Key Management and Adjacency Management for KARP-based Routing Systems

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Definitions

- **Administrative Domain (AD)**
  - Set of routers under a single administration
    - RFC 4375 provides a convenient definition (in the context of Emergency Management)
  - An AD is not bigger than an autonomous system
    - Because we are dealing with Interior Gateway Protocols

- **Group Controller/Key Server (GCKS)**
  - Specific to a particular routing protocol (RP), because “adjacency” may be defined differently for each RP
    - Rules may be the same for different protocols, but stored data will be different
Definitions..2

- **Group Member (GM)**
  - Any router within the Administrative Domain
    - Note that depending on the keying model in use, we may form smaller “groups”

- **Neighbor**
  - The set of routers that are adjacent to a particular router
AS and AD

AUTONOMOUS SYSTEM

ADMINISTRATIVE DOMAIN

GCKS

GM2

KMP

GM1

GM3

IGP

Ext.GP

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IETF 84-KARP
Keying Scopes (1)
Whole AD

- Same key for the entire AD
Keying Scopes (2)
All routers on a link

- Key per link
Keying Scopes (3)
Group per sending router

- Separate key per router
Keying Groups (4)

Group per sending router per interface

- Separate key per router per interface
Keying Groups (4)
Group per sending router per interface

- Separate key per router per interface
Keying Assumptions for RKMP and MaRK

- Both documents make the same statement
  - “Routers need to be provisioned with some credentials for a one-to-one authentication protocol”
  - “Preshared keys or asymmetric keys and an authorization list are expected to be common deployments”
Observations (1)

- To establish the router identities and legitimate adjacencies, this will involve walking to each router and carefully configuring the paired keys and authorization lists
  - Or, at the very least, remotely logging on to each router...

- This seems somewhat error prone to us
Observations (2)

- Adjacency control has to be centralized
  - No individual router can determine, by itself, who its legitimate neighbors are
- We have explored the issue of key generation in the context of making adjacency management easier.
- The operation of MaRK appears to us to make managing adjacency more difficult
  - Specifically, the election of a GCKS for the routers on a link, which can be different each time it happens.
Our goals

- To explore ways that allow easy adjacency control (which has to be centralized)
- Without depending on a central facility when you have a power failure
- In a manner that works for both the unicast and the multicast cases
Key Management Architecture

- Overall Controller
- Protocol GCKS
- Protocol Keystore

- Group Member
  - Local KS/GCKS
  - Local Keystore

- Group Member
  - Local KS/GCKS
  - Local Keystore
Structure

- Two levels for the Automatic Keying Management
  - GCKS ⇔ GM Negotiation
  - GM ⇔ GM Negotiation

- Four steps
  - Mutual authentication (GCKS ⇔ each GM)
  - Push policy and adjacency information on this path
  - Mutual authentication (GM to each adjacent GM)
  - Push or negotiate keying material from GM to/with adjacent GMs
System Goals

- To generate, distribute and update keying materials

- 11 “security goals”
- 6 “non-security goals”

- These were assembled from review of the Design Guide and the Threats and Requirements Guide

- Details are in the draft
Results

- The framework allows us to simplify the establishment of the pre-shared keys
- Allows us to introduce centralized control of adjacency
- Allows incremental deployment, with different keying models on different interfaces
- Avoids DoS attacks on the central controller after power failure
System architecture

Conforms to the Multicast Group Security Architecture Specification
Key Management Phases: Between Components

Step 1
Step 2

Step 3

Step 4
System Operation (1)

- Step 1 – Mutual authentication GCKS to GM
  - Establish secure path and mutual authenticity between GCKS and individual Group Members
    - This path will be used to distribute information for use by the GM to identify and authenticate its neighbors
  - Standard IKE or IKEv2 exchange
System Operation (2)

- Step 2 – Push policies to the GM
  - SA policy corresponding to the TEK
  - Signed certificate to identify this router
  - Key scope to be used
  - Policy token
  - Adjacency information

- Plus the necessary hashes and nonces to ensure that the security requirements are met
Step 3 – Mutual Authentication between adjacent GMs

- Establish secure path and mutual authenticity between adjacent Group Members
  - To be used to distribute parameters that will be used by the GM to send information to its neighbors (i.e., routing protocol control packets)
- The identity information pushed in Step 2 is used to identify legitimate neighbors
- Standard IKE or IKEv2 exchange
Step 4 – Exchange or negotiation of keying materials

- SA information corresponding to the TEK of the sending router
- Request for SA information corresponding to the TEK of neighbor routers

Plus the necessary hashes and nonces to ensure that the security requirements are met
Key Management Exchanges: Within GMs

KMP (Key Management Protocol)
- Join group
- Initial key
- Change key

RP (Routing Protocol)
- Notification of new keys

LKS (Local Key Server)
- SA parameters related to TEK
- Key Store

SA parameters related to TEK
Academic Aspects

- Formal validation of the security of the protocols has been done, using AVISPA (Automated Validation of Internet Security Protocols and Applications).
- GCKS and GMs are modeled.
- Intruder can take any role.
- Security goals (for example, secrecy of the generated TEK) can be formulated.
- AVISPA reports “safe” for the set of security goals and scenarios explored.