Cryptography and Java

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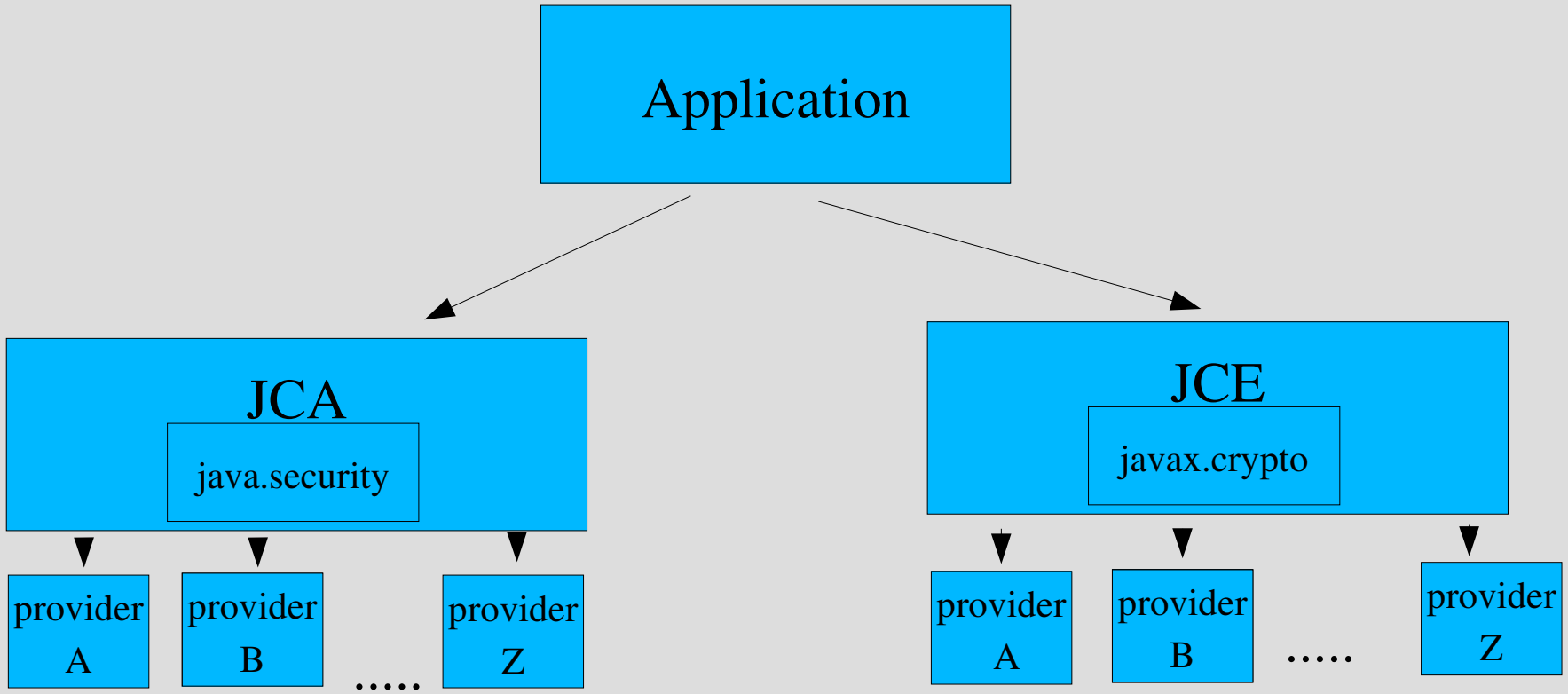
Java provides cryptographic functionality using two APIs:

- JCA – Java Cryptography Architecture
  - *security framework integrated with the core Java API*
- JCE – Java Cryptography Extension
  - *Extensions for strong encryption (exported after 2000 US export policy)*

Basic Architecture

- Provider based architecture



Design principles

- Algorithm independence
  - *specification of engine classes*
- Algorithm extensibility
  - *easy updation of engine classes with new algorithms*
- Implementation independence
  - *use of cryptographic service providers*
- Implementation interoperability
  - *providers working with each other*

Engine classes

- Cryptographic operations are classified into classes in JCA/JCE. This classes are called as engines.
  - JCA engines
  - JCE engines

JCA engines

- MessageDigest (*produces hash value)*
- Signature (*produces digital signature)*
  - KeyPairGenerator (*produces pair of keys)*
- KeyFactory (*breaks down a key)*
- KeyStore (*manages and stores keys)*
- SecureRandom (*produces random numbers)*
  - AlgorithmParameters (*encoding and decoding)*
  - AlgorithmParameterGenerator (*generates parameters)*
- CertificateFactory (*public key cert, revocation)*
- CertPathBuilder (*establish relationship chains between certs)*
- CertStore (*stores certificates and revocation lists)*

JCE engines

- Cipher (*encryption/decryption*)
- KeyGenerator (*produces secret keys used by ciphers*)
- SecretKeyFactory (*operates on SecretKey objects*)
- KeyAgreement (*key agreement protocol*)
- Mac (*message authentication code functionality*)

Location

- JCA engines are located in java.security package
- JCE engines are located in javax.crypto package

Getting started

- Example 1: Generate a DES/AES key and use cipher to encrypt a message.

```
byte[] message = "I am a superman, sshhh don't tell anyone".getBytes();

KeyGenerator keygenerator = KeyGenerator.getInstance("DES");
SecretKey desKey = keygenerator.generateKey();

Cipher desCipher = Cipher.getInstance("DES/ECB/PKCS5Padding");
// Initialize the cipher for encryption
desCipher.init(Cipher.ENCRYPT_MODE, desKey);

// Encrypt message and return
byte[] encryptedMessage = desCipher.doFinal(message);
```

- Example 2: Generate random bytes using SecureRandom.

```
import java.security.SecureRandom;

public class Main {
  public static void main(String[] argv) throws Exception {
    SecureRandom secRandom = SecureRandom.getInstance("SHA1PRNG");
    secRandom.setSeed(711);
    byte[] bytes = new byte[20];
    secRandom.nextBytes(bytes);
  }
}
```

Your Best Friend

- Look up API docs for the relevant packages
  - java.security
  - javax.crypto
- JCA reference guide
  - http://java.sun.com/j2se/1.5.0/docs/guide/security/CryptoSpec.html

Appendix

Algorithm extensibility - example

```
MessageDigest ultrafastImplementation =

 MessageDigest.getInstance("UltraFastHash");
```

Implementation independence

- Offers the developer a choice of how to handle the presence of providers

```
MessageDigest Dev1Md5Implementation =

 MessageDigest.getInstance("MD5", "Provider1");
```

Implementation interoperability

- Providers are interoperable
- The developer might use provider A to generate a key pair, passing that key pair along to provider B's signature algorithm

Adding providers

There are two ways

- Adding statically
- Adding dynamically

Static addition:

- Copy the JCE provider JAR file to java-home/jre/lib/ext/
- Stop the Application Server
- Edit the 'java-home/jre/lib/security/java.security' properties file in any text editor. Add the JCE provider you've just downloaded to this file.

security.provider.n=provider-class-name

Adding providers

Static addition (cont..)

```
security.provider.2 = org.bouncycastle.jce.provider.BouncyCastleProvider
```

- Dynamic addition

```
// create a provider object
Provider bountyProvider = new org.bouncycastle.jce.provider.BouncyCastleProvider();
// Add the bountycastle Provider to the current list of
// providers available on the system.
Security.addProvider (bountyProvider);
```