BEREAL

INTRODUCTION

Released in 2020, BeReal is an up-and-coming social media app that has gained a large user base of over 10 million daily users [1]. It has a unique format whereby users are only able to post once a day, and view posts from that day. Posts consist of a photo from both front and back cameras, taken immediately on the app without a viewfinder or any filters or edits. Consequently, the app is only available on smartphones. Each day, users are notified to post at a random time, meaning you always see a different part of your friends' day. For someone to be able to view other posts, they must first post themselves. You can post at any time of day, but if you don't post within 2 minutes of the notification, your post will be displayed as late to other users. While this may all sound like an inconvenience for the user, it's all in an attempt to create a more devoted user base and increase user retention. Being unable to post photos from your camera roll forces you to be more authentic and personal, making users feel more connected with others as they get to see a raw, unedited snapshot of their day. Not being able to view your friends' posts until you post keeps you coming back to post every day.

The app was developed by Alexis Barreyat, who previously worked for GoPro, and Kevin Perreau [2]. They utilised many concepts during the development of BeReal, including:

- Compression
- Abstraction
- States
- Modularity
- Networks
- Encryption
- Databases

COMPRESSION

In computer science, compression is used to reduce the size of files while keeping as much if not all the information of the original. One of the earliest uses of compression was in telephones, where Adaptive differential pulse-code modulation (ADPCM) was developed at Bell Labs in 1973[5]. Transmitting or storing large files can impose a significant burden on networks and servers, especially when dealing with numerous clients. To mitigate this, applications commonly use compression to reduce file sizes before transfer or storage. Compression falls into two categories: lossless and lossy. Lossless removes only completely redundant data without the expense of quality, while lossy removes as much data as needed. When dealing with images, videos and audio, lossy is often used as it is usually quite hard to discern any degradation of the original. With text-based files, lossless is the only form of compression that is used. This is because lossy would remove integral information, such as the letters of a word. Lossless is also used with other types of files when we wish to keep all the data of the original file. Many file formats utilise compression, including JPEG for lossy images and PNG for lossless images, H.264 for lossy videos and FLAC for lossless audio.

Images taken on a phone vary in size as they have different resolution cameras but are usually around 1MB to 8MB. For each BeReal post, two photos are taken meaning their servers are expected to handle over 20 million images per day. Compression is used not only to reduce stress on the servers but to also decrease loading

times. As the app is exclusively used on mobile devices, users expect it to be responsive even when using mobile data. BeReal most likely uses a form of lossy compression as phones have smaller screens and users are unlikely to notice any difference in image quality. Their servers may send different-sized images depending on the size of the client device and its connection speed to keep things running smoothly.

ABSTRACTION

Computers are highly intricate systems, and it can be hard to understand what they are doing. However, people have been designing and using them for decades, and because of this, it has never been easier to utilise technology. Abstraction is the concept of simplifying these complex systems by masking their fine details so we may focus on the larger details with ease. There is abstraction at multiple levels, at the fundamental level computers process everything as binary, whether it's text, images, video or audio, it all comes down to ones and zeroes. When we create applications, we're not telling the computer what to do directly. We instead use programming languages to write scripts which are then compiled into machine code, instructions composed of binary that the CPU can understand. In recent times these programming languages have been abstracted further with the use of

When a user opens up BeReal, they expect to be able to share and view posts easily. The application uses abstraction to simplify this process for the user. Instead of having to manually take each photo and send it to all their friends, users can share what they're doing with a single tap. Several abstractions happen behind the scenes that enable this, such as connecting to BeReal's servers, retrieving posts, decoding the image and text files and displaying them on the screen. There are then many abstractions that the developers themselves have benefited from, including the Transmission Control Protocol (TCP) which allows data to be sent from the server to the user's device reliably, file formats which allow raw data, binary ones and zeroes, to be interpreted as images and text as well as device drivers that enable images and text to be drawn to the screen.

STATES

A state is a specific configuration or condition of a computer program that affects its response to input, the most basic example of this is the power state of a computer. A computer can either be off or on, if off the computer won't do anything despite any input you give it, however, if it's on it will do a lot. Another example is the read state of a message, if a message hasn't been read the recipient will see a notification of the message and sometimes a glyph or number of unread messages on the app icon. Once the message has been read these disappear and the sender may be able to see a read receipt. Applications often have many states and can be in any number of them at a given time. They switch between them depending on preceding events, either due to the user's actions, such as completing an action, or other aspects such as time or network connection. The application can store its state in the form of a file or variable as well as all possible states, this is called a state space [4]. These states affect the behaviour of the application such as what it allows the user to do or what information it displays.

BeReal has two main states, one is before the user has posted and the other is after they have posted. Before the user has posted they will only be able to view a blurred thumbnail of their friends' posts and are unable to interact with them in any way. They can still, however, add or remove friends, view their previous posts and change settings. After they have posted they will be able to view their friends' posts as well as send reactions and comments on them. These posts are also saved locally in case of network failure. Once a user has posted, they can also view featured posts from anyone in the world in the Discovery section. These posts are not saved meaning in the disconnected state only saved friends' posts are visible. This is an example of a state that is not caused by the user's actions.

MODULARITY

Modularity is the concept of splitting a complex system into separate parts, or modules, each with its own specialised function. For example, a computer can be seen as a system of individual components, such as the CPU, GPU, RAM, etc. On their own, these components do very little but are all required to create a complete, functioning system. Each function of an application can be split into separate modules which link together and contain everything required to perform these functions individually. This allows us to build large complex applications out of smaller, more manageable pieces of software. Developers often reuse pre-existing modules whether they're open-source or proprietary to a certain application or hardware. A module can be anything from a basic device driver to a large library such as p5.js which enables a lot of functionality and simplifies the development process of applications.

BeReal uses lots of modules for their functionality, such as device drivers allowing the app's basic functionality. There are two major operating systems which smartphones run, iOS and Android. Supporting just these two OSes allows BeReal to reach approximately 99.4% of the smartphone market share[3]. Within these OSes will be device drivers that enable the functionality of the device's components such as its screen and cameras. The app itself is also made up of modules such as the login system, creating new posts and the Memories function where users can view their previous posts. For each of these large modules, there will be smaller modules within them which solve a very specific problem, like sending a request to the server. These are also used across several different modules. Breaking down a problem into smaller, more manageable, sub-problems reduces the complexity of the problem and allows us to focus on one at a time. It's very important that these modules then work together effectively as they are all required for the final system to work.

Building the app out of several modules allows the developers to easily deploy new features, identify bugs and implement improvements quickly, without having to change the entire codebase.

NETWORKS

Computers communicate with each other via networks of which there are two main types; Local Area Networks and Wide Area Networks. LANs are smaller geographically usually covering one building or site while WANs are larger and can. The most common example of a LAN is a home WiFi network where all devices are connected via a single router. WANs are much larger geographically, connecting several LANs and servers, the internet itself is considered a WAN. Each device or node must communicate according to strict protocols for the network to work effectively. In your home, each device connected wirelessly will use some variation of the IEEE 802.11 protocol to communicate with the router. There are also protocols for applications, such as the Simple Mail Transfer Protocol (SMTP), allowing emails to be easily transmitted between servers.

BeReal utilises networks to send and receive posts from users' devices to their servers. This is an example of a server-client network as each user's device communicates only with BeReals servers, and not other clients like peer-to-peer applications do. This increases security as users don't have to connect directly to other users, exposing their IP address to potential hackers. This also increases stability and reliability as it doesn't require all users to be connected to the internet at all times for file transfer to work, if BeReal used peer-to-peer networking when a user opened the app, they would only be able to see posts from friends who are currently

online. The major protocols they use come under the Internet Protocol suite. This consists of four layers: Application, Transport, Network, and Link. Each of these layers uses one or more protocols, the LInk layer uses the IEEE 802.11 protocol, Network uses either IPv4 or IPv6, Transport uses TCP and the Application layer uses HTTP, TLS and DNS. When the user opens the app, a request is sent to BeReal's servers, including data about the user and authentication. The server will send back their friends' posts if the user has posted.

ENCRYPTION

Encryption is the process of encoding data to protect its information. One of the earliest and most basic examples of encryption is the Caesar Cipher in which each letter of a piece of text is replaced with a letter further down the alphabet of a fixed amount. The recipient would be able to decode this text provided they know the shift amount. Due to the structure of the internet, when our devices communicate with servers, data is sent between several routers. Because of this encryption is used when sending sensitive information such as passwords or bank details. Today, most client-server applications use the Transport Layer Security (TLS) protocol to encrypt data including websites, which use the Hyper Text Transfer Protocol Secure (HTTPS). TLS uses two main types of encryption algorithms, asymmetric-key and symmetric-key. With asymmetric-key algorithms, there is a public-private key pair, where the public key is used to encrypt the data and the private key is required to decrypt it. Whereas symmetric-key algorithms use the same private keys for the encryption and decryption of data. There is sometimes a mathematical transformation to distinguish the two keys but they can also be completely identical as these keys represent a shared secret between the client and server.

Whenever a user opens up BeReal, a secure connection is made to the servers using the TLS protocol, starting with a 'handshake'. Firstly, the client sends the server a list of supported cypher suites or encryption algorithms. The server then picks one and sends its decision back to the client. A digital certificate is also sent to confirm the authenticity of the server. Finally, the client generates the session keys using either the Diffie–Hellman key exchange. This secure connection is essential for keeping the user's sensitive information safe, such as login information and means that only the user can access and post from their account.

DATABASES

A database is a structured collection of data that allows us to store and retrieve information efficiently and effectively. Databases often store vast amounts of data making them an integral part of modern applications. Businesses rely on large databases to process analytics, financial records, user preferences and much more. Databases consist of rows and columns to form one or more tables, where each row is a single entity or record, and each column is a variable or attribute of that entity. This simple structure ensures data can be easily stored and retrieved safely and also manipulated such as filtering and sorting by column. We use a Database Management System Software (DBMS), to simplify the process of creating and managing databases. Instead of accessing and writing to the database directly, we send requests to the DBMS which does this for us. This makes it easier for applications to use the database as no extra code is required to read and write data to the database. Separating the database from the user or program also increases security and data integrity.

While BeReal doesn't publically say how they use databases, we can assume that the data they collect, as declared in their privacy statement[6], is stored in a large secure database. This data will be accessed across several servers and programs for example, 'Content Data' which includes comments on a post, will be added to the database from different servers depending on the user's location. Another example is 'Account Creation Data', where the user's phone number is used to connect users with others they might know but also to for the sign-in process. To handle all this, BeReal might use MySQL which is a very popular open-source DBPS. While MySQL is free and secure and is supported on many systems, it lacks some features that proprietary options such as Microsoft SQL have.

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