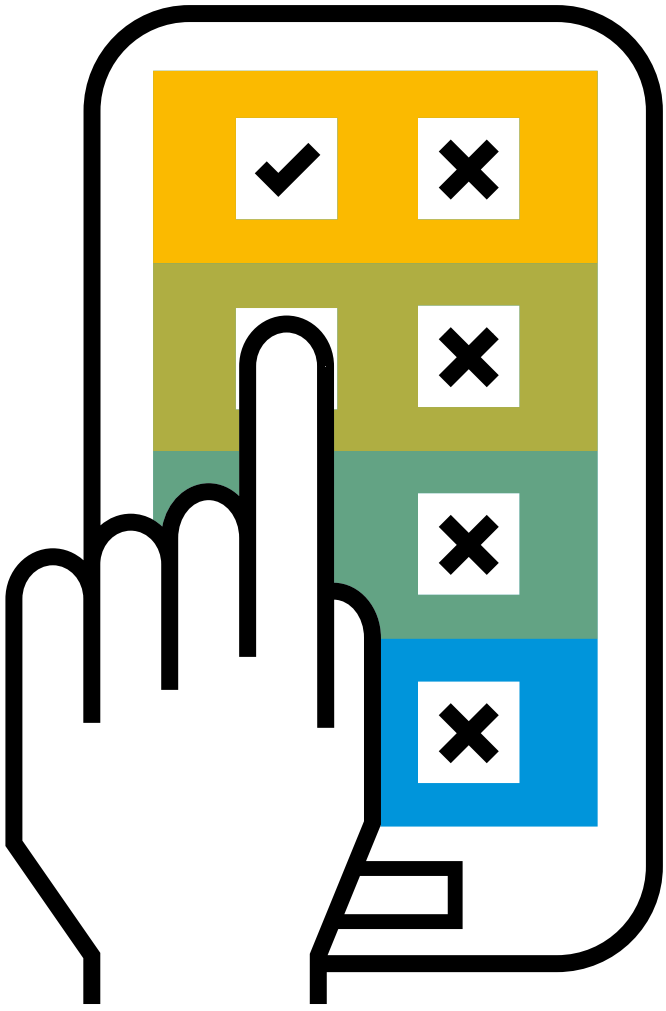
SAP Thought Leadership Paper
SMS and Security

Revisiting Two-Factor Authentication and Security

Examining the Arguments for and Against This Reliable and Pervasive Methodology



For many of the applications that require the extra security that two-factor authentication (2FA) provides, SMS will more than suffice as a delivery channel. Most enterprises and end users can view 2FA over SMS with confidence as a key method of providing security. In this paper we address arguments about the efficacy of this delivery methodology and examine what you should know about 2FA leveraging SMS going forward.

Introduction

Two-factor authentication (2FA) is one of the most effective ways of protecting accounts, and it is widely used across the world. A common and convenient method of deploying 2FA is to deliver tokens (PIN codes, verification codes, one-time passwords [OTPs], and the like) through SMS to the user's mobile device.

In a recent survey performed by the SAP Digital Interconnect group, 75% of the respondents indicated that SMS was their preferred delivery method. Furthermore, 85% of the respondents said they preferred receiving an authentication code on their mobile device to provide additional security with their user ID and password for online transactions.

As an out-of-band delivery channel, SMS is overwhelmingly popular with consumers and is provided by major online shopping sites such as Amazon and eBay as well as banks, social networks, e-mail providers, and many others. The key benefit to SMS is that users don't need to download a specific mobile, code-generator, or authenticator app, which could be viewed as a barrier to 2FA adoption by consumers.

In June 2016, the United States National Institute of Standards and Technology (NIST) published a draft of its Digital Identity Guidelines (NIST SP 800-63-3). Section 5.1.3.2 noted that out-of-band verification through SMS will be deprecated and will not appear in future releases of NIST's guidance. This recommendation was specifically targeted for U.S. government applications; however, in the final version of the document, the deprecation of SMS was ultimately withdrawn.

The NIST proposal raised significant alarm in the United States and elsewhere about 2FA over SMS, evidenced by some attention-grabbing headlines proclaiming that the end of 2FA through SMS was at hand. This sort of exaggerated hype is damaging to 2FA overall. Furthermore, while the NIST recommendations did bring up valid points, we believe that most of them were of debatable value because they represented rare edge cases and, if followed, would have unnecessarily limited use of 2FA – which remains a very good solution that benefits overall security for the majority of situations.

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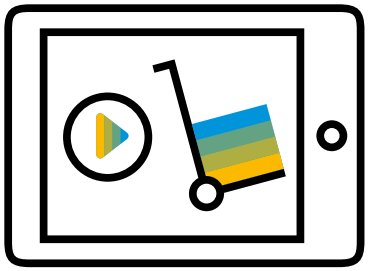

Examining Common Arguments Against 2FA over SMS

Arguments against 2FA over SMS as an out-of-band delivery channel range from SIM swap fraud to issues with encryption to questions about the availability and efficacy of SMS itself. Let's examine a few of these.

INTERCEPTION OF A PHONE NUMBER (SIM SWAP FRAUD)

There have been a number of attacks against mobile phone providers in which the attacker transfers the phone number to a third party. This is called SIM swap fraud (for background, see this UK-operator-centric post). This fraud requires a bit of social engineering by attackers on the mobile operator representatives. These bad actors must convince whomever they are dealing with at the mobile operator that they are, in fact, the owner of the phone number. If this happens, this type of fraud can be serious and difficult to overcome.

Today, solutions vary by country, but most major operators around the world have already put in protections against this type of fraud or are in the process of doing so. For example, in the United States, mobile operator reps ask for a particular security passcode that subscribers have set before any action will be performed on the account through a chat or phone call. This is different from the account password.

While SIM swap fraud does still occur in many markets, it has become more difficult to achieve, as mobile operators are implementing new security procedures and protocols for customer service reps to prevent this type of fraud. For most applications, the potential security issue of delivering 2FA tokens to phones through SMS does not outweigh the benefits and convenience of 2FA over SMS.

Additionally, many providers of SMS-based 2FA solutions are now turning to capabilities by working with mobile operators and mobile-number registry providers that can detect when a SIM change has occurred on a mobile device. If the SIM change was very recent (within the last seven or so days), an alternative method to validate that particular user may be offered to the business that does not leverage the mobile phone number. For this, both the end user and the business are further protected. While these types of SIM-swap detection methods may cost more than simple 2FA through SMS, they can still offer significant protection in cases where the SMS method of delivery of 2FA codes is desired.

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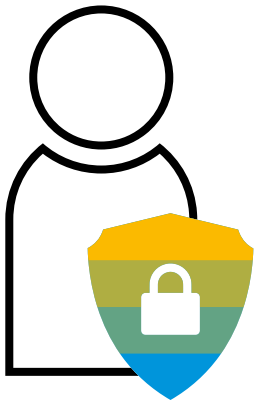

ENCRYPTION QUESTIONS

This issue was originally related to the 2G GSM standard, which uses an over-the-air encryption scheme called **A5/1**. There have been a number of published attacks on A5/1, and it can be decrypted in real or near-real time. It has been said that 2G towers are easy to spoof and the encryption is easy to break, and that most phones will downgrade (from 3G or LTE) without informing the user. The downgrading part is true; however, most actors that can deploy or spoof 2G fake towers are extremely sophisticated, and the cost versus the benefit of doing this to capture 2FA over SMS messages is limited at best. In fact, documents leaked by Edward Snowden in 2013 indicate that the U.S. National Security Agency can process encrypted GSM A5/1. Today, in 2020, 2G and even 3G networks are being sunsetted around the world. Very few places in the world are using 2G as a primary mobile network. Today, it is mostly 4G (for example, LTE), and in many places, 3G is also being phased out. With 3G and LTE, basic services such as voice and SMS employ over-the-air encryption that is much more robust.

While network decryption is certainly possible, it is not practical and definitely is not a reason to rule out 2FA over SMS for most applications.

INTERCEPTION ON THE DEVICE

Some devices may be compromised by malicious apps that can intercept SMS messages and relay the content to bad-actor third parties. In these cases, the user of the device has likely been deceived through some social engineering technique into accessing the malicious app through a nonstandard app store or by downloading unknown or phishing data from an e-mail – both practices that are fraught with peril anyway.

Yes, this can be done; however, in these cases, we need to assume that device owners should maintain some control over what is downloaded to their device. Legitimate Android and Apple app stores actually have very little (known) malware. While it is possible that what appears to be a legitimate app can have malicious capabilities, these cases are rare.

Again, limiting or deprecating 2FA over SMS as a result of these types of situations is significant overkill. With some malware, time-based one-time password (**TOTP**)–compatible authenticator apps may be equally compromised through the use of screen-scraping technology.

Overall, these very technical arguments against SMS are definitely not wrong, but in real-world cases, they relate to situations that are already quite rare and are diminishing in frequency. It is easy to cite SIM fraud or SMS interception as an argument against 2FA over SMS, but even so, two-factor authentication is just that – two factors – the first being a user ID and password (something the user knows) and the second being the delivered verification code through SMS. So unless the bad actors have both factors, the account is still protected.

SMS RELIABILITY AND EFFICACY

Detractors of 2FA over SMS will cite SMS reliability as an argument against using SMS as an out-of-band delivery channel. They will say that 2FA codes should have a short (typically less than 15 minutes) expiration time. We say, the shorter the better, but not so short as to not be useful – a 10- to 15-minute range is quite sufficient.

SMS delivery times are highly dependent on how messages are delivered. While the details are sometimes complex, it is incumbent upon the business that offers 2FA over SMS to use a well-known and respected SMS provider. SMS reliability is absolutely dependent upon how messages are routed from the enterprise entity to the appropriate mobile operator.

Service providers that offer lower-cost or least-cost routing for 2FA traffic (for example, by leveraging the so-called grey routes for SMS) run the risk of having their messages delayed or blocked entirely. SMS delivery providers who employ hundreds or thousands of originating numbers in an attempt to avoid message blocking on behalf of their customer (for example, a bank) are usually trying to get around regulations.

The SMS delivery provider should leverage as many direct mobile-operator connections as possible, using all high-quality routes since many of these 2FA tokens have short expiration times. It is imperative that these SMS messages comply with all regulations and best practices for the country and mobile operator for which they are intended. When they do, the message delivery rate is extremely good and usually occurs within seconds.

To provide better security for 2FA, it is also recommended that businesses using it would use approved short codes or vanity toll-free numbers – essentially vetted and approved sender IDs for their 2FA SMS messages. They should not be using random long codes, which are popular with fraudsters.

Another common argument against SMS for 2FA is that some locations don't have phone reception, either due to their location or because the user is in a different territory with an incompatible phone device or without roaming enabled. Lack of mobile phone reception (such as within some buildings) can be an issue for some people. To overcome those situations, an enterprise deploying 2FA should consider multiple delivery channel options – for example, the 2FA token could be delivered to

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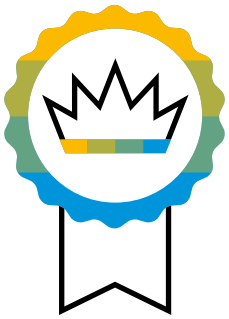


an e-mail address, accessible from a connected laptop. Alternatively, the enterprise could also use validation of tokens generated by a specialized authentication app such as Google Authenticator to support those users who don't have indoor (or even roaming) connectivity. Once again, while these edge cases do exist, they do not amount to a reason to completely abandon 2FA over SMS for the majority of users.

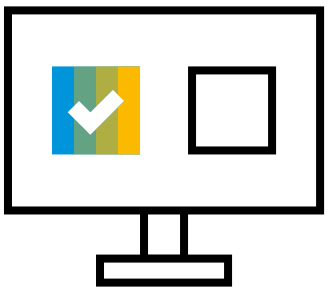
SMS is limited to a single device because it is tied to the user's phone number, while a TOTP app can be used on multiple devices, such as a mobile device and a desktop. This is actually not a bad situation. In today's mobile age, the mobile device is almost always with its owner. The single phone number acts as a true out-of-band address – a good thing for using 2FA with SMS as the delivery channel.

HIGHER LEVELS OF PROTECTION

There are situations in which an enterprise may not want to expose its customers to the risk, however small, of receiving an authorization code through SMS – for example, for high-value financial transactions or access to government or high-security applications or platforms. In these cases, the recommendations put forth in the latest NIST guidelines can certainly be valuable.

For many users, a TOTP-based authentication app (such as Google Authenticator) on their mobile device provides incrementally more security than receiving the authentication or verification code through SMS. TOTP apps are relatively easy to download and use on smartphones and typically do not require a data connection to generate a code. The app must be configured to work with the site or application by the user (or IT department). However, this is typically trivial – and today many TOTP authentication apps offer additional capabilities such as backup and restoration of configurations.

If a user's mobile device is questionable, then high-security options include using separate hardware tokens or deploying three (or more) factors such as biometrics (fingerprint, iris or retina scan, facial recognition, or voiceprint).



In very nearly all situations, 2FA over SMS provides **sufficient security** to protect both enterprises and end users from fraud, with little disruption for the end user.

MESSAGING CHANNELS OTHER THAN SMS

In many parts of the world, it may be beneficial to use an alternative messaging channel, such as WhatsApp or even rich communication services (RCS). These are also typically phone-number based, but both can offer some additional security features directly to the messaging client.

For example, with RCS, a 2FA message may no longer require that the user respond with a code they received from the message. Instead, directly in the message, the user is asked to "Accept" or "Deny" the authentication. Other checks can be made with RCS that go beyond just the phone number, such as reusing an ID that could have been set up when the user's account was set up. A bad actor's phone with a new SIM for the user's phone number would not have the original session ID and, consequently, could be blocked from receiving the RCS message.

Many options exist when using social messaging platforms such as WhatsApp and others to receive 2FA messages. While not as straightforward as SMS, they can offer some additional options for users and even additional security – even though they are phone-number based like SMS.

Summary

For most applications that need the extra security that two-factor authentication provides, SMS as a delivery channel will more than suffice in most situations. While SMS may not be completely secure since the messages are transmitted over mobile networks, this is still a high-security solution. We should note that 2FA tokens generally have a short expiration time – usually no more than a few minutes – and that there are limitations on how many times a user may try to enter a received code before the solution locks the user out for a specific time period.

While no scheme is 100% secure, in very nearly all situations, 2FA over SMS provides sufficient security to protect both enterprises and end users from fraud, with little disruption for the end user. Add to this the fact that it is convenient and does not require any additional downloads or app installations, and you have a solid and practical security solution for most uses. Still, as we move into the 2020s, there are also newer options, such as social messaging apps and RCS, that can offer newer use cases for user validation, as well as better security.

LEARN MORE

The SAP Digital Interconnect group offers global, reliable messaging solutions using SAP® SMS 365, enterprise service, as our messaging hub. The SAP Authentication 365 mobile service is an end-to-end, portable, and configurable 2FA solution for multiple channels including SMS, WhatsApp, e-mail, URL validation via SMS and WhatsApp, and more. SAP Authentication 365 provides:

- **Integrated connectivity to SAP SMS 365, enterprise service, and the SAP Social Channels 365 mobile service, as well as our e-mail solutions**
- **Connection with more than 1,000 mobile network operators through a single, standard interface reaching 7.3 billion subscribers, or nearly 99%**
- **Validation of codes from TOTP-based mobile apps such as Google Authenticator and many others**
- **Accurate and fast message routing using our advanced number resolution system to correctly identify the destination mobile network operator**
- **High-priority messaging delivery solutions to ensure fast delivery of 2FA/OTP messages**
- **Highest-quality approved routes for delivery of all messaging, including 2FA/OTP messages**
- **Multiple configurability options for 2FA tokens, as well as a comprehensive administrative and analytics user interface**
- **Simple, secure APIs for easy integration of 2FA capabilities into existing workflows**

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