An Architecture and Key Management Approach for Maintaining Privacy in Location Based Group Services

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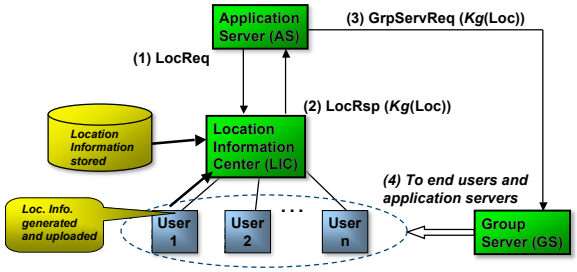
Location based services are becoming increasingly important to the success and attractiveness of next generation wireless systems. It is a challenge to maintain location privacy while still providing the flexible access to location information required to enable a rich set of location based services.

Design Philosophy

- user controlled location information access
- a group of entities defined by user to access its location information
- hierarchical coding of location information with different granularity
- providing keys to the group members to decrypt location information

LBGS architecture



Service Example

Location Based Instant Message Service:

For example: alert is sent to subscribers when a buddy is within a certain proximity.
Two models:

- end users and LIC are members of the location information group
- IM server is also a member of the location information group

Service Characterization

WHERE location information is generated
- by the end device or the network.

WHERE location information is stored
- in the end device, network, or not at all.

HOW information is accessed
- pushed at various intervals or pulled on-demand.

with WHOM the location information is shared
- information may be shared with other end users, network servers, or both.

MIKEY and LKH

MIKEY as the basis of our protocol:

- lightweight protocol.
- adopted by the 3GPP MBMS group for 3G multimedia services

Two limitations of MIKEY:

- no hierarchy of group key servers support
- no re-keying support

Basic Solution:

- apply LKH to MIKEY to improve scalability with re-keying.

MIKEY-LKH Applied to Hierarchical Coding

Coding by Information Class

A user subscribes multiple groups to receive multiple granularity of location information. The cost of re-keying :

$$C_{class}(N) = \sum_{i=1}^{C_{max}} r_i (2K(\sum_{j=1}^{i} \log((\sum_{m=j}^{i} r_m) \cdot N)) + iP)$$

Coding by Group

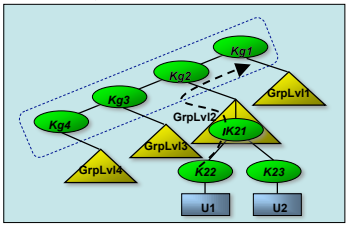
Each group re-keys independently of other groups. The cost of re-keying :

$$C_{group}(N) = \sum_{i=1}^{C_{max}} r_i (2K \log(r_i \cdot N) + P)$$

Nested Hierarchy Coding

This relies on information hierarchy
The cost of re-keying :

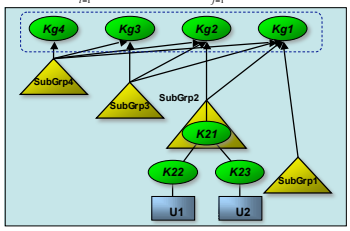
$$C_{nested}(N) = \sum_{i=1}^{C_{max}} r_i (2K(\log(r_i \cdot N) + i) + P)$$



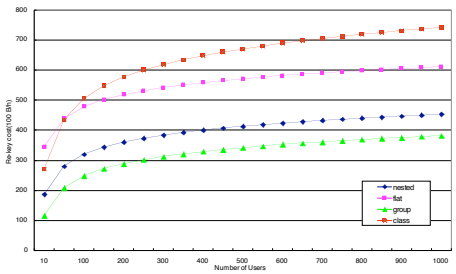
Flat Coding

A flat relationship among sub-groups.
The cost of re-keying :

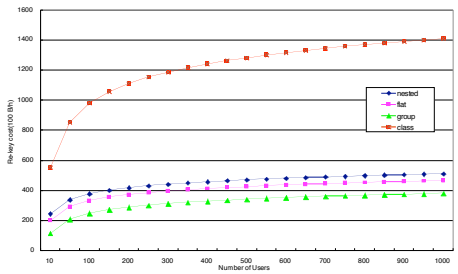
$$C_{flat}(N) = \sum_{i=1}^{C_{max}} r_i (K(2\log(r_i \cdot N) + \sum_{j=1}^{i} (c - j + 1)) + P)$$



Performance Evaluation



Hierarchical LKH re-keying overhead (r1:r2:r3:r4=30:10:8:5)



Hierarchical LKH re-keying overhead (r1:r2:r3:r4 = 5:8:10:30)

Summary of Evaluation

Method	Class	Group	Nested	Flat
User Storage	-	+	-	-
Multi-cast groups	-	-	+	-
Re-key	-	+	0	0
Message delivery	-	+	+	-
Computing at end device	-	+	-	-
Flexibility	+	0	0	+

Note: + corresponds to an attractive characteristic, - corresponds to a drawback, and 0 is neutral.