetric cryptosystems use the same key for both encryption and decryption. Asymmetric cryptosystems use two separate keys; a message encrypted with one key can only be decrypted with another. Usually one of these keys is called public, another private, meaning that anyone can encrypt a message with the public key but only the party knowing the private key can find out the plaintext.

Some asymmetric cryptosystems, e.g., RSA, work also in another way. A message encrypted with the private key can be decrypted only with the public key. In essence, the RSA is a 2-way cryptosystem. An ideal encryption system for multicast or for any multi-party communications would have n keys, one for each participant. Such a system could be called an n-way cryptosystem.

IV. GROUP KEY MANAGEMENT PROTOCOL

This paper describes architecture for the management of cryptographic keys for multicast communications. It Identifies the rules and responsibilities of communications system elements in accomplishing multicast key management, defines security and functional requirements of each, and provides a detailed introduction to the Group Key Management Protocol (GKMP). It provides the ability to create and distribute keys within arbitrary-sized groups without the intervention of a global/centralized key manager. The GKMP combines techniques developed for creation of pair wise keys with techniques used to distribute keys from a KDC (i.e., symmetric encryption of keys) to distribute symmetric key to a group of hosts.

A multicast encryption scheme ME = (Kgen, Γ, E, D) consists of the following set of algorithms:

1.Kgen: a probabilistic polynomial-time (in k) Key Generation algorithm which takes as inputs a security parameter 1α, a threshold τ, the number of (initial) group members n, and generates global information , the encryption key π and the master secret key η.

2. Γ: a probabilistic Registration algorithm to compute the secret initialization data for a new user

subscribing to the system. Γ receives as input the master key η and a new index i associated with the user; it returns the user's secret key ηi.

3. Encryption E: a probabilistic polynomial-time algorithm that, on inputs π, the encryption key, and a string s ∈ {0, 1}α, and a set Γ́ of revoked users (with |Γ| ≤ α) and their keys, produces as output ψ ∈ {0, 1}* called the ciphertext1.

4. Decryption D: a deterministic polynomial-time algorithm can be described such that ∀m ∈ {0, 1}α, ∀ i ∈ U \ Γ, D(ηi, E(π, {(j, ηi)|j ∈ Γ́,s)) = s (1).

4.1 Multicast Routing Protocols

In the previous section, some algorithms that can potentially be used in multicast routing protocols are reviewed. Similar to unicast routing protocols (such as Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) protocol), there should be multicast routing protocols such that multicast routers can determine where to forward multicast messages. In this section, existing multicast protocols are discussed and how these protocols use some of the algorithms discussed in the previous section for exchanging the multicast routing information are also discussed. Review three routing protocols (Distance Vector Multicast Routing Protocol (DVMRP), Multicast Extensions to OSPF (MOSPF) protocol, and Protocol Independent Multicast – Dense Mode (PIM-DM) protocol) which are more efficient in situations where multicast group members are densely distributed over the network. Then, discuss the Protocol Independent Multicast – Sparse Mode (PIM-SM) protocol which performs better when group members are sparsely distributed.

4.2 The Internet Group Management Protocol (IGMP)

The IGMP is used by IP hosts to report their multicast group memberships to any immediately neighboring multicast routers. This memo describes only the use of IGMP between hosts and routers to determine group membership. All IGMP messages of concern to hosts have the following format:

Figure 4.1 IGMP – IP Address

Routers that are members of multicast groups are expected to behave as hosts as well as routers, and may even respond to their own queries. IGMP may also be used between routers, but such use is not specified here. Like GMP is a integral part of IP. It is required to be implemented by all hosts wishing to receive IP multicasts.

4.3 Multicast Key Management Architectures

It includes: Group Key Creation, Group Key Distribution, Group Rekey, Group controller, Group receiver, Group Key Deletion.

It is desirable to be able to delete group members for either administrative purposes or security reasons. Administrative deletion is the deletion of a trusted group member. It is possible to confirm the deletion of trusted group members. Security relevant deletion is the deletion of an untrusted member. It assumes that the member is ignoring all deletion commands.

Administrative delete Administrative deletion removes the group keys from trusted group members. This deletion consists of two messages the first sends a command to the group encrypted in the groups TEK. The command essentially says: acknowledge receipt and then delete group keys. This command is signed by the group controller to prevent unauthorized deletions. The acknowledgment message is also encrypted under the group TEK and is sent to acknowledge receipt of the command. Acknowledge accomplishment of the command if the net is willing to accept the burden of creating pairwise keys between the exiting group members and the group controller.

4.5 The Progressive Group Key Management Protocol

The Local Key Hierarchy (LKH) protocols, They reduces the re-key messages and encryption operations from $O(n)$ to $O(\log n)$ when compared to the Group Key Management Protocol (GKMP) and Secure Lock, where n is the number of group members. In proposal, The Proposed the progressive group key management protocol (PGKMP) is based on The Chinese Remainder Theorem and a hierarchical graph in which each node contains a key and a modulus.

4.5.1 The Hierarchical Graph:

In the new protocol, the keys and moduli are constructed as a tree and maintained by the key node [5]. The tree graph is similar to the tree graph in the LKH protocol but each node of the tree in the new protocol is assigned two values: a key and a modulus. Figure 3.2 depicts the key and modulus graph, where *TEK* is a traffic encryption key, *kij* is a key encryption key, and *mij* is a modulus.

4.5.2 Moduli Maintenance:
The key server needs to store 2*log*2*n* moduli and each member needs to store *log*2*n* moduli but they do not need to keep the moduli secret. The sibling nodes in the tree graph are assigned with two different moduli (i.e., *mi*1 and *mi*2 where *i* is the depth of the tree) and the nodes in the different level of the tree are assigned with the different moduli but each a pair of siblings at the same tree depth are assigned with the same two moduli under the different parents.

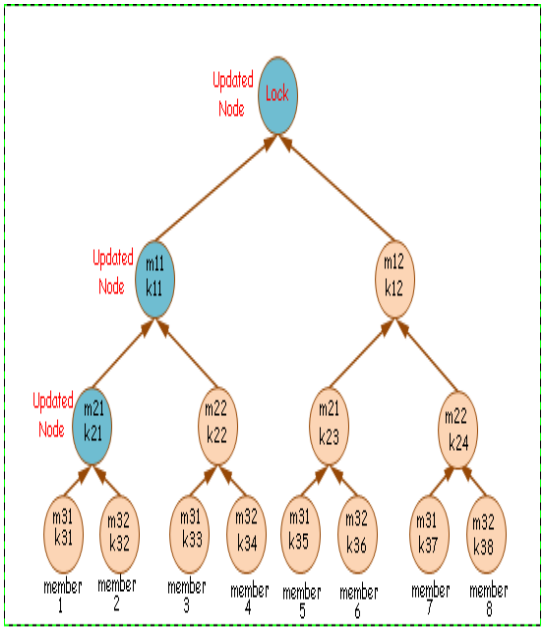

Figure3.2: A Tree Graph containing Key and Modulus

For instance, in Figure 3.2, for a path from *u*1 to the root, the moduli on the path include *m*11, *m*21, and *m*31, and the moduli on its direct children include *m*12, *m*22, and *m*32.

4.5.3 Key Maintenance:
The key server needs to store 2*n*-1 keys, i.e., *TEK* and *kij*($1 \le i \le log2n$, $1 \le j \le 2i$) where *i* is the depth of the node in the tree and *j* is the ordinal number of the node in the *i*th depth of the tree, and each member needs to store *log*2*n*+1 keys. The key server shares the keys with each member on the path from its leaf to the root.

V. PERFORMANCE ANALYSIS SECURITY
In multicast network basic functions like packet forwarding, routing and network management are done by all nodes instead of dedicated ones. Instead of using dedicated nodes for the execution of critical network functions you have to find other ways to solve this, because the nodes of a mobile multicast network can't be trusted in this way.

- Confidentiality
- Integrity
- Authentication
- Nonrepudiation

A key reason for this good performance is the fact that PGKMP operates entirely on-demand with no periodic activity of any kind required within the network. PGKMP finds disjoint paths, so the route discovery cost will be less as compared to LKH.

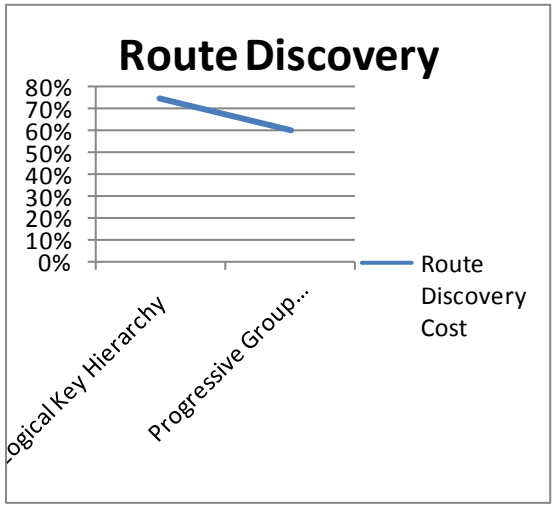

Figure 5: Route Discovery Cost

5.1 Solutions on security issues:
All the above security mechanisms must be implemented in any multicast networks so as to ensure the security of the transmissions along that network. Thus whenever considering any security issues with respect to a network, always need to ensure that the above mentioned for security goals have been put into effect and none (most) of them are flawed.

Using authentication techniques during all routing phases exclude attackers and unauthorized nodes from participating in the routing by using digital signatures or some public key infrastructure (PKI). This can be done by cryptography techniques such as key system.

Figure 5.1: Comparison of Security

VI. CONCLUSIONS & FUTURE SCOPE

Multicast routing protocols provide resilience against collaborating malicious nodes. PGKMP is a complete multipath protocol, in the sense that it provides the maximum security in the network when compared to the existing protocols like LKH etc. The security of PGKMP is mainly based on neighborhood authentication of the nodes, as well as on security associations, while the use of public key cryptography is minimized. The PGKMP protocol can be integrated on top of existing on-demand routing protocols such as LKH. A key reason for this good performance is the fact that PGKMP operates entirely on-demand with no periodic activity of any kind required within the network.

PGKMP finds disjoint paths only, so the route discovery cost will be less as compared to LKH where all possible paths exist and a key server has to be maintained. Also due to the double encryption scheme provided to the protocol, the network is more secured.

There is a scope to further decrease the overheads and increase more security with this Protocol (PGKMP) and a positive hope for the enhancement of this protocol.

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