

8.7.5 IKE: Key Management in IPsec

When a VPN has a small number of end points (for example, just two routers as in Figure 8.28), the network administrator can manually enter the SA information (encryption/authentication algorithms and keys, and the SPIs) into the SADs of the endpoints. Such “manual keying” is clearly impractical for a large VPN, which may consist of hundreds or even thousands of IPsec routers and hosts. Large, geographically distributed deployments require an automated mechanism for creating the SAs. IPsec does this with the Internet Key Exchange (IKE) protocol, specified in RFC 5996.

IKE has some similarities with the handshake in SSL (see Section 8.6). Each IPsec entity has a certificate, which includes the entity’s public key. As with SSL, the IKE protocol has the two entities exchange certificates, negotiate authentication and encryption algorithms, and securely exchange key material for creating session keys in the IPsec SAs. Unlike SSL, IKE employs two phases to carry out these tasks.

Let’s investigate these two phases in the context of two routers, R1 and R2, in Figure 8.28. The first phase consists of two exchanges of message pairs between R1 and R2:

- During the first exchange of messages, the two sides use Diffie-Hellman (see Homework Problems) to create a bi-directional **IKE SA** between the routers. To keep us all confused, this bi-directional IKE SA is entirely different from the IPsec SAs discussed in Sections 8.6.3 and 8.6.4. The IKE SA provides an authenticated and encrypted channel between the two routers. During this first message-pair exchange, keys are established for encryption and authentication for the IKE SA. Also established is a master secret that will be used to compute IPsec SA keys later in phase 2. Observe that during this first step, RSA public and private keys are not used. In particular, neither R1 nor R2 reveals its identity by signing a message with its private key.
- During the second exchange of messages, both sides reveal their identity to each other by signing their messages. However, the identities are not revealed to a passive sniffer, since the messages are sent over the secured IKE SA channel. Also during this phase, the two sides negotiate the IPsec encryption and authentication algorithms to be employed by the IPsec SAs.

In phase 2 of IKE, the two sides create an SA in each direction. At the end of phase 2, the encryption and authentication session keys are established on both sides for the two SAs. The two sides can then use the SAs to send secured datagrams, as described in Sections 8.7.3 and 8.7.4. The primary motivation for having two phases in IKE is computational cost—since the second phase doesn’t involve any public-key cryptography, IKE can generate a large number of SAs between the two IPsec entities with relatively little computational cost.