

# **Smoke**

An Android Echo Software Application

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## About

Smoke is an Android communications research project. The software is composed of a single multi-threaded application. A companion application, SmokeStack, provides mobile server services.

Software sources are available at <https://github.com/textbrowser/smoke> and <https://github.com/textbrowser/smokestack>.

## Android

Smoke has been successfully tested on Android versions 4.4, 5.0, 5.1, 6.0, 7.0, and 7.1. Android versions 4.4, 5.0, and 5.1 are not officially supported.

According to <https://developer.android.com/about/dashboards/index.html>, Smoke supports 92.7% of all Android versions.

## **Congestion Control**

Smoke implements a software-based congestion control mechanism. The SipHash algorithm is used for computing digests. Computed digests are stored in an SQLite database table. Routinely, expired entries are removed.

## Corrupted Database Values

Encrypted database values pose an interesting design problem. How should an application depict a faulty database value to the user if the application is unable to properly decrypt an encrypted value? Some software packages ignore the potential problem altogether. Others, delete or hide the corrupted entries; logging the failures in squandered logs. Smoke offers an exceptionally-transparent solution. Damaged database entries are depicted in various containers. These depictions offer insight into potential system failures.

## Database Containers

Most of the database fields contain authentically-encrypted values. Some fields contain keyed digests, including keyed digests of binary (false / true) values. Values are stored as  $E(\text{Data}, K_e) \parallel \text{HMAC}(E(\text{Data}, K_e), K_a)$  and  $\text{HMAC}(\text{Data}, K_a)$ .

## Discovery via Cryptography

Cryptographic discovery is a mechanism which allows servers to lighten the computational and data responsibilities of mobile devices.

Shortly after a Smoke instance connects to a SmokeStack service, the Smoke instance shares some non-private material. The material allows a SmokeStack server to transfer messages to their correct destinations. SmokeStack instances routinely distribute gathered, non-expired material to other SmokeStack services, thus creating a network of cooperative SmokeStack faculties.

Cryptographic Discovery assumes a trustworthy network.

To mitigate replay attacks, Smoke offers SmokeStack instances random identity streams during message-retrieval requests. The identity streams self-expire.



## Exchanging Private Credentials

The Calling feature allows two parties to exchange private key material. Please note that messages which have been recorded in a SmokeStack instance via one set of credentials will not be available if the credentials have changed. The process of exchanging private credentials is as follows:

1. A participant issues a Call via a selected participant. A new 2048-bit RSA public-key pair is generated. A signature fastening the two participants is computed. The bundle is then transferred to the recipient.
2. A participant receives the bundle, verifies the included signature, generates private authentication and encryption keys, and bundles the private key material via the included public RSA key. The participant transfers the signed private key material bundle to the initial participant.
3. The initiating participant receives the private key material, verifies the included signature, and unpackages the private key material via the ephemeral private key.

## Fire

Fire introduces communication networks between Smoke and Spot-On. Key generation is described below.

```
authentication_key = pbkdf2(sha512(Digest || "sha384"), // Salt
                             Digest,
                             10000,
                             768)                      // Bits (96 Bytes)
authentication_key, destination_key := authentication_key[0 ... 31], authentication_key[32 ... ]
encryption_key := pbkdf2(Salt,
                          Channel || "aes256" || "sha384",
                          10000,      // Iteration Count
                          2304)       // Bits (288 Bytes)
encryption_key := encryption_key[0 ... 31]
```

## Inflate

Smoke expands text-messaging data to 8192 bytes. If the provided data exceeds 8192 bytes, Smoke expands the provided data by  $1024 + \text{mod}(\text{data length}, 2)$  bytes.

## McEliece CCA2

As of version Drooling Dragon, Smoke supports McEliece-Fujisaki via BouncyCastle. Parameters are SHA-256,  $m = 11$ ,  $t = 50$ . Some discussions:

- Authentication process may require several minutes to complete.
- During the key-sharing process, McEliece signatures are not provided.
- Expect degraded performance.
- Initialization processes may require several minutes to complete.

## Outbound Queues

Smoke offers near-real-time communications. As network services may be unreliable, certain outbound messages are enqueued in an SQLite database table. Each network peer is assigned a separate queue. Messages are dequeued in a timely manner and placed onto the network. Calling messages, retrieval of offline messages, and status messages are considered expendable and are therefore written to network sockets regardless of network availability.

Please note that peers which are in disconnected status-control states are ignored during the enqueue processes.

## Ozone Address

An Ozone address is a pseudo-private string which identifies a virtual entity. Smoke and SmokeStack utilize Ozones as a means of retrieving and storing offline messages and public key pairs. Smoke supports one Ozone while SmokeStack supports infinitely many. Ozone addresses must be shared separately. Retrieved messages are only meaningful within the context of a session. It is possible for multiple Smoke parties to house distinct Ozones if common SmokeStack instances are aware of the distinct Ozone addresses.

Please note that public Ozone addresses will introduce denial of service vulnerabilities.

## **Private Public Key Server**

In addition to housing messages, SmokeStack also serves as a private public key server. A SmokeStack administrator is responsible for coordinating the storage of public key pairs of participants. Participants may request public key pairs of specific participants via Ozone addresses.

## SipHash Identities

Exchanging public key pairs is often an involved process. Smoke implements the pseudo-random function SipHash so as to simplify the process. The SipHash function generates outputs of 8 bytes (16 characters hexadecimal). These short strings are easily memorized and/or distributed via other communications applications. SipHash identities are generated as follows:

```
id := siphash(public-encryption-key || public-signature-key,  
              pbkdf2(sha512(public-encryption-key || public-signature-key), // Salt  
                    public-encryption-key || public-signature-key,  
                    4096, // Iteration Count  
                    128)) // Bits (16 Bytes)
```

Non-confidential authentication and encryption key streams from SipHash identities are generated as follows:

```
keystream1 := pbkdf2(sha512(id), // Salt  
                    id,  
                    4096,          // Iteration Count  
                    160)          // Bits (20 Bytes)  
keystream2 := pbkdf2(sha512(id), // Salt  
                    keystream1,  
                    1,            // Iteration Count  
                    768)          // Bits (96 Bytes)
```

### Public Data

Chat Encryption Key

Algorithm: RSA

Fingerprint: 27:1ef6:31:d7:67:4b:b3:82:00:4b:59:3c:d9:16:41:93:47:a5:a3:c5:17:1e:5f:

70:56:06:cc:a8:de:f2:1d:ea:b4:ca:d7:99:34:a0:a6:8f:27:2e:df:9a:78:7c:43:a1:a1:bc:63:3f:51:e2:9a:83:1f:73:66:22:63:01:f6

Format: X.509

Size: 3072

Chat Signature Key

Algorithm: RSA

Fingerprint: a3:42:81:f1:34:d1:dd:c8:2f:2c:1d:a3:c4:95:31:17:79:73:d7:b2:6c:df:9c:91:8e:1c:07:6f:42:af:16:31:4a:9c:

69:7d:d8:b6:de:5f:ab:8a:b1:58:38:ae:96:ec:37:fd:ef:fc:21:3d:a4:c2:db:36:a3:80:92:fb:ee:5e

Format: X.509

Size: 3072

**SipHash Chat ID**

**@39B8-3DE5-A567-9C6F**

RESET SMOKE

The transport keys which are generated from SipHash identities may be used for exchanging public-key data via the Echo Public Key Share (EPKS) protocol.

It is impossible to avoid SipHash collisions as there are infinitely-many inputs and a limited number of outputs.



## TCP, UDP Protocols

Smoke supports both the TCP and UDP network protocols. Multicast and unicast UDP varieties are provided. Multiple clients may be defined via Settings. A limit on the number of clients is not imposed. When defining neighbors, one may define SmokeStack and/or Spot-On neighbors. SmokeStack, the companion application of Smoke, offers mobile server services as well as message and public-key storage.

### Neighbor Servers

Control	Remote
Action ▾	Control: Connect Status: Connected 192.168.178.18:4710:TCP 192.168.178.165:59430 Proxy: Remote Certificate's Fingerprint: 35:88:56:47:8a:b5:7f:0d:9d:4b:6f:48:16:16:4d:0f:a8:d3:a6:6f:67:10:fd:33:c0:d1:06:64:ee:db:3b:a0:11:30:d5:55:7f:cc:b0:a6:89:33:08:ea:2d:7f:c3:eb:90:89:6d:bd:1e:5a:47:f8:fc:f1:7b:d9:7f:34:fc Session Cipher: TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 Temp. Queued: 0 / 256 In: 48.23 KiB Out: 25.27 KiB Outbound Queued: 0 Uptime: 1:52 Min.
Action ▾	Control: Connect Status: Connected 192.168.178.100:4710:TCP 192.168.178.165:46678 Proxy: Remote Certificate's Fingerprint: ac:e0:fc:62:a3:90:d1:89:20:3e:f7:b5:ee:31:ea:7f:87:f9:67:86:38:d1:e5:44:37:ae:30:b3:1e:ea:e0:c8:70:23:8f:9f:31:70:7f:1b:04:02:5a:15:71:81:f0:ce:d2:e2:7c:66:7e:86:61:80:85:78:02:d7:74:b3:cc:3a Session Cipher: TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 Temp. Queued: 0 / 256 In: 10.42 KiB Out: 25.27 KiB Outbound Queued: 0 Uptime: 1:52 Min.

☒ Automatic Refresh ☒ Details

☐ Echo

REFRESH

IP Address

4710

Scope ID

☒ IPv4 ☐ IPv6

TCP ▾

Proxy IP Address

Proxy Port

HTTP ▾

ADD

RESET FIELDS