Gallagher Command Centre

Mobile End to End Encryption

Technical Information Paper

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Important: If you received this document along with your Command Centre installation media, or via another similar channel then it may be out of date with respect to the functionality/behaviour of the cloud, and of the Mobile Connect Apps, which are distributed through platform App Stores and may be more recent than your Command Centre installation.

It is recommended you refer to the latest revision of this document, which can be found here:
https://gallaghersecurity.github.io/r/mobileconnect-end-to-end-encryption

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1 Introduction

1.1 Pre-requisites

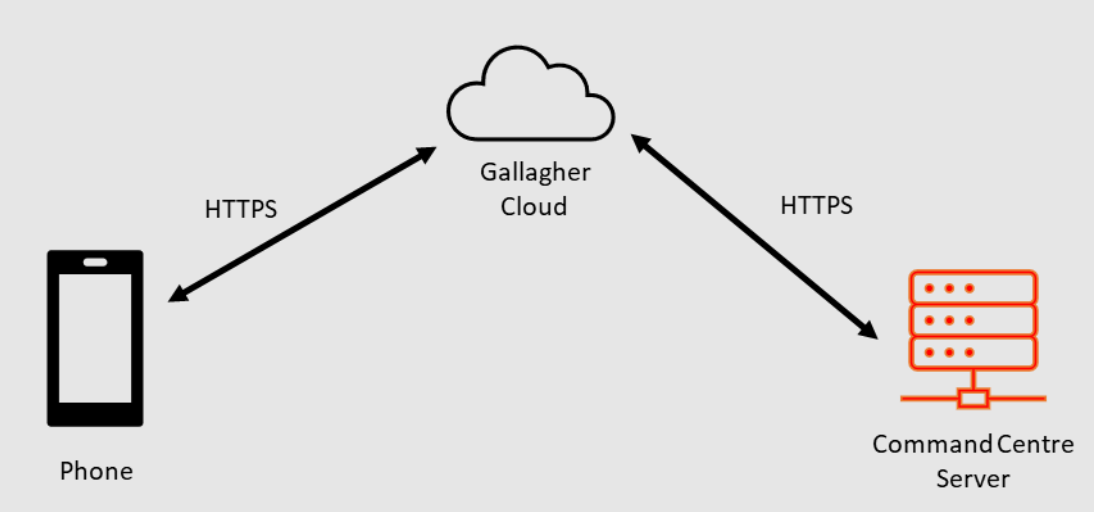
A pre-requisite to this document is the Mobile Connect Cloud and App Security technical information paper. If you are not familiar with that document, you should read it before proceeding.

The document is located here:
https://gallaghersecurity.github.io/r/mobileconnect-cloud-and-app-security

Alternatively, you received this document along with your Command Centre installation media, The Cloud and App Security TIP document should also have accompanied it.

1.2 Background

The communication architecture of Gallagher's Mobile Connect app and SDK is such that all data exchanged between Mobile Devices and a customer's on-premises Command Centre server is relayed through the cloud. This is necessary because either the server or mobile devices may be intermittently offline, reducing the stability of a direct connection between the two. Furthermore, allowing direct network traffic from mobile apps through to a Command Centre server is likely unpalatable to many customer IT departments.



As detailed in the Cloud and App Security TIP, Command Centre v8.40 and Mobile Connect v15 for iOS and Android adds support for Digital ID cards. Digital ID cards may contain personal information such as Photos, Names, identifying numbers (such as a Student ID) and more. Keeping this information safe and secure is critical.

Without end to end encryption, this would mean that:

a) Gallagher's Cloud Services would always have access to Digital ID card information as it passes through.

b) If the cloud services were ever to be compromised or suffer a data breach, attackers would gain access to that information.

Gallagher considers the security of our cloud services as paramount, and we take many steps (such as secure coding guidelines, external third-party security review and penetration testing, etc) to ensure our environments are robust against attack; however it is naïve in today's modern computing environment to claim that a cloud service could never be compromised, or that a data breach is impossible.

The best to protect our customers from attacks like these is to have the edge devices (Mobile apps and Command Centre server) encrypt data in a way that cannot be decrypted by our cloud services. This is end to end encryption.

Note: In addition to securing Digital ID cards, end to end encryption will also be used to protect SALTO key data as it transits through the cloud, once a server is upgraded to v8.40 or later of Command Centre.

2 End to End Encryption Overview

There are a variety of protocols/schemes for implementing an end to end encryption system. Fundamentally they all depend on the core concept of **Asymmetric Encryption**.

Disclaimer: This section is intended to introduce the concepts employed in end to end encryption and may not be strictly correct at all levels of detail. Consider this a high-level overview rather than a technical reference.

With asymmetric encryption, the key used to encrypt data consists of two parts - a "public" key and a "private" key. Together these form a "key pair". The underlying mathematics of cryptography are such that data encrypted by one side can be decrypted by the other, and vice versa.

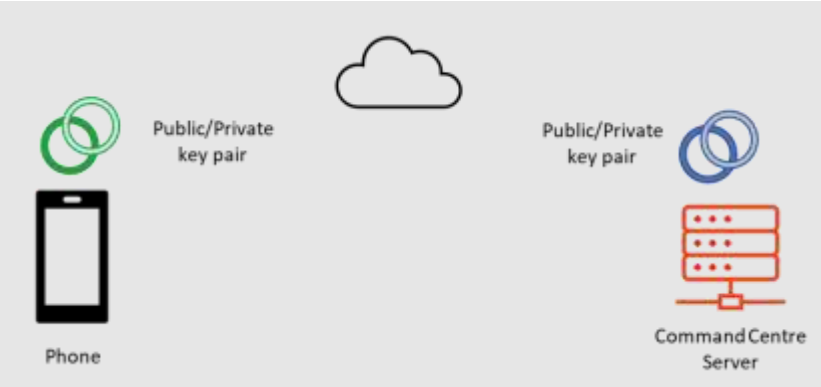
If a party wants to communicate with another using asymmetric encryption, it will generate a key pair, and send the public key to the remote device. It will keep the private key which will never be transmitted over a network. The remote device can use the public key to encrypt a message. Only the private key can successfully decrypt this message, so the remote device knows that it is safe to send across the network.
For two-way communications, both ends can generate a key pair, and exchange public keys.

The public key is called the "public" key because it is safe for anyone to have it. As such, we can safely transmit it over the network, via the cloud, or any other mechanism. The foundation of the security lies in the private key, which is never transmitted.

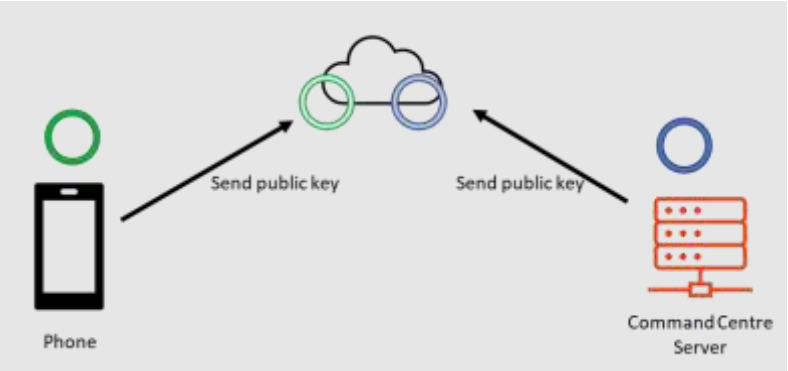
2.1 Key and Message Distribution

The Command Centre server and Mobile Connect apps exchange public keys using the Gallagher Cloud. The Gallagher Cloud keeps a copy of the last-known public key for a server or phone; as above the public key is not sensitive and is safe to keep.

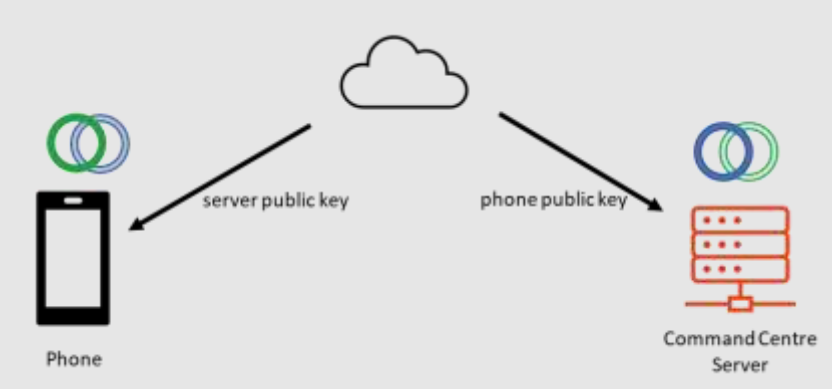
Step 1: Both ends generate a key pair.
In the following series of diagrams, light colored circles represent public keys, and dark colored circles represent private keys. A paired set of keys is indicated by sharing a color.



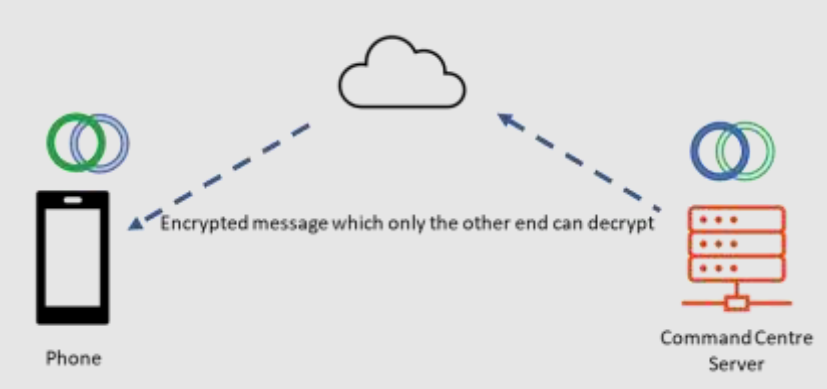
Step 2: Both ends send their public key to the Cloud



Step 3: Cloud sends public keys to the other end



Step 4: The server can now encrypt messages that can only be decrypted by the private key of the target device, and vice versa. The Gallagher Cloud never receives the corresponding private keys, and thus cannot read or modify data passing between the phone and server.



3 Technical Implementation Details

The above sequence diagram represents an abstract view of what is happening. In practice the situation is much more complex; keys are used to derive other keys, message authentication codes are employed, and so forth.

Note: The following details refer to version 1 of the Gallagher Cloud end to end encryption system. If flaws or weaknesses are ever discovered in this system, we will update it and publish a revised version.

This document is current as of October 2021.

3.1 Protocol

Gallagher implements the Elliptic Curve Integrated Encryption Scheme (ECIES) for end to end encryption.

ECIES is an industry standard and is most notably used by Apple in their implementation of end to end encryption for their iMessage service. We modelled our encryption off of Apple's and aim provide communication security at least as robust as iMessage's.

More information can be found online, such as at the Wikipedia Integrated Encryption Scheme page:
https://en.wikipedia.org/wiki/Integrated_Encryption_Scheme

Or this general overview article:

https://www.nominet.uk/how-elliptic-curve-cryptography-encryption-works/

3.2 ECIES implementation details

- Elliptic-curve P256 (secp256r1) is used for public and private keys
- AES-128 is used for per-message derived keys
- HMAC-SHA256 is used for message integrity

3.3 Key rotation and revocation

As private keys never leave the device, and ECIES generates unique keys per each message that is sent, we do not rotate the underlying elliptic curve keypair on a periodic basis

Our network protocol between the phone, cloud and server does allow for future key rotation, and if a key's integrity were in doubt, we could issue an update to either Command Centre or the Mobile Apps to rotate keys if necessary.

Note: In the event of a phone being compromised, a specific key rotation would not be necessary; The Mobile Connect app ties encryption keys to the end user's Mobile Credential, which can simply be revoked from the Command Centre server.

3.4 Key storage

On iOS devices, the private key is generated and stored in the Secure Enclave. This is a separate processor with its own isolated secure hardware key storage. More information is available from Apple:
https://support.apple.com/en-nz/guide/security/sec59b0b31ff/web

On Android devices, the private key is stored in two parts. The native Android keystore provides the most secure form of storage and uses hardware-backed key storage on all devices which support it.

However, while the Android keystore can store Elliptic Curve P256 keys, those keys can only be used for signature verification, rather than encryption. As such, we store the Elliptic Curve private key on the device filesystem inside the app's sandbox, and this key is encrypted by a second key which is stored in the keystore itself.

On Android 6 and newer devices, the second keystore key is encrypted using AES-256. On older Android 5 devices, RSA-2048 is used.

More information is available from Google:
https://developer.android.com/training/articles/keystore

4 Security Controls

4.1 Mobile Devices

Security, Access Controls, and Isolation are provided by mobile operating systems and hardware.

4.2 Cloud Services

Our cloud services are securely hosted using Amazon Web Services. They are isolated from other Gallagher or external services using an AWS Virtual Private Cloud.

Strict firewall and access control rules are in place protecting all administrative functions and other endpoints.

All administrative users accessing our cloud infrastructure require two-factor authentication and strong passwords.

Services within the cloud environment are only allowed access to the minimum set of resources they require to function (for example: they are only allowed to connect to the specific database / key storage they require and cannot access resources for any other services).

Platform security updates are applied daily as required. We employ automated scanning tools which alert if any third-party software components we use are identified in a vulnerability database such as (but not limited to) the public CVE database.

Regular external penetration tests, system hardening, and audit logging are all in place to provided verification and assurance.